Article

So Who Was Nobel Anyway?*

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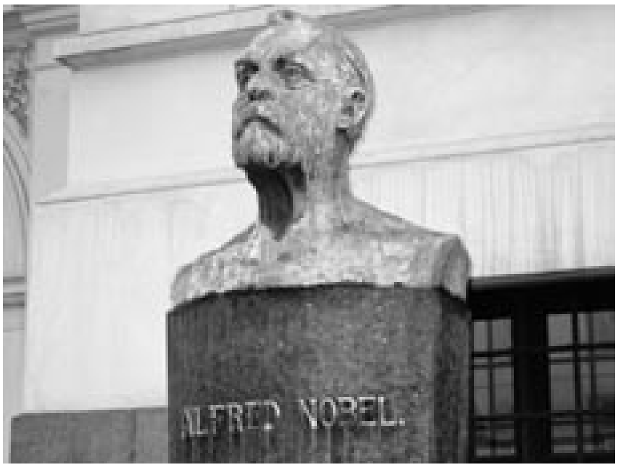
*Dedicated to Drs. Ron Easthope, Phil Matsis and Mark Simmonds with appreciation for their care, consideration, and intervention for almost a quarter of a century.



Alfred Nobel statue, Oslo © 2005, 2006, 2007 by Bjørn Erik Pedersen (public domain image from *http://commons.wikimedia.org/wiki/Image:Alfred_nobel_statue_oslo.jpg*).

Ask anyone who ***Nobel*** was and you will get a reply that gives either *someone involved with explosives* or *the man behind the Prizes*, or both. Correct of course, but there is much more to Alfred Nobel than any such simple statement could imply. With the 2007 Prizes about to be announced, a brief synopsis of this most amazing of men seemed appropriate.

Alfred Bernhard Nobel was born in Stockholm on October 21st 1833, the third of four sons to Immanuel and Andrietta (Ahlsell). His father (1801-72) was a man of genius – an inventor, building constructor and contractor – who built bridges and houses in Stockholm. Financial misfortune, including a disastrous fire and the loss of three barges carrying building supplies for a bridge he was building, led to bankruptcy in the year Alfred was born. In order to escape Swedish jurisdiction (apparently imprisonment) he moved to the then Russian controlled Finland in 1837 leaving his wife and sons behind.[1,2] It was five years before they were able to join him, now in St. Petersburg, where he had established a mechanical workshop providing equipment for the Russian army; he was a pioneer in arms manufacture and steam engine design but with interests in explosives. He persuaded Tsar Nicholas I and his Generals to a belief in the naval mines that he had developed. These comprised wooden casks filled with gunpowder and they were deployed below the surface of the Gulf of Finland in the Crimean War (1853-56); they are credited with saving St. Petersburg from attack by the British Navy. Immanuel was awarded the Imperial Gold medal by the Tsar in 1863 despite being a foreigner.

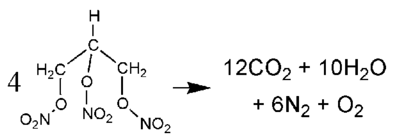
Alfred received but cursory formal education in Sweden prior to his moving to Russia when he was eight years old; it comprised a mere three terms of primary education at the parish school. However, during his Russian sojourn, his father had his sons under the tutelage of private teachers with training in languages, literature and the natural sciences. By 17 Alfred was fluent in Swedish, Russian, German, French, and English, and held interests in chemistry, physics, English literature and poetry. But his father thought him something of an introvert and sent him overseas in 1850 (Sweden, Germany, France, USA). In 1852 he was asked to return to Russia as the family business was in strong heart from its military patronage. However, the subsequent end of the Crimean war led to cancelled orders and Nobel and his father had to seek new products.[1,2]

Clockwise from top: Robert, Ludwig, Alfred and baby Emil Nobel in St. Petersburg, *ca*. 1843 (public domain image from: http://commons.wikimedia.org/wiki/Image:Nobel_3.jpg)

