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Monthly Newsletter of Vigyan Prasar

DREAM 2047

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VP News

VACCINATION PROGRAMME ON HEPATITIS-B ORGANISED BY VIGYAN PRASAR

Hepatitis-B Virus (HBV) is similar to the viruses that cause the common cold. But unlike cold viruses which infect the cells of nose and throat, HBV infects liver cells and reproduces itself within them. Consequently, HBV particles are released into the blood causing irreparable damage. India has an alarming number of 42.5 million people carrying this virus. Keeping this in view, besides fulfilling its responsiblity of creating awareness in society, Vigyan Prasar organised a one day panel discussion on "Control of Hepatitis-B Virus" on 29.9.99 and a vaccination programme from 30.9.99 to 2.10.99 at Technology Bhavan for the employees of Vigyan Prasar, Department of Science and Technology (DST) and Department of Scientific and Industrial Research (DSIR) and their dependents. The vaccine was supplied free of cost by M/s Bharat Biotech International Ltd., Hyderabad.

The panel discussion on HBV was addressed by Prof. (Dr.) B.N. Tandon, Director, Dr. Anurag Tandon, Consultant and Dr. Sarath Gopalan, Consultant from the Pushpawati Singhania Research Institute of New Delhi. Prof. Tandon spoke on Hepatitis-B virus, liver disease caused by Hepatitis-B virus and efficacy of HBV prevention. Prof. Tandon emphasised that Hepatitis-B disease is 100% curable provided proper preventive measures are taken. It is prevented by vaccination and the vaccine available is safe and effective. Dr. Anurag Tandon discussed transmission of HBV and its prevention. Human beings are the only carriers of Hepatitis-B. Dr. Sarath Gopalan discussed on HBV vaccines and HBV immunisation. Dr. Krishna Murthy Ella, CMD, Bharat Biotech International Ltd., who also attended the panel discussion, talked about his company and the vaccine.

A total of 1720 people were vaccinated. They would all need to be vaccinated on two more occasions at appropriate intervals.

Dr. Anurag Tandon, Dr. Sarath Gopalan and Prof. B.N. Tandon at panel discussion

Dr. Laxman Prasad and Dr. Ella Krishnamurthy, CMD, Bharat Biotech International Ltd. at the discussion.

A scene of vaccination programme

Inside

... think scientifically, act scientifically ... think scientifically, act scientifically ... think scientifically, act ...

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OVERDEPENDENCE ON GOVERNMENT

In our country it has become a standard practice to blame the government, or hold it responsible for anything and everything, no matter what the occasion, or what the context. It could be an earthquake, accompanied by loss of life and property - both public and private; it could be a devastating flood which causes extensive damage to crops, renders large number of people homeless and leaves behind dead cattle; it could be a road or rail accident, causing injuries to and deaths of passengers; it could be a bomb explosion in a crowded place which blows up people and buildings; an old art or craft may be dying because its practitioners kept it in the family and didn't train outsiders; a famous scientist, now old, is forced to live alone and uncared because he has no relatives or none who want him with them; a well-known artist of yester-years lives in penury because he/she did not manage his/her riches well; it could be a self-styled inventor, unable to get anyone interested in his/her invention; a self-styled 'scientist' who thinks he/she has done something revolutionary but is unable to get working scientists convinced or to appreciate his/her work; some one sets up an industry, but is unable to sell one's wares; and so on and on.

And there may be any number of other situations. In each of these cases, the government is either blamed or held responsible for something that has or has not happened, or for not coming up quickly or adequately with tangible help for the victim(s), sufferer(s) or for those who feel they have been neglected or wronged by society.

Why have people come to expect that the government ought to come to their rescue, or bail them out, whenever they find themselves in serious trouble? Perhaps, this is a hangover from the days of kings and queens who were supposed to take care of and look after subjects and their total well-being - welfare state, the modern-day version of the older Ram Rajya. In Principle, there is nothing wrong or objectionable in the concept of a welfare state.

If the government has the wherewithal in terms of resources and a population in which citizens willingly and actively contribute to this effort in more ways than one, it can become a feasible proposition.

Let's look at the prevailing situation in India. The financial position of the government at the centre (or governments in States) has never been a very happy one. Not all citizens, who ought to pay taxes, do. Many of those who do, pay only part of what they ought to, by concealing income.

The government loses revenue in distributing electricity, in phone services, in running public transport; through ticketless travel on the railways, theft and pilferage in stores, or of goods transported by road and rail; loss of duties and levies on goods illegally imported; and so on and on. Not only that, the government regularly bears losses and damage to its property through outright theft, vandalism, misuse, wilful abuse, etc. And all this is happening on a massive scale! One of our Prime Ministers once mentioned something to the effect that out of every rupee meant for development only about 17 paise got actually utilised for that purpose. The rest i.e. 83 paise got lost on the way to its final destination.

All this points to some clear messages: continuing the way we have been carrying on is unlikely to take us to any desirable destinations; expecting and letting the government take on responsibility for anything and everything would only mean a big drain on available resources, without matching results/gains; people ought to learn and get used to taking their own initiatives to overcome problems facing them or adversities that come their way, without expecting or wanting every time the government to come to their rescue with doles, sops/subsidies; government employees at all levels ought to be made to work for the wages they receive and fully accountable for all their actions (and inactions where action is warranted) - every wrong-doing attracting deterrent and heavy price, without exception; all laws, dealings, public behaviour and individual/institutional actions which affect other individuals/institutions - ought to be implemented ruthlessly, at least till a majority of our citizens learn to respect and follow the rules, as a matter of habit.

What do you think? Readers' views would be welcomed.

❑ **NKS**

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THE ULTIMATE SYMBOL OF ACHIEVEMENT

"Lives of great men all remind us,
We can make our lives sublime,
And, departing, leave behind us,
Footprints on the sands of time."

Henry Wadsworth Longfellow (1807-82), the US poet

The Nobel prize is the most highly regarded (and also the most visible) international award in science, a metaphor for supreme achievement. The Nobel Prizes in science have acquired such prestige that they affect institutions as well as the recipients. Thus the Nobel Prize has been 'adopted as a universal measuring rod for the scientific standing of nations and organisations'. It has become a symbol of ultimate achievement, a measure of fruitfulness of new lines of research. Max Born (1882-1970), the German physicist and Nobel Laureate commented on the achievements of Otto Stern (1888-1969), the fellow Nobelist :

'Stern became a great physicist, as I had predicted. The method of molecular radiation which he introduced into atomic physics has become one of the main instruments of present day research; his teaching has spread all over the world, and has produced numerous discoveries of the first rank as well as a significant number of Nobel prize winners.'

No single cause may be attributed for the extraordinary prestige associated with the Nobel Prize. In comparison to some other science awards, the Nobel Prize is a latecomer. For example Copley and Rumford medals were established by the Royal Society of London in 1731 and 1850 respectively. There are prizes in science as rich or richer than the Nobel Prize. For example, John and Alice Tyler Ecology Award and the Robert A. Welch Award in Chemistry carry equal or more cash value than the Nobel Prize.

