

Swedish inventions and discoveries

The Celsius thermometer, dynamite, the GP&C system and Losec stomach medicine – Swedish inventions all. And they are just some of many that laid the foundation for modern Sweden's welfare and status as a leading industrialised nation.

Historical inventions and discoveries

Sweden's natural science revolution took place in the 18th century. Until then, technical progress had come mainly from immigrants arriving in the 16th and 17th centuries. Skilled artisans and traders came from Germany, Scotland, Holland, France and Belgium, paving the way for the coming developments.

1739 is seen as the birth of Swedish natural sciences. In that year, the Royal Sciences Academy was founded.

Scientists of the time were often polymaths and contributed strongly to technical and natural science developments.

- *Olof Rudbeck the Elder* (1630–1702) was

a university dean, natural scientist, archaeologist and more. In 1652 he discovered the lymphatic system. He also built bridges, constructed water mains and taught in many subjects, including mathematics, astronomy and the art of construction.

- *Christopher Polhem* (1661–1751) was both inventor and industrialist. His major field was mining technology and he improved the system for extracting iron ore from mines.
- *Anders Celsius* (1701–44) was an astronomer and mathematician most famous for the 100-point thermometer scale, widely used across the world.
- *Carl von Linné or Linnaeus* (1707–78) is most famous for his classification of



Wonder and curiosity – beginning a future inventor's career. Foto: © Tom Titt/ Gustav Frisk

Published by the Swedish Institute
January 2007 FS 91 e

More fact sheets can be found on
www.sweden.se

Si.
Swedish Institute

A potato campaigner enters the Academy

Every Swede knows that the potato was introduced to Sweden by Jonas Alströmer in the mid-18th century.

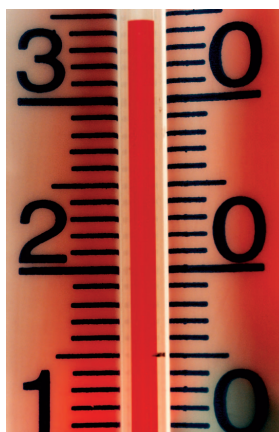
Far fewer know about the woman called Eva Ekeblad (1724–1786) who showed Swedes how to make best use of it.

In 1748 she wrote an academic paper: "Attempts to produce bread, brännvin, starch and powder from the potato". Her scientific arguments and accompanying samples were so convincing that she was voted into Sweden's Royal Scientific Academy. She was the only woman, just 24 and already a mother of five. (She married at 16.) Her motivations were practical and social: she saw that large volumes of wheat were being used for drink, wheat that otherwise could have made bread. Potatoes were better suited for the purpose, she said. It sounds strange today that potatoes were used to make powder. But at the time, fashion demanded powder for the face and on wigs, and Eva Ekeblad showed that potatoes could produce flour to compete with the expensive and sometimes unhealthy imported powders.

Eva Ekeblad was an aristocrat – her maiden name was de la Gardie – so she enjoyed far greater liberties than most other women of the time. But she showed the Academy great modesty and wrote in gratitude that she felt unworthy and begged forgiveness for her "lack of education".



Ericsson Mobile



100-point thermometer scale



Tetra Pak

plants and animals using the so-called sexual system. The system was used until evolution theory and genetic engineering took over in the modern era. In his major work, *Systema naturae*, Linnaeus described his categorization of the natural kingdom.

- *Carl Wilhelm Scheele* (1742–86) discovered several elements. His discovery of oxygen is, however, disputed since Englishman *Joseph Priestley* was first to publish the same discovery.
- *Jöns Jacob Berzelius* (1779–1848) created the first table of atomic masses in 1818. He also introduced the modern chemical vocabulary by denoting the elements using one or two letters from their Latin names.
- *Anders Jonas Ångström* (1814–74) laid the foundation for modern spectroscopy. He introduced a unit of length – one ten-millionth of a millimetre – named the angstrom in his honour.

Inventions from the time of Sweden's industrialisation

From the 1870s, the Swedish engineering

industry enjoyed a period of expansion unmatched in the country's history. Engineering companies were hugely successful and the inventors – the engineers – became heroes of the age. Many names are still nationally and internationally familiar.

