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Editorial

DEVALUATION—SCIENCE AND TECHNOLOGY

Devaluation is admittedly an irreversible process and even its most vociferous advocates have claimed it as best an 'expedient' to gain time to tide over a dfficult period. It would be a futile exercise to deliberate if and how it could have been avoided. Along with a major section of the people, the scientists consider it an unwise measure which has dampened the enthusiasm of those who had accepted the challenge of 'self-reliance'. Recent import liberalisation has resulted in a set-back to some of the newly started industries based on Indian know-how. Ferro-alloys, surgical instruments and medical supplies industries are facing a serious situation.

Devaluation has been accompanied by an economy drive to slash the government expenditure on administration—which is entirely welcome. Since most of the research organisations are also borne on the government budget, their entitlement will be subject to a similar cut and the present inadequate investment in research will be further scaled down. Funds for research and development are even now below their threshold value and this has been one of the factors responsible for their lack of impact on industrial development. A situation due to depleted funds, may develop where research would appear to be an unproductive activity and expendable luxury. Research institutes may not be shut down and scientists may continue to draw their salaries but they would not have the 'job satisfaction'. Denial of resources for essential instruments, equipment, libraries and pilot plants—without which no scientific research is possible, may cause widespread frustration. Already there appears to be a 'surplus' of engineering graduates. While a couple of years ago it was difficult to get suitable candidates for junior posts in research and development institutes, the current response to advertisements is indicative of a trend towards un-employment in qualified engineers. A situation where they may not find gainful employment is likely to compel a number of brilliant young scientists to stay and settle down abroad. Such a 'brain-drain' cannot but have a deleterious effect on the speedy progress and development of the country. Timely steps must be taken to arrest such a course of events—which can be only if the malaise is correctly diagnosed and appropriately remedied.

Economically speaking, there is a gap between import expenditure and export earnings and this gap shows signs of widening. The debt servicing charge alone is Rs. 1500 crores out of the total aid expected of Rs. 4000 crores during the Fourth Five Year Plan. By devaluation, the rupee value of this gap has already widened corresponding to the appreciated price of foreign currencies—the immediate impact is that you have to pay more in rupees for your imports and export more to earn the some amount of foreign exchange. Undeniably, rupee had lost its value in foreign markets and Indian exports were uncompetitive—devaluation will give them a sporting chance. However, these considerations only skim the surface and are more like juggling of figures to prove their favourite theories by the economic Pundits. We have too many lawyers and economists

guiding the affairs of the country and too few of scientists and technologists in the councils and policy making bodies of the Government.

The main fact is side-stepped that devaluation is the result of the failure of the government to implement its own science policy and harness the resources of science and technology for national development. In spite of 18 years of enlightened leadership of Jawaharlal Nehru, the powers-that-be have yet to recognise that in the period of national emergency, whether due to war or economic crisis, the country must step up its industrial research and development efforts and spend more on science and technology. While paying lip service to science and scientists, the State continues to treat them as decorative flowers. It considers National Laboratories as symbols of prestige and superficial modernity and not as real instruments of economic and industrial development. While devaluation may be the consequence of economic mismanagement, it is much more due to lack of appreciation by the government of the role of science and technology and its failure to put its faith in the Indian scientist and technologist. The tragedy is that the post-devaluation Indian has lost faith in himself and his destiny to be self-reliant. The country, the government and the people must realise that no community can go on living on borrowed crutches and still retain its self-respect and dignity. Continued dependence on foreign aid, charity of PL-480 food imports, foreign technical know-how, investments and collaborations have lowered the prestige of this great country and its people in the eyes of the world. While arguing for the need of importing know-how and technology in highly sophisticated areas such as petroleum technology, petrochemicals, synthetic fibres, fertilisers, atomic reactors, the reality has been twisted to indiscriminately 'open the womb' to let in investment, plant and technology even for making of biscuits, automobile wind screen wipers, furniture, ceramics-ware and even simple instruments and chemicals. Discarded plant and outdated technologies have found welcome and earned profits in this land of sheltered markets, of man-made shortages, currency inflation and high investment returns. Wrong and disastrous policies on the industrial and financial front are not permitting the industrial firms to build a self-sustaining technology for future growth and development. The climate is more favourable, to importing capital and know-how from firms abroad and then go leaning on foreign know-how and making easy profits without doing anything to catch up, much less outstrip other countries in any field of enterprise.

We are not against foreign know-how but we are opposed to the present dispensation which is more favourable to imported technology in preference to building a self-reliant industrial potential. Let us, by all means, let in susperior technology in sophisticated areas of development, while making simultaneous arrangements to Indianise it, catch up, and base future progress on our own efforts. This can only be if the government firmly lays down a policy of self-reliance and mobilises its technical departments and research organisations as major levers of operation towards an economy of self-dependence. Such a policy needs a change in outlook of the government and the people and it should be the task of scientific organisations and societies to bring about this change. Let it be clearly understood that unless there is a major shift in policy towards greater faith and reliance on science and technology, we shall inevitably move to a second devaluation and a deeper economic crisis which may threaten the basis of our national independence.

Frankly Speaking

SURPRISING—IF TRUE !

Indian news agencies are not always known for accurate, reliable and objective reporting. Still the UNI version of CSIR's reaction to devaluation and the economy cuts proposed in governmental expenditure make interesting reading. Reportedly, devaluation has been hailed as a help to Indian know-how and utilisation of the results of its research. It is not unduly worried about the increased cost of equipment, instruments and chemicals, since it can fabricate and manufacture most of these itself and in any case it had hardly any foreign exchange available to it. On economy cuts, CSIR claims to be in the forefront of those who have voluntarily agreed to cut their budget by 10 per cent. All posts are frozen and even the scientific posts will need utmost scrutiny and justification to be filled. If true, those responsible for the destinies of this major scientific organisation must be feeling a glow of self-satisfaction with their utterly patriotic reactions.

While the cost of imported plant and equipment will increase in money value, capital investment in India will become more attractive—that is logic and purpose of devaluation. Returns on newer investments will be better and may encourage inflow of technical know-how as a part of investment. Foreign capital, particularly where accompanied by managerial participation has always succeeded in persuading the Indian partners to accept foreign know-how, to eliminate any risk on untried local processes. It has also argued on a continuing link with foreign firms ostensibly to keep technology uptodate. Actually it has resulted in discouraging investment to develop Indian know-how and basing future developments and progress on self-reliant effort. These are formidable hurdles in the way of Indian know-how which will only get further strength through devaluation. It will be wishful moonshine if the scientists and technologists were to believe that industrial firms will accept half-baked processes and inadequate data simply because it is Indian. Whatever the disadvantages of devaluation due to increased cost of imports, industry will still prefer foreign know-how unless reliable process, product, design engineering and market data is available locally.

Immediately after the Chinese invasion in 1962, Kurt Mendelsohn in an article drew attention to the paradoxical situation that while foreign danger to India should have resulted in higher investment in research and development for the defence of the country, actually the science budget had been cut down. Perhaps the gods who run the destinies of science and its organisations in this country themselves have lurking doubts about its usefulness !

Surveyor's Flight to the Moon

P. R. GUPTA

A significant milestone on the pathway to the moon was the soft-landing of the Surveyor spacecraft on June 2 last. Surveyor is an advance scout for the men who will land on the moon. It was five years ago that President Kennedy spelt out the American national objective in space—manned lunar landing in this decade.

With about 2,000 men-hours of manned space-flight, including walk in space, and rendezvous and docking of spacecrafts, man has made much headway in his goal of reaching the moon. All this has been achieved within ten years of the first artificial satellite going into orbit.

One fine example of the technological revolution sparked off by the space age was evident when millions of TV viewers in America and Europe saw pictures of moonscapes flashed back to Earth by Surveyor minutes after it had soft-landed—to be precise 40 minutes after it had squatted there. This TV transmission was made possible via the communications satellite *Early Bird*.

Surpassing most optimistic expectations, Surveyor continued to flash to Earth moonscapes right through the 14-day long lunary day, withstanding the scalding 250 degrees F temperature and transmitting in all 10,335 pictures of the moon and other celestial bodies. A command from Earth shut down the communication system on Surveyor on June 14 for the two-week long lunar night, when the temperature drops down to a freezing minus 250 degrees F. Space scientists are quite hopeful that Surveyor will be able to endure the lunar night and continue to operate through a series of lunar days and nights before it lapses into total silence.

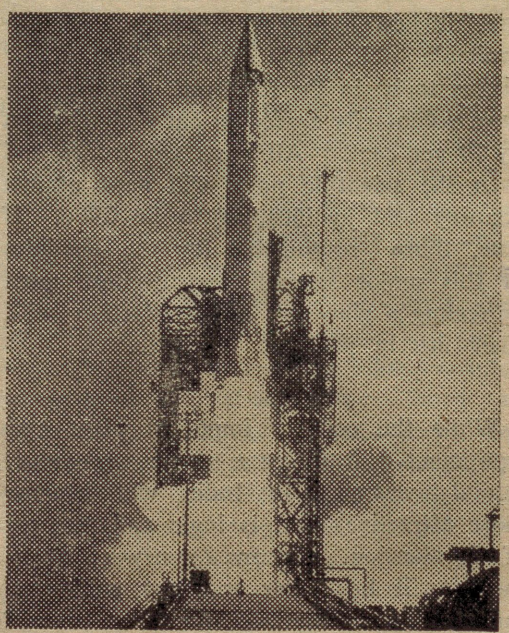
Among other things, Surveyor established the following:

(*i*) the moon is not covered with loose dust;

(*ii*) a manned spacecraft can safely land on the moon;

(*iii*) man can walk on the lunar surface without any fear of breaking through it, or being "shot down" by micro-meteorites;

(*iv*) the area where Surveyor landed is a "typical mare" or plain; and,



An Atlas-Centaur rocket lifts off the launch pad at Cape Kennedy in Florida on May 30, starting Surveyor on its way to the Moon.

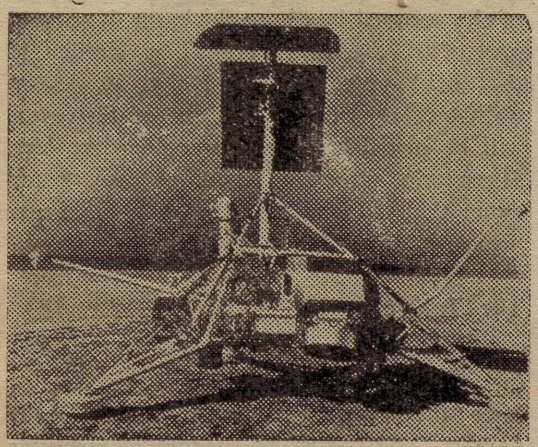
(v) a rock and pebble-strewn region, with the lunar floor level having the consistency of a freshly plowed field.

The subsequent six Surveyor flights planned will be landed on different kinds of plains and possibly in the rugged mountainous moon regions. These crafts will carry "scratchers" to dig up lunar samples, to analyse and forward the results to Earth, Seismometers to record moon "quakes", and detectors to measure the amount of radioactivity on the moon. A record will also be maintained of the frequency of micrometeorites.

By the time the series of these flights are completed, space scientists hope to answer these questions: What is the moon made of? How rough are the landing grounds? How thick is the lunar dust? How much weight will the lunar surface bear? What are the chances of an astronaut's space suit being hit and punctured by micrometeorites as he walks on the moon?

Primary Objectives

The three objectives of the first Surveyor flight were:



A view of Surveyor

One, to demonstrate the capability of the launch vehicle to inject the Surveyor spacecraft successfully on a lunar-intercept trajectory;

Two, to demonstrate the capability of the Surveyor spacecraft to perform successful midcourse and terminal manoeuvres and a soft-landing on the moon; and, Three, to demonstrate the capability of the Surveyor communications system and the Deep Space Network to maintain communications with the spacecraft during its flight and after the soft-landing.

From the take-off on Earth to the touch-down on the moon, Surveyor performed beyond all expectations, completing its 247,536-mile journey in 63½ hours. The Surveyor programme had more than its share of technical problems which resulted in a delay of three years and increased its cost more than ten times to $800 million. Aware of the complexity of the soft-landing mission and the five attempts made by the Soviet space scientists before Luna-9's success, American scientists had given the Surveyor mission odds of one in four for its success. In the circumstances, scenes of wild jubilation at the Jet Propulsion Laboratory, Pasadena, in California following the landing of Surveyor and its transmission of 144 pictures of lunar landscapes in an initial burst of activity, are quite understandable.

The success of the Surveyor mission proved the concept of a spacecraft capable of automatically decelerating from about, 6,000 miles an hour to a touch-down speed of about 3.5 miles an hour within three minutes. Also, it demonstrated that a spacecraft can function in the intense heat of the lunar day when the temperature goes beyond that of the boiling water.

To accomplish the critical terminal descent and soft-landing, Surveyor was equipped

with a retro-rocket, three guidance rockets, a flight programmer and analog computer, and radar to determine altitude and the rate of descent. Surveyor carried a single scanning TV camera designed to photograph the moon's surface.

The terminal descent sequences of Surveyor were as follows:

1. The spacecraft was positioned for retrofire 25 minutes 23 seconds before the touchdown, when it was about 1,300 miles away from the moon and moving at the speed of 4,500 miles an hour.

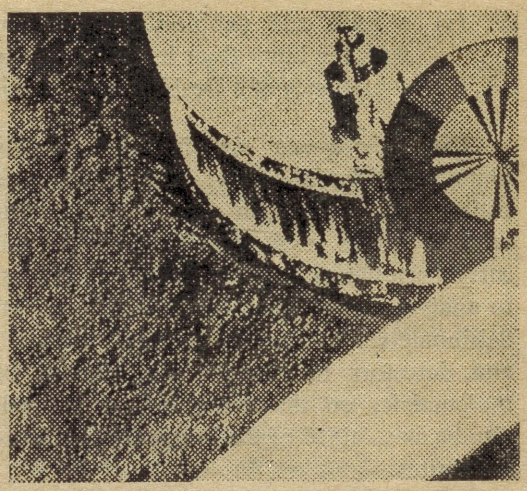
2. The main retro-rocket was fired 2 minutes 53 seconds before the touchdown, when Surveyor was 53 miles away and speeding at 5,840 miles an hour.

3. The main retro-rocket burnout was completed within 40 seconds by which time the speed of the spacecraft had come down to 267 miles an hour and was about 5½ miles away. At this stage, the retro-rocket was jettisoned.

4. Guidance rockets cutoff: It took place one second before the touchdown when the Surveyor spacecraft was barely 13 feet above the landing site, and its speed had gone down to 3.3 miles an hour.

5. Touchdown: at 11.47 a.m. (I.S.T.) on June 2, 1966, the descent completed by a free fall. Surveyor's speed on impact with the moon's surface was 8 miles an hour.

In the final phase of descent for the last sixty miles (from the stage 2 to 5 given above), Surveyor's own computer and radar were issuing the necessary orders and controlling the landing. The command station on Earth 230,930 miles away was a silent spectator and resumed communication with the spacecraft only after it had perched nimbly on the moon. During these last three agonising minutes of the descent scientists could do no more than keep their fingers crossed and, perhaps, pray.



The fine texture of the moon's surface and the depression made in it by one of the three landing pads of Surveyor show in the narrow-angle photo. Grains of 0.5mm diameter can be resolved in the disturbed surface next to the pad, according to project scientists at the Jet Propulsion Laboratory in California. A camera test pattern disk is mounted on the spacecraft's leg.

With Surveyor's soft-landing on the moon, America has moved closer than ever to its goal of placing man on the moon. The design of the manned landing vehicle on the moon, part of the Apollo spacecraft, is similar to that of Surveyor, except that its 15-ton weight (compared to 620 lb. of Surveyor) will be distributed on four spider-like legs. Surveyor's successful landing gives confidence that the design of the manned lunar vehicle is sound.

The Take-off

At launch, Surveyor weighed 2,194 pounds (about a ton). The retrorocket jettisoned after the burnout, weighed about 1,377 pounds. And the landed weight of Surveyor on the moon, which is 620 pounds, is the

net weight after the use of liquid propellants and the altitude control gas. At the takeoff the total weight, including that of the launch vehicle, was 150 tons, and the liftoff height of the whole assembly was 113 feet. Significantly ,the launch vehicle (the Atlas-Centaur 10) made its first operational flight.

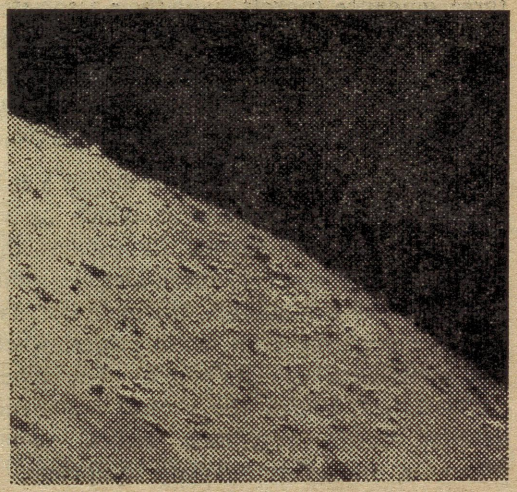
Centaur is America's first high-energy rocket, using liquid hydrogen as the fuel. Hydrogen is known to be a very efficient fuel being about 40 per cent more powerful than the conventional kerosene fuels. Its handling is quite complicated and it has resulted in the development of special techniques. Liquid hydrogen is very cold (minus 423 degrees F is its boiling point) and very light (the hydrogen atom is the lightest known).

The rapid rate of acceleration of the moonward bound rocket can be well appreciated from the following table :

Event	Time, Sec.	Vel MPH
1. Liftoff	0	0
2. Booster Engine Cutoff	142	5560
3. Booster Engine Jettison	145	5630
4. Centaur Engine Start	251	7600
5. Centaur Engine Cut-off	685	23,500
6. Spaceraft Separation	757	23,500

Not many appreciate the complex nature of marksmanship called for in sending a spaceraft to the moon. It has been compared to aiming gun from a speeding train while rotating on a swivel chair and trying to hit a fast-moving tennis ball several miles away.