At the time of his death in 1896 Nobel left more than thirty-three million kroner, or about nine million US dollars. At that time it was a princely estate. His will specified that the bulk of the estate be put aside in a fund :

"The interest on which shall be annually distributed in the form of prizes to those who, during the preceding year, shall have conferred the greatest benefit on mankind. The said interest shall be divided into five equal parts, which shall be apportioned as follows: one part to the person who shall have made the most important discovery or invention within the field of physics; one part to the person who shall have made the most important chemical discovery or improvement; one part to the person who shall have made the most important discovery within the domain of physiology or medicine; one part to the person who shall have produced in the field of literature, the most outstanding work of an idealistic tendency; and one part to the person who shall have done the most or the best work to promote fraternity between nations, for the abolition or reduction of standing armies and for holding and promotion of peace congresses.

"The prizes for physics and chemistry shall be awarded by the Swedish Academy of Sciences in Stockholm; the one for physiological or medical works by the Karolinska Institute in Stockholm, that for literature by the Academy in Stockholm, and that for champions of peace by a committee of five persons to be elected by the Norwegian Storting (Parliament). I declare it to be my express desire that, in the awarding of prizes, no consideration whatever be paid to the nationality of the candidates, that is to say, that the most deserving be awarded the prize, whether he/she be a Scandinavian or not ...."

The additional award for economics was set-up in 1968 by the Bank of Sweden and the first award was given in 1969.

While the general principles governing awards were laid down by Nobel in his will it took no less than four years to finalise the complex details involved in establishing the Nobelstiftelsen (Nobel Foundation) and other institutional arrangements for distributing the prizes. The rules after being agreed upon between the executors, representatives of the prize awarders and Nobel family were confirmed by the King of Sweden in council in 1900. The statutory rules have more or less remained unchanged. However, over the years there have been minor modifications here and there. As the list of prize winners in literature will show the will's ambiguous words 'idealistic tendencies' as qualifications for the prize have gradually been interpreted more flexibly. Till 1974 astronomy and astrophysics were excluded from the contest for the prize in physics. So great astronomers like Edwin Powell Hubble (1889-1953), Jacobus Cornelius Kapteyn (1851-1922) and Harlow Shapley (1885-1972) could not get the prize. However in 1974 the physics committee broke a long standing taboo and awarded 1974 prize in physics to astronomers Antony Hewish (1924–) and Martin Ryle (1918-84).

The selection process begins in the early autumn of the year preceding the awards with sending out invitations for nominations. Nominations are invited from two sets of proposers: those with permanent rights to nominate (members of the Academy of Sciences, the faculties of the Caroline Institute and of the eight Scandinavian universities in the appropriate sciences, and past Nobel laureates) and others who are invited to nominate year by year. In 1900 that is the year when the first nominations were invited the committees supervising the prizes in

Table 1: Country-wise Distribution of Nobel Laureates (1901-98)

S. No.	Country	Physics	Chemistry	Physiology or Medicine
1.	Argentina	-	1	1
2.	Australia	-	1	3
3.	Austria	3	1	5
4.	Belgium	-	1	4
5.	Canada	2	3	2
6.	China	2	-	-
7.	Czechoslovakia	-	1	-
8.	Denmark	3	1	5
9.	Finland	-	1	-
10.	France	11	7	8
11.	Germany	20	27	15
12.	Great Britain	20	23	23
13.	Hungary	-	1	1
14.	India	1	-	-
15.	Ireland	1	-	-
16.	Italy	3	1	3
17.	Japan	3	1	1
18.	The Netherlands	6	3	2
19.	Norway	-	1	-
20.	Pakistan	1	-	-
21.	Portugal	-	-	1
22.	South Africa	-	-	1
23.	Spain	-	-	1
24.	Sweden	4	4	7
25.	Switzerland	3	5	6
26.	US	69	47	77
27.	USSR	7	1	2

chemistry and physics each sent out 300 invitations for nomination.

Nominations must reach the concerned committee in writing before February 1 of the year of the prize. The Nobel committees start their work on February 1 on the nominations received. During September and early October the committees submit their recommendations to their respective prize awarding institutions/bodies as specified in Nobel's will. The awarders must make their final decision by November 15. The deliberations and the voting are strictly kept secret.

While nominators may propose several candidates but the prize is given to one person or more than one person jointly. So far the prize has not been divided into more than three shares. All nominees must be alive not only at the time their names are proposed but also at the time the award is made. Prizes in the sciences have never been given posthumously. The prizes may not be awarded every year. This kind of situation may arise when no candidate is found as per guidelines laid down by Nobel's will or the prevailing circumstances in the world prevent the gathering of information required to reach a decision as it happened during the two world wars.

Each prize consists of a gold medal, a diploma bearing a citation and a sum of money. The amount depends on the income of the Foundation. The ceremonial presentations take place on December 10, Nobel's death anniversary in Stockholm (for physics, chemistry, physiology or medicine, literature and economics) and Oslo (for peace).

One of the major objectives that Nobel wanted to realise by establishing the awards was to foster research by providing "such complete economic independence for those who by their previous work had given promise to further achievement that they could ever afterwards devote themselves entirely to research". It may be noted that in the late 19th century, that is when Nobel established the awards, there was no substantial organised or institutional support for research. The number of scientists employed as fullfledged researchers was very small. This is despite the fact that the cost of research was not very high. For example as late as 1920 the research grant for the entire Cavendish Laboratory was about 10 thousand US dollars. The monetary value of the Nobel prize in 1901 was US $42,000.

Nobel has not explained why he excluded mathematics from the scientific fields to be covered by the prizes. But it has been argued later that perhaps this is because he wanted to benefit mankind in a concrete, rather than abstract way. Now of course, besides mathematics there are many significant specialties that fall outside the boundaries of eligibility. This is because the boundaries of the sciences and their internal geography have greatly changed since Nobel's time. Nobel could not have dreamt of many of the specialities that now exist.

As per Nobel's statutory requirements statements of scientific principles or organising conceptions cannot be considered for the prizes. Prizes must be awarded for 'a discovery', 'improvement' or 'invention'. However, conceptual contribution can be considered provided they are validated by the discovery of 'new facts'. Ideas that do not directly lead to new discovery like Darwin's principles of evolution and Cannon's concept of homeostasis do not qualify for the prizes.

Many have argued that it is scientific principles or organising conceptions which make science coherent and ensure its progress further in a systematic way. Thus Donald Fleming, a science historian at the Harvard University, USA, observed:

"Anybody solely dependent on following the Nobel citations would be imbibing a narrowly positivistic conception of science as an accumulation of many hard little pellets of empirical knowledge to be shaken free of any conceptual matrix in which they are unaccountably embedded. It is a peculiarly end-of-the nineteenth-century view, comprehensible in a man

Chandershekhar Venkat Raman (1888-1970)

of Nobel's generation and outlook but now hopelessly antiquated as a way of looking at science and the dynamics of scientific progress".

But then there is counter argument. Arne Wilhelm Kaurin Tiselius (1902-71), Swedish chemist, Nobel Laureate and who served as Vice-President of the Nobel Foundation (and also on the Nobel Committee for chemistry) defended Nobel's line of approach :

"Concepts are extremely useful to the human mind... but concepts change and change very fast. What remains are the facts, the experimental facts...concepts are instruments in scientific research. They help you make new discoveries. If they can't, they have no justification. And the only way you can prove the justification of a concept... is to see if it not only explains already-known facts but also leads to a new and unexpected discovery. That proves there is something new in the concept."