- *Nils Gustaf Dalén* (1869–1937) was CEO of AGA (AB Gasaccumulator). His most important inventions were for lighthouses and beacons. The AGA lighthouse was used around the world for most of the 20th century. In 1912 Dalén received the Nobel Prize for Physics.
- *Gustaf de Laval's* (1845–1913) most famous invention was the milk-cream separator. In 1883 he and others founded AB Separator (later Alva Laval).
- *John Ericsson's* (1803–89) most important inventions were of ship propellers. Ericsson became widely famous when he built the "Monitor" an armoured battleship that in 1862 triumphed over the Confederate States' "Merrimac" in an American Civil War sea battle.
- *Lars Magnus Ericsson* (1846–1926)

started his telephony company L.M.

Ericsson in 1876. Ericsson made a number of improvements on contemporary telephones, built exchanges and constructed a telephone network. In 1885 he invented the telephone handset.

- *Johan Petter Johansson* (1853–1943) built and patented the adjustable spanner in 1892. He founded the company later called Bahco. Spanners are still produced by Sandvik Bahco.
- *Gustaf Erik Pasch* (1788–1862), *Johan Edvard Lundström* (1815–88) and *Alexander Lagerman* (1836–1904) laid the foundations for the Swedish match industry. In 1844, Pasch patented the safety match, where dangerous yellow phosphorous was replaced by red phosphorous.
- *Alfred Nobel* (1833–96) invented dynamite in 1866. He founded 90 companies in 20 countries. When he died, Nobel owned 355 patents and a fortune approximating €160m in today's currency. In his will, he set up the Nobel Prizes in physics, chemistry, medicine/physiology, literature

Tetra Pak's men – and woman

The development of the Tetra Pak came from dedicated teamwork. A young chemist, Erik Wallenberg, an engineer, Harry Järund and a sales manager, Erik Torudd, succeeded after hard work and much experimentation in inventing a totally new milk package: the Tetraedern. It was made from a long paper cylinder, lined on the inside with plastic. The cylinder was twisted one way at one end, another way at the other, to form a small paper pyramid. The pyramid was sealed and sliced off.

The three men worked for Åkerlund & Rausing. The original idea is actually credited to the company owner, Ruben Rausing. He was not an inventor but an economist and industrialist. And dead set on being first to produce a paper milk packet.

The prototype was ready by 1944. Eight years later, the first packaging machine was installed at Rausing's factory in Lund.

Those four men were behind the Tetra Pak phenomenon. But there was also a woman: Rausing's wife Elisabeth (1894–1946). History gives Elisabeth Rausing credit for solving the problem of filling the tetra. She suggested a method based on how she stuffed sausages. It worked. Milk was filled from the top and each tetra was snipped off a bit below the liquid level. No air entered and the milk remained bacteria-free. This kept the perishable milk fresh for days at room temperature, revolutionising milk handling.

From loser to world-beater

Stomach ulcer drug Losec® could easily have disappeared as a real loser. But it became a world-beater. All because of stubbornness. Even though pharmaceuticals giant Astra repeatedly tried to shut his stomach ulcer project down, research chief Ivan Östholm got what he wanted. After 20 years of toil and manoeuvring, his stomach ulcer medicine was finally launched in 1988. It was called Losec, an abbreviated form of LOw SECreTion.

It all began in the mid-1960s at pharmaceuticals company Hässle, then an Astra subsidiary. Ivan Östholm had gathered a small circle of researchers to search for a new type of stomach ulcer medicine. They also had advice and support from Arvid Carlsson, who many years later, in 2000, would win a Nobel Prize in medicine for his discoveries regarding the naturally occurring substance dopamine.

Östholm's group developed a medicine, Omeprazol, that restrained the stomach's own production of hydrochloric acid. Unfortunately, there were bad side effects on rats and the project looked doomed. But the research group succeeded in proving that Omeprazol was harmless for people and in the end Astra ventured on introducing the new stomach ulcer drug.