In the launching of a mooncraft, space scientists have to reckon with the following factors: Earth from where the lunar rocket



This Surveyor view of the rock-strewn surface of the moon's Ocean of Storms, covers an area starting about 100 metres from the spacecraft to the outside rim of a crater, several hundred metres distant. The crater falls away to the right beyond the horizon. Boulders on the horizon at upper left are estimated to be about one or two metres long and the smallest rock fragments shown are only a few centimetres across. Surveyor program scientists at the Jet-Propulsion Laboratory in California say the rocks, which appear to be broken solid material, were probably scattered from the craters toward the site where Surveyor rests. The crater is estimated to be about a half kilometre in diameter.

is to be launched is moving round the sun at 66,000 miles an hour, while simultaneously Earth is spinning on its axis at 25,000 miles per day along the equator. Moreover, the target—the moon—is orbiting round Earth at 2,287, miles an hour at a distance of about a quarter million miles away. Besides the aim, the rocket must achieve enough speed (24,500 miles an hour) to escape the pull of Earth's gravity.

Inside Surveyor

The triangular aluminium frame of Surveyor provides mounting surfaces and attachments for the landing gear, retrorocket and

three guidance rockets, with their associated tanks, thermal compartments, antennas and other electronic and mechanical assemblies. Surveyor stands 10 feet high, and its landing legs can be placed within a 14-foot circle.

Two thermal compartments house sensitive electronic apparatus for which active thermal control is needed throughout the mission. One compartment contains two radio receivers, two transmitters, the main battery, battery charge regulator, main power switch and some auxiliary equipment. The other compartment houses the central command decoder, boost regulator, central signal processor, and other auxiliary equipment.

Twenty-nine pyrotechnic devices mechanically release or lock the mechnisms, switches and valves associated with the antennas, landing leg locks, roll actuator, retrorocket separation attachments, shock absorbers and the retro engine detonator. Some are actuated by command from the spacecraft, others by ground command.

The solar panel is the spacercraft's primary source of power during flight and during operations on the moon. It consists of 3,960 solar cells arranged on a thin, flat surface of approximately nine square feet. It is mounted at the top of Surveyor's mast. Winglike it is folded during launch and deployed after the spacecraft has been ejected into the lunar transit trajectory.

When properly oriented during flight, the solar panel can supply about 89 watts which is most of the power required for the average operating load of all onboard equipment. On command from Earth, the panel can be adjusted to track the sun within a few degrees, so that the solar cells remain always perpendicular to the solar radiation. On the moon, the solar panel is designed to supply a minimum of 77 watts power at a temperature of 140 F, and a minimum of 57 watts at 239 F.

The telecommunications equipment aboard Surveyor serves three functions: Providing transmission and reception of radio signals; decoding commands sent to the spacecraft; and selecting and converting engineering and television data into a form suitable for transmission.

To facilitate transmission and reception of radio signals, the spacecraft is provided with three antennas, two transmitters and two receivers. The command decoding equipment can handle up to 256 commands, both direct (which control on-off operations) and quantitative commands (which control time interval operations). Each incoming command is checked with a central command decoder which will reject a command and signal the rejection Earth if the structure of the command is incorrect. Acceptance of a command is also radioed to Earth. The command is then sent to subsystem decoders that translate the binary information into an actuating signal for the function command.

Processing of most engineering data (temperatures, voltages, currents, pressures, switch position, etc.) is handled by the engineering signal processor. There are over 200 engineering measurements of the spacecraft. None are continuously reported.

Surveyor has one television camera. The camera is mounted nearly vertically, pointed at a movable mirror. The mounting containing the mirror can swivel 360 degrees, and the mirror can tilt from a position where it reflects a portion of a landing leg to above the horizon. The camera can be focussed by Earth command from four feet to infinity. Its iris setting, which controls the amount of light entering the camera, can adjust automatically to the light level or can be commanded from Earth.

The camera has a variable focal-length lens which can be adjusted to either narrow angle or to a wide-angle field of view. A

focal plane shutter provides an exposure time of 150 milliseconds. The shutter can also be commanded open for an indefinite length of time. A sensing device coupled to the shutter will keep it from opening if the light level is too intense. The sensing device can be overridden by ground command.

The camera system can provide either 200 or 600-line pictures. The 600-line mode provides a picture every 3.6 seconds, and the 200-line mode every 61.8 seconds.

The primary objective of the rocket which carried Surveyor as its payload is to inject the spacecraft on a lunar-transfer trajectory. Its accuracy must be precise enough to ensure that the midcourse manoeuvre correction required some 20 hours after the liftoff does not exceed about 112 miles an hour in a speed of the order of 23,500 miles an hour.

The second stage of the rocket—the Centaur stage—is required to perform a retro-manoeuvre after the separation of the spacecraft. It results in altering Centaur's trajectory sufficiently to avoid impacting the moon and also prevents Surveyor's star seeker from mistaking Centaur for Canopus star on which Surveyor will focus for spacecraft orientation.

Flight Phases

Surveyor was launched by an Atlas first stage and Centaur second stage into a direct ascent lunar trajectory. This trajectory was preferred as opposed to the parking orbit technique mainly to simplify the demands on the newly-developed hydrogen-fuelled Centaur in its first operational mission. A parking orbit is more complex in that it requires the Centaur second stage to fire its engines to achieve the initial circular orbit, coast into orbit about Earth and then to fire its engines the second time to accelerate the spacecraft to the required lunar transit velocity, approximately 24,500 miles an hour. In a direct ascent lunar trajectory this complex double burn is not necessary.

Just before liftoff, all five of the Atlas engines are ignited. For the first two second after takeoff (T+2 sec.), the 113-foot high Atlas—Centaur assembly rises vertically and then for 13 seconds rolls to the desired flight plane. After 15 seconds of the flight, the vehicle begins pitching over the desired flight trajectory. At T + 142 seconds, booster engine cutoff takes place, followed three seconds later by the jettisoning of the boosters. At T + 240 secs. and an altitude of about 97 miles, Atlas cutsoff, and two seconds later separates from Centaur.

Prior to the ignition of the Centaur second stage, its engines are prechilled with propellants to avoid vaporization of the — 423 degree F. liquid hydrogen as it enters the turbopumps. At T + 251 secs, Centaur's two engines are ignited for a planned burn of 434 seconds, by which time the spacecraft has attained the desired velocity.

After T+757 seconds of flight at an altitude of 11 miles, Centaur and Surveyor get apart. After separation from Centaur, Surveyor gives an automatic command to fire explosive bolts to unlock the solar panel. It then performs an automatic Sun-seeking manoeuvre to so orient itself so that its solar panels get the solar radiation to power the space-craft. Prior to this, the spacecraft's main battery is providing power.

The next critical stage is for Surveyor to be in communications link with one of the three Deep Space Net tracking stations. It is essential that the command station on Earth determines quickly the condition of the spacecraft and compute its velocity and trajectory.

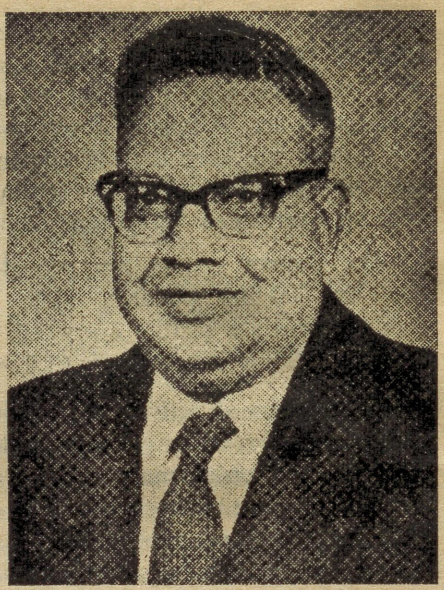
The tracking data is used to determine how large a trajectory correction must be made to land Surveyor in a given target area.

(*Contd. on page 16*)

Obituary

Prof. Panchanan Maheshwari

D.Sc., F.R.S., F.A.Sc., F.N.A.Sc.



On May 18, 1966, India and the Scientific community at large lost, in the passing away of Professor Panchanan Maheshwari, not only an outstanding scientist but also a most lovable personality. Professor Maheshwari was a perfectionist: whether in the class-room, in the research laboratory or while delivering a learned lecture to a scientific elite, his carefully chosen expressions, erudition and bubbling enthusiasm for his research field left no one in doubt about the eminence of this charming personality. A profilic writer and an excellent lecturer in English and Hindi, he dispensed information as readily as he acquired it.

Panchanan Maheshwari was born in 1904 at Jaipur and was the son of an employee in the office of the Medical Department there. His family seems to have been unconnected with either Botany or Science in general. Nevertheless, his father, with his modest means, gave young Panchanan every possible assistance to complete his education in the Allahabad University where he took his Master's Degree in Botany in 1927 and the Doctor of Science in 1931. His early life was influenced by late Dr. Winfield Dudgeon of the Ewing Christian College, Allahabad. Once in the field of Plant Embryology, in which he was a pioneer in India, he never looked back in quest of other fields of research in botany. With a singleness of purpose and devotion to his chosen field he forged ahead, publishing many original papers and scintillating reviews. He soon attracted a large team of young aspirants in botany and a formidable school in phytomorphology was born and literally a steady stream of scientific papers published. An authoritative book in English entitled: *An Introduction to the Embryology of Angisperms* was published by McGraw-Hill in 1950. This, and the acceptance of the newly created Chair in Botany in the University of Delhi in 1949, put Maheshwari on top in contemporary Indian Botany. Not least of his qualities that helped make his ventures succeed, was his ability to judge his men shrewdly, and pick out outstanding ones to act as leaders not only in his laboratory but elsewhere where his expert opinion was sought. In this task Professor Maheshwari was totally free from linguistic, caste, creed or community barriers and that in fact, went to make his immeasurable strength.

I have had the privilege of working with Professor Maheshwari on scientific bodies, review committees and examination and selection boards on many occasions. Clear thinking, objectivity and balanced judgment marked his approach to the many problems one normally faced in these meetings. I still vividly remember an occasion when a policy decision involving a state Government and the Centre had to be taken by us and effectively incorporated in our report to Government. Professor Maheshwari curtly told the members, without any vacillation whatsoever, "it is for this Committee, as men of science, to clearly enunciate what in our opinion Governments should do but it is not our concern whether they choose to concur, differ or defer". Wise counsel!

Whatever work Professor Maheshwari undertook received his personal care and attention and was executed with thoroughness and promptness. Editing of Monographic series, other editorial responsibilities to national and international journals and multifarious calls on his time never irritated him. Yet, with all the pressure of daily routine Maheshwari had a reputation for promptness in correspondence second to none in this country.

A high sense of duty and devotion to the cause of advancement of science in India were nearest to his heart. The problem of 'brain drain' among Scientists disturbed him beyond measure. I have heard him say, even in the case of his own son who went abroad for doing his doctorate: 'What are we running our universities for if our young scientists still look to other countries for research degrees in areas in which we have already made a mark'? It is little wonder, therefore, that he zealously guarded academic values and gave an equal opportunity for employment to those having Indian doctorate when they competed with those that obtained them from abroad.

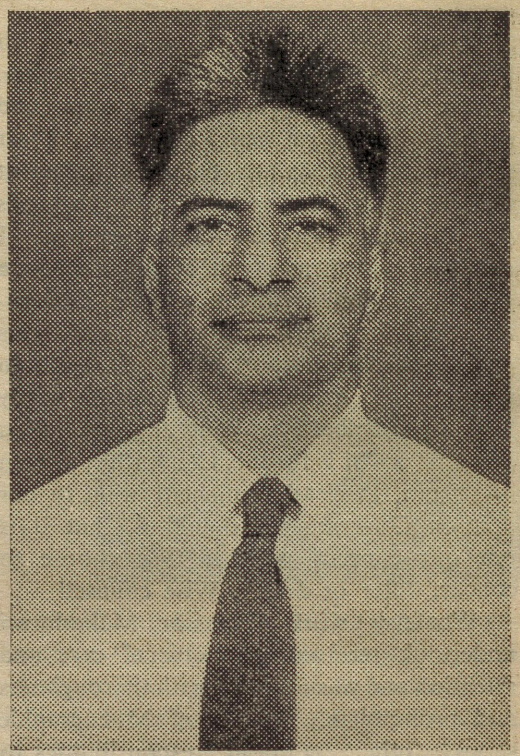
The extent to which Professor Maheshwari developed his own subject and his department in Delhi, is a tribute to his untiring energy and the generosity with which he would lend literature from his personal collection of even rare reprints. Even during short visits to various university centres where young scientists were working in morphology or embryology, he would volunteer to see their micro-preparations, plan of research and un-edited manuscripts and offer valuable advice. I have never known him relax in the ordinary sense of the term; his entire academic life was one of high pressure dedication to the cause of higher learning—a constant yearning for attaining nothing short of international standards in scholarship. Despite all these excellent scholastic traits he was a ready mixer, a perfect host, quick witted and most affable. To know him was to respect and admire him.

Maheshwari loved meeting people, travelled extensively at home and abroad, read widely, and, indeed, his knowledge was encyclopaedic. Only a man of exceptional ability, energy and determination could have achieved what he did in the condition in which a scientist has to be continually striving to overcome difficulties and indifference to ones aims at improving our research institutions and laboratories. To have been schooled the ordinary way more than fifty years ago in this country and be elected to the highest academic bodies in India, the Leopold Academy of Natural Sciences of Germany and the Royal Society of London is unique, particularly as self-made success is much rarer in research than in industry. The successful man of science has to constantly think of leading a rebellion against ignorance and indifference and, in this, courage of conviction of men like Maheshwari with their objective reasoning and forthright criticism will be sadly missed in many a forum where science policies are evolved.

T. S. SADASIVAN

Obituary

D. D. KOSAMBI



Way back in 1947, there was an obituary on D.D. Kosambi in the Harvard journal. It was the result of a letter lost in the post and so the Harvard authorities concluded he was dead. There could be no other explanation for an unanswered letter. But on the 29th of June 1966, Kosambi died—and this time his death is real.

Kosambi was born in Kosben in Portuguese Goa in 1907. His father, Professor Dharmanand Kosambi was a highly respected scholar in Buddhist studies, Pali and Sanskrit. He taught at Harvard and helped in the publication of some Pali texts by the University. Like many of the intellectual luminaries of the late 19th and early 20th centuries, he taught at Fergusson College, Poona and was connected with the national movement especially with Gandhiji and the non-co-operation movement. Kosambi inherited, from his father, scholarship, social concern and political commitment. Together with his father, Kosambi was at Harvard but of course as a student. Kosambi specialized in mathematics and it was at Harvard that he also got interested in languages and social problems. "With the complexion of a Negro and the nose of a Jew, I learnt a great deal about Democracy in America," he used to say.

Perhaps that was one of the reasons why Kosambi taught at Fergusson College and made his home in Poona. He wasn't a Utopian, but he did have his ideals. Money didn't attract him, but Fergusson College traditions did. That was the college where both Gokhale and his own father had taught. Ranade had also been closely connected with it and since its foundation, Fergusson College had always stood for rationalism and progress and resisted all types of superstition. The Bhandarkar Institute was also in Poona, besides Poona was a historical place. Kosambi was interested in the life of the common people. He could study

their life at close quarters in Poona. He did indeed study their life and learnt a lot from them about Indian superstitions, Indian history and culture; and it was with their help that he could discover megaliths and microliths. These discoveries were made to speak their live pre-history and our living history. Kosambi made them do it by his scientific approach to history. Before people can make history they have to make their life. All unknown to them, in the very act of making their life they make history. The business of History is to discover with the help of archoeological remains how people had lived and worked, and what expressed and implied ideas of theirs made them live and work so in those times.

Some of his conclusions may not stand the test of time but the methods, the outline he laid down, however controversial they may be at the moment, will continue to inspire future work on those very lines, because that's the only way to know about ourselves and our past. Kosambi's "Introduction to the Study of Indian History," "Myth and Reality," and "The Culture and Civilization of ancient India", are works of depth and erudition and are contributions of a fundamental nature to Indian history and sociology.

Allied with history is numismatics. It had a two-fold interest for Kosambi. The historian in him studied old coins to find out the economic and fiscal history of the period. Statistics and Geometry were invaluable help to him in the study. That gave him a chance to devise appropriate mathematical method for the correct and thorough study of coins. His last paper on the subject was published only last February in the "Scientific American."

Because of his interest in both history and mathematics, there used to be confusion between Kosambi the historian and Kosambi the mathematician; strangely both had the same address! Kosambi, the mathematician, is well-known through his papers published in mathematical journals of various countries. On the basis of this work he was invited by the Chicago University and by the Institute of Advanced Study, Princeton, to lecture on his own work. At Princeton he had an opportunity to discuss with Einstein his own work as also the geometry of general Relativity. Kosambi's combination of statistical theory with geometrical methods has yielded furitful results and has had varied applications. Kosambi quotient is well-known in the science of Genetics.

Kosambi's consistent scientific approach to and sensitive feeling for literature have found more than adequate expression in his work on Bhartrihari Subhashitas.

All this varied intellectual work did not deter him from actively participating in the World Peace Movement. In those days, the Peace Movement was the most maligned and repressed movement all over the world. Even usually broad-minded people in India thought that Peace was Russian or Communist and did not hesitate to denounce it. This was the time when Kosambi came forth without hesitation to head the Peace movement. His intellectual stature, his reputation and standing among scientists of the world helped the growth of Peace movement in India.

It would be hardly an untruth to say that he worked for peace and understanding in the world more actively and earnestly than some peace prize-winners did when Peace became quite respectable. It was during this time too that he had to make his choice between world peace and retention of his job in Tata Institute of Fundamental Research. He decided that peace was infinitely beneficial, though not at all personally profitable. After this decision, curiously enough, he had to publish his mathematical papers under a pseudonym.

Kosambi worked to a rigorous and inviolable schedule. He would see visitors only for an hour in the evening. He was prepared to play with children and entertain them to a never-failing chocolate bar. He could crack a joke and enjoy one at his expense. But he could never take a tolerant view of cant, humbug and charlatanism which deservingly received a fair share of his sarcastic tongue and poor things felt ill-treated and never forgave him.

