PURE VERSUS APPLIED SCIENCE- A CENTURY OF DISORIENTED DEBATE

By
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Over a hundred years ago (1875) Richard Temple, Lieutenant Governor of Bengal, made an interesting proposal which ran as follows: the system of education in the English language and Law, introduced in India following the famous Macaulay Minute (1835), had not been entirely successful; in producing in the Indian mind the sense of inferiority originally intended. Somehow, the Indians still tended to display a sense of equality with British Learning. As an alternative approach, Indians should be exposed to an education in the practical sciences , which were an exclusive preserve of Western culture. These disciplines, with their Exact Methods might overwhelm the Indian Mind and thus help induce the requisite sense of inferiority vis-à-vis the British who were the masters of this kind of learning.*

This proposal for a benign, bloodless conquest of the Indian Mind was rather well founded in theory at least. William Wilberforce, father of the Victorian Era in England, had articulated such a scheme of subjugation of the Indian Mind in religious terms in a celebrated parliamentary speech in 1813.

In the middle of the nineteenth century there was talk of the Triumph of the Mind as a package of specific theories and practices that dealt with the subjugation and extermination of the alien races . Concrete expressions of such an ideology could be found in the Republican Ideology of the USA, which held that it is the Virtuous Person who must rule. The Virtuous Person was one who tamed his boisterous passions (Jefferson) with his mind and thus rose above other men who wee incapable of exercising such subtle control, continuing to identify themselves with base instincts . Such peoples or whole races composed of such peoples needed to be ruled over by the Virtuous Persons or their Race, as dominion over them (and their resources) had been granted to the Virtuous. Taming of bodily forces by the mind was held to be almost identical with taming the natural forces . Thus, one of the most potent expressions of Virtuousness or moral temper was Technology which was the capacity to tame and array the forces with the purpose of reaching subtler goals. The technologists, or the mechanicians as they were termed in the editorials of Scientific American wee repeatedly called upon to liberate suffering millions the world over, with the help of their machines and mechanisms that tamed forces hitherto held beyond control. Thus when the other people were thought of as possessing primitive technology, one without the guidance of a Method, it was derivative of the doctrine that Mind should exercise control over all systems, certainly that of transformation of earth s resources for production and distribution.*

When the practical sciences were sought to be imposed on India, the suggestion thus had grounding in a theory just as powerful as theology and whose practice had been tested against various peoples. Technology as it was called, was to be one more means of scoring a victory in a battle, perhaps not quite as bloody. Technological superiority was identified with the demonstration of a superior Mind that produced it and entitled it to an almost Divine Right to exercise greater dominion over resources.

Around the time when proposals like these were being put forward, a somewhat different set of proposals were being developed in Britain by the Neglect of Science Committee. This Committee was an informal association of scientists who were alarmed at the rise of a new kind of technological power in Germany in the form of the synthetic dye industry. Starting with the synthesis of aniline dye on an industrial scale, German companies such as Badische Aniline and Soda Fabrek (BASF) and Hoechst invaded the European scene with new synthetic dye-products in succession, alizarin followed by indigo. The formidable alliance of university-based chemists with craftsmen and mechanics resulted in rapid

* Quoted in Dharampal, Indigenous Indian Technological Talent and the Need for its Mobilisation , PPST Bulletin, NO.9, Dec.1986, p.6.

* A critical study of republicanism may be found in *R.T.Takaki, Iron Cages: Race and Class in Nineteenth Century* America, University of Washington Press, Seattle, USA.

changes in the character of industrial products, which Britain found difficult to cope with. Britain till then had enjoyed supremacy in terms of Triumph of Mind with the harnessing of steam power for production and with steel manufacture and coal mining but Germany had started Britain by developing in altogether different set of production processes.[1] This challenge at the technological level was also a challenge to the Right of Dominion that Britain possessed by virtue of the Triumph of Mind ideology. This sense of surprise was compounded by the fact that aniline synthesis was based on a reaction discovered by an English Chemist, Perkins.

