

number of rooms seems to be an essential requirement. If IUC could restrict the topics to be covered and make the lectures truly pedagogical, the purpose of organizing such workshops will be served better.

IUC should put some effort in improving the laboratory curriculum of B Sc and M Sc classes. It is involved in one such education project which is restricted to five colleges of Madhya Pradesh. The project has just started. It will be interesting to watch how this project succeeds.

Finally, it may not be inappropriate to caution IUC about the dangers of doing too many things in too short a time. IUC must now consolidate the gains it has achieved so far. The experiment of getting university people to work together is alien to our prevailing culture. Hence, one must wait for sufficient time for the idea to take root. Sometimes pushing an idea too fast may generate an adverse reaction!

The success of any venture depends on the initiative and dedication of the leadership. IUC has been lucky in that the first two directors have shown qualities of dedication and purposeful action. To nurture IUC, which is a young plant today, into a spreading tree tomorrow with well-entrenched roots, great care must be taken in selecting the next Director of IUC-DAEF. He must be an experimental physicist of repute and must command the respect of the physics community as a whole. He must be deeply committed to the cause of providing service to the university community and to strengthening the bonds between the scientists of DAE and the universities. He must have administrative competence and should keep in check the universal, ever-present tendency for the growth of red-tapism in any organization. It is to be hoped that the IUC-DAEF will be fortunate in having a succession of such leaders.

Modern science and technology: The public perception

V. Govindarajulu

Positive public perception and attitude towards modern science and technology (S&T) is a vital link in the all-round economic, industrial and cultural development of a nation. Public hostility and/or indifference towards modern S&T, on the other hand, is a drag on the growth of economic productivity of any nation. Public policy options, as derivatives of public perceptions, can be the basis for formulating effective and productive development programmes. The results of this DELPHI study, conducted in the State of Kerala, highlights the public perceptions and attitudes towards modern S&T, productivity and industrial development. The public in the State of Kerala possesses a positive and desirable perception that modern S&T is the key to productivity and national development. The results are comparable to the studies done elsewhere and, therefore, universally valid. This study provides a broad spectrum of philosophical and sociological foundations of modern S&T and industrial development. In-depth areawise, sectorwise and disciplinewise impact assessment studies are required before initiating large-scale investment-oriented S&T projects in the states and in the country.

SCIENCE and technology (S&T), nowadays, plays a vital role in the daily routines of our lives. Industrial development, economic productivity and thus national prosperity depend much on the vital role played by S&T. Efficiency and productivity of our nation's economy are functions of social technology of the people. Social

technology is the level of knowledge base, entrepreneurship and social consciousness acquired by the people, that continuously helps them to raise the quality output of goods and services per given quantum of resources as input. The gross domestic product (GDP) per capita or per capita income at any given time is the index of the level of social technology of the people and their economic productivity attained. Thus, per capita income of some Asian countries – in 1993, for example, Japan

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\$ 23,800, Singapore \$ 10,450, Taiwan \$ 8500, Malaysia \$ 2160, China \$ 650, India \$ 340 – indicates their level of economic productivity, social technology, entrepreneurship, social consciousness and public perception and attitude towards modern S&T. Accordingly, public hostility and/or indifference to S&T is an insurmountable hurdle to nation's economic and industrial development. The economics of underdevelopment and the politics of communalism, which sustain each other, are the characteristics of stagnant and/or low productive economy. And when they are reinforced by the hostile and/or indifferent public perception and attitude towards modern S&T, they lead the country to a negative entropic decline as seen nowadays. On the other hand, the economics of development and the politics of democratic secularism, which are complementary to each other, are the characteristics of increasing orders of productive economy. And when reinforced by a positive public perception and attitude towards modern S&T, they lead the country to a positive entropic growth. One could infer such an all-round growth in the early stages of many civilizations. Therefore, a positive public perception and attitude towards modern S&T is imperative for shaping more effective public policy options¹. Such effective S&T and public policy options could make powerful guidelines for action plans and accelerated growth of national economy.

Scope and objective

We have initiated this research project to assess and map out public perceptions and attitudes towards modern S&T by DELPHI study in Kerala and help the development agencies in the state(s) and in the country to harmonize various group interests by a process of reconciliation, while implementing large-scale investment-oriented S&T projects.

Methodology

The methods adopted here to assess and map out the public perception are: DELPHI study, i.e. seeking intuitive views of the concerned public, statistical aggregate analysis of the data received and cross-comparison and correlation with similar studies. A structured questionnaire was prepared and circulated to as many as 3000 volunteers in Kerala drawn at random and a 10% response was received, which is considered to be fairly good.

Though many participants were from in and around Trivandrum district, they were the people representing all parts of the state and the country with wide exposure to world developments. Hence, the study results could represent the public perception of the state as well as

of the nation. The presentation, made here in two parts, follows a pattern of stating general principles, followed by public perception and attitude as assessed, and then is concluded by derived public policy options as guidelines for future action plans. Part 1 deals with public perception on modern S&T and economy while Part 2 deals with people's perception and attitude towards development issues and action plans.