Soon after his last book, 'Civilisation and Culture of Ancient India' went to press, he chalked out a long programme of work for himself. He had been theoretically working on methods for exploiting solar energy and intended to go into practical experiments. He wanted to do in two or three volumes mediaeval and modern history of India. As a preliminary to this he was making preparations to study the twentieth century peasant movements in India. He had been engaged in guiding research on bird hormones and wanted to see it through. As an Emeritus Professor attached to the CSIR he was in the thick of scientific activities and projects. Above all, he had some new mathematical ideas to work on; for, a few weeks before his death, he wrote to me that he had a very "bad attack of mathematics and arthritis." All these plans were abruptly cut short. Death has made short shift of them.

Kosambi's death is a great loss to his family. It is an equally great loss to the cause of Indian science. But there is one consolation. Kosambi physically survived his first obituary. Now, he will survive because of his work.

KUSUM MADGAUKAR

ASWI Activities

Karaikudi Branch

At a General Body Meeting held on 14th March, 1966, the new Executive Committee took charge.

The Executive Committee has so far met six times this year on 7th, 18th and 29th March, 15th April, 25th and 30th May to transact business of routine nature and to pass policy resolutions.

Some of the resolutions passed related to the following subjects:—

(*i*) Recognition of CECRI as a research centre by the Madurai University.

(*ii*) Introduction of an Insurance Scheme to protect workers from accidents etc.

(*iii*) Making the retirement ages of scientific and technical personnel the same.

(*iv*) Revision of pay scales of the scientific and technical staff and stipend to Research Fellows.

(*v*) Overtime allowances admissible to all technical staff.

(*vi*) A.I.C. Examinations regarding Centre, subjects, recognition, Research diplomas, etc.

(*vii*) Setting up of semi-commercial units.

Shri K.S.A. Ganasekaran and Shri T.R. Venkata Subramanian attended the CEC meeting held at Delhi on 1st May, 1966.

The CEC has accepted in principle the idea of holding a National Symposium at Karaikudi by the end of this year under the auspices of the ASWI.

The Branch deputed Shri K.S.A. Ganasekaran as a delegate to assist the organisation of the CAAUST Sympsosium held in New Delhi during April 25-May 2, 1966. Shri T.R. Venkatasubramanian, Shri R. Viswanathan and Shri S. Kalyanaraman also took part in the symposium. The following papers from the Branch were presented:—

(*i*) Techno-Economic Cooperation Among the Developing Countries by T.R. Venkatasubramanian and M.A.V. Devanathan,

(*ii*) Scientists and psychological barriers by M.A.V. Devanathan, and

(*iii*) Education and Training of Scientific and Technological Personnel by K. C. Narasimham and S. Sampath.

ASWI Ordnance Establishments, Kirkee

The 19th annual general body meeting was held on 1st May at the "Andhra Association Hall". A short report of the proceedings of the meeting is as follows:

(1) New Executive Committee for the year 1966 was elected as under:—

Shree	S.V. Kulkarni	*Vice President*
,,	S.P. Saxena	*Secretary*
,,	B.N. Savadi	*Treasurer*
,,	T.R.N. Nair	Member
	A. K. Mukhopadhyay	,,
,,	V. D. Joshi	,,
,,	A.V. Thomas	,,
,,	V.N. Joshi	,,
,,	S. K. Khandkar	,,
,,	Y. D. Namjoshi	,,
,,	M.A. Bhave	,,

General Body authorised Executive Committee to nominate the President.

(2) *Resolution passed*:

Resolved that the bureau of such members, who can meet conveniently often, should be constituted by the E.C. The bureau will meet between two E.C. meetings and the bureau proceedings will be ratified by the E.C.

(3) *Amendments passed*:

As per the amendment passed by the Parliament to Trade Unions Act, our year will be from January to December instead of April to March, with immediate effect. Consequent on the change, the necessary amendments in the constitution are incorporated.

(4) General Body decided to continue the affiliation to A.S.W. India for 1966.

E. C. Meeting

Following business was transacted in the first meeting of the E.C. held on 15th May at the Association's Office:

(1) A. K. Mukhopadhyay was appointed as Joint Secretary.

(2) A resolution seeking a deposit of Rs. 5/- from those who loan books from the library of the association was passed. This is to check loss of books.

(3) Another resolution condoling the death of Mr. R.P. Paranjpe was passed.

(4) A bulletin sub-committee was constituted as follow:

A.V. Thomas .. Editor

S.P. Saxena

S.V. Kulkarni

(*Continued from page 9*)

This trajectory correction, called the mid-course manoeuvre, is required because of uncertainties in the launch operation that prevent absolute accuracy in placing a space craft on a trajectory that will intercept the moon.

More than 250 ground commands were required to control Surveyor during flight and after a successful landing on the moon. About 300 persons were involved in flight control at peak times in the mission.

With the soft-landing of Surveyor, America is hotly pursuing its objective of landing man on the moon in this decade. In quite a few respects, Surveyor is distinctive from Luna-9 which landed on the moon in February. For example, Surveyor stands 10 feet high and weighs 620 lbs., compared to the two-foot high, 220-pound Luna-9. It is powered by solar cells, unlike Luna-9 which carried batteries and consequently had a limited life, its picture transmission being confined to 48 hours.

All in all, the lunar probes in the first half of 1966 have brought the moon much closer to man.

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Editorial

ATOM BOMB OR ELSE !

Pakistan has recently circulated a document among the members of the United Nations charging India with near-preparedness to explode a nuclear device. In turn, India has reiterated its policy of development of nuclear energy for peaceful purposes only. Among our neighbours China has already gate-crashed into the nuclear club and demonstrated its ability to manufacture nuclear weapons. It would not suffer from unnecessary scruples in using them to attain its objectives. The possibility of Pakistan itself launching upon a programme of nuclear weapons' development cannot be lightly dismissed—in this it may receive the surreptitious support, scientific, material and military from the traditionally anti-Indian coterie of nations. This could perhaps also explain the Pakistan charge against India, for it may serve as a means to whip up public opinion in their own country to enable a major diversion of resources from nation-building activities to a nuclear armament programme.

Within India, public opinion is sharply divided and influential circles have advocated a break with the past policies. They argue that interests of national defence demand India going in for nuclear armaments with its own efforts if possible, with outside assistance if necessary. Threatening postures of Chinese and Pakistani armed forces on our borders and the possibility of clashes and invasion lend strength to the pro-armaments opinion. Even within the scientific circles there is a considerable section who would vote for the atom bomb. They maintain with considerable logic that if we have to live with threats of danger and invasion, it would be detrimental to public and defence morale and unfair to our Jawans to put them at comparative disadvantage against a nuclear armed enemy.

If the present state of tension continues, the arguments in favour of nuclear armament will progressively gather strength and public opinion will grow increasingly biased towards a change in policy. If that happens, resources both in terms of foreign exchange and rupee finance will have to be diverted from development programme, industrial projects, agriculture production and invested in this highly capital intensive non-productive activity. Prime Minister Smt. Indira Gandhi has already dismissed as 'completely nonsensical' the estimate of Rs. 17-18 lakhs as the cost of an atom bomb. The expenditure will be many times higher and coupled with the need for perfecting a delivery system—it will mean a sizeable investment. Considering the strain that the recent border war has caused on the economies of India and Pakistan and the fact that even now both countries are spending an unduly high proportion of their income on defence, a major drain of resources for nuclear armaments can only mean an economic disaster. In its mildest form it may mean a crippled economy and an impoverished people, in case of virulence the situation may

(Continued on page 2)

Frankly Speaking

A 'MORAL' LESSON

Those who have always adopted a 'holier than thou' attitude in international forums and excelled in prudery as heirs of Buddha, Gandhi and Nehru, must feel dazed at the jolt to their 'peaceful' complacency by the growing pro-nuclear armament opinion. A few baby bombs on our border towns and the yet 'underdeveloped' Chinese atomic explosion, and the spiritual heritage eased out through the back door. The stark realities of a military and political situation have dampened the oratorical skill of those adept in giving homilies on universal peace and brotherhood from carefully tended platforms. The common man in India has reacted with the same instinct of self-preservation and defiance as his counterpart in any part of the globe. The ball is squarely in the court of the scientist, the economist and the political leader—the moralist has double-faulted and lost the match.

The socio-scientific activity is at a low ebb. Devaluation, economy measures and tight domestic budgets have turned the sights inwards—even of the scientific community. Specialists in science, technology and economics of the nucleus are busy with problems other than the opinion drift in the direction of destructive uses of the atom. While the moralist is bowled out, will the scientist be leg before.....!

(*Continued from page 1*)

be pushover to surrender of national sovereignty and prestige.

Can we escape what appears as the inevitable logic of the drift towards the atom bomb? The answer lies with scientists only partly and is tied up with the overall strategy of working out a programme of peace and neighbourly relations with these countries. In this context, the words of President S. Radhakrishnan in his eve of the Independence Day broadcast, acquire an outstanding significance. His was a forthright call to reason and commonsense for finding an acceptable formula for peace and amity with China and Pakistan. We cannot live in enmity with our neighbours for all time to come. Can we project to the neighbours and to the world at large, the image of a country determined but reasonable in its approach to solution of its border problems. To this solution, there is an escapable question: what happens if our 'reasonable' approach is rejected. The answer is too terrible to be stated—economic ruin and disaster.

It is in this formidable and still essential task of convincing the authorities and the people in India, Pakistan and China of the imperative need of peaceful solution to our problems—lies our salvation. It is incumbent on the scientists of these countries to marshal facts and figures and bring home to the powers that be, the consequences of drift towards the atom bomb—particularly in the developing countries, where economy is resource-hungry and under pressure of rising population with a low standard of living. In this task the scientists will have the support of all right thinking people.

India and Atom Bomb

M. RAMAMOORTHY*

The Birth of New Age of Atomic Energy

Mankind's successful transition to new age, the Atomic Age, ushered in July 16, 1945, before the eyes of a tense group of renowned scientists and military men gathered in the desertlands of New Mexico to witness the first end results of their $200,000,000 effort is however, the culmination of the work of scientists from many nations, the pooling of the scientific and natural resources of the United States, Britain and Canada. Here in a remote section of the Alamogordo Air Base 120 miles Southeast of Albuquerque, the first man-made atomic explosion, the outstanding achievement of nuclear science, was achieved at 5.30 a.m. on that day. Darkening heavens, pouring rain and lightning immediately up to the zero hour, heightened the drama.

Mounted on a steel tower, a revolutionary weapon destined to change war as we know it, or which may even be the instrumentality to end all wars, was set off with an impact which signalized man's entrance into a new physical world. Suceess was greater than the most ambitious estimates. A small amount of matter, the product of a chain of huge specially constructed industrial plants, was made to release the energy of the universe locked up within the atom bomb from the beginning of time. A fabulous achievement had been reached. Speculative theory barely established in pre-war laboratories, had been projected into practicality. Atomic fission would no longer be hidden in the cloisters of the theoretical physicists' dreams. It was almost full grown at birth. It was a great new force to be used for good or for evil. All seemed to feel that they had been present at the birth of new age—The Age of Atomic Energy—and felt their profound responsibility to help in guiding into right channels the tremendous forces which had been unlocked for the first time in history. As to the future, there had been brought into being something big and something new that would prove to be immeasurably more important than the discovery of electricity or any of the other great discoveries which have so much affected our existence.

The Bomb And Peking's Prestige

To proliferate or not to proliferate? To make the bomb or not to make? Whether any searching scrutiny has been initiated by the Government in consultation with their military and scientific advisers about the atomic bomb is doubtful though reportedly certain probings and soundings have been made. Within the past two years China has exploded two atom bombs and is on the way to becoming an operational nuclear power. The two explosions in the deserts of Chinese Sinkiang have convinced Western experts that China is producing her own Uranium-235 at the gaseous diffusion plant which the Russians apparently earlier helped to construct at Lanchow, the new industrial centre in West China.

The major Uranium plant is at Lanchow. Since a gaseous diffusion plant of this type, involves not only high cost but a high consumption of power to generate

*Electrolytic Cells Division, Central Electrochemical Research Institute Karaikudi.

the energy required, it would appear that Peking has found not only a cheaper way of producing Uranium-235 but also a device for using less power. At her present rate of progress China will have an H-bomb by 1970. Large plants for the actual production of bombs are located near Peking, Tientsin, Chungking, Shenyang and Sian. The Chinese capacity to make fissionable material is currently far ahead of India's. Unknown to United States, China has completed gaseous diffusion plant to make enriched uranium—Americans had thought it would take a long time for that plant to be completed—and her capacity to produce Plutonium has also exceeded expectations.

Communist China is building a giant gaseous diffusion plant which would enable her to produce on mass scale atomic and hydrogen bomb material. About 7000 grams Plutonium are needed to build Hiroshima-type bomb or device. It is believed Communist China obtained nuclear fuel for its explosion from the home-made reactor. The device used for explosion appears to be a close copy of bomb dropped on Hiroshima. This would mean Chinese Communists detonated 10 to 20 Kilo-ton Plutonium device, from the test tower by the guided missile or by the sub-sonic Ilushyn-18 Jet Bomber. But experts in Washington believe it would take three to five years for China to build an atomic bomb which can be dropped from air. It should take ten to fifteen years to construct sophisticated delivery vehicles. The London Institute of Strategic Studies estimates these plants turn out 20 to 50 atomic bombs per year. But it is still the Lop Nor installation that symbolised Red China's nuclear test facility. Teams from the Lop Nor installation, fused Red China's first atomic explosion on the adjacent desert on October 16, 1964. The same teams detonated Peking's second blast on May 13, 1965.

China in her second atomic test in May, 1965, exploded in flight a nuclear war-head carried by a guided missile (?) thereby demonstrating that she is capable of becoming a full nuclear power earlier than Western authorities had estimated. Just as Chenghiz Khan used Lop Nor as a stepping stone to new victories, for the Red Chinese it is a symbol of the increased political power that automatically accrues to any member of the "Nuclear Club."

The Western Trained Chinese Scientists Who Made It Possible

China began its nuclear development programme about seven years ago with strong Soviet support. Russia gave Communist China a number of atomic reactors including an 8,000-Kilowatt atomic reactor which helped Peking to produce Plutonium for the recent atomic blast. After some years, when the Russians withdrew their help the programme was slowed down but not abandoned. For the sake of their national pride they set back some sectors of the economy and gave the nuclear programme top priority.

Mao sent for his scientists, met them at a conference and selected a handful of them to go ahead with his ambitious plan. The men whom he chose were American, British or Russian-trained scientists. Thus, it is seen that the West itself contributed to the Chinese development of the nuclear bomb. It is said that at present there are some half a dozen reactors throughout China which are capable of producing Plutonium for nuclear weapons.

The world is having second thoughts on China's explosion of her nuclear device which evidently is more sophisticated and advanced than was originally suspected. Its low-yield blast initially suggested that it represented a small, crude Plutonium bomb which was described as technically primi-

tive. China, however, seems to have exploded a nuclear bomb, in which enriched Uranium, known as Uranium-235, and not Plutonium was used. This Uranium is produced from naturally occurring ore of Uranium-238 and is a fissionable isotope of Uranium from which fusion weapons are developed, a process which normally takes five years. Plutonium, a by-product of nuclear rectors, is less complicated to extract since reactors fueled with Uranium produce Plutonium automatically as the Trombay Reactor does. Its yield is in the neighbourhood of ten Kilograms of Plutonium annually, enough for two atomic bombs. The Chinese, however, have obviously developed a plant for separating Uranium-235 from natural Uranium which places them some jumps ahead of India and at least a jump ahead of France which has yet to develop this technique. Russian nuclear scientists helped the Chinese from 1958 to 1960 in putting up a nuclear reactor capable of producing Uranium-235. This is believed to be located in Paotow in inner Mongolia. They have another plant, sited near Lanchow in the Kansu Province, for producing Uranium-235 by means of gaseous diffusion of Uranium Hexafluoride. This was the method the Americans employed to produce their first atomic bomb.

China Could Test H-Bomb Early

According to Physicist Dr. Lapp, the Chinese nuclear establishment is far vaster than is generally realised in India. The eight-acre gaseous diffusion plant near Lanchow would be capable initially of producing enough fissionable material for one moderate-sized atomic bomb every month. This output could eventually be increased to two in a month from one plant.

Mr. David R. Inglis, American Physicist, has stated that the Chinese production of fissionable material is more substantial than we would otherwise have guessed. It also means that they have greater versatality of production and are more independent of other countries in further production than we might have thought. He said it was entirely possible that China's first hydrogen bomb test might follow her atom bomb more quickly than had been the case in any other country.

Did China Explode Uranium Bomb Or Conduct Tests For A-Bomb?

Dr. Switaaro Koyama, Professor in the Analytical Chemistry laboratory of Niigata University, North Eastern Japan, had analysed 50 intense radiation particles in the fall out over Niigata from the last Chinese nuclear blast and seven radio isotopes found in rain water. Dr. Koyama said, reporting on the results, the mechanism of nuclear explosion this time had become large-scaled and the bomb's performance rendered higher. It is quite possible that it was a Uranium-235 bomb.

A group of meteorological scientists in Japan reported the possibility that the two nuclear bomb experiments carried out by Communist China in the past were partly preliminary tests to develop hydrogen bombs. The group of scientists, led by Dr. Yasuo Miyake of the Geochemical Laboratory of the Meteorological Research Institute of the Government's Meteorological Agency, made this report in their paper presented to the ninth national radiochemical panel discussion at Hiroshima University. The group based its belief on chemical analysis of fallouts obtained from rainfall following the Communist Chinese nuclear bomb detonation of October 1964 and May 1965. The Uppsala Observatory in Stockholm reported that the second Chinese atom bomb exploded was at least three times more powerful than the first one detonated on Oct. 16, 1964. Prof. Markus Baath, Director

of the Seismographic Institute at the Observatory, said the size of the bomb was about 70 Kilotons. (The first bomb was about 20 Kilotons).