So far scientists of 27 countries have got Nobel Prize (as shown in Table-1). Since 1901 only one Indian scientist has got the Nobel Prize — Sir Chandrasekhara Venkata Raman (1888-1970) in 1930 under the category of physics for his work on the scattering of light and for the discovery of the effect named after him. Two other India-born scientists (who later became US citizens) who got the Nobel Prizes are : Subrahmanyan Chandrasekhar (1910-95) and Har Gobind Khorana (1922–).

Twice recipients of the Nobel Prize are :
Marie Curie: *1903 (Physics) and 1911 (Chemistry)*
John Bardeen: *(1908-91) 1956 (Physics) & 1972 (Physics)*
Frederick Sanger: *(1916-) 1958 (Chemistry) & 1980 (Chemistry)*

Linus Carl Pauling (1901-94) who got Nobel Prize in 1954 in Chemistry was also awarded a second prize in 1962 in Peace.

There are many great scientists who were not awarded the Nobel Prize. "Often, Prizes honour those who harvest rather than those, who sow, the successors rather than the originators". The physicist John Ziman observed: " The experts themselves will tell you how many superb scientists have been passed over because their discoveries were not important to the view of the day, or because they were only stepping stones in a very long investigation by many different research workers."

At the beginning the problem was not to identify the scientists for the prizes but to determine the order in which the scientists to be awarded were to be given the prizes. This is because there was a large backlog of the still-living giants of the 19th century science. To name a few : Wilhelm Konrad Von Roentgen (1845-1923), Hendrik Antoon Lorentz (1853-1928), Pieter Zeeman (1865-1943), Antoine Henri Becquerel (1852-1908), John William Strutt Rayleigh (1842-1919), Pierre (1859-1906) and Marie Curie (1867-1934) among the physicists; Jacobus Henricus Van't Hoff (1852-1911), Emil Hermann Fischer (1852-1919), Svante August Arrhenius (1859-1927), Sir William Ramsay (1852-1916) among the chemists; Emil von Behring (1854-1917), Ivan Petrovich Pavlov (1849-1936) and Robert (Heinrich Hermann) Koch (1843-1910) among the physiologists and physicians. The first Nobel Laureates were Roentgen (Physics), Van't Hoff (Chemistry) and von Behring (Physiology or Medicine). In fact before the prizes acquired extraordinary visibility and prestige, the Nobel Foundation honoured itself while honouring the scientists of great eminence. The high standing of the early Nobel Laureates within the scientific world and also among the common people set the standards for later selections. It cannot be said that the high standards have been maintained in every case. There have been 'weak' candidates who have been awarded the prizes; there have been controversial cases and what is more in a few cases it has been officially acknowledged that the prizes went to the wrong candidates. For example the Danish scientist Johannes Andreas Grib Fibiger (1867-1928) was awarded the Nobel Prize under the category of physiology or Medicine in 1926 for his work on the propagation of malignant tumors which later proved to be totally unfounded.

Another serious error was the selection of John James


Marie Curie
(1867-1934)


Wilhelm Conrad
Roentgen (Physics)
(1845-1923)


First Nobel laureates
Emil Adolf Von Behring
(Physiology or Medicine)
(1854-1917)


Jacobus Henricus Van't
Hoff (Chemistry)
(1852-1911)

WOMEN NOBEL PRIZE LAUREATES

Physics :
1903 Marie Sklodowska Curie (1967-1934)
1963 Maria Goeppert Mayer (1906-1972)
Chemistry :
1911 Marie Sklodowska Curie (1867-1934)
1935 Irene Joliot-Curie (1897-1956)
1964 Dorothy Crowfoot Hodgkin (1910-1994)
Physiology & Medicine :
1947 Gerty Radnitz Cori (1896-1957)
1977 Rosalyn Sussman Yalow (1921-)
1983 Barbara McClintock (1902-1992)
1986 Rita Levi-Montalcini (1909-)
1988 Gertrude Elion (1918-1999)
1995 Christiane Nusslein-Volhard (1942-)

Alfred Bernhard Nobel was born on October 21, 1833 in Stockholm. His mother Caroline Andrietta Nobel was a descendant of Olof Rudbeck (1630-1702) the Swedish naturalist known for his description of the lymphatic vessel. His father Immanuel Nobel was an engineer, inventor and an explosive expert. In 1842 Alfred Nobel alongwith his mother and brother left for St. Petersburg to join his father. Nobel was never in good health. He was educated mainly by tutors. From his father he developed a passion for invention. At the age of 16, he was a competent chemist and was fluent in five languages viz., English, French, German, Russian and Swedish. He had keen interest in literature. In his youth he even wrote some poetry in English. In 1850, he came to Paris where he spent a year studying chemistry. From Paris he moved to USA where he worked for four years under the guidance of John Ericsson (1803-89) builder of iron-clad *Monitor,* the first warship with an armoured revolving turret. Nobel joined his father's factory in St. Petersburg and worked there till it went bankrupt in 1859. The Nobel family came back to Sweden. Back in Sweden Alfred Nobel began experimenting with nitroglycerin, the liquid explosive. However, as the production was under way in 1864, there was an explosion which blew up the whole factory causing the death of five persons including Alfred's younger brother Emil. The Swedish government refused permission to rebuild the factory. Alfred Nobel, who by then used to be referred as 'mad scientist' started experiments on a barge to discover safe ways of handling nitroglycerin. A chance discovery saved him. It was found that nitroglycerin was absorbed to dryness by kieselguhr, a siliceous packing material and that the mixture could he handled safely. Soon after this discovery Nobel perfected dynamite and suitable detonation cap and he obtained a patent for the same in Britain (1867) and in USA (1868). Subsequently he developed a more powerful form of dynamite, blasting gelatin or gelignite (patented in 1876). Later he produced ballisite - the first smokeless nitroglycerin in powder form and a precursor of cordite. On the strength of these inventions, he created an industrial empire and amassed a huge fortune, much of which he left to endow annual Nobel prizes.

He died on December 10, 1896 at San Remo, Italy. The synthetic transuranic element nobelium was named after him.

❑ **Subodh Mahanti**

Rickard Macleod (1876-1935) alongwith Frederick Grant Banting (1891-1941) for the 1923 award in Physiology or Medicine for the discovery of insulin. It is true that Macleod was the director of the Lab in which Banting and Charles Herbert Best (1899-1978) discovered insulin and studied its therapeutic use in human diabetes. But he was not even present when the experiments on insulin were done. At the most Macleod facilitated the work done by Banting and Best. Not only Best but the Romanian scientist N. Paulesco (who even six months earlier came to many of the same conclusions as Banting and Best) was also excluded from the controversial award. Tiselius observed in a letter to the Romanian Academy: "I have thoroughly studied the documents you have sent me and I have also discussed the case with colleagues, especially with Prof. Ulf von Euler, President of the Nobel Foundation and, as you know, himself a physiologist and endocrinologist of the highest reputation. As you know well, the Nobel Prize to Banting and Macleod has been criticized by many, especially the fact that Best was not included. In my opinion, Paulesco was equally worth the award. As far as I know, Paulesco was not formally proposed, but naturally the Nobel Committee could have waited another year....Unfortunately there is no mechanism by which the Nobel Committee could do anything now in this or similar cases. Personally I can only express the hope that in an eventual celebration of the 50th anniversary of the discovery of insulin, due regard is paid to the pioneer work of Pualesco."