Neglect of Science Committee had been formed in this context, to warn the government of the following problem: Britain had undoubted superiority in producing great ideas in pure science, while their application to industry was lacking. Germany could challenge Britain technologically, only because an alliance had been forged between university-scientists and industry by way of new organisational linkages. The Committee therefore urged the British government to take up measures to support applied research to counter the German challenge, by creating new organisations for research. This sort of lobbying resulted in setting up of a permanently funded laboratory, the National Physical Laboratory in London in 1900 and in the creation of a Department of Scientific and Industrial Research (DSIR) in 1916 during the War II.[2]

This is the context of the origin of the dichotomy between pure and applied science. The problems was: given an idea , how does one get it transformed into a product , how does tame a force of nature so as to constitute it as an array of forces to reach a specific goal; what are the linkages or mechanisms that will direct such transformations on appropriate occasions and at an appropriate pace. These are issues that are overtly mobilisational in character and have, in fact, been considered as such in some recent writings on the sociology of science .[3] They call for the creation and development of an ability to establish or dismantle idea-formations and organisational linkages/mechanisms at a rate faster than an enemy could sense and all this is to take place through the Mind, rather than with the aid of arms and strategists as it would be in a battlefield. In such a context, the ideas or the organisational forms and arrays are themselves subject to drastic changes that may result in radical alterations in them. The essential concern, however, is to set the pace and character of the changes in linkages or formations. Thus, what may be pure or applied science is fundamentally dependent upon the particular context of a campaign and the course of changes in them may remain as uncertain as the course of the campaign itself.

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This was the broad context when the Indian Mind was sought to be directed to the more practical sciences as part of a campaign for its subjugation. Not that there was no work going on in India on the British sciences earlier, elaborate taxonomic, classificatory exercises in zoology, botany, meteorology and geology were being carried out by various British officers in India since the late 18th century. But when Mahendra Lal Sircar founded the Indian Association for Cultivation of Sciences (IACS) in 1876 in Calcutta, it was the first time that Indians got together to carry out scientific research on their own . The IACS was founded on the vision of Mahendra Lal Sircar whose eclectic belief in the scientific method led him to call upon Indians to save it from the West that was deviating from its Christian ideals. But Sircar soon ran into trouble over the debate on the purpose of research in IACS; should it be pure aiding the advancement of knowledge , nothing more nothing less, or should it be oriented to providing popular technical education. A believer in the purity of scientific research over its mere purposefulness. Sircar claimed, in exasperation quoting Thomas Huxley, that the term applied science had never been invented. Thus, as soon as scientific research started in India, it was beset by a pure versus "applied science controversy.

The Swadeshi Movement (1905) brought in its wake a number of industries into India, stressing the theme of self-reliance . One of the major demands of the Swadeshi Nationalists had to do with the promotion of technical education in India that would sustain and propel industrialisation for self-reliance. The government then came up with its strategy of forming an Indian Industrial Commission) thought by many to have been formed due to the exigencies of World War I, to deal with the entire

spectrum of issues ranging from technical education to large scale industrialisation.* This commission, headed by a certain Thomas Henry Holland had three Indians (Pandit Malaviya and Dorabji Tata notable among them) on it. The Commission cross-examined many prominent Swadeshi spokesmen and industrialists and compiled the evidence into a massive report. This report does not seem to have been taken seriously, nor its recommendations implemented. The entire approach of the commission s found in the 7-volume report was colored by the attitude of the British officers that technological incompetence was a reflection of moral temper .

As a systematic effort to recast Indian society into an Industrial mould as it was understood then, the Commission proposed a scheme that would view (and develop) India as a series of organisations of scientific services . Apart from this, the most important contribution of the Commission was to inflict upon the Swadeshi industrialists a sense of utter incompetence in technical matters. (Implicit in the Commission s report was the recognition of the need to impose upon India newer forms of Scientific organisation and, as such, it appears to have paid little attention to the other, pure type of research.

But these issues of pure versus applied science were brought to the surface in the thirties through the writings of Meghnad Saha (1893-1956) in his journal Science and Culture. Saha was a physicist of moderate standing in the 1920s who made contributions to the body of international physics and was an ardent believer in the capacity and right of scientists to rule the World. As is the case with such visionaries always, Saha felt it his duty to espouse his cause by exposing the Gandhian anti-industrialism and by promoting a view of industrialisation of India through study and monitoring of key sectors in the West. Saha expressed unreserved admiration for the model of the USSR, where he claimed the Academy of Sciences provided crucial inputs to the National Planning Commission.