The respondents

The public who responded to this DELPHI study were the volunteers with tremendous enthusiasm in the social function of S&T. About 88% are males and the rest females. The participants to this study were aged between 20 and 60 years, of which 38% belonged to the age group 40–49 years, followed by 26% in the age group of 30–39 years, 20% in the age group of 20–29 years, 14% in the age group of 50–59 years and 2% in the age group of 60 years and above. Majority of the respondents (56%) were postgraduates, followed by 28% doctoral, 10% graduates and 6% undergraduates. Currently, 44% of the participants are engaged in scientific research, followed by 18% in engineering, 12% in government bureaucracy, 10% in teaching, 4% in management and 12% in other professions.

Part 1: Modern S&T and economy

Given the freedom: The choice of profession

Given the freedom, the respondents would like to accord first ranking (R1) to scientific research as choice of their career and profession, followed by teaching (R2), engineering (R3), social services (R3), journalism and mass communication (R4), business and industry (R5), so on and so forth (Table 1). It indicates the occupation prestige attributed by the public to different professions and careers. Similar trends to occupation prestige, in recent studies, were also attributed by the public in China and United States^{2,3}. It indicates the universal nature of occupational prestige attributed by the public.

Table 1. Given the freedom: choice of profession

First five professions	Respondents (%)	Rank accorded
Scientific research	36	1
Teaching	35	2
Engineering	12	3
Social service	12	3
Journalism and mass communication	13	4
Business and industry	25	5

World problems: Role of S&T

World develops by a process of constant struggle, unity and struggle. Constant struggle and unity are the processes of resolving contradictions that exist in nature, society and human thought, thereby raising economic productivity by many orders. These contradictions are perceived as societal problems. Recognition of such societal contradictions itself is half the solution. Therefore, it is heartening to see here that 88% of respondents to this study do recognize that the people of the world in general face innumerable problems. And 86% of them perceive that such problems do pose potential threats to ecology, environment and human habitat. An equal proportion of respondents assert that such threatening problems could provide ample opportunities to S&T and other professions in searching for feasible solutions.

When asked to rank the groups which are capable of providing more feasible solutions to such threatening problems, the majority accorded R1 to scientists (Table 2). It is followed by technologists (R2), engineers (R3), decision makers in business and industry (R4) and decision makers in the government (R5).

The ordering of ranking by the public is precise, as scientists, as a group capable of understanding the basic laws that govern the development of nature, society and human thought, technologists, as a group capable of developing viable and feasible models and systems to advance the knowledge base to the application levels, engineers, as a group capable of converting these models and systems of knowledge base on a social scale; decision makers in business and industry, as a group of social entrepreneurs converting such a knowledge base into productive investment projects, and, finally, the decision makers in the governments to put the politics in the right perspective (i.e. the art and science of making desirable things possible) to mobilize the resources of states, nation and world to convert all such societal contradictions into socially useful productive opportunities. But, as the saying goes, for every economic problem there is a political solution. That means putting politics in command but on the firm understanding of the knowledge base. Therefore, what is needed here is a mix of all disciplines commencing from all directions, each one taking lead from strengths of its own discipline and merging with strong points of others at appropriate stages.

Table 2. Groups capable of providing more feasible solutions

Groups capable of providing feasible solutions	Respondents (%)	Rank accorded
Scientists	35	1
Technologists	29	2
Engineers	34	3
Decision makers in business and industry	31	4
Decision makers in the government	21	5

S&T development: Decision by whom?

The public has given good regard to scientists, technologists and engineers. As these groups are capable of offering more feasible solutions to the world-threatening problems, the public desires scientists, technologists and engineers to take the first three places of responsibility of decision making in the process of S&T development (Table 3). It is also important to see that the bureaucrats in the governments, people in non-governmental organizations (NGOs) and industries are accorded R4th, R5th and R6th, respectively, to hold responsibilities of decision making in S&T development.

But a synthesis of roles of all the groups is necessary to obtain synergistic effects by striking harmony of interests.

S&T: People's motives

People's motives towards certain disciplines are conditioned by certain internal urges inherent to them besides the opportunities for material and spiritual gains. Accordingly, the response here is more positive and corresponds to Maslow's desirable hierarchical theory of motivation. About 48% of the respondents accord R1 to the disciplines of S&T as they give them opportunities for achieving self-accomplishment (Table 4). It is followed by social recognition (R2), excitement (R3) and security and basic needs (R4). It is a surprising but desirable response, in the present days of crisis-ridden and poverty-dominant society, where the majority of the people are generally driven by the basic and security needs. It indicates people's willingness towards self-accomplishment by advancing the knowledge base despite all-round

Table 3. Groups to hold responsibility of decision making in S&T development

Groups	Respondents (%)	Ranking
Scientists	54	1
Technologists	48	2
Engineers and professionals	44	3
Bureaucrats in the government	38	4
Others (NGOs)	16	5
Business and industrialists	14	6

Note Multiple responses accepted.