Herbert M. Evans who was responsible for three major contributions—identification of both the growth hormone and the oestrus in the rat (which made endocrinology come of age as a discipline); discovery of the anti-sterility vitamin (vitamin-E) and determination of its structure was also not given the award. Even according the official history of the Nobel prizes, Evan's work on vitamin-E "has been held to deserve the Nobel prize even if it was not victorious in the competition with others."

Several truly great scientists have been overlooked in the award of the Nobel Prize. Some of them are: Dimitri Ivanovich Mendeleyev (1834-1907), who formulated the Periodic law and table of elements; Josiah Willard Gibbs (1839-1903), 'who provided the foundations of modern chemical thermodynamics and statistical mechanics'; and Oswald Theodore Avery (1877-1955) 'who laid the ground work for explosive advances in molecular biology. Among the non-recipients also include many great mathematicians, astronomers and astrophysicists.

❑ **Subodh Mahanti**

FROM SHRIRANGAPATTANA TO SHRIHARIKOTA

The British consider the Duke of Wellington, Colonel Arthur Wellesley (1769-1852), who defeated Napoleon at the famous battle of Waterloo (1815), one of their greatest national heroes. However, not many people know that this hero of Waterloo had to run away from the battlefield when attacked by the rockets and musket-fire of Tipu Sultan's army.

It happened at the time of the Fourth Anglo-Mysore war (April 1799). General Harris led the British forces on the siege of Shrirangapattana, the capital of Tipu. The British forces had reached quite close to the fort of Shrirangapattana, but there was a formidable obstruction. To the south-west of the fort, near the village of Sultanpet, there was a large tope, where Tipu had stationed his rocketmen. Obviously, they had to be cleared out before the siege could be pressed closer to Shrirangapattana island. The commander chosen for this operation was Col. Wellesley.

Col. Wellesley was not an ordinary Englishman. He was the younger brother of Lord Wellesley, the then Governor-General of India (1798-1805). Col.Wellesley, advancing towards the tope after dark on the 5th April, was attacked by a tremendous fire of musketry and rockets. The men gave way and retreated in disorder. In the midst of chaos that followed, Col. Wellesley lost his way, hid himself somewhere in the night and could report to Harris late only on the next day.

The 'Sultanpet incident' had a profound and traumatic effect on Arthur Wellesley.

His biographer Guedalla tells us that, even late in his life, after Waterloo, the unpleasing night lived vividly in Arthur's memory.

After some days Gen. Harris planned another attack on Shringapattana. Help also came from Mumbai in the form of Gen. Stuart's forces. On the afternoon of 4th May when the final attack on the fort was led by Baird, he was again met by "furious musket and rocket fire". But this did not help much; the fort was taken. Tipu still refused to beg for peace on humiliating terms. He met a hero's end on 4th May while defending his capital. The taking over of Shrirangapattana was described by Arthur Wellesley, the future Duke of Wellington, in the following words:

Nothing therefore can have exceeded what was done on the night of the 4th. Scarcely a house in the town was left unplundered, and I understand that in camp jewels of the greatest value, bars of gold, etc., etc., have been offered for sale in the bazars of the army by our soldiers, sepoys, and followers....

Arthur Wellesley (1769-1852)

Tipu Sultan (Reign : 1783-1799)

Along with the enormous loot another precious gift from India arrived in England. It was the Mysorean rocket, two specimens of which can still be seen in the Royal Artillery Museum,Woolwich Arsenal, London.

European rockets of the time had combustion chambers made of wood or some kind of paste board. The metal cylinder (casing) used for the Indian rocket was hammered soft iron; it represented an advance over earlier technology. At that time iron made in India was of a high quality, even though Indian furnaces were small and inefficient compared with those of Europe. Indian iron was sent to Sheffield, because it was 'excellently adapted to for the purpose of fine cutlery'.

The use of iron cylinder for the Mysore rockets increased bursting pressures, which allowed the propellant (gunpowder) to be packed to greater densities. This gave the Mysore rocket greater thrust and range. The metal cylinder was tied to a long bamboo pole or sword to provide stability to the rocket missile.

From different accounts we come to know that the Mysore rocket weighed from 2.2 to 5.5 kgs. The metal casing was 4 cms in diameter and 10 cms long. The range is often quoted as about 1.5 kms. In exceptional cases it was upto 2.5 kms.

There was a regular Rocket Corps of about 1200 men in Hyder Ali's army. Hyder's son Tipu raised it to about 5000 men. Furthermore, three or more rockets could be fired rapidly using a wheeled cart as a launch-pad. Though not very accurate, their flash and noise had much moral effect on men and beast when mass-fired.

Rockets were in use in Karnataka long before the Anglo-Mysore wars. Hyder Ali's father was already

MILESTONES IN ROCKET DEVELOPMENT

A.D.

1044 : The Chinese work *Wu-ching tsung-yao* gives the earliest gunpowder formula in any civilization.

1232 : Rockets were used by the Chinese against the Mongols at the seige of Kai-Feng-fue.

circa 1250 : Gunpowder became known in Europe.

1280 : An Arabic work refers to gunpowder and 'arrows from China'.

circa.1400 : Gunpowder became known in India. After that we find many references to *agnichurna* (gunpowder), *agnibana* (rocket) and *agnikrida* (fireworks) in several literary sources.

1780-99 : Hyder Ali and his son Tipu Sultan used rockets against British forces.

1801-02 : Englishman William Congreve examined Indian rockets.

1806-14 : Britain used rockets developed by Congreve in several sea-battles.

1903 : Russian scientist Tsiolkovsky published his work on rocket propulsion and space voyage.

1909 : American professor Robert Goddard completed his first studies on liquid-fuelled rocket.

1926 : Goddard launched his first liquid-fuelled rocket.

1929 : German scientist Hermann Oberth experimented with liquid-fuelled rocket-engines and later helped in the development of German military rockets.

1939-45 : Research on military rockets in Germany. Production and use of powerful V-2 rockets. After World War II several V-2 rockets were taken to USA, and rocket experts like Wernher von Braun also reached there.

1957 : USSR's first artificial satellite *Sputnik-1* launched into orbit.

1961 : First manned spacecraft, *Vostok-1*, piloted by Yuri Gagarin, launched into orbit.

1963 : First time foreign-made sounding rockets launched from Thumba.

1967 : Indian made *Rohini-75* rocket successfully launched from Thumba.

1969 : American spacecraft Apollo 11, launched by a powerful Saturn V rocket, softlanded on the moon, and Neil Armstrong and Edwin Aldrin became the first men to set foot on its surface.

1969 : (15 August) Indian Space Research Organization (ISRO) formed under DAE.

1979-83 : SLV-3 rockets launched from Shriharikota.

1987-92 : ASLV rockets launched from Shriharikota.

1993-99 : PSLV rockets launched from Shriharikota.

1999 : (26 May) Launched from Shriharikota, the PSLV-C2 rocket placed into orbits three satellites - one Indian and two foreign.

2000 : Proposed first flight of GSLV rocket.

❑ Gunakar Muley

Tipu's rocketeer using a wheel-cart as a launch-pad.

commanding 50 rocketmen for the Nawab of Arcot. In the Second Anglo-Mysore war, at the Battle of Pollilur (10 September 1780), Hyder and Tipu achieved a grand victory, the contributory cause being that one of the British ammunition tambrils was set on fire by Mysorean rockets. The scene is depicted in a famous mural at the Darya Daulat Bagh in Shrirangapattana.

