43

TECHNOLOGY POLICY:
SOME IDEAS,
A TECHNOLOGISTS VIEW POINT

JULY 1990

EMMAY ASSOCIATES (PVT) LIMITED
LAHORE KARACHI

CHAIRMAN	**M A ALLAWALA**
MANAGING DIRECTOR	**MASOOD HASAN**
DIRECTOR	**DR M A WAJID**
DIRECTOR	**R A ALLAWALA**

This paper HAS BEEN written for the Special Technical Cell, Ministry of Production for the Seminar on Engineering Goods Industry (May 1990), is the third in a series by EMMAY an organization dedicated to improving the management function. In addition EMMAY is involved in energy, electronic data processing training and other functions. The views expressed are those of the author.

About the Author

MASOOD HASAN

MSc Punjab Univ Lahore in 1946, received his MS (Chem Engg) from Case Institute of Technology Cleveland (1948). Has was a Joe E Seagram International Fellow Louisville Ky (1949). Is fellow IE (P), PIChE and registered with Pakistan Eng Council (Chem No 1) also member ACS and AIChE. Attended Session 39 of the General Management Course at the Administative Staff College. Henley-on-Thames in 1960. Worked with Unilever (1950), Lever Bros (Pakistan) (1951-53) Wazir Ali Group (1954-63) set up EWP Computer Services Ltd (1963)and United Consultant (1967), was a Federal Secretary, Ministry of Defence (1973-77), Chairman Federal Management Development & Inspection Commission (1978), set up EMMAY Associates (Pvt) Ltd 1979 of which he is Managing Director. Is President of the Engineering Consultants Association of Pakistan (ECAP) Has contributed articles on Administration in national newspapers and professional journals, has also deigned and conducted post graduate and post experience training courses in public and business administration, is also on several committees/boards/councils. Is also a consultant to international agencies.

TECHNOLOGY POLICY: SOME IDEAS,

A TECHNOLOGISTS VIEW POINT

by Masood Hasan*

The power of the West comes from science and technology. And with that selfsame flame its lamp is bright: For science and technology, elegant young spring. Brains are necessary, not European clothes. If you have a nimble intellect, that is sufficient, if you have a perceptive mind, that is sufficient (Javed Nama - translation by Arberry A.J.)

It is so easy to equate technology with science, particularly when it has been fashionable for scientists to talk about technology. However, the fault lies with technologists who should know better. Economic strength is synonymous with technological competence. The technologists that acts in a responsive manner acts on someone elses initiative and is not responsible for any act of commission. The creative technologist apart from manipulating physical resources initiates and accepts responsibility for results involving both human and economic factors.

STEAM ENGINE

There is a basic difference in methods of science and technology. May be a better understanding of the nature of technology might be useful. An example whose development covered many decades and spurred research has been the development of the steam engine. It involves names including, Huygens, Papin, Savery, Newcomen, Smeaton and Watt. The effort was started in 1680 in Holland by Huygens to harness the explosive nature of gunpowder, to create a vacuum to do work. In 1690 Papin, inventor of the pressure cooker, suggested a piston steam engine and assisted Huygens. Steam was used to create a vacuum. In 1698 Savery an Army Engineer in the UK moved in the direction of using pressure. Since mechanical technology had not developed sufficiently his engine was used for low water lifts to pump out water. This engine fell into disuse. In the early eighteenth century an ironmonger/plumber, Newcomen made a blown up version of the Pain engine, an atmospheric steam engine which was used for pumping

* President Engineering Consultants Association of Pakistan (ECAP) and Institute of Self Reliance, and Managing Director, EMMAY Associates (Pvt) Ltd

water out of Cornish coal mines, an internal jet was used for cooling and atmospheric pressure moved the piston. The efficiency of the machine was such that it cost one third to one sixth of living horses performance. It achieved 4 horse power.

In 1767, an instrument maker raised 4 to 7-12 ie an increase in 200 to 300%. However, there was no new invention on his part, he had merely improved on Newcomen's materials of construction and bored better cylinders.

In 1775 Watt, also an instrument maker got into the act after he was asked to put a Newcomen engine in order. Watt supplied the engine with a separate condenser, steam moved the piston and a governor for control was introduced. The result was the duty that Smeaton had achieved of 12 was doubled to about 24. Later the introduction of the two-stroke engine upped output by 50% to 36.

During the 1800-1830 period machines with more than one cylinder were introduced in which the duty was increased by 200-300% bringing the output to about a 100.