While in Paris, Alfred worked in the laboratory of Jules Pelouze (Zinin, his Russian chemistry tutor was a former Pelouze pupil), gaining an interest in nitrated organics. Pelouze was the first to isolate nitrocellulose (1837) and another of his pupils, Italian Ascanio Sobrero, was the 1847 discoverer of *piroglycerin* (nitroglycerine - NG, **1**) from slow addition of glycerine to nitric and sulfuric acids. In one experiment, he and his laboratory colleagues were injured in the ensuing explosion. Because of this he refused to exploit his discovery further. Indeed, NG could explode (Scheme 1) at any time if handled carelessly or when impure from nitric and nitrous acid contaminants, thus making it more than difficult to work with. It was not until he was encouraged by Zinin that Alfred Nobel began experiments with NG as an explosive in construction work, and in these he was ably assisted by his father. Nonetheless, the death of Tsar Nicholas I in1855, the end of the war, and a change in government resulted in promises of trade being ignored and the workshop became bankrupted. Immanuel returned to Stockholm with his wife and youngest son Emil in 1859, broken and almost as poor as when he had left.

$$2KNO_3 + 3C + S \longrightarrow 3CO_2 + K_2S + N_2$$

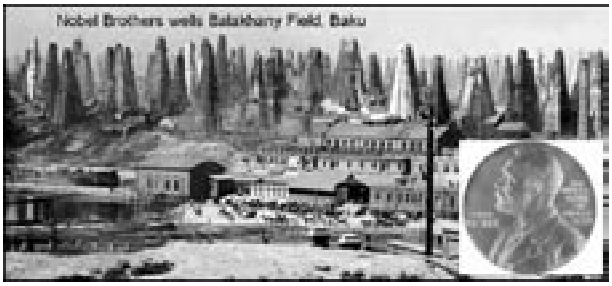
gunpowder



1, nitroglycerine
$C_3H_5N_3O_9$

Scheme 1. Gunpowder and nitroglycerine decompositions

Alfred remained in St. Petersburg staying in an apartment with his brothers [who subsequently established the *Branobel* (Brothers Nobel) oil company in Baku (Azerbaijan) in 1876 and started distilling oil on a 24-hour basis on an idea proposed by Dmitry Mendeleyev (during the late 19th century it became one of the largest oil companies in the world)]. He turned the kitchen into a laboratory and began the search for a ***safe*** way to manufacture NG on a large scale. He tamed the chemical to detonate at will, while simultaneously exploiting its power. Thus, a firmly stoppered glass tube placed inside a metal tube packed with black powder (the original gunpowder and almost the only known propellant and explosive until the mid-1800s) when ignited with a fuse and tossed into a waterway caused a notable underwater explosion.



Branobel wells, Baku (public domain image from the archive of Hazar Nesimi: http://en.wikipedia.org/wiki/Image:Oil_Nobel.jpg)

Rejoining his family in Sweden in 1863, Alfred continued work with NG and repeated the St. Petersburg experiments. He and his father had obtained a loan that allowed pursuit of their NG interests and they began manufacture at Heleneborg on the southern outskirts of Stockholm. Here, Alfred reversed the packing order by placing a small tube of gunpowder with its fuse attached into a tube of liquid NG. The results were excellent as explosion of the primary charge triggered the NG detonation and released the full power of the *blasting oil*. The initial device was simple and comprised a small wooden cylinder about 5 cm in length that contained a sealed charge of gunpowder with an attached fuse. The *Patent Detonator* was thus invented and it became the most important of Nobel's invention as it revolutionized the use of explosives. Refinements soon had the gunpowder replaced by mercury fulminate (**2**, Scheme 2)[3] in a copper tube and this *blasting cap* was patented in 1865.[4] Detonation of the fulminate triggered a shock-wave that, in-turn, detonated the NG.

