The role of atomic energy, space and defence

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Atomic energy

The main mandate of the Department of Atomic Energy is the production of safe and economical nuclear power. The department has successfully developed the capability to build pressurized heavy water reactors based on indigenous resources. While a series of standardized 220 MWe reactors are operating and are under construction, the design of the 500 MWe nuclear reactor is also ready for implementation. The effort in the development of this technology has been of multidisciplinary nature since nuclear technology is not just one technology. The component technologies include mechanical engineering, fuel and structural materials, manufacturing, control systems, fuel reprocessing, nuclear waste management and numerous other disciplines related to physics design, water chemistry, chemical engineering, robotics, backed up by the concept of quality assurance in every area.

The professional capability in the nuclear fuel cycle developed in the country is unique and is available only with a few countries in the world. To maintain this position we must ensure continuous upgradation of this technology, integrating the latest developments in safety and advanced engineering concepts. The advanced heavy water reactor, which is evolutionarily related to the existing proven PHWR design, is being studied. Fast breeder reactors, which will enable India to produce an order of magnitude more power from the existing uranium resources are important for India and a fast breeder test reactor has been built. The next step will be to use our vast thorium resources. Some initial steps have already been taken in this to enable us to move into the thorium-uranium 233 cycle.

While pursuing the above programmes, capabilities have been developed in numerous areas of advanced technology, particularly related to mechanical and chemical engineering, electronics and computer engineering, control systems, advanced instrumentation such as mass spectrometers, information technology and materials technology which can be made use of by Indian industry to achieve other social and economic goals.

In addition to nuclear power reactors, efforts have also been put in by the R&D organizations of the Department of Atomic Energy to indigenously build a variety of research reactors including the advanced high flux Dhruva reactor. Skills have also been developed to build accelerators including the synchrotron radiation sources, lasers and other advanced systems. Research reactors and accelerators also require capability in a variety of technologies like magnet design, R. F. Systems, control systems, cryogenics, high precision mechanical engineering, etc., which can again provide spin-off support to Indian industry.

Scientists of the Department of Atomic Energy have also been pursuing basic research in various frontier areas, particularly in nuclear sciences, solid state physics, spectroscopy, nuclear chemistry, radiochemistry, biology, etc. In addition, multidisciplinary basic research capabilities also exist in the Department of Atomic Energy and DAE scientists have interacted successfully with the Indian university system. These interactions must be strengthened both with a view to make synergistic advances as well as to provide major facilities of the department like research reactors and accelerators to the university system. In this context, an inter-university consortium for making use of the DAE facilities has been set up. The department has also set up national facilities like Joanki for preparation and supply of labelled biomolecules. This is located in CCMB campus. The Centre for Compositional Characterization of Materials has been set up adjoining the NFC campus.

The safety of reactor and environmental protection against radiation has been the prime concern of the DAE. Capabilities in the areas of biology, health and environmental sciences, which exist here, can again provide avenues of collaboration with university system as well as suitable inputs to industries in these areas.

A major R&D effort in the laboratories of the Department feeds the industrial units within the department. However, in addition, there are many spin-off technologies which can be made available to Indian industry. As an example, DAE has contributed to industrial radiography, health care through supply of isotopes and associated equipment, agriculture through improved seed varieties, railways, space and so on. Specific technologies have also been passed on to industries for their commercial exploitation. This process must also be strengthened further.

Space

Direct benefits

Telecommunication. (Already available): Satellite telecommunication including business networks, rural telegraphy, communication for disaster warning and management, search and rescue, facsimile, etc.

(Future): Personal communication through low earth orbiting satellites, radio determination satellite service, computer interconnection, inter-library network, integrated data network, etc.

Television and education. (Already available): National coverage reaching even the remotest and inaccessible areas of the country, education through UGC programme, regional network, etc.

(Future): Dedicated satellites for eradication of rural illiteracy using one-way video two-way audio, continuing education for industrial workers and special social groups, video conferencing interconnecting business houses from different places, university education, single-video multiple-audio TV system benefitting people all over the country to see the programmes in their own languages, etc. High power direct broadcast transponders for reception with small dish antennas.

Meteorology. (Already available): Half-hourly VHRR imagery, meteorological data collection from unattended platforms, cyclone warning systems, etc.

(Future): Improved short-term and long-term weather prediction through better sensors on-board meteorological satellites.

Remote sensing. (Already available): Agricultural crop acreage and yield estimation, soil mapping, land use/land cover mapping, urban sprawl mapping, ground water resources mapping, detection of erosion-prone areas, generation of flood mapping in near real time, ground water potential maps, coastal environmental monitoring, forest survey, mineral prospecting, identification of prospective zones for fishing, detection of forest fires, environmental impact assessment, snow-melt run-off estimates, monitoring of water levels in major reservoirs, etc.