China's Second Bomb & 1963 Partial Test Ban Treaty

China is exploding her way into the Nuclear Club and through that to the international forum from which she has been excluded by pressure of certain countries. The tempatation to invest the explosion of China's second bomb with a method of sinister timing can be unduly magnified. Essentially, the timing of China's second atomic bomb has political rather than technical significance. This is that China does not subscribe to the 1963 Partial Test Ban Treaty and is therefore, despite her protestations, not really against the proliferation of nuclear weapons. It would be unrealistic to deny that the speed of China's nuclear advances is greater than was originally suspected. The first bomb which was exploded on October 16, 1964, surprised American experts by its use of the sophisticated U-235 enriched Uranium. The second test appears to be on the same sophisticated pattern. Among other countries, India, Sweden, Switzerland and Israel could in the view of competent judges explode nuclear devices if they so desired with comparatively small effort.

Nuclear China "Most Disturbing" Problem For U.S.

The U.S. Atomic Energy Commission has said that Red China's second blast, like the first one, was a fission weapon using Uranium-235 as the explosive. The AEC estimated that the second device was an improvement over the first and was equal in power to slightly more than 20,000 tons of TNT.

This would make the blast slightly more powerful than China's first explosion and the U.S. bombs dropped during World War II on Hiroshima and Nagasaki. All three of these were the equivalent of about 20,000 tons TNT. The second Chinese atomic explosion is invested in Washington with profound significance. It was certainly expected. American officials had been warning since February 1965 that it was coming. The shock effect, however, was not less because the event was not unexpected. Much of the U.S. assessment of Communist Chinese nuclear potential is classified, and it indicates that the United States had in the year 1964 upgraded the Chinese threat. Already, with no nuclear capability Communist Chinese government possesses "a huge land army." This land army assumes additional significance in the context of the nuclear capability which Communist China will undoubtedly build in 10 or 15 years. Even today the United States has to take the Chinese threat seriously. It is abundantly clear from Mr. McNamara's testimony that when the United States talks of the Chinese threat, it does so in terms of a threat to the United States mainland.

The document that Mr. McNamara presented was a remarkable one. It takes full note of the fact that the defence of a country cannot be divorced from such other apparently non-military factors as the growth rate of the economy, the state of the governmental apparatus, balance of payments, the condition of the agricultural sector of the economy and so on. Here again, China's red star is rising. She has many weaknesses in her economy and in her armed forces as organised today. However, Mr. McNamara says, "on the economic front, given reasonable weather and rational policies, there seems to be no reason why growth cannot continue". On the military side, she is able to exploit the impact of the nuclear explosion politically and psychologically. They will certainly continue to support

subversion and insurrection in Asia and attempt to gain control of revolutionary governments in the world. And further United States Defence Secretary, Robert McNamara has warned that Communist China's expanding nuclear capacity poses a most disturbing long-term problem for the United States. This is the first time a top ranking Administration spokesman has stated that the Chinese nuclear power is a potential threat not only to China's immediate neighbours like India but also to the American mainland. Mr. McNamara said that China would have the capability of launching a small nuclear attack on the United States in the 70's. Mr. McNamara added while this nuclear development might be slow there was no reason to suppose that Chinese could not in time produce medium-range and even long-range ballistic missile systems and arm themselves with thermo-nuclear warheads. He claimed, however, that the direct nuclear threat to the United States could be nullified by developing or shifting American defences before the foreign delivery systems were established.

The most sombre part of Defence Secretary's testimony before the House of Representatives Armed Services Committee, was his warning against underestimating the potential nuclear peril from China. He said, "The nuclear explosion in October 1964, provided confirmation that the Chinese Communist leaders are determined to produce modern armaments even though the cost be great. That the nuclear programme was able to continue in spite of a very severe economic crisis is testimony to the determination of the Chinese to produce modern weapons." Dr. Edward Teller, who developed the American Hydrogen bomb, warned that in a few years' time (Dr. Lapp, who worked on the original American atom bomb, feels it would be much less than ten years) the Chinese may have rockets to blackmail anybody, including the United States. Dr. Teller urged that the United States should start building anti-missile defences so that the United States could not be blackmailed. He believed such defences could be set up against newcomers like China.

U.S. For Cultural Contacts With China

A Congress Foreign Affairs Sub-committee in Washington has recommended limited, direct contacts between America and China primarily through cultural contacts by scholars and journalists. This should be considered at an appropriate time, the Committee says in a report, written before China's second atom bomb explosion. The report says, "China has become a nuclear power. Within five years it can be expected that she will have developed a limited delivery capability adequate to reach and intimidate Japan, the Philipines, nearly all of Southern and South-east Asia, and a large part of Russia. With nearly 1000 million Chinese led by militant leaders having nuclear warfare capability on her borders, Russia may find it necessary to make an accommodation with China or seek defensive alliances with the West.

Chinese Nuclear Explosion's Psychological Effect

Assuming, and with reasonable justification, that the Chinese nuclear explosion does not pose an immediate threat of war, it does not necessarily mean that acquisition of knowledge to manufacture this weapon is not a threat to peace. In fact it is a near certainty that China will exploit her newly acquired strength for this purpose. That exploitation will naturally be based on the knowledge that the countries of Asia and Africa can be influenced politically while

the bomb remains stored in its arsenal. In other words, the effect that will be sought will be psychological. China herself need not brandish openly the strength that she possesses. The mere knowledge of it will sway opinion in a large part of the world. Her membership of the Nuclear Club of five world powers gives her a status of which the bomb is a symbol. Americans do not seem to comprehend the intolerable psychological effects of the possession of crude bombs, capable of being delivered by obselete bombers on neighbours like India, until we too develop a retaliatory capability.

Ambassador Bowels, in the General Electric Forum, says: "India shares, perhaps more than any other country in the world, our concern over the aggressive potential of China. If China should succeed in overrunning South East Asia, it would be a serious set-back to India."

Chinese Blast Evokes Mixed Feelings in Tokyo

There is speculation in Tokyo that the second Chinese atom bomb was dropped from the air or detonated in the air, possibly by a guided missile with a nuclear warhead. Even if it is not true, the bomb had been dropped from the air and it is a dangerous development. Whatever, it is, the major powers have underestimated China's capability in this field. In Japan, the country that claims to be the "first" to be atom-bombed and never misses to remind the world of the fact, the news was received with mixed feelings. The second test came as no surprise to Japan but there is a deepening feeling of anxiety and worry everywhere.

The question is what does China want to achieve ? It has no capability and won't have it in the near future, to hit back at the U.S. or even Soviet Russia, or for that matter any of the European powers with nuclear capability, in case she is involved in a shooting war with any of them. Then, the only possibility is Asia and among the Asian countries only two nations, India and Japan, the rest being either friends or too small to reckon with. Whatever it is, the Japanese are divided in their opinion over the blast and their protests sound too lukewarm to take seriously as such. She wants trade with China and does not want to displease her. On the other hand, she is afraid of her rising power and rivalry for Asian leadership.

But why did China test the A-bomb against world opinion? Now that it has tested two bombs, will it stop at that? In the absence of any direct access to the Communist mind, scores of theories are being pressed forward. One point is that the test was meant as a direct hit at India, Yugoslavia and the UAR. As far as India is concerned, Peking will now get tougher and will not agree to talk terms with India's leaders except on her own terms. The second reason, which is equally important, is to warn the world powers, particularly the USA, that China could not be ignored in any international conferences and that agreements could be effective only with China's blessings. The Chinese leaders know that they have neither ability nor the capacity for another 10 years to watch the American nuclear might. However, from the present atmosphere it appears that the tide is in favour of the Chinese. Now that Peking has qualified itself for the associate membership of the nuclear club it is likely to demand that the old order be restored and that China be accepted as one of the Big Five. Though China may not succeed in her aim to communise Asia, she has proved that she is the biggest power in Asia and that the destiny of Asians cannot be changed without her approval.

India's Prestige Suffers Jolt in South East Asia

India's prestige in South-East Asia has suffered yet another jolt as the result of Peking's atomic test. But the fact remains that by a single test, Peking has not only qualified itself for admission to the Nuclear Club but has also achieved a tremendous psychological victory over the smaller countries in South-East Asia which had earlier looked to India for inspiration because of close cultural and religious ties. For a man in the street it does not matter whether the Chinese atom bomb would be more effective or not than the Western nuclear weapons. What impresses him is that China, an Asian country, has produced an atom bomb and that one should be on its right side whether one likes it or not.

Premier Chou En-lai told in an interview in Peking that the atomic bomb exploded by China on Oct. 16, 1964, was bigger than those dropped on Hiroshima and Nagasaki by the United States in 1945. He said, "it is true that as compared with nuclear weapons now in the hands of the United States our atom is insignificant. But we are after all now in possession of it and it is the fruit of our own efforts — efforts of Asians".

Will then India also produce an atom bomb ? Or can it produce one ? — this is a common question which an ordinary Thai, Cambodian, Laotian or Malaysian asks. When told that India, if it wants, can make atom or even nuclear bombs within 18 months, they doubt its authenticity and begin to doubt India's ability to match the Chinese. According to the sober diplomats, India, if it wants to counter the Chinese propaganda, will have to prove that it is capable of producing superior weapons. How India should do this, depends upon the Indian nuclear scientists. They say that Japan with its technical superiority can always produce destructive weapons but it would not do so because it has experienced an atom bomb horror. The tussle is primarily between India and China.

"India has Capacity to be a Nuclear power" says U.K. Expert

Western sources accept without question India's technical capacity to produce the bomb. In the Listener of May 13, 1965, Alastir Buchan, Director of the Institute of Strategic Studies, writes: "For about 15 years India has been devoting a high percentage of her limited scientific resources to nuclear research under the direction of the dynamic Dr. H. J. Bhabha. Since about 1958 the programme has been shaped in such a way as to make it possible to produce weapons-grade Plutonium, and the last stone in the arch was completed when a chemical separation plant went into operation at Trombay, near Bombay, in August 1965. There is no reason to doubt Dr. Bhabha's claim that India could explode her first nuclear device within twelve months of deciding to do so. Figures have been canvassed in India suggesting that India could build up a stock of 50, 20-kiloton bombs for as little as £18,000,000. This assessment by a noted British Military Expert is widely accepted in all quarters, Western and Eastern."

Washington Experts fully supported late Dr. H.J. Bhabha's claim

Experts in Washington fully supported the statement made by the then Chairman of the Indian Atomic Energy Commission, late Dr. H. J. Bhabha that the cost of producing atomic bomb is low. In several ways high officials of United States have hinted that nuclear deterrent is well within India's capacity—deterrent not in the American sense of having a whole range of sophisti-

cated weapons and delivery vehicles but deterrent of the kind comparable to what India's neighbour, China, will have. Defence Secretary Mc Namara said: "Nuclear technology is advancing so rapidly that the cost of building a minimum nuclear capability is decreasing every year in terms of capital expenditure, human skills, and time".

India's Nuclear Deterrent

An expert assessment shows that the present Chinese fleet of sub-sonic Ilushyn-18 jet bombers is capable of delivering a nulcear device as heavy as "Little Boy", the Hiroshima bomb, which weighed 10,000 lbs. The Soviet designed them precisely for such a mission. How such economy in weight is possible is shown by the fact that the Nagasaki bomb dropped a few days later weighed only 6000 lbs. In the past twenty years the dissemination of knowledge of fissionable materials has given both China and India the "Know-How" to pack a "20-kiloton" punch into a device weighing only 2000 lbs. Thus the Chinese Air Force qualifies as credible on one of the two counts. Military parity between Asia's two giants therefore requires that an immediate start be made in the manufacture of Indian nuclear weapons. The strenthening and concentration of our Army in the Himalayas without a nuclear cover, makes no sense !

The Pakistani spokesman, Mr. Aga Shahi, during a debate in the U.N. Political Committee on the non-proliferation of nuclear weapons, accused India of having made "tremendous" advance in nuclear technology, an unintended compliment which our spokesman Mr. V. C. Trivedi, accepted. India has indeed made tremendous advance in nuclear technology since she started her programme for peaceful utilisation of nuclear energy in 1954.

Trombay can make Yearly two A-Bombs

According to statistics in the seventh annual report of the Institute for Strategic Studies, the Canada-India Reactor (CIR) at Trombay near Bombay with a power rating of forty thermal megawatts has the potentiality to make two atom bombs a year. For an ordinary or average atom bomb it had been calculated that five kilograms of Plutonium was needed and that four thermal megawatts had the capacity to yield one kilogram of Plutonium. It was on the basis of such a calculation that it had been estimated that India's present atomic reactor, if it were switched over to production of nuclear weapons, could produce at the rate of two bombs a year. The potentialities of the new nuclear reactors which India is either building or proposes to build, are given as follows:

.."Tarapur with an estimated power rating of 380 electrical megawatts, 76 possible bombs a year; Rajasthan reactor with a rating of 200 electrical megawatts, 40 possible bombs annually and Madras nuclear station with an estimate rating of 400 electrical megawatts, 80 possible bombs a year." However, it made clear that the data analysis about bombs was only hypothetical and it was not assumed that the reactors would be switched over to nuclear arms production.

India's A-Bomb: Canada Disturbed

The Canadian Government, which has supplied the basic pre-requisites of India's nuclear energy programme, is taking "a critical view" of any possible use by India of these facilities for making nuclear weapons. The Canadian government has issued a statement stressing that Canada's research reactor was for peaceful purposes only. Canada has been trying for sometime to get an effective international agreement preventing further dissemination of nuclear weapons.

Pakistan Sniffs at Canada's Reactor Offer to India

Canada is to establish a 200-megawatt reactor in Rajasthan under a 1963 agreement. "Pakistan wants Canada to refuse to supply the proposed nuclear power reactor to India until India accepts international inspection of her use of it and also Canada may be requested to prevent India from acquiring control of the separation of Plutonium from the reactor, Canada provided India in 1954" ——the Pakistan Foreign Ministry said in Karachi. But the Canadian Government had assured Pakistan that it was aware of its responsibility to ensure that Canadian equipment and technology was used only for peaceful purposes — and that applied in transactions with other countries as well as India. Canada and the United States, which is also supplying India with a reactor, both assured Pakistan that their agreements with India contained effective safeguards and inspection rights for donor Governments. But this has obviously had no effect on Pakistani authorities who are fearful that India's pledges are not dependable. This pledge of India had been acknowledged by the Canadian Foreign Minister, Mr. Paul Martin, in the House of Commons on Nov. 4, 1964. 'Pakistani concern about Indian venture into the nuclear arena may have been understandable but her unconcealed glee about China's impressive entry into the nuclear club' makes her motives suspect. If Pakistan is worried about proliferation of nuclear weapons in the neighbouring countries she should have protested against China's test.

Johnson May Press India Not to Make A-Bomb

Some political observers in Washington believe President Johnson may press India not to develop nuclear weapons. Part of the reason for the American resistance to the idea of an atomic explosion by India is that United States is not psychologically prepared to accept India as a great power.

... Entry into Nuclear Club whether by explosion of the bomb or test for peaceful purposes, necessarily involves that status regardless of India's economic weakness. It is felt by some that while United States will do everything possible to persuade India not to conduct a test, if India actually does so, she will adjust herself to the situation in view of long-term interests between two countries. And further United States Defence Secretary, Robert McNamara said that India's entry into nuclear race would probably substantially accelerate the spread of nuclear weapons in other countries not only in Asia but also throughout the world. He hinted that President Johnson's offer to support nations against nuclear blackmail covered also India, though other equally weighty sources have suggested that American nuclear protection is automatically available to its allies. Mr. McNamara said, "Mr. Johnson's offer of support to non-nuclear countries facing nuclear threat signalled our willingness to take action to prevent this spread." He conceded that "overshadowing all other issues, of course, is Chinese Communist detonation of a nuclear device and that the prospect of an unfriendly neighbour on its northern border armed with nuclear weapons is understandably disturbing to the Indian Government and the people." The main reason why Americans oppose India building nuclear bomb is the fact that they have vital interests both in India and Pakistan and if India produces atomic bomb their relations with Pakistan will deteriorate further. The Johnson administration is reportedly re-examining the idea of guaranteeing either unilaterally or with other non-nuclear nations against nuclear blackmail by those that have weapons. This issue is regarded

urgent in view of the growing demand in India for an atomic test and the refusal of the Indian public opinion to regard the mere American press and radio statements as constituting a guarantee, which under American system has to be ratified by the Senate. However, the American efforts to prevent India from going in for nuclear bomb are vitiated by confession by American spokesmen that one of their chief aims is to prevent Karachi from being mentally disturbed by the Indian effort.

Indian observers suspect that the chief reason why the United States would like India not to make the atom bomb is the impact of the Indian decision on America's uncertain ally, Pakistan. This may be good enough for the United States but is it so for India ? The United States has no sympathy for the Indian view that all atomic weapons in the world must be destroyed. The United States has expended billions of dollars of hard-earned taxpayer's money on its nuclear arsenal and it is not going to destroy them. It does not believe that the Sovient Union would be willing to destroy its weapons under any circumstances. While the United States had declared that it would like to see membership of the Nuclear Club kept to the minimum, it has not given any indication, publicly or privately, that it will automatically go to India's help if she feels menaced by Communist China.

...The big powers who between themselves are unable to agree to cut down their nuclear stockpiles are in no moral position to preach to the non-nuclear countries whether they should or should not proliferate ? The American argument against proliferation of nuclear weapons to small nations cannot apply to India because India is world's largest democracy and is not despite her economic weakness in any sense a small nation ! China, which has twice exploded the bomb, has declared that she would never be the first to use nuclear weapons, thereby deliberately demonstrating that she has not only the power to do so but the sense of responsibility to refrain from doing it. Why should India not do likewise ? As the second largest country in the world and also as the most populous democracy on the globe, this would transform her flabby image and give teeth to her power status !

Sweden's Blackmail Against Nuclear India!

According to Swedish Defence Minister Sven Anderson, Sweden will develop its own independent nuclear defence system if attempts to prevent nuclear proliferation are a failure. Sweden would already have an atomic force if it had really wanted one. A leader of Sweden's majority Social Democratic Party, Mr. Anderson stated in an interview: "We have the technical know-how, we have the financial means and we have gone as far as we wished in research, short of producing prototype weapons. Our policy is to be ready to develop a nuclear deterrent if necessary but, until further notice, we are absobutely opposed to the widening of the atomic club. If Sweden went ahead with the production of nuclear weapons, this would encourage such nations (India ?), to do likewise, and you can imagine the result. By pushing forward our planning and research in the nuclear field we are giving the big powers a hint of what could happen if they don't step-up their non-proliferation efforts". He added that several nations of Europe including Switzerland and Spain, as well as such other countries as Israel and Egypt, could probably produce a nuclear force. Sweden, which had followed a policy of strict neutrality and which had not been at war since 1814, would spend for defence in 1965, 5 percent of its gross national product.