$$Hg(CNO)_2 \longrightarrow 2CO + N_2 + Hg$$

2, mercury fulminate

Scheme 2. Mercury fulminate decomposition

On September 3rd in 1864 the Heleneborg plant suffered a major explosion that was heard throughout Stockholm. It demolished the workshop and six people died, including Alfred's 20-year old younger brother, Emil.[5] The accident has been attributed to Emil himself and had a dramatic impact on his father who never really recovered. The subsequent enquiry led to the first regulations on NG and these prohibited manufacture in residential areas of the city. Despite this, and the impact that it had on him, Alfred continued his work, at first on a barge moored in the middle of Lake Mälaren, a lake that flows to the Baltic Sea and past Stockholm at its outlet. Business prospered and an NG manufacturing plant was built at Vinterviken (Winter Bay), just outside Stockholm. Within a short time other plants were built in Germany, Norway and the USA as the use for the (NG) blasting oil in mining and construction work grew significantly. A further explosion in 1866 destroyed the Krümmel plant in Germany.

United States Patent Office.

ALFRED NOBEL, OF HAMBURG, GERMANY, ASSIGNOR TO JULIUS BANDMANN, OF SAN FRANCISCO, CALIFORNIA.

IMPROVED EXPLOSIVE COMPOUND.

Frontispiece of Nobel's 1868 US Patent 78317 taken from ref. 6.

Nobel was more than aware that the problems with NG lay in its transport and he had been conducting experiments to find a method of stabilizing the liquid. While working on a raft on the river Elbe outside Hamburg,[2] he found that the diatomaceous earth, kieselguhr, could absorb up to four times its own weight of NG giving a red powder that was safe to handle. Not only this, but it could be detonated with the mercury fulminate blasting cap and give the same force of explosion as liquid NG. Dynamite was born. It was patented in Sweden in 1867 and in the USA in 1868 as *Improved Explosive Compound*.[6] This invention is second only to his blasting cap.

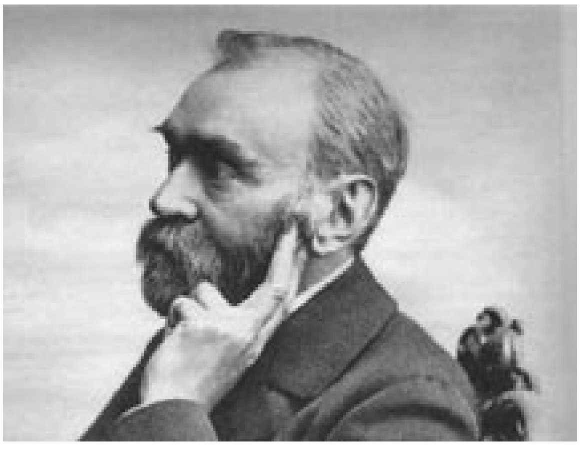
Replacement of the diatomaceous earth by nitrocellulose (guncotton or collodion and known from 1846) led to blasting gelatin or gelignite whose properties can be varied according to need; it was a favourite of the IRA in the not too distant past. By increasing the amount of NG to *equal* that of the nitrocellulose, Nobel obtained a material that was capable of being heated between rollers and pressed to a brick-like substance that could be pulverised. This was patented by Nobel in 1887 (while he was living in Paris) as *ballistite* [Nobel gunpowder; the composition was 10% camphor, 45% nitroglycerin and 45% collodion (nitrocellulose)] and, contrary to gelignite, it exploded less violently on detonation. Ballistite lent itself as a propellant ballistic force that resulted in subsequent improvements in the manufacture of ammunition. Nobel's ballistite competed quite successfully in many countries with the first smokeless powder, the French *Poudre B* (1886; *Poudre Blanche* or *Vieille powder* after inventor chemist Paul Vieille[7]), and also with the British *cordite*, a minor variation of ballistite.[8]