Combining space data with socio-economic data, Integrated Mission for Sustainable Development (IMSD) at each village level already initiated.

(Future): Better monitoring of the agricultural crops, especially crop stress and pest detection, incorporation of camera payloads with better spatial and spectral resolutions, on-board recording, stereo viewing and more frequent revisits to help in enhancement of scope in resources management and monitoring. New types of remote sensing payload such as synthetic aperture radar for imaging during day and night for a number of possibilities of using remote sensing in many areas of development.

Indirect benefits:

- Technological upgradation of industrial infrastructure in the country through participation in the space programme. New materials development such as magnesium alloy, maraging steel, beryllium, a variety of composite elements, chemicals, etc., which find applications in many areas, (e.g. composite materials used in textile industry, artificial limbs (Jaipur foot), prosthodontics, chemical intermediates for use in fertilizers for oil seeds, etc.).
- New products such as batteries, solar cells, optical instruments, telemetry systems for aircraft flight tests, etc., which have direct applications in many other fields.
- New technologies such as EBW, CADCAM, a variety of software (FEAST and ISROVISION).
- Development of scope for a number of industries manufacturing satellite communication equipment, remote sensing data interpretation equipment, etc., which have a very large and ever-expanding market both within and outside the country.

Infra-structure utilization and commercial exploitation of space technology

- Sophisticated and elaborate infrastructure built under the space programme such as major precision fabrication facilities, test facilities, computer facilities, can be allowed to be used by industries depending upon the spare capacity.
- Major R&D facilities including computers, electronics test facilities, various chemical laboratories, etc., can be utilized by R&D institutions and industries.
- ANTRIX Corporation already set up to exploit the immense potential of country's space capability by marketing space hardware and software in the international market. Export of up to one billion dollars per year is expected in five years. ANTRIX will coordinate with industries and the space establishments to exploit infrastructure and manpower base for commercial purposes. Export of many materials, components and propulsion system has already begun.

Future thrusts

- Advanced propulsion systems, high strength/light weight materials, fault tolerant avionics systems.

– Serviceable satellites, space platforms, planetary missions, microgravity applications and life support systems for generating the necessary technologies.

Technology of source generation and management, energy storage system, long life control systems, thermal management systems and the means of communications to and from the space platforms.

R&D laboratories may be involved in the development of indigenous technologies in the above areas to meet the demands of the space programmes of the future. However, R&D laboratories need a reorientation in the management of their programmes. They need to work in a target and goal-oriented environment. R&D efforts are to be pursued with the same vigour as projects and should keep in view commercialization aspects of such efforts from the very beginning. Also, the R&D laboratories should concentrate on a few areas, which are need based rather than thinly spreading their scarce resources and efforts on a number of areas in an open-ended research. They should work in close liaison with industries and academic institutions to maximally utilize the existing infrastructure.

Defence

DRDO's major technology projects are based on the requirements of Armed Services. These requirements are essentially for state-of-the-art high-tech products and systems. This means DRDO essentially performs user-driven technology tasks. The technologies developed and accepted by the Armed Services are then transferred to different production centres like HAL, BEL and Ordnance Factories. Quality Assurance Organizations are entrusted with the task of acceptance of the products on behalf of Armed Services. Regular weekly reviews at high levels ensures timeliness of delivery of results with consequent production for Armed Forces. There is a continuous technology transfer from R&D laboratories to production units. In 1992 this resulted in a substantial technology transfer from defence laboratories to production units, the value of production being about Rs. 1000 crores. Mission-oriented projects and programmes have also resulted in scientific and technological breakthroughs in the areas of millimetric wave components, speciality ferrite phase shifters, guidance control technology and advanced composites. DRDO's experience in mission management and technology transfer could be very valuable for our scientific/technological community.

Joint Advanced Technology Programmes have been started with five academic institutions, resulting in state-of-the-art science and technology partnerships between the Academia and DRDO. Through its research and training programmes, DRDO is also promoting aeronautical and electronic and materials research in twenty Universities, several IITs and IISc. DRDO would like to share with scientific communities the results obtained.

Recently DRDO's technology on advanced composites has resulted in a joint sector company formation with COMPROC–DRDO and private company. Also through DST–DRDO collaboration and agency consortium for development of composites has been formed. A society for Non-ferrous Materials Technology Development Centre (NFDTC), a consortium of four public sector companies (HCL, NALCO, HZL and BALCO) of Department of Mines and DMRL of DRDO, is a successful venture already. There are other scientific/technical areas that have been opened out to industries recently.