An innovator in many ways, Tipu was greatly interested in rocket development. He showed great interest in such European inventions as barometers and thermometers and several other novel devices. Tipu had sent some of his rockets to the Sultan of Constantinople as presents.

Rockets were known in India much before the Anglo-Mysore wars. Their early references are mostly from south India. The Mysore rulers might have got information about gunpowder and rockets from Malabar, where the Chinese used to come for trading. For fire-crackers words like 'china-bedi' and 'china-padakkam' are still in use in the Malayalam language.

*Gunpowder was discovered in China in the ninth century A.D., when the first reference to the mixing of charcoal, saltpetre and sulphur is found. About the early eleventh century the Chinese developed a kind of incendiary arrow, in fact the rocket. We have descriptions of their use against the Mongols at the siege of Kai-Feng-Fue in 1232 A.D. It was through the Mongols or the Arabs that the know-how of gunpowder and rockets reached Europe in the thirteenth century.

India also acquired the know-how of gunpowder about the same time, either through Chinese alchemists or through Chinese traders coming to Indian ports. Anyway, it is certain that by about 1400 A.D. the Chinese fireworks techniques were well-known in India. There is a treatise on fireworks in Persian written about 1450 A.D. by Zain-ul-Abidin, the Muslim ruler of Kashmir. In the fifteenth century A.D. various kinds of

A rocketeer in Tipu's army

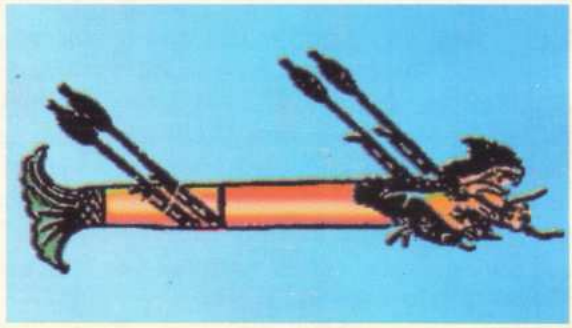
In 1232 Chinese Tartars used rockets against the Mongol invaders

fireworks were displayed at Vijayanagar during festivals. *Ain-e-Akbari* gives a list of 77 weapons in the arsenal of Akbar, *bana* (rocket) being mentioned at the end. In fact, the word *bana* or *agnibana* in the sense of a rocket finds a place in several Sanskrit works of the mediaeval period. In China the tube of a rocket was made of bamboo. The use of iron tube for rocket is probably an Indian innovation.

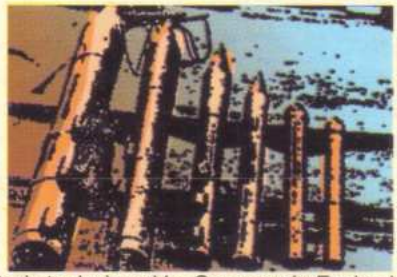
The British were greatly impressed by the Mysorean rockets using iron tubes. Several of them were sent to England, and from 1801, William Congreve (1772-1828), son of the Comptroller of the Royal Woolwich Arsenal, London, after thoroughly examining the Indian specimens, set on a vigorous research and development programme at the Arsenal's laboratory. Congreve prepared a new propellant mixture, and developed a rocket motor with a strong iron tube with conical nose, weighing about 14.5 kg. He also published three books on rocketry.

It is important to note that Congreve, on the basis of Newton' third law, recognised one of the chief advantages of the rocket -- the absence of recoil force, making it suitable for sea-borne assault. In the first quarter of the nineteenth century the British used Congreve's rockets in several sea-wars, e.g., in a trial attack on Boulogne in 1806, in the siege of Copenhagen in 1807, etc. The rockets that Congreve ultimately developed weighed 20 kg with a range up to 2.7 km.

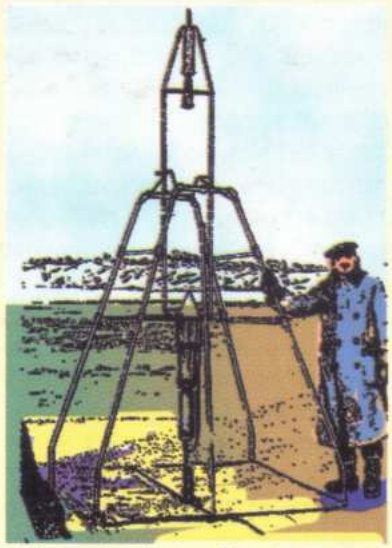
Thus, from the above description it is amply clear that better rockets came to be developed in England only after experiencing and examining the Indian rockets. It was a time when in England the first wave of the Industrial Revolution and technical innovations had begun. Till the end of 18th century several products of Indian technology were much superior to that of the British, but there was no proper environment for their scientific development in our country. However, we



A two-stage rocket from ancient China



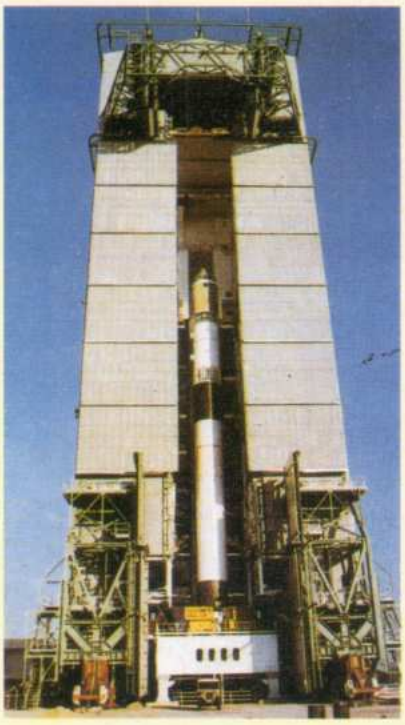
Rockets designed by Congreve in England



The first liquid-fuel rocket fired on March 16, 1926 by Goddard

should not forget that the plunder of Shrirangapattana and Tipu's rockets had also made a small but significant contribution to the Industrial Revolution that took place in England.

A new era of rocket development was initiated in the early 20th century. In 1903, Russian scientist Konstantin Tsiolkovasky (1857-1935) published his theory of rocket propulsion. He was the first scientist to establish that only a rocket can travel in interplanetary space. Then the American professor Robert Goddard (1882-1945) worked on the development of liquid-fuelled rockets, the first one being launched in 1929. During the Second World War a powerful V-2 rocket was developed in Germany and was used in large numbers against Britain and other European countries. At the end of the World War several V-2 rockets were shifted to America, and Wernher von Braun (1912-77), a German rocker expert, also took shelter there. After that there was vigorous development of modern rockets and missiles in the USA. However, the first artificial satellite *Sputnik-1* was put into orbit in 1957 by the USSR. Also, it was a Soviet rocket that put the first man, Yuri Gagarin, into orbit in 1961.



Mobile Service Tower, Shriharikota

GSLV rocket

Till then India had no modern rocket of its own. First time sounding rockets for atmospheric research were launched from Thumba in November 1963. They were acquired from foreign countries. The first indigenous rocket, *Rohini-75*, weigning 10 kgs, was successfully launched from Thumba in November 1967.