Despite success in many parts of the world, Nobel had problems in Britain. Parliament enacted a law in 1869 that prohibited the manufacture, import, sale, or transport not simply of NG but of any substance containing it. It was two years before Nobel was able to gain the support of Glaswegian businessmen and build a manufacturing plant at Ardeer on the Clyde estuary in North Ayrshire; NG production from *The British Dynamite Company* began in January 1873. After his death the name was changed to *Nobels' Explosives Company* and, in 1926 at the behest of its then chairman, it amalgamated with British Alkali, British Dyestuffs, and Brunner Mond to form *Imperial Chemical Industries*.[9] ICI accepted a take-over bid from Akzo Nobel in mid-August of this year. The delays in gaining access to Britain and its Empire, and in not patenting dynamite in Australia until 1872 (Patent No. 315, 30.5.1872) led to one Friedrich Krebs importing a dynamite variant *Lithofracteur* there. Despite violation of the patents, manufacture began at Deer Park, Victoria in 1874 with the *Australian Explosives and Chemicals Company* named in 1888. This aside, importation from Nobel's Explosives Company grew dramatically and the Nobel shareholding in the small Australian enterprise was increased such that, in 1898 it was acquired, became *Nobel (Australasia)* in 1925; three years later incorporated into *ICIANZ*, which transformed into *ICI Australia*.[10]

From the mid-1860s until his death on December 10, 1896, Nobel built up an empire of about 90 different factories and laboratories in some 20 countries, normally retaining control himself. Despite the ever exhausting round of travel, he continued his studies not only into high explosives but also on many diverse chemical topics such as artificial silk, synthetic rubber and leather, anesthesia and blood transfusion (prior to the recognition of blood groups) such that, at the time of his death he held some 355 patents.[2] With his very competent, even brilliant investigators, he had tamed NG and provided a whole range of explosives for specific tasks. Thus, modest explosives were designed for mining coal and decorative stone while high brisant explosives (ones in which the maximum pressure is attained so rapidly that a shock wave is formed) were used for blasting hard rock.

The intensity of his work and travel did not leave much time for a private life and at age 43 apparently he felt like an old man. At this time he advertised for a *lady of mature age, versed in languages, as secretary and supervisor of household* and accepted Austrian Countess Bertha Kinsky who, after a very short time, returned to Austria and married Count Arthur von Suttner. Despite this the two remained friends and kept in contact. Over the years Bertha became increasingly critical of the arms race, wrote *Lay Down Your Arms* (1889) and was prominent in the peace movement seeking (and receiving) financial support from Nobel for a peace conference in Bern in 1892.

Following Nobel's death in San Remo (Italy), it came as a surprise to most that his amassed fortune of 33 M Swedish Crowns was to be devoted to prizes in chemistry, physics, physiology or medicine, literature, and peace. It seems that Nobel was a pacifist believing that his explosives ultimately would deter war, and he was sensitive to the criticism that rather than being a pacifist he was a promoter of war. Inclusion of the peace prize in the will was likely also influenced by Berta von Suttner. Importantly, his estate was not left to family members (his brothers were already dead) who had expectations. His executors were two employees Ragnar Sohlman, his personal assistant over his last three years, and Rudolf Lilljequist. The fact that the will was carried out with little opposition has to be credited to Nobel's nephew, Ludwig's son Emanuel, declaring to the King that he would do his best to ensure his uncle's wishes were respected. In mid-1898 a proposal was made that the children of his brothers receive one and a half years income conditional upon recognition of the will and agreement to make no further claims on the estate. This was accepted and the Articles for the Nobel Foundation were approved by King Oscar II on 29 June 1900.



Alfred Nobel from a photograph by Gösta Florman (1831–1900) (public domain image from *http://commons.wikimedia.org/wiki/Image:Mininobel.jpg*)

The first Nobel Prizes were awarded in 1901: van't Hoff (Leiden University, Netherlands) the chemistry recipient for *his discovery of the laws of chemical dynamics and osmotic pressure in solutions*; Roentgen (University of Würzburg, Germany) the physics winner *in recognition of the extraordinary services he has rendered by the discovery of the remarkable rays (or x-rays)*; von Behring (University of Marburg, Germany), physiology or medicine *for his serum therapy to treat diphtheria*; René-François-Armand (Sully) Prudhomme (France) was the literature laureate *in special recognition of his poetic composition, which gives evidence of lofty idealism, artistic perfection and a rare combination of the qualities of both heart and intellect*; the Peace Prize was shared between Swiss businessman Henry Dunant *founder of the Red Cross and initiator of the Geneva Convention* and French economist Frédéric Passy *founder and President of the Société d'arbitrage entre les Nations*. The Norwegian Parliament awarded the 1905 Nobel Peace Prize to Bertha von Suttner.