India Must Have Atomic Explosive Devices

Prof. Humayun Kabir, Ex-Union Minister for petroleum and chemicals said that India should have atomic explosive devices for developmental activities and that research should be taken up in this direction to keep pace with technological progress in other parts of the world.

Such development should include nuclear explosions for peaceful purposes. This may be for making artificial lakes, construction of irrigation or navigation canals or using them for controlling the flow of rivers. This will be consistent with India's policy of using atomic energy only for peaceful purposes and at the same time demonstrate to the world that India has the technology necessary for making atom bombs. When India would be in a position to produce her atomic devices the world would realise that India had the capacity to produce atomic bombs, whenever she wanted but deliberately refrained from using nuclear bomb for military purposes.

Nuclear Explosions for Peaceful Purposes

Late Prime Minister Shastri had declared that India intended to use nuclear energy in different projects such as building of dams, canals, tunnels and so forth. Observers in Washington point out that while technology for making nuclear bomb and for nuclear explosion for purely peaceful purposes may be same, India will be violating no international agreement by engaging in peaceful underground nuclear tests. For obvious reasons the United States will be happy if India does not conduct tests even for peaceful uses but this would mean India is left behind in nuclear age as she was during industrial revolution. The consequences of backwardness in nuclear age will be even disastrous than failure to enter industrial age which led to slavery for India at the hands of Britain, France and Portugal. In January 1965, Mr. Shastri inaugurated a plant near Bombay to extract Plutonium from spent reactor fuel. As was then pointed out, this forms a legitimate part of the peaceful nuclear programme since India requires Plutonium as a second atomic fuel and later for use in breeder reactors for converting Thorium, which is abundantly available in India, to U-233. This process is necessary in order to establish a self-sufficient fuel cycle and is within the terms of our agreement with Canada. The peaceful uses of the atom are varied and have been employed for electric power, hydrology, automation, medicine and various other purposes. Nothing prevents India from accelerating further developments on this peaceful plane.

When one thinks of setting off a nuclear or thermonuclear explosion, one instinctively associates it with warlike aims. But this is a great mistake. The U.S. Atomic Energy Commission in its "Plowshare Programme" and other projects has emphasized the industrial and scientific uses of nuclear explosives, based on the idea that the tremendous and relatively inexpensive energy released in a nuclear or thermonuclear explosion can be used for constructive purposes.

Nuclear explosions can be divided into two broad categories — contained explosions and cratering explosions. Contained nuclear explosions shatter rock underground, which could have value in mining and oil and gas production. It also appears that certain valuable radio-isotopes can be produced in and recovered from contained nuclear detonations. Most plans for using nuclear explosions for scientific research involve contained detonations. Industrial uses for cratering explosions depend primarily upon the energy from nuclear explosives to move earth. In this way it appears possible to simplify construction of

harbours, transportations and water conveyance canals and storage reservoirs. Of the many potential industrial applications for nuclear explosives, excavating earth is the most certain of being accomplished with large economic gains.

...The tremendous power of nuclear explosives makes it possible to build broad deep, easily, navigable sea-level canals at less cost than a conventional lock canal. Of special interest is the possibility of using contained explosives in the development of water resources by creating underground reservoirs and by fracturing impermeable strata blocking the connection of the surface to the porous water-bearing strata below the ground.

India's Choice

Even if India, for reasons good or bad, were to decide not to make a single nuclear or thermonuclear weapon, she has every moral and material reason to try to master the technology of nuclear and thermonuclear explosions. We can do so with the sole aim of using modern technology to overcome the backwardness of centuries. India owes her political slavery for centuries and her economic weaknesses to her neglect among other things of technological processes developed elsewhere. If we are to have some chance of making up for past neglect, at least we should take full advantage of the vistas being opened up by nuclear and thermonuclear energy. Nuclear and thermonuclear explosions are important and potentially the most important aspect of modern technology and the second most populous nation in the world cannot afford to take a back seat because the late Prime Minister made a commitment that India will not go in for the manufacture of nuclear weapons !

Should India Manufacture Atom Bomb ?

Vijnan Karmee had contacted persons in different walks of life in order to elicit their opinion on the topic 'Should India Manufacture Atom Bomb'? The views of these people are given below :—

VIEWS OF MEMBERS OF PARLIAMENT

SHRI P.N. SAPRU (CONG.)

"I am opposed to the manufacture of Atom Bomb for this country. It will not add to our security and its manufacture will be opposed to the stand that we have taken on *inter alia* ethical grounds against it. The problem controlling the manufacture of atom bombs and indeed eliminating them altogether, complicated as it is on account of the attitude of some big powers, will become very much more difficult if we were also to become an atomic power. We need to spend all the energy we possess for building up our social and economic strength for we have big problems of poverty, disease, ignorance, superstition and finding employment for our young people, to tackle. I do not think that we can solve our problems of border disputes with China or any other country by the manufacture of atom bombs. We need to review our policy with our neighbouring states and we should not give up our policy of solving our problems by peaceful means. This will be in accordance with the traditions which we have inherited from Gandhiji and Nehruji. My view is that we should display vision, imagination and a big mind in approaching this problem."

SHRI HIREN MUKHERJEE (COMM.)

"I am positive that India should not manufacture the Atom Bomb.

This country had made clear its policy in this regard, and I hope that inspite of provocations and temptations we continue determinedly to adhere to it.

Knowledge is power. It should grow more to more, but society should make sure that power is used beneficiantly for humanity.

Let India devote herself to the task of accummulating atomic knowledge and use it for the good of her people and of all the world.

We are against the proliferation of atomic weapons. Such proliferation increases the terrible hazard of the most wicked kind of warfare. It solves no problems. It helps no sensible purpose. It means a normally inconceivable form of self destruction, in so far as human civilization and its values are concerned.

In this country we have inherited certain traditions which incline us strongly against the atomic weapons. But that is not the only reason, nor the decisive reason for our being against it.

Atomic warfare is a noxious and primarily offensive weapon. It is not a defensive weapon, except in so far as it is intended to prevent (by an implied but not very effective threat) the other fellow from using it. It is morally opprobrious, militarily devastating, politically stupid and humanly intolerable.

Should the world seek to live in peace by achieving a balance of fear ? It is inhuman and impractical.

There is no end —but the end of human life and dignity—to competition between States for possession of the devilish weapon. "China has it, therefore let us also have it" is a most dreadfully naive and dangerous notion. It leads nowhere but towards the prospect of mutual disaster.

It is hard enough that the Super Powers possess this terrible weapon. They can plunge humanity into the cruellest abyss. It will be no better if the chances of destroying practically the human race, are increased by a further competition among lesser powers.

Non-proliferation of nuclear weapons, here and now, abolition of them and destruction of all stockpiles tomorrow—that is the wish of all who care for peace and the survival and development of human civilization.

India cannot but share this wish most deeply. Let not specious arguments and a false sense of national pride and the requirements of security deflect this country from the policy in this regard which Jawaharlal Nehru had laid down."

SHRI C. K. BHATTACHARYA (CONG.)

"About the Atom Bomb I have a conviction. The Bomb has been used in human history only once. It will not be used for a second time. How and why this conviction has grown I cannot say. But it is there. The manufacture and exploding of nuclear devices continue around. But "Manava-dharma", will ultimately prevail. Having seen once the consequences of the use of this bomb, human conscience will make another use of it impossible. In the words of Gandhiji:

'Behind the death-dealing Bomb there is the human hand that releases it and behind that still is the human heart that sets the hand in motion.'

In a second attempt the heart will revolt.

With this conviction it is easy for me to state that India need not go in for its manufacture. But I shall not be dogmatic. I am quite prepared to concede the other point of view. Let me agree that for her own safety, India should have the up-to-date weapons of war.

Here comes the question. Should the Atom Bomb be regarded as a weapon of war ? To me it is not, it is something beyond. It is an instrument of mass destruction. The possibility of wars is accepted in society and weapons are meant for wars. That is why a code has been formulated and accepted about the character and use of war weapons. Certain types of destructive devices are banned though these are effective killers. This has been done because of the inhumanity involved in their use. The use of war weapons are restricted to the parties fighting. The Atom Bomb cannot be brought under the recognised restriction. Of course victory in the war mostly goes to superior arms. But as I have stated the Atom Bomb does not fall in the class of arms.

As I write this, the reaction of Prof. Oppenheimer, the acknowledged father of the Atom Bomb, comes to my mind. It was Prof. Oppenheimer's work at Los Almos (USA) which led to the manufacture of the A-Bomb in 1945 that President Truman had ordered to be launched on Hiroshima and Nagasaki. Ten years later in France giving his reaction to the first A-Bomb explosion he said, 'What came to my mind ? I am trying to recollect what I thought. Yes, two verses came to my memory then....Two verses of Bhagavad

Gita in which Krishna, the wise Krishna, the eighth and the most beautiful incarnation of God Vishnu addressing Arjuna said—'I have become the Death, I have made the world tremble.' 'We all had that feeling' continued Oppenheimer, 'of sudden disproportion between the tools of life and tools of death.'

I might mention here that Prof. Oppenheimer is versed in and fond of Sanskrit. Let me now quote further from the newspaper report I am referring to:-

'This feeling was so strong that he offered his resignation after the Hiroshima explosion which was not accepted. Scared of the power of the arms he had invented, it was he who conceived the idea of the control of atomic energy internationally — the famous Baruch Plan. But politics was never Oppenheimer's strong point. He was deeply hurt when Moscow rejected it. The nuclear scientist had no luck. The Atomic Energy Commission in 1949 had unearthed his project for the manufacture of H-Bomb which had been in the ice for 4 years. Oppenheimer flatly opposed the experiments which led President Truman to hesitate for a number of months before it was finally okayed. Oppenheimer obeyed but was evidently playing for time. He came to Paris for the approval of General Eisenhower—then NATO Supreme Commander, for his plan to renounce nuclear weapons against Russian cities in case of war. Ike was favourable but the Pentagon turned it down. When H-Bomb was nearly ready, Oppenheimer asked General Eisenhower again to issue a public declaration that the U.S. would not experiment it. Ike refused.'

I may take Indian tradition as the guide. There was the great battle of Kurukshetra between two branches of the ruling dynasty. Before the battle there was the attempt on each side to collect the most effective arms. On the Pandava side, Arjuna had, after great endeavour, secured a tremendously superior weapon, the use of which could have immediately destroyed the entire army on the other side. But strangely enough, this superior weapon was never used, not even on the day when Arjuna's young son was unfairly surrounded, attacked and killed in an unequal fight. Somehow this instance comes to my mind, whenever the question of atom bomb comes up for consideration.

With her resources in men and materials, India can have the atom bomb whenever she likes. But as I have said, my conviction is, it will never be used. We may have it as an instrument of threat. Nothing more".

VIEWS OF SCIENTISTS

Botanists

DR. M.S. SWAMINATHAN, *Director, I.A.R.I., New Delhi.*

"All the wars chronicled in history provide ample evidence to show that neither the spirit of a people can be killed nor any other objective attained through them. In fact, recent history suggests that the vanquished in a war may be even better off in many respects than the victor. Therefore, the multiplication of weapons of mass destruction is a sterile activity. Such a venture is neither compatible with our national traditions and aspirations nor would be economically desirable. The funds for such a project, if diverted towards the more urgent task of power and agricultural production, will help us to attain the strength necessary to maintain our independence. Economic slavery is worse than political slavery and our attention and efforts should therefore be canalised towards increasing

production both in factories and farms, rather than on making atom bombs."

PROF. T.C.N. SINGH, *Head of the Department of Botany, Annamalai University, Annamalainagar.*

"We in India should not always go on boosting our policy of non-violence and non-alignment.

But we must possess military strength like USSR and should not mis-use it.

I am of the firm opinion that India should manufacture Atom Bomb in consonance with her economic conditions and keep them ready in her armoury.

The world should not gain the impression that our policy of non-violence is based on our weakness."

Dr. (Mrs.) S. BAIRA, *Head of the Botany Department, Bethune College, Calcutta.*

"Personally I feel India cannot ignore the threat of atom bomb. It is like production of any other armament — the difference is only in degree. India knows from past experience that she cannot depend on others to help her out in case of emergency. Things being as they are and people being as they are, it is better to be prepared for the worst."

Chemists

SHRI M.N. RUDRA, *Director, Rudra Institute of Biochemistry, Kadamkuan, Patna.*

"India must make, if she had not already made not only the Atom Bomb but also other nuclear weapons including thermo-nuclear bombs.

But we must not make noise about it but go on silently and dedicatedly with the object.

I had, long ago, written to this effect to our late beloved and dedicated Prime Minister Shastriji."

DR. W.V. BHAGWAT, *Professor and Head, School of Studies in Chemistry, Vikram University, Ujjain.*

"India must manufacture its own Atom Bomb. There can be no two opinions. It is just like asking, 'should India exist or should it become a slave ?' America was in similar situation and scientists gave the verdict that Atom Bomb be dropped on Hiroshima. They had to choose between two evils? Was the war to be continued till the whole of Japanese army was annihilated as it would not surrender or to bring the realities before the country and force a surrender ? We see the results. End justifies the means. Pakistan and China have shown that they believe in no principle except 'Preserve oneself at all cost.' Do we wish to learn the lessons again ? It is a land of Rama and Krishna, Gandhi and Nehru and their followers. They always said 'honour must be preserved at all cost, may be even through 'Himsa'. It is cowardice to say that 'souls of Nehru and Gandhi would not appreciate the manufacture of Atom Bomb'. Make no mistake. Your enemies will not give you another chance. Prithviraj gave six chances to Mahmud Gazani. He was given none."

SHRI R.N. SEN, *Chief Chemist, British Medicine & Th. Co., Calcutta.*

"Whether India use it or not but she must have Atom Bomb at her disposal from her own resources."

DR. NARENDRA SINGH, *Central Food Technological Research Institute, Mysore.*

"If Atom Bombs are weapons of total warfare, the Army has every right to demand for the best and latest to be well prepared for any eventuality, because any war has the possibilities of developing into total warfare. A country can not afford to wait till that time for building up its armoury.

But the main point *is that the nuclear weapons are not weapons of military warfare, total or otherwise, but only of mass destruction* and this has to be borne in mind when taking a decision.

In the context of situation as it exists in this country, I would pose the question in this manner: If a country fears a threat of nuclear attack by one of its hostile neighbours, would its own atom bomb or one in the hands of its 'protectors' act as a deterrent ? My answer is an emphatic "No." The deterrent nature of nuclear weapons is, now, a myth. An objective analysis would show that as for as such a weapon remained the monopoly of one army, it could be used as a threat to the enemy army by mass destruction (as it happened when the bombs were dropped over Hiroshima and Nagasaki), and in such a situation its acquisition by another army might act as a deterrent. Once not only such a monopoly is broken, but a proliferation has occurred and we have, now, not two but five nuclear powers and others on the way, the whole character of situation has changed. The only sane answer at present is total nuclear disarmament and destruction of stockpiles by all powers, once for all. There is no other way than this, if we sincerely desire to eliminate the danger and threat to the whole mankind. Any other suggestions and ways of dealing with this situation is a mere reflection of lack of seriousness in realising the gravity of problems and engenders doubts about the honesty and sincerity of motives.

Now, the question 'Should India manufacture its own atom bomb ?' become hypothetical in that its acquisition could be a morale booster for the army and people. The three aspects of such a programme, if undertaken, to be seriously considered are the capabilities and resources in India and economic effects of this programme on other developmental activities. One basic premise has to be that any such programme should be wholly independent of assistance from one or the other nuclear power, otherwise the nation gets a noose around its neck which has only one side that of getting more and more tightened in its all-embracing sense. Four of the five nuclear powers in the world have gone ahead independently into the nuclear race, U.K. getting together with USA and we know how independent its policies are as a result of this. It is said that China got some help from USSR in the beginning, but later it has done it alone.

There is no reason for doubting the capabilities of Indian scientists and technicians, but the red herring is our experience in other fields in the past and the organizational demands for a programme of such magnitude. Atom bombs are of no solace without the bombers capable for its delivery. It would be interesting to know whether we are manufacturing the aricrafts, bombers or others, wholly from Indian components or getting the engines and spares from abroad. We have had an industrial developmental programme for the last fifteen years. Can we manufacture even such simple equipments like pH meters, freeze-driers and a horde of other things without going into collaboration with foreign firms for importing technical know-how, vital components, and spares ? Is it possible for us to build-up reactors from scratch, wholly dependent on our capabilities and resources without the least foreign collaboration or gifts, and subsequently make available materials in sufficient quantities for weapons along with the other components from other Indian industries ? Such and many other are the questions which have to be answered by the scientists, not in an emotional, but in an objective manner. If the

answers are in affirmative, what stands in way of rapidly creating the technical base in the country for taking off towards bettering the life of masses, and why it could not be done so far. Would scientists play their role effectively only for the manufacture of atom bombs and not for economic development of the society?

Fifteen years of industrial and agricultural planning in the country has resulted into no conceivable betterment in the economic and cultural life of masses. Recent defence-oriented programmes in all spheres of national life have in effect led to further tightening of belts. People's response was magnanimous, because defence of the country was the supreme task. Diversion of further resources for a programme of manufacture of atom bomb would, no doubt, have serious effects on other developmental programmes and would result in greater hardships to the people than now. The people may again accept it without demur, patriotic and sincere as they are. Is it all necessary ? Let the scientists deliberate over it with all social responsibilities at their command.

My answer is that atom bomb is no deterrent any more, and that as the technical base and resources for making an Indian Atom Bomb, which might act as a morale-booster, are missing, the first and the only task before the scientists is to find out ways and means of rapidly improving the economic and cultural level of masses, as only such people are the best defence of a country. Let us find out what stands in the way of economic development and build up an environment for progress."