In the prevailing atmosphere of naiveté and confusion among Indian leaders in their comprehension of Western institutions and organisations, Saha put forth his theories as to how scientists should rule, how eugenics should be employed (!) in demographic redistribution etc., without being contested. As a result, Saha today is taken by academic sociologists of science or science-policy studies specialists to have articulated a policy-making programme for India. All that he and his cohorts of the Science and Culture group achieved was to produce a series of disjunctions between pure and applied science, without the slightest hope of ever being able to grasp the nature of the innovative industrialisation of the West.

While Saha a much-vaunted march towards industrialisation guided by pure or applied science or engineering was being articulated, the colonial government came out with a new scheme for promoting innovative scientific research, by creating the Board of Scientific and Industrial Research (1940) which shortly thereafter became CSIR. Saha s Science and Culture group which had been advocating a muddled vision of scientifically guided industry could not produce a single worthwhile scheme for organising it; at best, the British DSIR was cited as an organisational; model. The body (BSIR) appointed several committee under Indian chairmen to assess the viability of a physics laboratory in India along the lines of the British NPL, but it was A.V.Hill, President of the Royal Society, who produced an organisational format for industrial research. Hill, a Babel Laureate, visited India in the closing phase of the World War II, met a number of scientists and claimed that his own scheme of industrial research was patterned after this acquaintance with the structure of science in India.

The Hill Plan advocated strong centralisation of research bifurcation of research department under government from user departments and was largely accepted and implemented. (The S & C group of course demanded that it be implemented). It was essentially patterned after the then existing British models which even Shanti Swarup Bhyatnagar, Director of CSIR, subsequently considered unsatisfactory in providing the link between idea and product . As on several occasions earlier, the British succeeded in thrusting on India an organisational network whose interlinks and mechanisms were too

* Shiv Viswanathan, Organising for Science: the Rise of Industrial Research Laboratory, Oxford University Press, Delhi.1985.

obfuscated for Indians to grasp and control. One of the key strategies of the British in India was the emphasis on creation and maintenance of extremely confused networks in an organisation which would prevent others from acquiring control. Thus, in the aftermath of 1857, Ellenborough, then the British Cabinet Minister for administrator of India produced a plan for reorganisation of the British armies in India, which suggested working out confusing linkages and command-chains, which, in course of time, would be incomprehensible to anybody barring a few, thus preventing sudden changes in the controlling unit or chain of command.* NPL in Delhi was fundamentally a unit in this kind of a scheme.

The false dichotomy between pure and applied research and the kind of disaster it wrought is perhaps best illustrated in the rise and fall of NPL.[4] NPL had been conceived with much fanfare and the S&C group worked out their own vision of it. However, CSIR under the stranglehold of Hill s Leviathan worked out its own version of it. Perhaps as a model of scientifically active India intended as a show-piece to visiting dignitaries, NPL was chosen to be located in Delhi, much to the consternation of the S&C group which had been pressing for its location in Calcutta, to preserve the latter as the scientific capital of India . Bhatnagar dealt a further blow to them by engineering the selection of K.S.Krishnan as the first director of NPL. Krishnan was considered by many colleagues and contemporaries as the archetypal pure scientist, and under his stewardship NPL brought out papers, rather than products or processes, which could pass for second rate contributions to the body of international physics . When asked by Jawaharlal Nehru as to what was the use of it all to the country, all that Krishnan could do was to get some scientists to build a solar cooker which died unsung quickly. But during his tenure (that lasted till his death the expectation that somehow NPL would deliver the goods as an industrial research laboratory ran high and the CSIR Review Committees appointed in that period did not have recommendations on NPL.

But soon after his death, questions begin to be raised about the relevance of NPL s work to the nation. Characteristically, Nehru asked P.M.S.Blackett, President of Royal Society (who became influential in Harold Wilson s Government) to look into NPL s activities and make suggestions he thought appropriate (1963). Should one ask for better evidence of the appropriateness of the Temple proposal of 1875?

Patrick Blackett, for his part came out with a scheme that would dissect NPL into a pure or advanced physics division and into an applied division. He suggested getting rid of the former by merging it with the university. His chief criticism was that NPL was like a university shirking its teaching responsibility and the problems handled in NPL were dull and more oriented towards obtaining Ph.Ds. His view of NPL as an industrial research laboratory consisted in each division contributing pilot-plants . Though the Blackett report was not accepted formally, ultimately, in about ten years time this is what appears to have happened, NPL giving up the attention being paid to pure physics.