Table 4. S&T and people's motives

Motive factors	Respondents (%)	Rank accorded
Self-accomplishment	48	1
Social recognition	38	2
Excitement	27	3
Basic needs and security	35	4

backwardness and limitations. People understand that knowledge is the source of wealth and one should advance it by all means and sacrifices. Therefore, one has to consolidate and strengthen this urge for self-accomplishment by superimposing Herzberg's two-factor hygiene theory of motivation on Maslow's desirable hierarchical theory of motivation. That is achieved by providing a conducive work environment. And such an environment will raise the economic productivity of people at par with that of advanced countries.

S&T progress: Does it benefit modern life?

Four decades back a vast majority of people in the country, particularly in the rural areas, were ignorant, suspicious and even hostile to modern S&T. One could recall such suspicions and hostilities, by the rural folk, towards vaccination to small pox. But today the scene is the reverse. Growth in literacy and awareness through mass media and cultural exchanges by travel and tourism have made all such desirable changes possible.

Accordingly, an overwhelming majority (98%) of the respondents here agree that S&T progress has immensely benefited the mankind and modern life. However, 56% of the respondents assert that such benefits extended to the whole cross-sections of the society, while 44% assert that it covered certain pockets only. Over 54% of the participants to this study assert that S&T progress has brought more of good impacts on society while 40% assert that there are both good and harmful impacts in equal proportions and 6% express nil opinion. Fortunately, none of the respondents attribute the occurrence of harmful societal impacts to S&T progress alone. Hence, the need for consolidating good impacts by weeding out bad ones by proper technology assessment and technology forecasting exercises and mass awareness campaigns. It should also be ensured that the good impacts spread to the whole spectrum of society benefiting one and all.

Societal benefits: The direct derivatives of S&T efforts

People's perception and attitude towards modern S&T is conditioned by their direct experiences with the modern amenities. Thus, public perception of societal benefits, as direct results of S&T efforts, is more realistic and positive (Table 5). About 70–80% respondents attribute to modern medical aids, better transportation and communication network, electrical domestic appliances and family planning and child birth control devices as societal benefits derived directly from the results of S&T efforts. About 50–60% respondents assert that better educational facilities, urban public utilities, declined infant mortality

and better food preservation methods are other societal benefits. And 40–50% view that extended life expectancy and modern methods of recreation are direct societal benefits due to S&T progress. This is an index of people's priorities to life-styles and systems, which deserve more attention. Raise in the people's per capita income can enhance the demand for such modern amenities much beyond the present level. Accordingly, cost-effective and more productive technologies are needed to produce such quality amenities at competitive prices.

Societal harmful effects: Inherent or by-product of S&T?

Societal harmful effects, in some cases, are both inherent and by-product of S&T. The first-generation technologies, which were energy-inefficient, exhibited both the characteristics. They get intensified when disregard is given to public safety under the presumption that they do not add to the benefits. But they can be overcome by the present-generation technologies when a balance is struck between social costs and social benefits. Thus, the public expresses its concern and alarm over the present-day harmful societal effects derived as direct results of S&T efforts (Table 6). About 60–80% of the respondents assert that arms race, militarization of industrial economy and environmental pollution and ecological imbalances are the societal harmful effects resulting directly from S&T progress. Another 40–60% respondents attribute the abuse of pesticides, insecticides and chemical fertilizers and excessive dependence on medicines and abuse of drugs as

Table 5. Social benefits as direct results of S&T efforts

Societal benefits as direct results of S&T	Respondents (%) attributing
Modern medical aids	82
Better transport and communication network	78
Electrical domestic appliances	76
Family planning and child birth control devices and systems	66
Better educational facilities	62
Urban public utilities	54
Declined infant mortality	54
Better and effective food preparation and food preservation methods and systems	52
Extended life expectancy	48
Modern methods of recreation	40

Note: Multiple responses accepted.

Table 6. Societal harmful effects as direct results of S&T efforts

Societal harmful effects as direct results of S&T	Respondents (%) attributing
Arms race and militarization of industrial economy	77
Environmental pollution and ecological imbalances	66
Abuse of pesticides/insecticides/chemical fertilizers	58
Excessive dependence on medicine and abuse of drugs	44
Food adulteration and low-quality foods	34
Degradation and withering of traditional values	26

being direct results of S&T. And 25–40% respondents believe that food adulteration, low-quality foods and degeneration and withering of traditional values are the direct results of S&T progress. Direction of S&T efforts determines its results, whose impacts can be either good or harmful. Sometimes the nature of impact can be the inherent characteristics of the type of technology itself. So what is needed is to do technology assessment and technology forecasting exercises, anticipate the nature of impacts, overcome the negative and consolidate the positives and educate the masses.

Societal problems: The root causes

Societal harmful impacts due to S&T obviously cause societal problems as well. They need to be thoroughly understood and properly tackled. Public perception here is that 38% respondents assert a few societal problems, while 34% think that some societal problems are caused by S&T progress, 6% assert most of the problems, 2% assert no problem and 6% express nil opinion. When asked to identify some such societal problems caused by S&T progress, 58% say the hampered human relationship, followed by 46% saying the environmental pollution, 27% the economic imbalances and 23% each the misuse of drugs, adverse media impacts and increased warfare.