DR. SATI PRASAD BANERJEE, *Department of Chemistry, University of Saugar, Saugar.*

"I would say, India should manufacture Atom Bomb. Research in the development of weapons of destruction is as important as in any other sphere of scientific activity. Just as a new medicine to save mankind from disease and suffering is welcomed, production of atom bomb to protect the life thus preserved should also be welcome. Atomic weapons are used not so much as a tool for destruction but mainly as deterrent. Scientific research and industrial development are not restricted within the boundaries of any one country any longer. What one worker does within the four walls of his small laboratory, becomes common knowledge of all mankind. This means that Indian scientists must do what scientists all over the world are engaged in doing. If a team of loyal and freedom loving scientists could produce the Atom Bomb in America twenty years ago for the protection and glory of their own fighting forces, I do not find the reason why Indian scientists cannot do the same. An American or a Russian scientist is, after all, human and he is likely to possess the same love for his fellow beings as an Indian scientist. The western powers are dependent on the scientific workers for the manufacture of more and more powerful weapons. At the same time they depend on them for the production of life saving devices as well. This means that the scientists find the ways of arming as well as protecting the troops. A jawan has to be prepared to fight his enemy. He needs to be assured to atleast fifty percent chances of coming out victorious in a battle. The brave Japanese forces surrendered most ingloriously within a week of the bombing of Hiroshima. What do you think our jawans will do under similar conditions ?

Preparedness is the order of the day. The Indian scientist can do well to help prepare the nation by not only producing atomic power for better life but also to protect the life from the menace that confronts us from across the border. Only atom bomb

can curb the expansionist tendencies of those who threaten us every day."

DR. D.K. CHAUDHURI, *Head of the Department of Applied Chemistry, University Colleges of Science & Tech., Calcutta.*

"I see no reason why we should not produce atom bomb for the defence of our motherland when even Pakistan is trying to build up their own nuclear weapons with the help of China. It is urgent and imperative that we should be in possession of the atom bomb as soon as possible notwithstanding the fact that the development programmes in our sectors might be, to some extent, slowed down for a while. This will give a tremendous morale boosting to the people of India who, I should imagine, are prepared to face any hardship for this cause."

Geographer

DR. MOHAMMED SHAFI, *Prof. & Head of the Department of Geography, Aligarh Muslim University, Aligarh.*

"My answer to this question is 'NO'. India does not want war. India wants peace. She wants peace not only in the sub-continent but in the whole world. Instead of manufacturing the atom bomb, she favours the destruction of all nuclear armaments and there are valid reasons for this.

Mahatma Gandhi, the Father of the Nation, gave the concept of Ahimsa to the world. Non-violence abjures the use of force and ensures the unity, will and determination of the people of the world. The will of the people is stronger and more powerful than the atom bomb. India, as a firm believer and promoter of world peace, should therefore strengthen those forces which strengthen peace and make no attempts to weaken it by manufacturing Atom Bomb.

Shri Jawaharlal Nehru, the architect of modern India firmly believed that instead of squandering money on nuclear armaments, India should devote her resources towards the eradication of hunger, poverty, disease and ignorance. Our late Prime Minister, Shri Lal Bahadur Shastri, the Apostle of peace, also held the same view. Nations become strong not by producing weapons of mass destruction but by strengthening the economic base. Instead of diverting resources towards the manufacture of nuclear armaments which India can ill-afford, she should use those resources for the betterment of the teaming millions who are ill-nourished and ill-clad and strengthen the world forces of peace by actively compaigning for the destruction of all nuclear armaments."

Geologists

DR. R.C. MISRA, *Head of the Department of Geology, Lucknow University, Lucknow.*

"I am of the opinion that India must manufacture its Atom Bomb. The question of its use will depend on circumstances. The cost of production has, of course, to be taken into account. The mere possession of the Atom Bomb will give strength to our army and the country."

DR. M.R. SAHNI, D. Sc. (LONDON), *Lucknow.*

"It is strange (Perhaps not so strange, after all) that some countries which themselves possess the Atomic Bomb, advise others not to make it. This gratuitous advice has been accepted so far by our politicians as well as men of science. In my opinion, this is a blunder of the first magnitude, and we must now reorientate our policies to forestall the dangers that lie ahead. Let us make the Atom Bomb, if we wish to survive, let us not be the first to use it, but let us also not be a late second."

DR. N.L. SHARMA, *Hony. Professor of Geology, Indian School of Mines, Dhanbad.*

"India, the land of Tagore, Gandhi and Nehru should never give up her basic policy of International Peace and Brotherhood of Man. It is essential to stick to this policy in spite of our being surrounded by hostile neighbours. Mahatma Gandhi taught us and showed to the world the efficacy of non-violence in the winning of freedom from a mighty empire, and the present generation of India should show to the world how a peace-loving nation should behave in the International field.

India never wants a single inch of space for herself from other countries' territories nor does she wish to interfere in any country's internal affairs, except by voicing her strong feeling where the fundamental human rights are denied and trampled under feet by a country's autocratic ruler or ruling party. This is the case generally with those countries which are not truly democratic and do not follow in actual practice the clauses of the Atlantic Charter. India is one of the biggest democracies of the world and she should in course of time, prove to the world how a vast under-developed country can be happy and prosperous by truly democratic methods.

Just as Mahatma Gandhi proved the effectiveness of non-violence in the social and political field of a nation, so should we prove its value in the international field. When Switzerland could remain a neutral country during the last two World Wars which originated near her own boundaries, we can also adopt a similar policy of friendship to all and enmity to none so that all the great powers of the world value and guarantee our freedom. After all, we are maintaining good relations with all the countries (excepting at present with two of our neighbours).

Possessing an atom bomb is no surety of our not being attacked and be more or less annihilated just in the beginning by a neighbouring power before we actually use our bomb to retaliate. We are by our very culture and inheritance, a very peace loving and conscientious people, an average person being completely averse to killing anybody, whereas an unscrupulous nation can easily use its atom bomb from her armoury on a flimsy pretence, especially if she has a vast population and does not mind a portion of it to be wiped out of existence when the other nation retaliates in such bombing. Moreover the manufacture of atom bomb will consume a huge amount of our annual budget.

If we decide to be a partner in the atomic bomb race, we shall never be able to provide to our teaming millions the basic necessities of life i.e. food, cloth, shelter and education. It is due to the absence of these necessities that the people of a nation become greatly discontented and the unscrupulous countries take advantage of the situation and are successful in propagating their ideals to the citizens of other countries and start infiltrations and supply of arms and ammunitions and training for guerilla warfare to those discontented people, which results in a civil war and ultimately leads to the partition of a country. This is what has happened in so many countries of the world today. Therefore, we should concentrate our all energies on making our common man contented in all respects and try to infuse and inculcate in them by our own individual example, and not by speeches alone, the sense of duty and unity, irrespective of state. language, religion and caste so that in case of emergency the whole nation can rise and resist as one man and there must not be a single traitor in the country to help the enemy in anyway whatsoever. It will be the complete unity of the Indian people, the fast friendship of the nation

with all other nations and a guarantee of freedom to the country from all nations of the world, which will finally help us and make other nations detract from taking hostile action against us.

Mathematician

DR. V.S. HUZURBAZAR, *Prof. and Head of the Department of Mathematics and Statistics, University of Poona.*

"I am of the opinion that in view of the recent developments it will be advisable for India to manufacture the Atom Bomb."

Physicists

SHRI M.P. SAKSENA, *Department of Physics, University of Rajasthan, Jaipur.*

"I strongly feel that India should have its own atom bomb. I am against its manufacture at present due to our miserable economic condition. What I mean is that India should definitely show to the world that it is capable of producing such a weapon if it desires. Although responsible authorities had claimed that India could produce an atom bomb within 18 months, but unless they work on it on an experimental basis, such claims are meaningless and do not create a convincing impression. I emphasize this point because however advanced our technologists may be, there are always so many slips before a final could be achieved.

These weapons are meant for mass destruction, there is no doubt in it, but one should not forget that in these days of atomic age they are also the means of maintaining peace by acting as a deterrent. The threat from China is real. Even if China itself does not come forward for aggression it can always encourage Pakistan to the extent of providing it with the atom bomb. To maintain the balance of power it is therefore essential for India to atleast *keep itself in state of readiness of acquiring such weapons.* Such a state can never be achieved by borrowing or keeping itself at the mercy of major nuclear powers to provide protection."

DR. P.S. VENKATA SWAMY SETTY, *Reader in Physics, Central College, Bangalore University, Bangalore.*

"In my opinion, one of the main causes of our failure to defeat the Britishers in various wars prior to 1857, is the inferiority of our arms. I feel that a sword should be met with a sword, a rifle should be met with a rifle and an atom bomb with only an atom bomb if we intend to preserve the greatness of our nation. India can become one of the strong nations of the world only when it is self sufficient and self reliant. Atom Bomb for India is a must. India is the land of Gandhi and Nehru; it is the land of Shivaji and Rana Pratap also. There should be no question of higgle haggling about the manufacture of atom bomb."

DR. (MISS) EVA MIMA, *Research Officer, Central Inland Fisheries Res. Station, Calcutta.*

"The progress in the manufacture of recent modern weapons is so rapid that all the big countries are having a race in arming themselves with the most progressive weapons. Why should India lag behind, when we are capable of manufacturing equally strong weapons? *India should manufacture its own atom bomb.*

Indians prefer to follow the path of peace almost at any cost, but why should we remain weak and dependable when there is a threat of a nuclear attack ? So India should manufacture its own atom bomb.

Let the world know that India has its own powerful equipments which, if necessary, can be used by her soldiers. But the Nation, belonging to the land of Gandhi, and Nehru, shall always try to avoid the use of such weapons. After having the atom bombs

if we restrict their use, then this will raise the prestige of India.

Our brave Jawans who have undergone and who have to undergo the troubles of war, definitely have the right to ask for the best and we should not discourage them in this matter. Their spirit shall be high under all circumstances when they know that all modern equipments are available to them within their motherland.

A progressive India should not depend on the wisdom and sanity of major nuclear powers for providing us weapons.

India should definitely follow the path of peace as shown by the Great Sons of the Soil but we should not lag behind in any line of scientific progress, be it for peaceful or destructive activities."

Veterinarian

SHRI G. L. SHARMA, *Head of the Division of Bacteriology & Virology, Indian Veterinary Research Institute, Mukteswar-Kumaon, U.P.*

"I personally feel that for defence, it is better to have the know-how of the manufacture of atom bombs so that we do not lag behind to defend the motherland, should the necessity of using atom bombs arise."

Engineers

SHRI RAMA KANTA SARMA, *Chief Electrical Engineer, Jaipur Udyog Ltd., Sawai Madhopur, Rajasthan.*

"The problem of manufacture of an atom bomb resolves into the following questions:

(1) Is the country in a position to manufacture the bomb ?

(2) Have we got the necessary raw materials with us and have we the technical know-how ?

(3) Is it worth manufacturing economically ?

(4) Knowing the hazards of manufacture, is it advisable to manufacture simply to prove our capacity to manufacture it ?

(5) Have we enough knowledge to understand what another Hiroshima or Nagasaki means ?

(6) Do we know enough of radiation effects of the bomb after explosion and do we also know its effects on the present and future generations ?

When we come to the question whether we are in a position to manufacture atom bomb, I may say probably we are and by getting certain raw materials we will be able to do so. The manufacture can be undertaken very easily but it can never be a mass production job as it will only have a piling effect. The scientist will never allow its use and as a military strategy it can be kept in our arsenal to show our prowess. Scientifically also there is not much of secret left now in its manufacture and it is only by non-technical people alone that doubts are being expressed at times. What is the use of blocking capital when we know that it can and it should not be used by any of the countries.

To make a trial bomb only to show that we can do it, is rather foolish so far as any scientist or a well informed person is concerned. This cry is only from persons who have no scientific knowledge about it. One of them can be kept and admired in 'India can make it' museum. It will neither affect or deter any technical man nor the military commanders will be so insane once again to give in to political pressures to use it any more as a war weapon after having fully known the effects on Hiroshima and Nagasaki where samples of abnormal humanity on this account are still available to tell the tale.

Let us realise that the energy released by disintegration of 1 kg. of Uranium is equi-

valent to that released by 2000 tons of high grade coal.

In addition to other radiations the Gamma radiation single dosage if allowed to exceed a few tens of roentgens, then with a 400r 50% of the cases are fatal whereas with 600r 100% mortality rate follows. What to say of an atomic bomb, even with a 1 megawatt reactor a protective shield of 3-3.5 metre thick concrete shield is needed to protect from radiation.

The more we think of the bomb manufacture, the more we are wasting our time and going insane. Our sanity lies only in the use of atomic energy in the form of reactors for power purposes and production of radioactive materials for use in medical science for the good of humanity.

Late Dr. Bhabha had very well forged ahead in setting up reactor, manufacture of moderaters like heavy water and plutonium manufacture plant. The existence of thorium in Kerala sea sand and its production will also lead further ahead and our energy should be diverted towards all these matters and we should not be led astray by political motive. Any explosion of atomic bomb by Pakistan will not only be destructive to us but to them as well."

SHRI D.P. CHAKRABARTY, *Reader in Electrical Engineering, Madhav Engineering College, Gwalior.*

"As regards the manufacture of atom bomb, I personally feel that India should produce a bomb and show to the world that we are really capable of making all types of nuclear devices. This is necessary to boost up the morale of the country as a whole. Though financial difficulty will be there, Government should try to allocate some fund for this purpose. A big country like India, cannot remain at the mercy of other nuclear powers for all times to come.

The Government can declare that nuclear bombs will not be used for any military purposes and the bombs produced will be destroyed according to international disarmament treaties.

I am definite, we are in a position to make atom bomb and we should be allowed to do it. Otherwise all big powers should destroy all their nuclear devices."

SHRI R.N. CHAKI, *Chartered Engineer, Calcutta.*

"I think India should manufacture atom bombs if she is to maintain her non-alignment policy."

ASWI ACTIVITIES

Jamshedpur Branch

Elections for the Executive Committee of ASWIJ were held in April 1966 and the following persons were duly declared elected:

Sarvshri T.V. Prasad (President), M.R.K. Rao & S.K. Banerjee (Vice-Presidents), A.K. Lahiri (Secretary), P. C. Sen (Joint Secretary), S. K. Ray, (Treasurer), S. P. Bhadra, R. R. Dash, B. M. Dutta, P. K. Gupta, J. Bhattacharya, S. P. Das Gupta, R. Ganesh, S. B. Mondal, J.K. Mukherjee, B.K. Palit, Surinder Singh, D. S. Tandon and P. K. Som (Members) and C. P. Saxena (Auditor). The new Executive Committee of the ASWIJ took charge from April, 1966.

Three meetings of the Executive Committee have been held so far. In the first meeting, the candidate to be sent to Delhi for CAAUST symposium was selected. In the second meeting, held on 7.5.66, the pending work of the old committee was reviewed and the necessity or otherwise of having sub-committees for different ASWIJ activities for the current year, was discussed.

The third meeting was held on 17.5.66. The recommendations and the report of the housing committee of previous years were considered and forwarded to the Director, National Metallurgical Laboratory, and the Director-General, Council of Scientific & Industrial Research. This report reviewed the housing situation for NML employees in Jamshedpur and recommended modification of some housing rules to suit the present needs.

The Executive Committee formed the sub-committees on following subjects for the current year:

(1) Popular Lectures
(2) Educational Classes.
(3) News Bulletin.
(4) Formation of Bye-laws for the local branch.
(5) Modification of ASWI Constitution.
(6) Establishment of Central School.
(7) Pay revision of SSA & STA.

The Executive Committee discussed the question of promoting SSA's, STA's and Scientists after five years of service as approved by CSIR and passed the following resolution, which was forwarded to the Director, N.M.L.

"Resolved that the consideration of promotion of all SSAs, STAs and Scientists who have completed five years of service, should be expedited."

CSMCRI Bhavnagar Unit

The Executive Committee for the year 1965-66 took over charge of the office on 5th January 1966. With the kind cooperation of the staff members it has been possible to maintain the strength of the Unit for the year at 58.

The tutorial classes for German Language were commenced with effect from January 1965. The participants for advanced and elementary course were 23 and 29 respectively. The Ex. Committee is thankful to Dr. G. T. Gadre and Shri J. N. Pathak for ably conducting these classes. Efforts to conduct classes in French were not successful. A German Lady, Miss Fritz Schultz Ittgert, who happened to visit Bhavnagar, delivered four lectures in German language which were interesting and educative especially with regard to correct pronunciation. In appreciation of her services, the participants of the German language

class presented her a nice souvenir at a get-together meeting.

A Science Club, named "Young Experimenters" was organised for the benefit of the children and dependents of the members, with a view to creating and encouraging interest in science among them. About ten youngsters took active interest and conducted many experiments in chemistry and physics. Shri Dhimant Mehta and Shri Mani Chalam acted as Secretary and Joint Secretary respectively. The youngsters received able guidance from Dr. G. T. Gadre who was assisted by Sarvshri P. R. Mehta and M. J. Mehta. The Executive Committee is thankful to all these gentlemen for their active co-operation. The Children Welfare Fund of the CSMCRI Club donated Rs. 75/- for the activities of this Club. This amount was utilised for purchases of one "Electric kit' with which one can perform about 60 different experiments. The donation is gratefully acknowledged.

In persuance of the suggestion of the last year's Executive Committee, a joint meeting of the Principal, the Professors of Chemistry and Botany of Sir P. P. Institute of Science, Bhavnagar, the Director, C.S.M.C.R.I. and President and Secretary of ASWI unit was organized to consider the possibility of securing a centre at Bhavnagar for studies for M.Sc.in Botany and Physical Chemistry. This matter was also discussed with the Director of Education during his visit to the Institute. Unfortunately, it was found that it is not possible to secure this centre at least during 1966.

For the benefit of the graduate research workers of the Institute, who wish to appear for the examination of Associateship of Institute of Chemists, ASWI organised a committee consisting of Dr. Seshadri, Sarvshri P. S. Rao, Sharma, Gadre, Chaudhari, V. P. Pandya, Sapre, Shukla, Chandorikar, Baxi, B.S. Joshi and Bokil to assist these workers in their preparation for this examination. Shri A. H. Bhatt undertook to organise the necessary details.