After that India went on building bigger and more powerful rockets. Right in the beginning, ISRO planned a rocket capable of sending a small satellite into orbit. Work also started on a rocket launching centre at the Shriharikota island.

There is not much difference between a rocket and a missile.Therefore, in the area of rocket technology one can not expect any help from foreign countries. India developed its powerful SLV-3 rocket with its own efforts within a short span of ten years. During the years 1880-83, SLV-3 rockets were successfuly launched from Shriharikota. It also successfuly placed a home-made 40 kg satellite in a near-earth orbit. With this India became the seventh country in the world to launch its satellite with its own rocket.

After SLV-3, Indian scientists developed a more powerful rocket -- the ASLV, which was tested for the first time in 1987. Then in May 1992, this ASLV rocket, launched from Shriharikota, placed the ISRO-made SROSS satellite into a near-earth orbit. Also, a more powerful rocket -- the PSLV (Polar Satellite Launch Vehicle) -- was in the making. Its second developmental flight in October 1994 was a great success. PSLV is capable of putting a 1000 kg remote sensing satellite into a 1000 km high polar orbit. This was proved when the PSLV rocket, launched from Shriharikaota on 26 May 1999, successfuly put into high orbits three satellites -- one Indian and two foreign made.

Now, in our country another rocket, more powerful than the PSLV, is almost ready for its maiden launching. Named GSLV (Geo-stationary Satellite Launch Vehicle), the rocket is capable of placing an Insat-like satellite into the 36,000 km high sun-synchronous circular orbit. According to ISRO, its first flight will take place some time in the first quarter of 2000 A.D. Thus, with the beginning of the new century and the new millennium (2001) India will step into a new era of rocket technology -- India will be capable of launching all its satellites with its own rockets.

In the field of rocket techology India is again attaining a leading position in the world. Modern rockets are based on a very high and advanced technology. But we should also remember that about two hundred years ago Indian rockets were the best in the world. The story of the development of Indian rockets from Shrirangapattan to Shriharikota has been quite topsy-turvy. The rockets of Shrirangapattan were used against an imperial power. The rockets being launched from Shriharikota are for space exploration and scientific benefits.

❑ **Gunakar Muley**

A UNIQUE SCIENCE POPULARISATION EFFORT IN PRE-INDEPENDENCE INDIA

The name of Prof. Ruchi Ram Sahni's may still be unfamiliar to a majority of Indians. In fact before NCSTC and Vigyan Prasar made efforts to publicise the pioneering efforts made by Ruchi Ram Sahni in popularising science in the last part of the nineteenth century, people knew him only as the father of Birbal Sahni, the founder of Birbal Sahni Institute of Palaeobotany at Lucknow. Ruchi Ram Sahni was a multi-faceted personality. He was a scientist, an innovator, an enthusiastic educationist, a fierce patriot and a devoted social worker. He was the first Indian scientist to issue daily weather forecasts on his own. He was also the first Indian scientist to work on the nucleus and cosmic rays — and that too with Ernest Rutherford. I first wrote on Ruchi Ram Sahni in *NCSTC Communications* (November 1991 and January 1992 issues). Subsequently, we brought out an edited version of his memoirs under the aegis of Vigyan Prasar. The way he popularised science is not only appealing but also instructive and is still relevant. That is why I thought it proper to include here the story already told for the benefit of the readers of *Dream-2047*.

The Punjab Science Institute (PSI) was established as a registered Society in 1885. The main objective of the Institute was popularisation of all kinds of scientific knowledge throughout Punjab by means of lectures (in English and in the vernacular) illustrated with experiments and slides, as well as the publication of tracts. (Incidentally, Punjab in those days consisted of the present-day Punjab, Haryana and Himachal Pradesh in India and parts or whole of Punjab in Pakistan.) The PSI objectives were expanded after a few years to include the encouragement of technical education, particularly of chemical industries.

Prof. Ruchi Ram Sahani (1863-1948)

Members of the PSI Society and most of those who promoted its activities were teachers (also called 'Professors') from various colleges. Those who gave popular lectures spent enormous amounts of time in preparing for them, since these were invariably accompanied by well-prepared slides and demonstration of experiments to make them interesting, popular and absorbing. And all this work was done voluntarily by these individuals on their own, without seeking any funds/grants from the government. However, there were some — mostly Europeans — who did invest a lot of time and serious effort in preparing their lectures, but these were faithful repetitions of published lectures delivered at different places/institutions in England, quite often word by word, without any acknowledgement whatsoever. Some famous examples of such published lectures were: 'Soap Bubbles' (by C.V. Boys), 'Chemical history of a candle' (by Faraday), 'Spinning tops' and 'The story of the tender-box' (by Perey).

There were others who chose their own topics and prepared their own lectures, designed and put together their own slides and experimental demonstrations. One of them was a physicist, Prof. Ruchi Ram Sahni, who was a co-founder and Joint Secretary of PSI. While working at Shimla, with the Meteorology Department as the Second Assistant Meteorological Reporter, he used to give popular lectures on 'Weather' with special reference to India and the Monsoon phenomenon. These lectures created much interest and were attended by Indian and European individuals, and clerks in Government of India offices.

The interest and enthusiasm generated all over the Punjab province by popular lectures organised by the Punjab Science Institute could be gauged from the demands received by PSI from all over to send lectures, and from the fact that it was even "decided to charge a small fee at mofussil stations to cover at least part of the expenses incurred in sending out lectures generally accompanied by a laboratory assistant and the necessary apparatus to illustrate the lecture". "... after 1886, a fee ranging from 1 to 2 annas became a common feature at the popular lectures given in mofussil even when the lecturer was a local man. As a rule, in such cases, part of the apparatus and very frequently, an assistant ... had to be sent from the headquarters". In 90 per cent of the cases, it was Prof. Ruchi Ram Sahni who was called upon to respond to these requests for popular lectures — one reason being that especially between 1890 to 1898, he had delivered so many popular lectures at Lahore and at other stations in Punjab that he was never `at a loss for a topic for his lecture, or the appropriate apparatus to illustrate it'. In fact, there was a rapidly widening circle of friends and pupils, some of whom used to send him personal requests and invitations to visit their stations for a popular lecture.

According to a rough estimate, Prof Sahni must have delivered some 500 such popular lectures. Included among these was the annual course of some twenty lectures in the Punjabi language which he gave in the compound of the Baoli Sahib at Lahore.

Prof Sahni considered these to be his most successful popular lectures which, week after week, attracted a large number of shopkeepers at a time of the day when people were out making their daily purchases. Not only that, the audience was always forthcoming with suggestions whenever Prof Sahni found himself struggling for a correct Punjabi expression or word for something he was explaining/describing. Each year, about ten of his lectures were devoted to very common, everyday subjects, such as "Soap-making", "The water Lahoris drank before 1880", "Pure and impure air", "The toys and their lessons", "Electroplating", "Electricity in the service of man (4 parts))", "Glass-making", "The Punjab and its rivers"(illustrated by a large relief map made in clay under Prof Sahni's direction for an exhibition in Lahore), "The common flame", "How does the telegraph wire speak?", etc. Several other lectures (of a slightly advanced variety) were repeated at mofussil stations and at other places in Lahore. All this had created much enthusiasm and interest in the study of science; so much so,

that "there were more schools teaching science as a regular subject of studies and more scholars studying elementary physics and chemistry in Punjab than in any other province of India".