Such societal problems and harmful effects do emerge due to the inherent contradictions that exist between the competitive but cooperative nature of the progress of productive S&T worldwide on the one hand, and the monopoly appropriation of the gains on the other. This does not permit one to give more thrust to prevent harmful effects. So, one has to resolve this contradiction by harmonizing production relations and not resist S&T progress as such.

S&T: Its substantial contributions

Public perception on certain areas in which S&T could

make substantial contributions is conditioned by their direct experiences. It is more logical but a simplistic view. About 60–80% of respondents assert that S&T could make substantial contributions to certain areas such as increased production and productivity of goods and services, exploration of space, earth and ocean and optimum utilization of resources, better, fast, safe and economical means of transportation and communication and better and cost-effective child birth control methods and devices. About 50–60% respondents think that S & T could make substantial contributions in providing better, effective and economic learning systems, improving the availability of quality food, control and prevention of environmental degradation and ecological imbalances, complement labour productivity, help better understanding of the laws that govern the development of nature, society and human thought, and reduce labour intensity and substitute labour force in production of goods and services. Still there are about 30–40% respondents who think that S&T could not make any substantial contributions in reducing natural disasters, in crime control and global wars by increasing international cooperation, in promotion of global trade and promotion of democratization of society by competitive and cooperative ventures. An equal proportion of the respondents express nil opinion.

On the other hand, crime is naturally controlled when the material and knowledge base of the society is democratized. That is, when people's entitlement to material and knowledge base is enhanced according to their capabilities and contributions, a more civilized and humane society is evolved. Such an entitlement is related to compulsory and universalization of education and employment. Reduction of threats from wars, in turn, is conditioned by the globalization of capabilities through competitive and cooperative spirits. This demands for promotion of global peace, understanding, harmony and respect for human values and rights. This, in turn, is conditioned by the knowledge and material base of the world people in general.

Such interdependences and interconnections among S&T and multiple human dimensions of world people are still in the meta-physical (abstract) state of development. It is due to the widespread disparities in capabilities among the world people. Hence, the need for correcting the negative and indifferent public perceptions and attitudes by proper education and mass awareness campaigns.

S&T areas: Public funding

Public perception on public funding in S&T areas is conditioned by the objective realities of the current societal issues. The public perception correlates to the thrust of research areas the country should focus while

allocating funds. About 70–80% of respondents assert that public funding in S&T should be towards areas like improving health care and population control systems, prevention of environmental pollution, ecological imbalances and strengthening of agriculture and food. About 50–70% stress on improving education, increasing economic productivity, developing better and cost-effective means of transportation and communication, clean and reliable sources of energy, remote sensing and weather forecasting, cost-effective and ethnically adaptive housing, and exploration of space, ocean and earth for optimal use of resources. However, a large section of respondents, 20–40%, express nil opinion. Neutrality of such a large section of population towards such topical issues could often be hurdles to the initiation of large-scale S&T projects which are otherwise needed for fulfilling the basic needs of the people. And India should increase its S&T expenditure, on accelerated basis, equal to or greater than 2% of GNP or 4 times the remittances for imported technologies, to reach the threshold level of technological assimilation and diffusion capability⁴.

S&T fields: India in the lead

India was one of the ancient civilizations, whose contributions to world knowledge base, since Indus Valley Civilization, are well known to all of us. India was a centre of learning which gave birth to many philosophical connotations that changed the social dimensions of many countries in Asia and elsewhere. Rise of Buddhism is one such example. Such was our tradition till the dawn of the Middle Ages of Feudalism and British Colonialism. Though there was a setback to this tradition since industrial revolution in Europe and its colonial expansion, the Indian brains still possess creative talents, which are now latent and which can blossom any time given the right fertile conditions. Thus, relatively favourable conditions in the form of vast S&T, educational and industrial infrastructure created since independence has helped India to regain the lost vigour. This is reflected in the assertion of India's S&T capabilities in many key sectors. Thus, 52% of the respondents assert that there certainly are a few S&T fields in which India is in the lead. And 10% of the respondents assert that India is in the lead in most of the S&T fields while 28% assert none of the fields and 10% express nil opinion. When asked to name some such fields in which India is in the lead, the following in the order, have emerged.

1. Space research
2. Agricultural technology
3. Textile technology
4. Atomic energy
5. Software development and advanced computer programming

6. Mathematical and social sciences and philosophy
7. Medicine and health care research.

Interestingly, these are the same S&T fields which have come under international pressures in the form of Missile Technology Control Regime (MTCR), Nuclear Nonproliferation Treaty (NPT), Trade Retaliations, Super and Special 301, and Intellectual Property Rights (IPR), Trade-Related Intellectual Property Rights (TRIPS), Trade-Related Investment Measures (TRIMS) in the Dunkel Draft Text (DDT) of General Agreement on Tariffs and Trade (GATT).

Despite such pressures, India cannot reverse its historical course of advancement. This can be better done by subjecting India's international relations, including trade and technology transfer, to the five principles of peaceful coexistence.