ASWI also conducted test examination for the benefit of staff members who were appearing for M.Sc. examination. Four papers in relevant subjects were set and examined by Sarvshri Shukla, Sharma, Gomkale, B.S. Joshi and Bokil.

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The Recruitment Quagmire of India's Science*

KSHIROD RANJAN BHATTACHARYA**

I. The Problem

A crisis of confidence has been the ban of Indian science since the very beginning of its widespread adoption. There are many facets to this problem, but perhaps in no sphere this is as actute as in the sphere of recruitment and promotion of scientific personnel. The directior of a National Laboratory recently lamented "Give one person one extra increment, and the whole Institute stops work for 15 days". If a little exaggerated, this picturesque statement sums up fairly adequately the appaling state of mistrust and dismay prevailing in India's scientific institutions in this field.

The cost of this is enormous. An intellectual zest and keenness is the most valued possession of a scientific institution, without which it quickly lapses into mediocrity. It is obvious that this keenness cannot be sustained in the face of the demoralization that exists. A cool and dispassionate analysis of the problem is therefore an urgent necessity, for what is at stake is the enthusiastic participation of the human material without which the entire edifice of a research organization becomes meaningless.

II. The Current System

A sober analysis of the present system of recruitment and selection makes the situation fairly obvious. What is the present system? The need arises in a laboratory (or so we are told) for a person with a particular training and background; the post is created and advertised; a certain number of people are called for interview after scrutiny of the applications; and the best available person is selected after careful assessment by a selection board. In form, no method could be more objective and rational. Unfortunately it contains a number of inherent fallacies which render it quite unworkable in practice.

(a) The most serious handicap of the system is that it contains no obvious provision for promotion, apparently conceived in the belief that a system of continuous fresh selection would be in the best interest of ensuring quality. Admittedly the concept sounds nice on paper; only it does not work in practice. Recognition of the concept of promotion may be withheld *de jure* but not *de facto*, for when a large number of grades exist, a recruited person has to be given recurrent promotion if he continues to prove his worth. But having made no overt provision for promotion, we are left with no choice but to subvert the system of selection and put up a facade by which what is really a promotion is shown as a fresh selection.

The process then operates something like this. A particular person having put in a number of years of service and done what may be considered excellent work, is considered, often rightly, to deserve a promotion.

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* Based on a talk delivered before a meeting of the ASWI, Mysore Branch, on 14th April 1966 and the discussion that followed. Although applying broadly to scientific and technical personnel in general, this discussion will apply primarily to research personnel.

** C. F. T. R. I., Mysore.

A post is henceforth created in his 'section', his qualifications are stealthily collected, a tailormade advertisement is sent out, certain selected individuals are called for interview (often with good deliberation), and our candidate is duly, 'selected' by the selection board.

The hoax starts, of necessity, right from the first step the advertisement; not the tailored form of the advertisement, which is well known and evokes universal amusement, but even its very genesis. The supposed need of a person with a specific background, as claimed by the advertisement, is more often than not only a cover for the real need to promote a particular person. This is self-evident for when a person already in employment in the laboratory is finally 'selected' for the advertised (higher) post (which is what happens in a vast majority of cases) the person with the required training was plainly already there in the laboratory for which there was no real additional need.

It must not be forgotten that this manner of 'selection' is the rule rather than the exception, for an overwhelming number of all appointments are of necessity made from among the people already employed in the organization. The tragedy of the situation is that the end-result is often not unjust but it is achieved by a process which can only be described as a sham and a fraud.

(b) The second defect of the system is the obvious discrimination it unwittingly causes by tagging promotion to sectional availability of posts. This again flows from a rigid system of selection. If all appointments are to be made by formal administrative selection, there must be something against which to select—namely, specified posts. So specific posts have to be created. But creation of posts must be an *ad hoc* administrative process, often separated in time by quite a long distance from their actual requirement or filling. It is thus bound to be arbitrary. The consequence is obvious. While a less gifted person may secure a promotion because of a post being available in his section, a more deserving man may have to go without it because of non-availability in his own section. Thus the very first link in the chain of our system (which is conceived to pick out always the best for advancement) becomes in effect largely a matter of chance. Curiously, people become so agitated over the obvious arbitrariness of the actual selections and so on, the less obvious but none the less real absurdity and injustice of this very first step often goes unnoticed.

(c) But the crowning piece of absurdity of the current system concerns the last link in its chain—the method of assessment of merit. If the 'selection system' was evolved in the desire that only the really merited should pass through the screen, it was forgotten that a satisfactory method for the assessment of merit had to be devised simultaneously—nothing uncommon for us, well-known for equating enunciation with accomplishment. In the event, the celebrated 'interview' system, developed originally to recruit civil service personnel, was borrowed.

As finally evolved, the process consists of a short session (averaging 7-10 minutes) where the interviewee is asked a few questions on 'science' in a highly charged and ritualistic atmosphere, and the answers are supposed to give a true indication of the intrinsic capability of the persons as a research scientist. It would have been actually redundant to point out the monstrous absurdity of this if the system was not so well entrenched and taken so much for granted. Not surprisingly, the system bears a striking resemblance to our traditional examination system which has been universally condemned by educators and thinking men. Of course, the attainments of the persons (a detailed account

of which is required to be submitted in advance) are also supposed to be within the purview of study; but this deceives none, for none can read, digest and assess them in the short time that is available *per capita*. The difficulty of the situation is enhanced by the fact that a large number of candidates are already preselected, and that the number to be interviewed is usually so large (all promotion seekers will naturally apply) that it is impossible to devote more than a trifle per head. Actually, even the selection board members (all but the green ones and the few sadists), however well-meaning, become apathetic knowing it futile to try to maintain objectivity.

Curiously, the ludicrousness of the process does not stop here. The board often proceeds to weigh merit upto the fourth place of demical of a gramme (with their hundred kilo platform scale;) and make fine distinctions among candidates in awarding increments of pay. One wishes that a psychologist was an ex-officio member of all selection boards, who could point out the disastrous consequence of such vain-gloriousness on the morale of the staff.

This then is the picture of the existing system. It is arbitrary, for it operates by selection against specified posts, the creation or consideration of which is largely a matter of chance; incompetent, for it has no valid means for assessing the merit on the basis of which to select; and corrupt, for in it covert promotion mosquerades as overt selection. Fortunately for the system, but unfortunately for ethics and morale, utter chaos is averted only because a very large number pf 'selectees' are actually preselected (most of the 'promotion candidates 'and a majority of the outsiders). As a matter of fact, very few advertisements are sent out without an eye on somebody. It is tragic that quite a good number of these 'selections' would have been considered excellent choices if the demoralizing eye-wash of advertisement-interview-selection were cut out.

III. The Effect

Recruitment, promotion and pay are of intimate personal interest to every employee and hence can give rise to explosive situations unless handled with farsight. The difficulty flows chiefly from the habit of comparative assessment of a situation to which every mortal (including those who decry it on the platform) is prone. Handling of these factors must therefore be scrupulously as well as demonstrably fair.

Unfortunately, neither is provided for at present, The system itself is patently arbitrary, which alone is capable of killing all trust and initiative. However, where the process really collapses is at the overt display of insensitivity to human susceptibilities. Distinctions in pay and position are made brazenly in the face of patent absurdities of the system and, to add insult to injury, it is given out in justification that so and so 'did well' in the interview and so and so 'did badly'. And 'merit' is constantly bandied about—promotion and pay according to merit, special 'merit promotion' and so on which, in the absence of an effective means to judge merit, appears to ordinary eyes as nothing less than hypocritical hoax.

The results follow expected lines—confusion and bewilderment at best, cynical contempt at worst. Frustration, corridor gossips, petty rivalry and sly attempts at sycophancy become the normal pattern. Work becomes the first casuality, both in quality and in quantity.

Not that these end-results are not known and deplored, but these are viewed in the classical medieval attitude of 'disci-

pine', not unlike what our ancients used to say 'spare the rod and spoil the child'. Something sternness is tempered with appeals. Sermons on the value of good-neighbourliness and on not bothering about such, mundane things as pay and position are given freely not realising that sermons are worse than useless and are usually nothing but a confession of one's own incapacity to foresee consequences and to provide for them.

IV. The Alternative

The need for a more rational alternative system for recruitment and promotion in institutions of scientific research is therefore obvious. This is not to say that an alternative will be easy to evolve; the problem must be faced with gravity and humility. An attempt is made in what follows to formulate certain broad principles and conclusions. However, it is the purpose of these suggestions more to evoke study and analysis than to lay down fool-proof solutions.

1. *The basic concepts*—A rational alternative must be based on certain basic concepts, among which may be listed the following:

(a) It is the people and their intellectual keenness which are the most precious possessions of a scientific institution. Therefore high morale and a feeling of mutual trust and confidence are essential ingredients of such institutions. It follows then that the system of employment in such institutions should be one that is not merely just, but manifestly so. It also follows that the system should be fully explained to and have the prior confidence of the staff. Open discussion and prior understanding is of special importance in large institutions where difficulties of communication impose severe strain on easy appreciation of motives and quick dispelling of suspicion.

(b) Need of promotion of persons already in employment must be recognized not only *de facto* but also *de jure*; and the system of promotion must be kept distinct from the system of original recruitment. Trying to accommodate cases of promotion in a rigid system of selection will only result in subverting and lowering the dignity of the system.

(c) True assessment of scientific ability of a person already engaged in the field requires evaluation of his accomplishments and his approach to scientific problems rather than his ability to remember certain textual matters in a formal sitting. The facts to be evaluated are whether he makes a concious hypothesis based on available information to start with, whether he proceeds to test each hypothesis, how he designs his experiments and what controls he keeps, whether he tries to interpret his results from different angles and in the background of available knowledge, and whether he makes further experiments based on the previous interpretations. What he does, why he does, and how he does, plus how much he does (effort), will utimately be reflected in one's accomplishment which is what must be assessed critically.

(d) Assessment, to be really impartial, should be made at regular intervals, *unconnected with the requirement of selection for the particular post*. Only then can the merit and progress of a person be judged objectively uninfluenced by extraneous circumstances.

(e) The type and volume of work a person does in a scientific institution is, by and large, quite independent of the post, position and pay he holds. Similarly, posts in these institutions are, on the whole, not identified with particular levels of responsibility. Consequently, unlike in administrative organizations, scientific organizations need not and should not have an acute hierarchical structure. It follows that the overall promotion pattern here should not be compulsively selective, to be in confirmity to a hierarchical tree, but broadbased—based solely on scientific

ability (and financial resources of the organization). For identical reasons, promotion should also be independent of relative sectional 'availability' of posts, the whole organization being considered as one single unit for this purpose.

(f) Money is not the only incentive for creative scientific work; respect, recognition and unhindered facilities for further work are often more important. Conversely, conferring of exaggerated monetary benefits on selected cases, without overwhelming *manifest* reasons, often creates difficult human problems and vitiates the atmosphere of the organization. In a similar way, existence of too many grades, rather than providing incentive, often creates conditions conducive to unhealthy rivalry.

2. *Promotion*—A system of promotion for personnel already employed in the organization based on the above concepts could now be presented in broad outlines:

(a) A competent committee will, *at regular intervals*, scrutinize at length the performance during the period of *each* individual based on a critical assessment of his scientific accomplishment.

(b) All those who have shown satisfactory scientific ability and effort during the period will be considered equally eligible for promotion, unconnected with any sectional availability of posts.

(c) If promotion cannot be given to all those who qualify because of limitations of financial resources, the actual number could be limited to the total number of available vacancies in the institution, taken as a whole, by applying a formula based on age and/or years of experience and/or academic qualification. Mention of age etc. will doubtless make many eye-brows rise (little realising that while 'merit' is to be surely preferred to qualification etc., to ignore the latter and yet do nothing to assess the former barring the shouting, as is now done, is far worse). However, since this secondary selection will be from among persons of already proven scientific ability, consideration of age, experience or qualification will not be unscientific.

(d) Introduction of a unified continuous scale of pay, with adequate safeguards at a number of stages, would be of obvious advantage because this has, built in itself, recognition of the concept that in scientific institutions, promotion should be based solely on scientific ability rather than on sectional availability of posts or the requirements of a hierarchical tree.

3. *First recruitment*—(a) Most of the fresh recruitments will necessarily be from freshers from universities. Academic record plus performance in a brief interview can form a satisfactory basis for their assessment. It is desirable that first recruitment of freshers should be made through a system of Fellowship for a period of 3 to 5 years, during which the person will be adequately trained and there will be ample opportunity to assess his aptitude and capability.

(b) Influx of experienced personnel into the organization according to qualitative or quantitative need must also be provided for. This might indeed be done through a system of advertisement; but such advertisement must be meant actually for outsiders, not as a cover for promotion of insiders. Similarly, persons returning from training abroad, if suitable for the organization, could also be recruited — preferably without a (phoney) advertisement. These selections being relatively few in number, can conceivably be made through an interview; but these interviews must be real, devoting a lot of time, rather than a mere formality.

For these recruitments, a rigorous system of equivalencing of experience and quali-

fication must be worked out. Scrupulous care should be exercised that no manifest disparity, either way, is shown between such fresh incumbents and those already employed in the organization.

4. *Fixation of pay*—In fixation of pay, no undue disparity between individuals should be shown. Unless based on demonstrable objective grounds, such disparities never fail to sow the seed of cynicism and distrust. Similarly, the question of out of the way reward for merit should be considered only when the assessment committee, in the course of its regular scrutiny, records an exceptional originality or industry on the part of a worker. In short, differentiation in pay and position among personnel must be strictly on the basis of merit—not 'merit' as a concept or a slogan, but merit as assessed by a trustworthy method of assessment.

V. Our Role

A few final words about the role of we scientific workers in this episode. It is inconceivable that so illogical a system as the existing one could have survived for such a long time without our indirect support and help. This may sound paradoxical, for we have grumbled plenty. Unfortunately, we have grumbled invariably on the wrong score, and we have only whimpered and grumbled, never protested.

It is astounding that most of us see the folly of the system only in piecemeal and only in so far as it affects our own interest. Usually we never feel anything amusing about it when we ourselves are its beneficiary; some of us even claim that we got the benefit as a 'recognition of our merit' or because we 'did well' in the interview little realising that we got it this time merely because this time the die was cast that way. But when we do not get the expected fruit, the system suddenly appears venomous to us. Then of course we whine, but whine about what? The injustice of this or that question being asked in the interview, the great folly of selecting that fool in preference to us, and of course the melevolence of the director! Often we also quarrel among ourselves for crumbs, and begin to see evil in somebody (or 'discover' his private dealings with the director) as soon as he gets a promotion or something. Frankly, such extraordinary reactions only help to perpetuate the foolish system, for the remedies that we can and do suggest with this background are often more grotesque than the defects they are intended to rectify.

To make the situation change, we must look over our self-interest and see the cause beyond the effect. It will then become evident that actually the whole thing is wrong from A to Z which cannot but yield results by chance, sometimes right, sometimes wrong, whoever operates it . We must therefore deplore and fight the *system*, not the *results* of its operation, nor so much the people who operate it. And the remedy lies in its total replacement, not in plugging here or mending there. It is therefore now our duty and responsibility to work out, after mature delibaration, a rational and workable alternative, for the adoption of which we must then press forcefully.

VI. Summary

1. The current system of recruitment and promotion in institutions of scientific research in India has serious fallacies and gives rise to disastrous consequences. Its replacement by a rational alternative system is imperative.

2. The alternative system should be on the following lines:

(a) Advertisements for posts should be issued only when additional personnel are intended to be recruited. If a person with a particular background

is asked for, it must be understood that such is not already available in the institution;

(b) First recruitment of university freshers could be on the basis of academic record and a brief interview. These recruitments should preferably be through a system of Fellowships;

(c) First recruitment of experienced personnel needed by the Institution should be through advertisement; assessment should be by an exhaustive examination of the scientific accomplishments;

(d) First recruitment of foreign-trained or such other persons, already working in the institution and known to be suitable, should be through an exhaustive interview but *not* advertisement;

(e) Personnel once recruited should be eligible for promotion on their own right independent of sectional availability or advertisement of posts and without having to undergo repeated 'selection' against fictitious requirements by farcical 'interviews'. These promotions should be based on periodic and simultaneous assessment of the accomplishments of the entire scientific staff of the institution;

(f) Differentiation in pay and position among personnel should not be made except on overwhelming manifest grounds.

3. Replacement of the existing irrational system will be hastened if the scientific workers realise that it is the system that is to be deplored, not its arbitrary results nor those who operate it.

Dependence on Foreign Aid for Fertiliser Units will Kill Indigenous Know-how

The built-up scientific technical know-how for the future fertiliser projects in India is in danger of being frustrated. This implication of the prevailing controversy about depending too much on foreign participation in both equity capital and technical management was clear from the views expressed to a party of twenty pressmen who visited Sindri recently and saw what the Planning and Development Division of Fertilizer Corporation of India is doing there.

Although by the Government directive in 1963 this division is to take over the setting up of national projects for fertiliser production in the country the present trend of looking even for ordinary know-how to foreign countries is causing considerable anxiety and pain to more than 1,500 people including 500 engineers, scientists and technologists who have been working hard to find new ways and substitutions whereby dependence on foreign countries can be brought down to the minimum if not totally. They have, in a very large measure, already achieved results.

Pressmen found in every section men working with determination to save the Indian economy. At one section it was convincingly demonstrated how the P. and D. division has been able to develop improved process for indigenous production of a catalyst at a cost of about Rs. 5,000 per tonne, whereas a foreign supplier imported at Rs. 24,000 per tonne.

New Units

The initial round of direct talks with foreign firms for setting up about eight fertiliser plants in the Fourth Plan period will begin from early September. By then representatives of one Canadian and two American companies will arrive in Delhi with proposals for collaboration. As it appears today the Government of India is prepared to tap every source all over the world from where inquiries are received, showing interest in investing for fertiliser production in India.

After the Sivaraman mission returned from a foreign tour serveral proposals have come from the U.S. Canada and Japan. The Government anticipates further enquiries from other sources also.