Every once in a while, Prof Sahni chose to speak on the latest scientific discoveries in his popular lectures; these proved a success far beyond his wildest expectations. In fact, his lectures on the newly discovered "X-rays", "Edison's phonograph" and the "wireless telegraphy" created so much interest that persistent demands came for their repetition at the same place two, three times and even oftener. Also, the experiments on the wireless during these lectures were perhaps among the earliest experiments repeated in India. Prof. Sahni has cited several of his personal experiences to nail the contention often made during his time (what's new! So it has been even in our times) that it was not possible to teach science through the medium of Punjabi or other Indian languages.

As a rule all these lectures, through fees charged for them, generated enough resources to cover all related expenses. In fact, because of the popularity of the lectures organised by PSI, enough funds had been collected that after investing money in the purchase of scientific apparatus and of books for the library, a sum of Rs. 3000/- in cash was left with the Society when it was decided to close the institute because of the circumstances that had arisen. The money left over was actually meant for building a lecture-hall at Lahore and thus a permanent local habitation for PSI, "which was not to be"! A new association, the Society for the promotion of scientific knowledge (SPSK), with objects similar to those of PSI, had been established by some students of the Lahore Medical College, with Dr C.C. Caleb as its President. By this time, Prof Oman, co-founder of PSI with Prof Sahni, had left India. Prof Sahni got deeply absorbed in "serious and complicated litigation in the Dyal Singh will case, which lasted for about 10 years". Several members of PSI had joined SPSK and there was not enough room for two bodies with same objectives to work parallelly. Also, at the Government College, with Prof A.S. Hemm as the Head of the Science Department (where Prof Ruchi Ram Sahni was a faculty member), "certain practical difficulties" led to the decision of closing down PSI and transferring all its assets to the new Society under Dr. C.C. Caleb, who was an active member of the erstwhile PSI.

The PSI workshop

During his deep involvement with the delivery of popular science lectures and with the overall management of this PSI activity, Prof Ruchi Ram Sahni had realised quite early that 'no science teaching in the province was possible without the provision of ordinary facilities for the repairs of simple school apparatus'. Even if PSI members were convinced of the need, no other member could be convinced that a workshop set up by them could possibly undertake the repairs of scientific instruments; everyone was so apprehensive of the likely difficulties even in undertaking repairs of scientific instruments; let alone manufacturing them, that no one supported the workshop idea. (In fact, the idea of a workshop attached to the Science Department of a College was even more unthinkable, then!)

Undeterred by this, and convinced of the need, Prof Sahni established the PSI workshop in 1888, armed with little or no spare money of his own but with the confidence that, somehow if he persevered with the project, success would have to follow!

Prof Sahni was able to work out an arrangement with a Railway workshop Mistri (technician), Shri Allah bakhsh — who had some ordinary tools and a simple charcoal furnace with a single goat-skin bellows at his house — to prepare a few simple pieces of apparatus for him. This man, who was getting a salary of Rs. 25 per month and making another Rs. 10 by mending locks, making keys and doing other odd jobs for the neighbours, later became the Head Mistri of the PSI workshop. For this, Prof Sahni used to spend four hours every day — 8 p.m. to midnight — at Mistri Allah Bakhsh's house located at the far end of a long narrow lane. This meant real hard labour, preparing for his lectures and class work in the morning, delivering popular lectures and managing the PSI's popular lecture programme, attending to his official duties at the college, and then spending long hours supervising his new 'baby workshop' at the Mistri's house. The simple items being made in the 'workshop' were sold to schools at cost price, or even less — price meaning the cost of materials and Mistri's labour only, and not accounting for the long hours spend by Prof Sahni supervising the whole operation.

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This arrangement continued for about a year. The workshop was then shifted to Prof Sahni's house, with Shri Allah Bakhsh as a whole time Mistri at a monthly salary of Rs. 45. Prof Sahni had invested his entire savings of Rs. 1500 as 'outlay capital' on the workshop. With a full-time Mistri and a few unskilled helpers, to begin with, the operations expanded manifold.

After some years, a "Lock and Safes" section was added to the workshop, as a side-enterprise, largely to keep such a large number of trained men occupied for half the day with lock-making; outside piece-jobs were also being taken up within a month of adding this section; two types of locks were designed and produced which no other key would fit and which could only be broken open. So quickly did the demand grow for these locks that this section was making a net profit of Rs. 100 per month. This, thus, assured the success of the scientific section of the PSI workshop; here was a source of regular monthly income which could make up any shortfall on the instruments side. Later, the `Locks and Safes' section had to be closed down because some friends of Prof Sahni wanted to start manufacture of such locks on a large scale. However, this new enterprise did not last

more than 3-4 years, in the absence of proper supervision and quality control; the company lost its reputation and had to wind up with heavy losses.

At the time, all the brass-casting and turning jobs till then used to get done outside on a contract basis. With increased work, however, getting piece-jobs done outside became more and more problematic. So, a small casting section had to be added to the workshop; this also meant allowing doing of outside jobs to keep all the employed workers gainfully engaged. This done, there were problems on the metal turning front, since the workshop did not have its own lathe; those few in the city who were doing contract jobs for the PSI workshop earlier, were becoming more and more unreasonable with every passing day, with hikes in their demands. The PSI workshop needed a lathe badly and right away, and also the services of a good turner!

With the help of Mistri Allah Bakhsh, Prof Sahni was able to locate an unemployed turner who knew of an individual in a place called Kusur (near Ferozepur) who had a used lathe that was available for sale at a reasonable price. Prof Sahni employed the turner on a decent salary on the condition that the lathe was purchased. On reaching Kusur, it was discovered that the lathe owner already knew Prof Ruchi Ram Sahni and had used his workshop in the past for odd jobs. Thus a very reasonable deal was worked out and the lathe was dismantled, packed and brought back by train to Lahore, taken straight to the workshop at Prof Sahni's house, assembled and installed overnight; a whole lot of associated tools and fixtures too had come with the lathe. Next day, every one was stunned to see a working lathe, where there was nothing the previous evening.

Prof. J.C. Oman, who was away on holiday to UK when the PSI workshop was founded, returned in mid-1889. He did not quite like the idea of this workshop having started during his absence, and insisted that it strictly limit itself to repairs of school apparatus. This was not quite possible, since there was not enough repair work to be done to keep engaged even the small number of artisans that the workshop had employed. It was thought prudent, however, to slow down the pace. With widening experience, the workshop began to handle repairs of more complicated apparatus. Prof Sahni's popular lectures all over Punjab, helped spread the good reputation of the workshop in the whole province; even some PWD offices began to send instruments like theodolites, prismatic compasses etc for repair to the PSI workshop. Such opportunities, involving overhauling and examination of the working of a variety of delicate instruments, helped raise confidence of the workshop Mistries (technicians) who were then emboldened to undertake the manufacture of more advanced school and college apparatus. By the early 1890s, despite all the self-restraint, the workshop had developed into a reputed institution in respect of its workmen and appliances, for the manufacture of a fairly decent set of scientific instruments.