S&T impacts: Life-style changes

Life-styles are culture-specific. Culture is a function of man's economic relationship with nature on the one hand and other fellow human beings in the society on the other in the process of production, distribution and consumption of goods and services. The economic relationship, in turn, is a function of S&T knowledge, that induces changes in values, attitudes and aptitudes towards environment that surround the people. S&T also provides material base in the form of better goods and services that ultimately brings desirable changes in the life-styles. Accordingly, the public is well aware of the impact of S&T in changing the life-styles. Thus, about 44% respondents feel that the rate of change of life-styles due to S&T progress is too fast while 38% think neither fast nor slow, 10% feel too slow and 8% express nil opinion. Telecommunications and electronics, transportation, automation, food and agriculture, information technology, domestic appliances, medicine, computers and engineering sciences are some S&T systems, which, according to the respondents, cause the rate of change of life-styles too fast. In fact, S&T progress enables democratization of the knowledge base worldwide, leading to cultural cross-fertilization of thought processes that ultimately weed out the obsolete customs and traditions. Once such hurdles are broken, S&T becomes a material force bringing rapid changes in values and life-styles. Information technology plays a vital role in bringing such changes. And such changes, however slow or fast, are irreversible. Therefore, suitable educational programmes should be developed to enlighten the public to acquire positive attitudes towards life-styles.

Part II: Development issues and action plans

We have posed many currently debated development issues before the public and sought their perceptions,

and action plans that could guide our country's S&T programmes towards emerging world trends. The consensus outcome, as presented below, is more precise and objective, hence worthy of consideration before undertaking S&T-oriented large-scale investment ventures.

Intellectual Property Rights

Intellectual Property Rights (IPR) in the form of patents, trademarks and copyrights are granted by the country's constitutional due process as a legal instrument to promote public good, while at the same time, protecting the legitimate interests of the first inventor. Any invention which is novel and possesses economic applications is considered for grant of patent rights. But products derived from chemical, biological, biochemical and microbial reactions shall not fall under the categories of inventions or innovations as their outcomes are inherent to the processes or methods. Likewise, life forms are the products of biological evolutions independent of man's efforts. Therefore, what is inventive or innovative here are the particular processes or methods developed by men and hence worthy of granting patent rights. On the other hand, a strong IPR regime, granting patents indiscriminately and kept in force beyond the economic utility of the inventions, becomes an instrument of obstructions in the hands of monopolies, which restrict the advancement of productive forces by competitive spirits⁵. Therefore, a desirable IPR regime is one which is liberal and sensible, and promotes productivity by competitiveness and respects self-reliance of nation states. Indian Patent Act 1970 is one such, primarily aimed at promoting technological innovations, transfer and commercial production in the country. And thus it was applauded as a model patent law by all the developing countries. Even this was the case with the patent laws of the developed countries in their early stages of development. But, in recent times, India has been subjected to international pressures, trade sanctions and retaliations such as Super and Special 301, TRIPS, TRIMS of DDT of GATT, to alter its Patent Laws fundamentally to fall in the line with the strong patent regimes. This international pressure is brought under the belief that a strong patent regime indeed will help promote global trade and commerce. The Parliamentary Standing Committee on Commerce, in its 3rd Report on Dunkel Draft proposals, presented in December 1993, urged the government not to succumb but to move with caution.

In this context, about 86% of the respondents did not accept the demand for strong IPR (Patent) regime, nor did they want India to sign DDT unless GATT agrees to revise its text to accommodate the legitimate economic interests of developing countries, including India. Only

14% of the respondents favoured the demand for strong IPR (Patent) regime and signing the DDT as it is presented today. A similar trend can be seen in the write-ups of as many as 20 lead authors that appeared in the April special issue of *JSIR*⁶ that devoted itself to IPR and development perspectives. Here about 65% of the authors favour defending the Indian Patent Act 1970 and country-specific liberal patent regimes, while 35% of the authors favour changing the Indian Patent Act 1970 to align with the strong patent regimes of Paris convention and DDT. Still there is a need for enlightening the public about the science of patent laws, their inherent limitations to protect the monopoly market rights of the first inventors, as in the modern S&T world; parallel discoveries, inventions and innovations can take place autonomously by the surging competitive productive forces. Under these conditions, India has to conduct its foreign relations, including trade and technology transfer, subject to the five principles of peaceful coexistence, while at the same time, safeguarding the basic features of the Indian Patent Act 1970. Now India has been a signatory to DDT of GATT (WTO). And people should learn to get along with it while safeguarding national interests as well. And the Parliament is divided on the Bill to amend the Indian Patent Act 1970, the majority not favouring.

Nuclear Nonproliferation Treaty and Global Security Plan

Nuclear Nonproliferation Treaty and Global Security Plan are the schemes operated by the clubs of 'nuclear-haves', mostly the West, to control the spread of nuclear weapon systems among the 'nuclear-havenots'. This does not discriminate between nuclear programme for peace and energy and for warfare. And there is an international pressure on India to join this exclusive club of NPT. Or else it will have to face sanctions and retaliations on imports and exports in strategic areas of nuclear energy research. Despite this, the 25 years of NPT has led to manifold proliferation of the weapon⁷. By the end of this century, there will be 20 more nations in addition to 26 with full capacity to develop their own nuclear weapons⁸.