Losec was a huge hit, medically and commercially. It cures fast – many patients are symptom-free after only a couple of days. And for a long time it was the world's top-selling medicine. Its successor, Nexium, is a more effective development of Losec but does not have the same strong market position.

and peace. The first prizes were awarded in 1901.

- *Sven Wingquist* (1876–1953) invented the spherical bearing in 1907. He founded a global company, SKF (AB Svenska Kullagerfabriken), still the world's leading producer of industrial bearings.
- *Jonas Wenström* (1855–93) invented the electrical three-phase system. He and Nikola Tesla are celebrated as the fathers of three-phased alternating current (a court ruled that Wenström was first). His inventions provided the basis for ASEA, today a part of ABB.

Recent Swedish inventions

Recent inventions are defined as those emerging later than 1944. The engineering

industry is still the major source but medicine/pharmaceuticals, electronics and other high-tech industries are gaining ground. Recent inventions are often born through teamwork, although the original ideas may stem from individuals.

Technical inventions

- *Tetra Pak* (1951) is an invention for storing, packaging and distributing liquid foodstuffs, for example, milk and juice. *Erik Wallenberg* (1915–99) was the main inventor, while businessman *Ruben Rausing* (1895–1983) developed and produced it. (See box). Several new package types have been added. The most ubiquitous is the *Tetra Brik* (1969).
- *The transmission of high voltage direct*

current, HVDC, is a method developed at ASEA (now ABB) under *Uno Lamm* (1904–89). ABB remains one of the leading makers of HVDC technology, now also used for terrain cable.

- In 1961 *Per Oscar Persson* and *Göran Lundahl* at Frigo Scandia Equipment developed *Flofreeze*, a process for flash-freezing vegetables in liquid nitrogen.
- The *AXE system* is a fully electronic telephony system using computer-controlled telephone exchanges. It was developed through a collaboration between Telia (then Televerket), Ericsson and their joint development company, Ellemtel AB. *Bengt Gunnar Magnusson* (1925–95) was project manager and inspirer. Today, Ericsson has the world's most widespread telephony system, incorporating AXE exchanges, base radio stations, mobile telephones and network services. The Ericsson Radio Systems group behind these technologies was led by *Ake Lundquist*.
- In 1979 *Sven Torbjörn Lagerwall* discovered *ferroelectric liquid crystals* in collaboration with Noel Clark. The technology allows the building of flat-screen monitors. Mass production began in 1994 by Canon, who bought the licence.
- *Håkan Lans* is recognised as one of Sweden's most outstanding inventors. Among his inventions is the digitizer, the predecessor of the computer mouse. He is also credited with the further development of the satellite-guided Global Positioning System (GPS) into the *GP&C Total System*. Lans's system has become world standard for shipping and civil aviation.
- In the 1990s, an ABB team under *Mats Leijon* developed a new generator, the *Power Former*, producing high-tension current directly to the network without transformer links.



Nexium

Medical inventions¹

Behind local anaesthetic *Xylocain*[®] are *Dr. Nils Löfgren* (1915–67) and *Dr. Bengt Lundqvist* (1906–52). The pharmaceutical company Astra took over development work and launched the product in 1948.

- *Arne Tiselius* (1902–71) used *electrophoresis* in the 1940s to analyse various proteins. Tiselius's work has been followed by other similar methods. All are important for medical and biological research. Tiselius received the Nobel Prize for chemistry in 1948.

- In the 1940s *Arvid Wretling* tried to achieve completely *intravenous feeding* for patients unable to eat normally. Wretling's work resulted in *Intralipid*[®], a preparation launched in 1962.

- *Osseointegration* is an early-1950s invention by *Per-Ingvar Brånemark*. It builds on the permanent acceptance of titanium by the human body. The invention's main application is in the *Brånemark System*[®] for tooth implants but it is also gaining ground in other types of surgery.

- In 1950 *Hellmuth Hertz* (1920–90) started the research into *ultra sound* for medical examinations that would make him world-famous. Together with *Dr. Inge Edler Hertz* developed electrocardiography, a bloodless method of examining the heart.