During a trip to Bombay, for making some essential material purchases (like brass, zinc and other metal plates, and copper and brass wires of various thicknesses etc), Prof Sahni landed himself in a local English firm dealing in scientific apparatus, to pick up some items for which his workshop had placed orders with this firm. While making inquiries about his order, Prof Sahni came across the name of Shri Hira Lal, Science instructor at Hoshangabad, C.P., who had placed an order for Tate's Air Pump with that firm. On returning to his residence, Prof Sahni shot off a long letter to Shri Hira Lal, telling him about PSI, the PSI workshop, and enclosing his own small catalogue of apparatus available from the PSI workshop at half the prices shown in the British firms' catalogues — with an offer to send him everything on approval and on a returnable basis, if necessary, at the PSI workshop's expense. This, subsequently, led to a longstanding relationship and the workshop enjoyed Shri Hira Lal's patronage for a long while thereafter.

Prof. Oman did not quite like the idea of this workshop having started during his absence, and insisted that it strictly limit itself to repairs of school apparatus. This was not quite possible. . . .

Also, during the above trip to Bombay, Prof Sahni accidentally wandered into a public auction being conducted on behalf of a firm dealing in scientific instruments, which had gone into liquidation. At this auction, Prof Sahni was able to 'outbid' all the others to pick up three platinum cups, 20 platinum plates for Grove's battery cells, four other machines, a huge lot of carbon plates, a lot of cotton and silk covered insulated wire, some electric bells with batteries etc, among others — all for a paltry sum of Rs. 124. He had all the stuff safely packed and had it despatched to his workshop at Lahore by train. On his return, he sold most of the items, picked up at the auction in Bombay, for a profit of at least Rs. 3000 which was credited to the PSI workshop account.

With a comfortable financial position, the workshop was able to afford sending gifts of simple apparatus costing Rs. 4 to 7 each to some of the schools. All the five inspectors of Schools in the province were informed, through a circular, about the history and progress of the workshop and its capabilities and were offered a set of a dozen selected pieces of apparatus produced by the workshop and a Mistri to explain and demonstrate the working of all the instruments. Of these, the only one to respond was the only Indian among the five inspectors, Master Pyare Lal from the Jalandhar Circle; the others did not even bother to acknowledge the circular! He offered to visit the workshop at his convenience to see the apparatus being actually made. He in fact did so sometime later and spend three hours familiarising himself fully with all the details. Master Pyare Lal proved a great source of encouragement, later, like Shri Hira Lal of Hoshangabad. One european gentleman, occupying a high post, "even blurted out the opinion that he would not cut the throat of his own people by

encouraging an industrial undertaking like the workshop. He seemed to regret the remark afterwards because he tried to explain himself away. The Head of the Department of Instruction, however, officially expressed his gratification that the workshop was providing facilities for the teaching of science subjects to the schools in the province".

Industrial conference at Poona

In the summer of 1893, Prof Sahni received an invitation from Shri Namjoshi of Poona (a well known public worker in the cause of industrial advancement of the country), to attend an industrial conference to be held in the ensuing autumn. Here was an opportunity to bring the PSI workshop to the notice of wider audience specially interested in new industrial undertakings.

Prof Sahni, accompanied by his Head Mistri Allah Bakhsh, arrived in Poona with several boxes of scientific instruments made at Lahore. At Poona, the grand old man Shri Govind Ranade insisted that Prof Sahni stayed with him at his house. Prof Sahni was greatly impressed by the simplicity and unconventional ways and characteristics of Shri Ranade during his six days of stay with him, and long walks in the morning.

The Conference, on a suggestion from Shri Namjoshi, had appointed a three-member Committee to examine the apparatus brought from Lahore and on display at the Conference, and to present a report on the same. Surprisingly, the Committee made its report confidential. 'Why?' No one was able or willing to tell Prof Sahni. At last, Shri Namjoshi told Prof Sahni in confidence that, in effect, "the Committee did not believe that the apparatus could have been made at Lahore or anywhere else in India". They were, in fact, convinced that the instruments exhibited were really made in England and that all that the PSI workshop had done was to remove the original varnish and replace it or create a varnish of their own so as to give it the appearance of an Indian origin, and the proof of it was the further fact that with all their own resources of skill and appliances in Bombay and elsewhere they themselves could not turn out similar articles.

With the permission of the President of the Conference, Prof Sahni was able to speak for ten minutes about his workshop with special reference to the instruments that were exhibited at the Conference. Prof. Sahni stated that, in his view, the Committee could not possibly have made it more flattering for the PSI workshop. For it meant only two things: (a) But for the varnishing, the Lahore-made apparatus stood on par with the imported British-made apparatus in respect of the actual working; and (b) the report showed that the workshop in Lahore had been able to achieve a success that was admittedly beyond all the resources of the more advanced presidency of Bombay. In response, Prof Sahni made three alternatives offers to the Conference.

(i) the Conference could depute any number of individuals to visit the PSI workshop at Lahore to see the apparatus in the actual process of its manufacture and that, if not satisfied with the made-in-Lahore claim, the workshop would be responsible for the to and fro second class fare of all the deputed individuals.

(ii) the Conference could place a large order for any of the items of the apparatus with the workshop. As the asking prices were only half of the English prices, they would be gainers at the expense of the PSI workshop. Or

(iii) the Head Mistry could be left at Poona, Bombay, or anywhere else where he could be provided with the necessary facilities for the manufacture of the apparatus. He would then make any of the items they liked in front of their own eyes. All that they needed to guarantee in return was the salary of the Mistri, for the time, not exceeding a month.

This submission by Prof Sahni was greeted with loud applause and Prof Modak of Baroda (probably the Chairman of the reporting Committee) came forward and embraced Prof Sahni. This was the start of a long association of Prof Modak with the workshop and with Prof Sahni.

The subsequent history of the workshop was a string of successes and achievements. It continued with the routine of manufacturing and selling apparatus from year to year ! Yes, the output increased, the sales mounted and its reputation spread to other provinces with orders from the most distant parts of the country. Some years later, when an industrial exhibition became a regular adjunct of the annual session of the Indian National Congress, exhibits from the PSI workshop attracted particular notice and were recommended for gold or silver medals. At the 1906 Calcutta Exhibition, Prof JC Bose was one of the Committee of judges for the section on scientific exhibits; he spoke of the workshop's contribution to the exhibition in flattering terms; and the workshop was awarded a Gold medal.

With the passage of time, the quality of the apparatus improved and more advanced and more delicate pieces of apparatus such as resistance boxes and chemical balances etc. were turned out. They compared favourably with most of the imported articles. Yes, the workshop never could come anywhere near the best instruments used for research work. But even for such of the delicate instruments that were produced by the workshop, the demand was very limited, so much so that it was difficult to make suitable arrangements for the callibration and reliable testing of these instruments. With a stronger effort at promotion, perhaps a few more orders could have been secured.

Prof Sahni was keen to add some new activity to the workshop. He thought of adding a section to make binoculars, and students' mircoscopes etc for which a fairly sizeable demand had grown. He even went to Germany in 1914, with a large sum of money, to bring back the required appliances for grinding lenses etc. But the war broke out and he had to return home empty-handed, after spending a year in England.

Towards the close of the nineteenth century, Prof Sahni seriously toyed with the idea of establishing a big chemical factory at Lahore. He did some ground work, made a practical study of the different aspects and, among other things, visited Calcutta to discuss the matter with Dr P.C. Ray. Sulphuric Acid was the chemical Prof Sahni had in mind for manufacture. With Dr. Ray's help, he was able to visit some factories. Despite all this, the idea never could materialise.

❑ **Narender K. Sehgal**