The applied/industrial aspect of physics research in NPL was a different kind of failure. Considered by many, including Blackett, as a viable, perhaps the only viable, division of research in NPL, the Ratio Components Unit (RCU) headed by T.V.Ramamurthy attempted design and manufacture of components for the electronics industry. While successes were achieved in terms of setting up a mini-plant the buyers of the technology, BEL, backed out at the opportune time. In another attempt, the government was inclined to favour technology of a multinational company rather than that of NPL. Yet whatever limited successes RCU brought about (including formation of a company, Central Electronics Limited, under the Ministry of Science and Technology) appear to have been more due to the influential network of friendships operated by Ramamurthy. Saying this is not to downgrade whatever were the achievements of RCU, but to observe that perhaps this is how, centering around individuals rather than institutions, that an innovative chain from idea to product could be developed.

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In the present continuing phase of bloodless conquest by the West, technology has become a fundamental issue. In the present day, supremacy of a system is granted on the basis of its engineering

* Dharmpal, Personal communication.

capabilities. The ability to dominate and hegemonies is identical with the ability to innovate, to fast-produce many latests . The classical Triumph of the Mind ideology is rephrased now in terms of getting outdated or keeping upto date with certain processes called innovation.

The underlying nature of innovation as it is broadly understood now, is scientific research conducted in an organised fashion. Innovative research is supposed to start from certain scientific principles and proceed along chains of processes, to lead ultimately to a product or a process. Attempts to describe these processes tend more often to obfuscate rather than illuminate the path from an idea to a product, in the process producing a whole series of disjunctions between fundamental research and applied or industrial research , or between technology and science , or between pilot scale and industrial scale researchers. Some of the CSIR Committees have outmanoeuvred all other attempts at this naming game; observe for example, what a certain Parliamentary Estimates Committee (1966) suggested as necessary classification for management and control of R & D , (a) pure basic research (b) objective basic (c) applied project (d) applied operational (e) development . This is after a similar classificationist exercise carried out by the Third CSIR Review Committee (1964), which improved upon the older distinction of pure versus applied by propounding (i) pure basic (ii) applied or technological (iii) objective basic as the categories of research.

To cap it all, sociologists and economists come up with variety of formidable forces taken out of their books-they may be market forces or anything else, but the social scientists would like to ensure that their contribution to spreading the malaise of disjunctive phrase mongering is substantial.

Leaving all this side, let us pose the question, how does an idea get transformed into a product. We observed earlier in this note that perhaps this entire process might be analogous to mobilisational efforts. A firm believers in the ultra-rational consistency of the innovative process, we may find any concept of scientific innovation repugnant. But some observers do describe this process in the kind of terms we suggested. What follows is an example.

The mechanical time piece brought the Swiss precision instrument industry to its peak of refinement. The Swiss watch has been synonymous with excellence (and) is an undisputed symbol of social status However, the timing mechanisms of contemporary clocks and watches are now manufactured by the microelectronics industry. The switch to a new technology came about in response to the demand for even greater precision in watches. Quartz watches first met the need, and they were first produced in Japan. The discovery that quartz was more accurate than conventional timing devices must have been made long ago. Theoretically, anyone could have marketed the idea. It seems strange that Switzerland, home of the mechanical watch did not.

The reasons for Switzerlan s failure (lay) in the structure of its watch industry. Simply put, the famous Swiss watch makers were not really makers at all, but assemblers. The moving precision parts that make up the Swiss watch were actually made in the cantons by small family producers and artisans. Manufactured watch components were sent to Geneva, where they were carefully checked for quality and then distributed to urban specialists for final assembly. The elaborate sub-division of watch manufacturing encouraged a spirit of independence among artisans at every stage of production, and it proved ultimately impossible to integrate all of the various production processes into one efficient factory system. Here the subdivision of production actually resulted in resistance to further modernisation of the industry.