In this context, 76% of the respondents did not want India to accept NPT membership while 24% favoured it. Further, they made certain startling but relevant assertions indicating their perceptions and attitudes. Thus, NPT is not a treaty reached among equals but an imposed one. GSP is irrelevant as there is no external threat to this world. This means that the threat to this world security is from within. NPT and GSP can be accepted if there is a universal agreement to dismantle the nuclear warheads of all the countries simultaneously. Even if India joins NPT and GSP, it should not be

under duress. Similar views were expressed by a group of eminent persons in the first quarter of 1993 commissioned by the Government of India (GOI) to look into this aspect. Even a high-level study group, commissioned by the Carnegie Endowment for International Peace, in its report entitled 'India and America after cold war' suggests US not to force India to sign NPT and MTCR under duress. And the majority of the respondents think that India should reduce its budget on the Department of Atomic Energy by making nuclear power generation a commercially viable and self-supporting venture. One can reduce the burden of defence by improving friendly relationship with neighbouring countries through improved diplomacy. This demand is nothing but a call for the renewal of India's one-time cherished foreign policy based on the five principles of peaceful coexistence and nonalignment, the *Panch Sheel*: Mutual respect for each other's territorial integrity and sovereignty; mutual nonaggression; mutual noninterference in each other's internal affairs; equality and mutual benefit; and peaceful coexistence.

Earth summit and biodiversity

Concern to save the earth, protect the environment, ecology and human habitat and preserve biodiversity (in fact, it should be rightly called as *biovariety*) has attained international dimensions in the recent times. The developed countries were the forefathers, who created those systems that caused environmental pollution and ecological imbalances. But that was the way the industrialization took place under the capitalist system. The same countries, after 200 years of capitalist industrial development, exploiting world resources at their will have now attained a higher level of human development index (HDI). As S&T progresses, people's concern for a clean environment increases. The developed countries could now come with third- or fourth-generation technologies, mostly automated, which are more environment-friendly. So, the sealing was fixed on the upper limit to environmental pollution to 1992 level, which the developed countries would like to impose on the developing ones. If the developing countries, with scarce resources, technologies and skills, want to reach the same level of development of developed ones via the routes of capitalist industrialization, they have to invariably depend on the inefficient, obsolete and environment-unfriendly technologies. Such obsolete technologies, now facing a threat of closure in the West, can be easily shifted to the developing countries. Therefore, one group in the West is eager to shift such obsolete units to willing partners in the developing countries. At the same time there is another group in the West which wants to put restrictions on the development as well under some pretext with which some other groups in the

developing countries would like to align either due to necessity or due to ignorance.

Likewise, the developed countries would like to consider the biodiversity (biovariety) of the world (mostly from developing countries) as universal properties and hence the demand for free access. At the same time, any improvement they make on them through S&T inputs they would like to treat as private properties, protected by IPR regimes, which the developing countries will have to acquire by paying a high price.

These are the contradictions of development inherent in the collective nature of production of knowledge and materials and the private nature of appropriation of the surpluses thus generated. The UNO (United Nations Organization) wished to reconcile the conflicts among these contradictions and strike a balance under the existing diverse sociopolitical-economic systems. This drama was enacted on the stage of the Earth Summit in June 1992 at Rio. In this context, an overwhelming majority (84% of the respondents) did agree that the Earth Summit and Biodiversity Convention 1992 were good beginnings while 16% did not consider so. However, it is observed here that the Rio Treaty and Biodiversity Convention were heavily biased towards Multinational Corporations (MNCs), which according to the majority of respondents should be checked. According to the respondents, country-specific action plans to protect national interests should be incorporated into the Treaty. Mass awareness campaigns and peace movements should be taken up vigorously to restore the lost varieties of life forms in the high tides of green revolution. India should formulate suitable policies to protect biodiversity on cooperative basis and strengthen environmental protection policies and Acts while venturing into large-scale industrial developments.

S&T in the strategic areas: Missile Technology Control Regimes

Like NPT, Missile Technology Control Regime (MTCR) is the club of advanced countries who have stock-piled heaps of missile systems. Members of MTCR are presumed to have freedom of access to high-techs in the strategic areas. But they are barred from entering into business contracts with non-MTCR member countries, mostly the developing ones, to pass on the missile technologies. Thus, by restricting missile proliferation, MTCR member countries believe that they could safeguard the global security.

As Indian space research ventured to launch Polar Satellite Launch Vehicles (PSLV), Geostationary Satellite Launch Vehicles (GSLV) programmes with cryogenic rocket engine systems, obtained from Russia on economy terms, the US has imposed a ban, under MTCR, on ISRO, restricting its deals with US companies in strategic

and aerospace industries under the pretext that Indian space programme is aimed at developing missile technologies. However, if India joins MTCR and accepts to pay higher prices, the US itself is willing to pass on the cryogenic rocket engine systems to Indian space programmes. This, according to the Chief of Glavkosmos, is nothing but a trade war⁹.