- In 1958, *Rune Elmqvist* developed a small *battery-powered pacemaker* that can be inserted under the skin of a heart patient. It produces electrical impulses that help the heart muscle work normally. In the same year, *Åke Senning* at the Karolinska Hospital in Stockholm carried out the world's first pacemaker operation.

- In 1968, *Lars Leksell* (1907–86) invented a *laser knife* for brain surgery. The 'knife' uses concentrated gamma radiation on the tumour or malformation. The method is bloodless and patients can often leave hospital on the day of the operation.

Did you know that...

- In 1885, Stockholm had the world's highest density of telephones, both in number of apparatuses and in telephones per inhabitant.
- Volvo, Sweden's largest car maker, was founded in 1915 as an early spin-off from bearings company SKF.
- Nils Bohlin's three-point seat belt, launched as early as 1959, saves a life every sixth minute and is recognised as one of the most important car-safety innovations.

- In the 1960s, Swedish pharmaceutical companies developed various kinds of so-called *beta blockers*. Among the most important are *Aptin*[®] (1965), a medicine to treat angina pectoris and irregular heart activity, the asthma medicine *Bricanyl*[®] (1966) and *Seloken*[®] (1970), a selective beta blocker that lowers blood pressure.

- *Losec*[®] is a stomach ulcer medicine that prevents certain cells in the stomach from producing hydrochloric acid. *Losec* is made and marketed by Astra Zeneca and was developed by its subsidiary AB Hässle. In the 1990s, *Losec* was the world's best-selling medicine. Its successor, *Nexium*, is even more effective but has more competitors. (See box).

- The *Turbuhaler* was developed by *Kjell Wetterlin* at Astra Draco. It is an inhalator for asthma medicine. The patient's own inhalation regulates the dosage.

Read more

Kjell Sedig: *Swedish Innovations*. Stockholm: Swedish Institute, 2006

Useful links

Vinnova (Governmental Agency for Innovation Systems) is a state authority specialising in innovations connected with

research and development – that is: pioneering, successful products, services or processes with a scientific base.

www.vinnova.se

The Swedish Inventors' Association

(SUF) is the world's oldest of its kind, founded in 1886 by the famous Polar explorer and patent engineer, Salomon August Andrée. Its mandate is to support inventors and inventions. The association has a division called **QUIS**, a network for the association's women members.

www.uppfinnareforeningen.se

Tekniska Museet (National Museum of Science and Technology) in Stockholm

is Sweden's biggest technical museum. A current exhibition shows inventions by women. About 50 women are showcased, both inventors active today and figures from history.

www.tekniskamuseet.se

Tom Tit's Experiment in Södertälje is Sweden's first and now largest independent experiment workshop for children and youth.

www.tomtit.se

Other experiment workshops:

Universeum in Gothenburg

www.universeum.se

Framtidsmuseet (The Future Museum) in Borlänge

www.framtidsmuseet.se

Kunskapsstivolit in Malmö

www.malmo.se/kultur/malmomuseer/artiklar/kunskapsstivolit.4.33aee30d103b8f15916800077409.html

Teknikens Hus in Luleå

www.teknikenshus.se

¹ All medicines are given their Swedish names.

Do you have any comments on this SI publication? Feel free to contact us at info@sweden.se.

This text is published by the Swedish Institute and can be found on www.sweden.se. It may not be reused without prior consent from the Swedish Institute. To obtain permission to use the text, please contact: webmaster@sweden.se. Photos or illustrations may not be used in other contexts.

The Swedish Institute (SI) is a public agency established to disseminate knowledge about Sweden abroad. It produces a wide range of publications, in several languages, on many aspects of Swedish society. For further information: www.si.se, www.swedenbookshop.com.

Further information about Sweden: www.sweden.se (Sweden's official Internet portal) or the Swedish embassy or consulate in your country. Swedish Institute, Box 7434, SE-103 91 Stockholm, Sweden. Office: Skeppsbron 2, Stockholm. Phone: +46 8 453 78 00. E-mail: si@si.se. Web: www.si.se

SI.

Swedish Institute