The chemistry and physics prizes are decided by the Swedish Academy of Sciences, the physiology or medicine prize by the Medical Nobel Assembly at Karolinska Institute in Stockholm (one of the leading medical universities in Europe), literature by the Swedish Academy, and the peace prize by the Norwegian Nobel Committee. The awarding ceremonies take place in Stockholm and Oslo (Peace) on December 10 each year, the anniversary of Nobel's death. The Economics prize was added in 1968 by the Bank of Sweden at their tercentenary and first awarded jointly in 1969 to Norwegian Ragnar Frisch and Dutchman Jan Tinbergen *for having developed and applied dynamic models for the analysis of economic processes*.

The scientific brilliance of Alfred Nobel as chemist and chemical engineer, coupled with outstanding business and entrepreneurial acumen, are embedded in the gift to humanity of the Prizes that are named after him.

Postscript - Trinitrin and Alfred Nobel

To a chemist ***trinitrin*** (GTN)[11] is the same as nitroglycerine (NG) and, like the anticoagulant Warfarin that is a rat poison, it is named pharmacologically so as not to dispel public acceptance. It appears to have been reasonably common among chemists in the mid-nineteenth century to smell and/or taste the chemicals they made. Sobrero reported placing a small quantity of NG on his tongue finding it to be sweet, pungent and aromatic, but with the decided disadvantage of causing a severe headache. Two years later, in 1849, Constantine Hering tested NG on healthy volunteers finding that headache was caused with *precision*. As a pioneer homeopath in the US, he persisted with testing and used NG as a headache remedy, manufacturing it with the help of Philadelphia chemist Morris Davis who also assisted in the experimentation.[11]

In Britain, physician Alfred Field used NG in an old lady with severe chest pain and, following this 1858 success, others began to experiment with its use. However, Frederick Guthrie's 1859 studies on isoamyl nitrate (first synthesised in 1844 by Ballard who is more noted for his discovery of bromine from sea-water in July 1826) noted[12] that one of its most prominent properties was from the inhaled vapour to the extent that two drops of the liquid on an absorbent paper and held to the nostrils gave a throbbing of the arteries in the neck after about 50 sec. This was followed immediately by flushing of the neck, temples and forehead, and acceleration in heart rate. Guthrie suggested its use in resuscitation but its use as a vasodilator was recognized and it was in use for the next 20 years.[11] It was William Murrell who, in 1878, began to use NG for the relief of angina because of its immediate effect as opposed to the delay that occurs with isoamyl nitrate. Within the next four years NG was recognized as *the* remedy for angina.[11] Trinitrin in tablet form, or now more commonly as Nitrolinguol® spray, remains the most efficacious remedy for angina pectoris.

What must not be overlooked is that the workers in the NG factories unknowingly *tested* its effects simply by being there. Severe headaches and dizziness were common during the first few working days in the factory but the effects wore off after as tolerance grew. However, the tolerance is short-lived and the phenomenon of *Monday disease* (a recurrence of the symptoms) was seen among those not exposed over the weekend such that it became quite common for men to take a piece of the solid NG-containing product home to rub on their skin or else for them to wear work clothes contaminated by the NG during the rest periods so as to avoid the problems. Worse still was nitrate dependence that some of those chronically exposed gained. This manifested itself over the weekend when there was no exposure and gave rise to a significant over-compensation resulting in severe heart pain; in the worst cases death resulted from the *Sunday heart attack* and it claimed a few workers each year.[11]