In the context of trade-related conflicting interest, as cited above, over 86% of the respondents did not favour India accepting MTCR terms. They assert so for the reasons that MTCR is an imposed one and that it does not help those who want to acquire high-tech systems. The ways suggested by the respondents are to strengthen peace movements that prevail over the arms race. Further, according to the respondents, India should use its missile technology development programmes to strengthen high-tech areas in the country and then extend its cooperation among the Third-World countries.

S&T-oriented large-scale investment projects and the priorities

Today, India is torn between antagonistic group interests. Different groups think that they are exclusive to one another in the development process. Ignoring the fact that the human development is an integral part of ecological balance, the multiple dimensions of social development are counterposed to one another, instead of enabling them to play complementary roles. Thus, we see, in India, that agriculture is counterposed to industries and large-scale industries are counterposed to small-scale industries, foreign trade is counterposed to domestic trade, domestic R&D and technologies are counterposed to import of foreign technologies, large-scale S&T-oriented investment projects in irrigation, power, space, defence, communication, transport, industry and infrastructure are counterposed to environment, ecology and human habitat, population itself is counterposed to development process and so on and so forth. Even modern S&T is counterposed to the future of human civilization. Thus, we see a stagnation (or rightly stagflation) in the development.

Such conflicts emerge out of the objective realities that India continues to live with the backward and obsolete productive forces sustained by backward and obsolete production relations which were the legacies of feudal and colonial rules. However, there is a surge of technologically driven productive forces advancing in the world simultaneously raising the living standards of the people by changing their production relations on more or less democratic norms. Indian society, as an integral part of the world, is also influenced by this trend, hence the urge for advancing the productive forces. But the groups desiring to advance the productive forces through noncontractual vested interests ignore the

simultaneous need for restructuring a more balanced and harmonious production relation. This is the source of conflict that counterposes several dimensions of human development, resulting in stagflation. Public perception, in this study, is more objective and balanced one. They understand the development needs of the state and the country by advancing productive forces while at the same time they appreciate the demand for restructuring production relations so as to avoid the conflicts of counterposing nature. Thus, over 74% of the respondents desire to give top priority to S&T-oriented large-scale investment projects as they give opportunities to raise the living standards of the people. Yet they assert that such large-scale investment projects often induce negative impacts on environment, ecology and human habitats. The basic principles to be respected here are the laws of conservation of biomass and bioenergy that enhance the net worth of all the groups concerned in the development process. In the absence of such corrective measures, the public prefers a large number of small projects. They assign top priority to the projects aimed at eradication of poverty, unemployment and illiteracy. They urge for reduction of import dependence in defence sectors as such a dependence does not guarantee national security. Further, they urge that defence sectors should be made to serve civil needs as well. The respondents assert that satellite communication systems, hydroelectric power projects and nonconventional energy systems should be given higher priority. The public urges not to convert natural forests into biological parks. According to them, priority to nuclear power plants can be given if the safety is guaranteed and power generation is made to earn its own return on investment. Further, they suggest to accord priority to missile technology programmes only as a means to advance high-techs in the strategic fields and earn return on investment by trading in defence systems and hardware.

Agriculture, industry, food, health care and family welfare programmes and the priorities

Agriculture and industry depend on each other for continued growth. Agriculture being the base, industry must play a complementary role as a superstructure. India, being an agricultural country, should not ignore this fact. The public perception to this that agriculture, purely on commercial grounds, is going to endanger the food security hence needs to be checked. Educated unemployed should be urged to take up vocations in agriculture and industry. All wastelands should be brought under agriculture and awareness should be created to cultivate every piece of land. Development of agriculture and industry should promote employment and economy. And S&T should play an active role in promoting agriculture, industry, employment and

economy. Mechanization of agriculture and automation of industry should enhance labour productivity and not replace the labour force.

Food security to the people is the national security. A threat to food security to the people is a threat to national security as well. Likewise, health is wealth. Unhealthy people means unhealthy nation, and hence insecure nation. Family welfare programmes should not only aim at regulating population growth in accordance with the means to feed but should also ensure food and health to one and all. There is a unity of consensus of all the respondents that top priority should be given to these programmes. The public asserts that more investment should be allocated to such areas. And S&T should focus more to meet the need for 225–250 million tonnes of food grains for 1044 million people in 2001 AD by raising the yield per hectare manifold from the present level of: rice 1.75 tonnes, wheat 2.27 tonnes, jawar 0.82 tonnes, maize 1.52 tonnes, ragi 1.1 tonnes, potato 16.22 tonnes and sugar 5.55 tonnes¹⁰. It is here that the productivity of foodgrains in the country, i.e. the output per work force, should be enhanced manifold by maximizing the product of two factor ratios, viz. output per hectare of land and hectare of land per work force. Maximization of the output per hectare demands for higher orders of productive technologies and maximization of hectare of land per work force demands for implementation of Land Reform Act as well as sharing of scarce resources by cooperative spirits. Simultaneously, population explosion should be controlled by persuasion and education following the Kerala model. Decentralized administration and acceleration of green revolution are suggested. Stringent checks on adulteration of food and drinks are sought. Indigenous health care systems to be strengthened on the lines of modern health care systems. One should avoid mixing up of the politics of religion, castes and communal divides with the politics of development.