However the Government seems to have come to the conclusion that foreign investors can come only on their own terms and would demand equity participation to the extent of 51 per cent. Mr. Nakul Sen, Secretary, Ministry of Petroleum and Chemicals during an informal chat with journalists at Sindri last week-end indicated that perhaps the augmentation of fertiliser production plan would have to be made under such terms. The acceptance of such conditions, however, specially for all eight projected units, would mean colossal draining of foreign exchange and depriving valuable experience that Indian experts might gain by having responsibility of designing, planning and engineering the country's future fertiliser projects.

There is apprehension that if stipulations are made to foreign firms that Indian contracts in regard to tasks that could be undertaken by them should be accepted by the collaborating firms they may evade the responsibility of keeping to the schedule and the

* Reprinted with permission from 'Economic Times' August 24, 1966.

Government would not be able to enforce guarantee in programming.

Challenging Situation

It is a challenging situation. In this, the Planning and Development Division of Fertilizer Corporation of India can play a great national role and can take over the entire responsibility of applying its know-how, acquired and self-developed, to deliver two plants a year for the whole Plan period.

The P and D division of FCI has in fact been given the task to deliver goods in respect of proposed plants at Durgapur and Cochin. Mr. Satish Chandra, chairman and managing director of Fertiliser Corporation of India and Dr. K. R. Chakravarty, general manager of the P and D division of FCI had no hesitation in firmly declaring at a press conference: "we are confident of fulfilling the task."

From the talks with Mr. Nakul Sen the pressmen, however, got surprisingly a different view. It appeared that the Government is more inclined to repose confidence in foreign promoters rather than in its own child, the P and D division of FCI.

It is to be remembered that a directive already exists by which the Government in 1963 has equipped the P and D division in all respects so that it can undertake departmental planning, design, engineering, procurement and installation of two major plants a year. Thus it is by the Government's own directive a comprehensive multi-functional organisation with inter-linked exists functions comprising not only process and technological development but also planning, design and engineering etc., of fertilizer plants. This is the single biggest organisation for such a purpose in India, if not Far East, and has on the technical side a complement of about 5,000 engineers, scientists and technologists, about 500 drawing office staff and about equal number backing technical staff for pilot plant and other developmental work. It has well-equipped laboratories for fundamental and applied research work.

U.S. FIRM'S DEMAND

It has also developed its own know-how for many processes and products and they have been applied in design, engineering and installation of not only pilot plants but also large-scale fertiliser plants. It was learnt from talks with Mr. Nakul Sen that Philips Petroleum Corporation representatives had already seen Haldia but terms given by this American firm have rather unacceptable monetary demand of $85 million with cost of production per unit of nutrient as high as Rs. 4,000 which Indian expertise could easily deliver at 30 per cent. lesser cost.

This is Government's estimation also and Mr. Sen said that the American firm has been asked to revise the proposal to bring down the cost. He also assured that Phillips being in the picture at the moment does not preclude of course P and D division from coming into the scene. However the damper caused to Phillips is the site at Haldia which is yet a jungle. There is a feeling that the Government of West Bengal has lapsed in carrying out the request to lay the infrastructure for setting up a plant. In contrast it was pointed out how the same American firm was pleased to find the site in Madras which was completely developed quickly for starting the construction of a fertiliser plant. Of course the engineers in Sindri have a regret that even the contract for building roads and quarters in Madras had been given over to the collaborating firm. Is the Indian civil engineering too was so undeveloped, they ask.

It is to be remembered that project reports do contain in detail the topography and various tasks involved. For example,

Sindri itself before the Chemical Construction Corporation of New York and the Power Gas Corporation of the United Kingdom came there was nothing but a jungle infested with tigers and snakes.

Wild Elephants' Habitat

Bhilai too was an habitat for wild elephants while Rourkela was equally a jungle with wild animals. If the Government of India finds no way out but to accept the situation in which foreign parties would come only if they get 51 per cent, equity participation it should also be remembered that commercial credit can be had on far better terms. For example it is perhaps at the discussion stage yet that from one country it is possible to get $50,000 as commerical credit. There is apprehension in some knowledgeable quarters that if projects are given away to foreigners like this it will only mean colossal drainage of the country's valuable foreign exchange. There is no doubt about it that the P and D division is in a position to undertake several jobs that would help save crores of rupees worth foreign exchange. Saving in foreign exchange which has been affected by direct substitution by replacement of imported commodities either as result of providing services in various aspects of the fertiliser industry alone would amount to about Rs. 4.25 crores to date. The estimated foreign exchange saving in 1965-66 alone on the same basis would be about Rs. 1.26 crores. Even on a conservative basis of capacities for production and assignment in hand it is expected that services of the P & D division would amount to recurring foreign exchange saving of Rs. 82 lakhs annually in addition to potential saving of Rs. 7.07 crores. These do not include potential foreign exchange saving of Rs. 4.7 crores that would have accrued in case the Korba project had been implemented.

New Sites

For the Fourth Plan fertiliser production, the Government has in view sites among others, such as Kandla, Mangalore, Tuticorin, Paradeep, Haldia, Nahorkatiya, Barauni, Korba and some site in western U.P. near Delhi. Talks in September with foreign concerns intending investment would cover various sites, a beginning has been made by entrusting the task of planning for two projects in the first year of the Fourth Plan at Durgapur and Cochin to the P and D division of FCI.

At Durgapur and Cochin, Mr. Satish Chandra said the work would be completed by the end of this year. In 1967 the division's main task would be to inspect and take follow-up work. FCI officers would go to countries like Germany and Italy to ensure deliveries of equipment in time; by the end of 1967 equipment will start arriving and the whole of 1968 would be covered in application of mechanical, electrical and instrumental building. Mr. Satish Chandra said that he hoped that both the plants at Durgapur and Cochin would be commissioned by 1969.

For both Durgapur and Cochin the quantum of foreign exchange expenditure will be the least. An Italian contract has been accepted since the terms are most suitable. Montecatinis have agreed to have the first payment 24 months after last the shipment made by them whereas other countries wanted 5 or 10 per cent down payment on the spot. On the basis of the saving of foreign exchange effected for the Durgapur plant—constituting the saving on design, engineering and know-how expenses as well as maximisation of indigenous equipment valuing about Rs. 5 crores—the country can save Rs. 10 crores. Close cooperation between Fertilisers and Chemicals Travancore Limited and P and D division of FCI has been established. FACT will design and engineer naptha steam gas

reformation section of ammonia plants both at Durgapur and Cochin on the basis of process know-how recently acquired from power Gas Corporation of the U.K.

Ammonia, Urea Plants

The P and D division of FCI will design, engineer and procure ammonia synthesis and urea plants both for Durgapur and Cochin projects. Durgapur is under the management of FCI and Cochin under FACT. For Durgapur both ammonia and urea plants with capacity of 1000-tonne per day of urea will be designed, engineered and procured departmentally by the P and D division. As a matter of policy where the Corporation does not immediately possess its own know-how it has been decided to buy out only process licenses from selected firms and carry out designing, engineering, procurement and installation by the P and D division itself. Ammonia and urea plants in Durgapur will be constructed on this basis. It may be incidentally mentioned that for the Korba project, which was first a full project to be handed over to FCI in 1963 for complete departmental execution more than 50 to 60 per cent, of design and engineering work had been completed. However Korba project has now been kept in abeyance.

It has also been decided that a plant for urea production of 1000 tonnes per day for Cochin fertiliser poroject will be designed, engineered and supplied by the P and D division of FCI. The P and D division is thus now fully organised to handle departmental execution of two major fertiliser plants every year.

Dr. Chakravarty said "When we have demonstrated our capability we hope the Government will utilise our services to the fullest extent."

Mr. Satish Chandra supported him by declaring that he had advised the Government to utilise the division's services. On turnkey projects when a question was put Mr. Staish Chandra said, "We have not advised the Government not to allow such projects but we are capable of taking up two projects every year and that the Government should utilise this capability of ours".

Collaboration

Dr. Chakravarty agreed with journalist that if the country should go in for collaboration arrangements with other countries India's indigenous development would be retarded. For the Durgapur project there were about 50 to 55 know-how projects and the P and D divisions had developed 47 of them. Mr. Satish Chandra said that if a country had achieved 95 per cent self-sufficiency, it would be well worth paying 5 per cent, to another country as royalty for the rest to be self-sufficient. For example dependence had to be there on foreign sources for naptha reformation plant or catalyst plant which at the present moment the P and D division could not deliver. It was because of this lack that FACT recently signed a contract with Power Gas Corporation for naptha reformation plant. The P and D division made many catalysts and there were some in which indigenous process for making was now under a developing stage. On the question of assistance from Russia, Dr. Chakravarty said certain technical assistance had been received from UNTAB which included Russia. It allotted a few apparatus only which was arranged through Russia. This was completely indigenously developed thereafter by India's young engineers. In the early stage equipment had been purchased through UNTAB from the U.S., U.K., and Germany but these were also developed later entirely within the country—full 100 per cent, of them with integrated concept for industry.

On the question of basing fertiliser units

Dr. Chakravarty is of view that a unit should be coal-based if the main raw material coal is available nearby. Whether coal-based or petroleum-based fertiliser production plants should be patterned suitably for either of two strictly according to economics of industry. As for the Korba project he is of view that it should be revived. The Government has asked the P and D division to prepare a revised project report after devaluation.

Foreign Know-How

When it was repeatedly stated by pressmen that engineers were doing great work at the P and D division, Mr. Staish Chandra admitted that many of "our engineers have a feeling that the Government does not give its confidence to this organisation".

Dr. Charkravarty declared that "we will certainly be in a postion to export know-how," when asked if the P and D division thought of such progress.

Initially the division is giving its concentrated effort to develop indigenous processes and know-how as also to manufacture in its own workshop pilot plants. quite a number of which have already been built.

In import substitution programme for process chemicals at present the expansion of manufacturing for various catalyst required in the fertiliser industry has been taken up and when it is completed the recurring foreign exchange saving will, it is estimated, be about Rs. 90 lakhs, per year in elimination of imports for indigenous requirements and about Rs. 80 lakhs as likely foreign exchange earning by export (pre-devaluation figures).

When the entire division was seen thoroughly it was an anticlimax to hear from the Ministry's Secretary that by delivering the two projects at Durgapur and Cochin the P and D Division has to prove its capability. This would mean that until 1969 when the two plants would go into operation the P and D Division would remain idle. Mr. Satish Chandra made it clear that the division ought to have its own five-year plan for rendering two projects every year. The division would actually be without employment in 1967 when planning would be completed for the two units. The Secretary's view that when T.V.A. could maintain its research division for the last 25 years why could not FCI'S P and D Division remain like that? What is causing anxiety to engineers is that if projects are handed over to foreign parties the P and D Division would stop at an early stage and rust away without an opportunity to gain and develop experience. As two complementary bodies, FACT and P and D Division for south and north, can be the biggest institutions for the whole country, ridding it of dependence on foreign countries and foreign exchange expenditure. In fact FCI itself may ultimately become a small unit and its P and D Division have all future for itself and for augmentation of the country's food production.

(Continued from page 13)

Governments of Asian and African countries directly, through Governments wherever possible and through international agencies.

(*vii*) The edited proceedings, reports and recommendations of the Symposium be given widest possible publicity in Afro-Asian countries.

Resolution on "Caaust Symposium and after, Adopted by the Symposium at its Plenary Session" on May 2, 1966 at New Delhi

The delegates and participants to the CAAUST Symposium *Believe* that it is necessary to further organise, strengthen and propagate the idea of collaboration between scientists of countries of Asia and Africa and to continuously indicate the necessity, the direction and the areas of collaboration to all official and non-official agencies of Afro-Asian countries.

Recommend that—

(*i*) a CAAUST Committee be formed consisting of one delegate from each country represented at the Symposium. Each member could nominate another person belonging to his country if he was unable to accept the membership of CAAUST Committee. The Committee itself could nominate another person from this country if for any reason the nominate was unable to accept it. The CAAUST Committee could also co-opt other countries of the region which are not represented at this Symposium.

(*ii*) An executive committee of the following be formed:

Cambodia	Dr. Phu Su Uy
Ceylon	Dr. P. P. G. Siriwardane
East Africa	Dr. D.M. Mugera
Ethiopia	Dr. A. Lemma
India	Dr. S. Husain Zaheer (representing ASWI) Convenor.
Indonesia	Dr. M. Makagiansar
Iran	Mr. N. Salehi
Japan	Dr. T. Kitagawa
Lebanon	Dr. S. Thabet
Madagascar	Prof. R. Granger
Nigeria	Prof. C. Bassir
North Africa	Vacant
Senegal	Dr. A. Daguerre
Turkey	Mr. M.N. Parlar
United Arab Republic	Mr. A. Sabet
USSR	Acad. S. Salayev

At all meetings of the executive committee invitation be extended to all members of the CAAUST Committee to participate in the deliberations. The Executive committee will keep CAAUST Committee members informed of its work through correspondence.

(*iii*) The second CAAUST Symposium or general conference be held in early 1969.

(*iv*) The offer made by UAR to hold the first meeting of the Executive of the CAAUST Committee in CAIRO by the end of 1966 be accepted.

(*v*) The CAAUST Committee will set up a Bureau to process the recommendations of the symposium. In the first instance the Bureau will be located at New Delhi and will be operated by the Association of Scientific Workers of India assisted by the International Scientific Collaboration Bureau of the Council of Scientific and Industrial Research (India). At a later stage it may be necessary to set up similar Bureaus in other Afro-Asian countries.

(*vi*) The report and recommendations of the Sympsium be transmitted to all

(*Continued on page 12*)

ASWI Activities

Karaikudi Branch

1. The Executive Committee of ASWI Karaikudi Branch met on 29-6-66 to discuss matters relating to the organisation of symposium-cum-national convention of ASWI (India) at Karaikudi by the end of this year.

2. The following resolutions were passed on 4-7-66 and action has been taken upon them:

(*i*) Resolved to request the Vice-Chancellors of Universities to give preference to scientific workers from national laboratories, who seek admission in post-graduate degree courses.

(*ii*) Resolved to bring to the notice of the Ministry of Education, the difficulties faced by the scientific workers in securing admissions to post-graduate courses in the universities.

3. The Branch has requested the Director, CECRI to explore the possibilities of starting a summer school/refresher course on electro-analytical chemistry.

4. The Fifteenth Pugwash Conference on Science and World Affairs was held in Addis Ababa, December 29, 1965, to January 3, 1966. It was attended by 87 scientists and scholars from 31 countries drawn from all the continents. Excerpts from the reports of the various working groups are given below:

Education in Developing Countries

A very important objective of the educational system of a developing country is to inculcate questioning, critical and experimental attitude to all knowledge and essentially so in the universities. Such an attitude is essential for the generation of new ideas vital for the solution of all the novel problems facing a developing country. In view of their responsibilities, the training of teachers should be very carefully planned to foster the spirit of vigorous independent inquiry.

Organization of Science in Developing Countries

The organization of research should be designed to liberate the creative energies of scientists and provide them with what they need for effective work. A rigid bureaucratic organization which does not sufficiently devolve responsibility on working scientists leads to grave frustrations among them and should be rigorously avoided. There are great advantages to be gained by the developing of a team spirit, a multi-disciplinary approach, the efficient use of equipment, and a proper evaluation of research. In the early stage of development, efforts should commonly be directed toward the solution of urgent national problems and they should be selected only after a realistic appraisal of the resources available for the execution of the work.

The group emphasized the importance of the integration of science and scientists into governments. A senior scientist should sometimes be prepared to give up his research work for a period of time in order to accept a post in the appropriate branch of government service. He may thus actively participate in creating a better understanding in high governmental circles of the role

of science, help in formulating national plans and in addition acquire some insight into the problems of government.

Specific Problems of Developing Countries

Both in planning for economic development and in implementation of the plan, scientists should play a far greater role in the future than they have in the past.

Industrialization is a key factor in development. Increased participation of scientists in industrial planning, concentration of industrial efforts, the coordination of industrial with agricultural development, and the creation of integrated markets to solve the problems of small countries are all necessary to accelerate industrial growth .

In the Executive Committee meeting on 16-7-66 the following business was transacted.

1. Miss Mary Juliana Mangalam was coopted as a Member of the Executive Committee in place of Miss Alice Kurian who proceeded for higher studies.

2. It was decided to prepare a case stressing the need for a bus for the CECRI.

3. It was resolved to bring to the notice of the University Grants Commission and Inter University Board the difficulties faced by scientific workers of National Laboratories in registering themselves for higher degrees in some Universities.

4. It was resolved to request the Municipal Commissioner and Chairman to merge Karaikudi-3 and Karaikudi-4 postal zone within Karaikudi Municipal limits to enable Central Government employees to get House Rent allowance.

5. It was decided that an Excursion should be arranged to one of the Industrial centres, preferably electrochemical.

Other items discussed pertained to—

(*i*) Central School for Karaikudi.

(*ii*) Mode of filing patents.

(*iii*) Advisability of giving royalty to Scientific workers.

(*iv*) The difficulty in the present procedure for obtaining journals from the library.

The business transacted in Executive Committee on 30-7-66 was:

1. Members were requested to study the constitution of ASWI (India) and suggest any necessary amendments.

2. Shri KSA Gnanasekaran was authorised to conduct the course for AIC examination till November, 1967.

3. It was resolved to felicitate Prof. K.S.G. Doss, Founder-President of this Branch on his 61st birthday.

4. Regarding the proposal for the formation of the Federation of Scientific Workers of CSIR, the committee felt that any change in the status-quo is not advisable for the present.

5. It was resolved to request the General Secretary (Organisation), ASWI, to take steps to bring to the notice of the Governing Council of CSIR the discrimination that exist in the service conditions of scientific and technical personnel of CSIR.

Honours

(a) The following members have been elected to the Associateship (without examination) of the Institution of Chemists (India):—

1. Shri S. Lakshminarasimhan
2. ,, S. Balakrishnan
3. ,, K. Dakshinamurthi
4. ,, S. Sivakumaran
5. ,, N. Karuppannan

(b) Dr. C. V. Suryanarayana has been elected as Fellow of the Royal Institute of Chemistry, London.

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