In Japan, the makers of watch parts were not especially independent minded, and it was not difficult to organise them under the factory system. Infact, they first came together to manufacture the quartz watch. Entrepreneurs had to mobilise not only makers of precision parts but specialists in microelectronics and chemistry in order to achieve the high degree of accuracy required of these watches.[*]

[*] Takeshi Hayashi Some lessons from the Japanese Experience of Modernisation in Michio Nagai(ed) *Development in the non-Western World, Tokyo, 1986,pp.106-107.*

This is an account of an innovation in the contemporary period, and the emphasis is on mobilisation of men and talent in a system that is based on perceived inadequacies of another system to be conquered. Quite often we have heard analogous to whole descriptions about Indian society by Western observers, e.g. the Idyllic village republics living in a world of their own etc. as a possible cause of defeat and decay. What is called innovation and is allegedly the nature of industrial research does not appear different from waging a warfare. One could almost say, paraphrasing Michel Foucault s inversion of politics and war, that technology/innovation is continuation of war by other means.

In the earlier sections we referred to the tactic of pushing the Indian mind into a morass of pure scienticism and institute-building, along lines laid down by foreign visionaries. We also referred to the sowing of further confusion by dilettantist groups such as those of Saha, who ardently advocated and believed in the myth of planned development of science or a science policy dictated by scientists and academics based entirely on foreign models. The disaster wrought by Hills and Blacketts and a whole host of British/American/German and Russian scientists on Indian innovation chiefly consists in the obfuscation or misrepresentation of the linkages that constitute innovation, that make up the entire process from idea to product.

Our own examples of Britain versus Germany in the earlier part of this century, or Japan against an established technological power in the contemporary period emphasise the need to develop a capacity to experiment with different organisational forms sometimes called pure science or applied science or technology . We have noted that for the last hundred years or so, the Indian approach to face this threat of bloodless conquest has been quite deplorable, in that it has been stuck in organisational forms without being able to change them.

We now bear of talks ranging from import substitution technological self-reliance to a dream of unrestricted pursuit of excellence in limited areas such as superconductivity. In the meanwhile, concepts of mission-oriented research and technological missions have also been floated around.

All this is certainly an indication of developing some sort of maturity from the kind of naivete that characterised research in India in the fifties. Perhaps this is all that can be said of them. As we have pointed out, the task is one of coping with continuing conquest, of fighting a game of endless classificationism that leads to proliferation of organisational forms. There is every need to study the nature of technological enterprises as war, in the sense we have talked about now, in the contexts of various Western countries. Equally important, rather than worry about sectoral concerns such as self-reliance in electronics , attempts could be made to match modern research with traditional Indian forms of learning of crafts, to offer possibilities of new linkages. One hopes that this aspect of the mobilisational character of research, than the philistine international , pure knowledge character will start receiving emphasis in the year of the 100th Anniversary of Jawaharlal Nehru.

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[1] Britain s supremacy in harnessing steam power for production was seen as a dimension of its political supremacy by Sadi Carnot, whose investigation on the motive power of fire was prompted by this perception. It is believed beyond doubt now that Carnot s research led to the formulation of the Second law of thermodynamics, enshrined as a fundamental law (See W.Clerk, *Energy for Survival*, New York, 1973 for details).

[2] That the innovative power of German chemists at BASF or Hoechst or Bayer was as much due to the particular kind of organisational scheme adopted must have been evident to the other powers, notably Britain and the USA. To minimise competition and duplication in research, three leading chemical firms in Germany, including BASF and Hoechst came together to form the formidable Intergemeinschaft Farben (IG Farben), anticipating the cartelisation of chemical industries into ICI in Britain or du Pont in the USA. In recent literature, IG Farben has often been charged with supply of unusual chemicals for mass extermination in Auschwitz and Treblinka. After the defeat of Germany, the allied powers dissolved IG Farben into various constituent units.

[3] Bruno Latour in his writings (*Laboratory Life*, 1979; *Science in Action*, 1987, *Pasteurisation of France,* 1988) has sought to bring out the micropolitical nature of scientific research. Most notable is his recent work on Pasteur (1988, see above) wherein he contends that the success of Pasteur s work lay in his capacity to be a spokesman

for the mysterious microbes in the same way as a politician claims himself spokesmanship for the masses , who are another mysterious force. Politics, Latour claims, is the art of taming and arraying of forces and science does so with natural forces .

[4] Shiv Viswanathan (op.cit) has produced a rather elegant sociological study of NPL as an archetypal industrial research laboratory in India. His work is first of its kind, at least in India, but suffers somewhat from an uncritical adoption of categories such as industrial or applied research and those of invention , innovation and development .