Education and employment

Education and employment are the two sides of the same coin. Education is useless if it does not lead one to gainful and productive employment. Most of the country's antagonistic contradictions could be resolved if compulsory and universal education and employment are ensured to all eligible and able-bodied people. Compulsory and universal education and employment to all meet the twin objectives of people's entitlement to the wealth of knowledge and the wealth of materials on more democratic and socialized basis. In this sense, Kerala has achieved a near cent percent success in universal education. And it has yet to go a long way in ensuring compulsory and universal employment to all. Whereas India, as a whole, is many years behind

in achieving both these objectives. As per the 1991 census, the literacy rate was 52.2% with a wide gap between males (43.88%) and females (39.42%). During the 1981–91 decade, the growth rate for literacy was 8.55% and that for illiteracy was 7.31%, leaving 302 million illiterates even in 1991. And about 63% of the population in the age group of 14–60 years is considered as nonworking though the unemployed registered with the employment exchanges was as high as 36.3 million in 1991, which grows at the rate of 10% per annum¹¹.

The public perception, in this study, desires to give encouragement to community level action plans and vocationalization of plus-two stage for attaining education and employment to all. The purpose of education should be to build a vibrant, productive self-confident, self-reliant, scientific-tempered, value-oriented, more humane and cultured society. S&T should help to create such a society.

Housing and human habitat

Housing and human habitat, in harmony with environment and ecology, is the index of developed and cultured civilizations. According to 1991 census, the demand for housing in Kerala was 11 lakh units¹². Of these, 55% were substandard huts declared unfit for human dwelling, 27% were old ones awaiting demolition and reconstruction; only 1% were considered as standard units fit for human dwelling and 17% were considered as numerical shortage. A similar trend exists on all-India basis as well. Thus, housing the millions is a massive public task. If such a massive task is taken in a coordinated manner, it could provide immense opportunities for investment, employment, innovative and productive techniques, methods and materials. The criterion on the choice of technique is the one that delivers maximum number of housing units per given unit of resources.

The public perception here is more positive. Accordingly, S&T should focus on cost-effective, modular-type, functional and economy houses by adopting Baker's type of techniques which encourage utilization of local resources and skills that conserve materials, reduce costs and improve aesthetic values in harmony with environment and ecology. Housing design and construction should be fully engineered based on architectural principles rather than on false prestiges. Minimization of noncontractual vested interests will also reduce the costs while improving cost-effectiveness.

National defence

Agriculture, industry, S&T and defence are considered as four vital elements of any nation. Without strengthening these four aspects concurrently, one cannot think

of a modern state. They are complementary to each other and not counterposing. If improperly handled and imbalances are created, they do become counterposing to one another. Though the public perception (about 85% of the respondents) is in favour of strengthening national defence, their attitude is conditioned by the imbalances that occurred due to the stifled nature of development as seen in agriculture, industry, S&T and defence. Thus, there is a demand for cut-down in defence expenditure, unless otherwise the nation wants to do business in the military hardware. Expenditure in defence can be brought down by strengthening peace movements, imparting military training to the civilians to develop para-defence systems and improving country's diplomacy and foreign relations.

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Impact of extreme events on coastal zones and small islands in the context of climate change

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The paper presents a review of the current state of knowledge on the likely impacts of extreme weather and climate events on coastal zones and small islands in the context of climate change. Possible response options, including prevention, preparedness and adaptation, are indicated.

At first glance, there appears to be little in common between the gradual onset and complex impacts of climate change and the unheralded onset and direct impacts of extreme events. While the magnitudes of the anticipated global warming and consequent sea level rise may be somewhat less than those indicated in the First Assessment Report¹ of the Intergovernmental Panel on Climate Change (IPCC), it is the extreme events and/or climate surprises that need to be taken seriously. It appears that more emphasis has to be placed on changes in frequency and/or intensity of various extreme or threshold events, particularly the extremes of temperature and precipitation, and the hazardous coastal events such as cyclones and storm surges. Such events would dominate the effects in coastal zones. The small islands would, however, appear to be highly vulnerable to accelerated sea level rise as well.

Definitions

Coastal zone: Coastal zone includes both the area of

land subject to marine influence and the area of sea subject to land influence. Coastal zones are very valuable parts of the economies – both the affluent and subsistence economies. Coastal habitats provide important areas for fish and wildlife, including many endangered species. Coastal zones filter and process agricultural and industrial wastes and provide a buffer for the inland areas against cyclone and wave damages.

Small islands: Islands less than 200 km² in area are defined as small islands and those with area less than 20 km² may be called very small islands. This categorization is not entirely arbitrary and is significant in the sense that while the larger islands generally have geological features and problems similar to those found in continental regions, the small and very small islands have their own characteristics and rather unique problems. The major conglomerates of small islands are in the Pacific, the Atlantic (Caribbean), the Indian Ocean, and the territories of Indonesia and the Philippines.

Physical changes

Tegart *et al.*^{2,3} have documented the potential impacts

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