But what has this to do with Alfred Nobel one may ask? Well, we know that Nobel suffered from poor health for most of his life. He complained of indigestion, headaches, and sometimes depression, and had a stay at a Bohemian spa as early as 1854.[13] Towards the end of his life he had spasms of intense pain (angina) and in 1890 his physicians recommended use of NG – he declined. In letters to Ragnar Sohlman he repeatedly commented on his state of health and the heart problems he was suffering. Some seven weeks before his death, he said (translated) *'My heart trouble will keep me in Paris for another few days at least until my doctors are in complete agreement about my immediate treatment. Is it not the irony of fate that I have been prescribed N/G 1 to be taken internally! They call it* ***Trinitrin*** *so as not to scare the chemist and the public'*.[13] He died some seven weeks later following a stroke that left him with partial paralysis.

One cannot but wonder how Nobel was affected by his constant exposure to NG. He was still working in the laboratory and performing experiments himself some eight weeks before his death. Thus, it seems more than reasonable to suggest that much of his ill health was caused by constant NG exposure over some 40 years and that, in essence, he suffered at his own hands and developed NG poisoning.[14] It is now known that tolerance to NG increases as the thiol (-SH) groups on vessel walls are oxidized and prevent stimulation of the guanylyl cyclase, the critical step in vasodilation; this tolerance is short-lived.

Continuous exposure to it (and other organic nitrates) can lead to malfunctioning of the cardiovascular system and can lead to ischemic heart disease, even in the absence of any narrowing of the arteries. The symptoms shown by Alfred match well to these, now recognised, features of long term exposure.

The essential discoveries concerning physiology of NG decomposition to nitric oxide and it behaviour as a signalling molecule in the cardiovascular system led to the 1998 award of the Nobel Prize in physiology or medicine to Robert Furchgott, Louis Ignarro and Ferid Murad.

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7. Poudre B comprised nitrocellulose (collodion and guncotton. softened with ethanol and ether, kneaded, and then rolled into thin sheets and cut into flakes, or extruded through a die. It was then dried into a horn-like material.
8. Cordite comprised 58% nitroglycerin, 37% guncotton and 5% vaseline by weight and, in acetone, it could be extruded as spaghetti-like rods initially called *cord powder* but subsequently termed cordite. It was patented in 1889 by Abel and Dewar, both members of the British government *Explosives Committee* that monitored foreign developments in explosives. Neither Poudre B nor Ballistite met with British satisfaction but cordite was accepted. The patent led to a major dispute with Nobel as the composition was, in his view, but a minor variation of his ballastite; Nobel lost the case but the decision was considered by one of the judges as unjust. Subsequently Nobel, who manufactured cordite for the British government at Ardeer in Scotland was paid a royalty not just on the NG but also on the cordite – see ref. 1, p. 331.
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Nanotechnology - Lessons From Mother Nature*

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*In an earlier article (*This Journal*,* **2006***, 70,* 48-49*), the author asked* Does Nanotechnology Have a Sporting Chance? *and reviewed briefly the hype surrounding the field. In this article, Alan Smith illustrates how lessons from Mother Nature are resulting in the design of new nanotechnology applications. These applications, which relate to our everyday life, provide excellent examples that children and adults can relate to, and should be used to promote good science.*

Photo credit: Alan Smith - Sunset over the Grenadines (Caribbean)—Palm Island.

Over the last hundred years Nobel Prizes have been awarded in medicine, chemistry, and physics for work that would nowadays be described as nanotechnology. Nanotechnology is certainly not new; Mother Nature has been the best exponent since creation!

For those not familiar with the nanoscale, it is about as small as you can get, and down at that molecular or atomic level it has been found that properties of things can change. To help understand how small the nanoscale is, it would take 80,000 nanoparticles in a row to be just the diameter of a human hair, and if a sea gull landed on the deck of an aircraft carrier the ship would sink in the water by only one nanometre (a millionth of a millimetre).

Although scientists are developing exciting new products that make use of the new properties offered by nanotechnology, nature has been the leader in this science. Geckos hang