Firstly, it is important to observe that in achieving 100 HP a number of incrementally cumulative steps were taken over a century. Technology, by and large progresses incrementally, each improvement adding on to the existing inventory of achievement. If only for the good reason that existing assets cannot be written off overnight without creating chaos. There have been very few genuine quantum advances in technology a good example is that of the transistor.

Secondly, another important point to observe is that improvements could only be made when there was **intimate knowledge of the physical transactions** taking place at the level where success or failure was spelt out to at the operative level, in no uncertain terms. These two important points have application in a host of other situations which should help technologists to understand why there are so many obstacles to progress.

My definition of **technology** is very simple, with reference to man made systems, it is the know-how to solve **problems all sorts.**

With comprehension of detail, the devil really is in the **detail,** more or less recognizable as a fully exploded mechanical engineering piece part drawing that cannot be exploded any further. To alter a system detailed knowledge of how it functions in all its glorious detail is essential otherwise the chances of enunciating unimplentable policy policy are greatly increased. However, if the correct approach is followed it leads to the identification of:

- what obstacles can thwart progress
- where the potential leverage points for attack are situated

What I have said is concerned with the **applications, not necessarily with an understanding of science.** However, lest it create misunderstandings it is true that there needs to be interaction between technology and science. Over a period of time one spurs the other. For example, when the power of the steam engine had got to what appeared to be its limit in 1830, it stimulated the development of the science of thermodynamics. The movement is, therefore, a two-way street. We may be more accustomed to science contributing to technology (usually outside Pakistan) but post-1830 the need to build better steam engines certainly advanced thermodynamics. As pressures or rotating speeds increased metallurgy, corrosion, chemistry and other disciplines were involved. Technological evolution usually makes better science instrumentation possible which can be a major factor in advancing science itself.

Technology is usually industry oriented and is exceedingly complex because it deals with two types of efficiency firstly, with the physical and secondly, with the economic. Physical efficiencies are always less than 100% and economic efficiencies must exceed 100% for continued successful operations. Usually in the final evaluation where technology plays a premier role economic efficiencies must take precedence over the physical. Technologists must make themselves aware of this fact of life because the fruits of technology are used in the economic environment which is to do with the requirements of the people who are a part of the social environment. The problems of technological advancement, unlike science concern a universe over which it may have no control whatsoever, unlike that of the scientist in the laboratory.

COMPUTER

It would also be useful to look at the development of the computer. Babbage in the UK invented it, but it could only be of practical use when the vacuum lube was invented, about a century later. It then became a practical (though somewhat expensive!) artitact in the immediate post-World War II period. This first generation machine has gone through several generations, the third in the 1960s, we are now with the fifth or is it the sixth generation? In the 1960s memory chips accommodated 16 bits, in 1972 1000 bits, in 1984 128,000 bits now the world has 256,000 bits and is looking to yet much more in this move towards increasing micro-miniaturization. Just as the steam engine drove the development of thermodynamics, the computer is driving computer science. The difference, of course, is what took the steam engine a century is taking the computer far less time!

Let us also look at what is developing in information technology right now. Consider expert systems ie after working out! The systems architecture computer programs are required for solving complex problems where prior experience is almost essential such as in medical diagnosis, geological prospecting or tax planning, such systems are also built up in an incremental fashion iteratively. This is hi-technology in which resources are invested in an **intangible** which requires maintenance and can be depreciated! In Pakistan we have problems in assessing technology involving tangibles! However, it can be seen that incrementing is how technology does progress. There is no good reason why it should not continue in this fashion.

Current cultural factors also play an important role take for example, attitudes towards financing. Do financiers look for minimizing risk? If so, is there any place for innovation? Then what about short term versus long term gains? Is there a preference for hardware and software based on the I A (Invented Abroad) syndrome? Do we find it easier this way, on account of the ease of hiding kickbacks? There are many other questions that could be asked. We need to learn out lessons from the cultural inheritance we claim to have on account of the liberalizing influence of Islam.

It is through the empirical, scientific or inductive method that it becomes easier to understand what transfer of technology implies. Simple things in technology are hard to keep secret, but even simple things in technology are difficult to digest because one has to develop masses of detail eg wagon loads of documentation may be required to make a machine gun. The discipline of technology requires the elimination of organizational feudalism because with such an attitude it is hard to "give away" technology to Pakistan, but is that so to Japan?

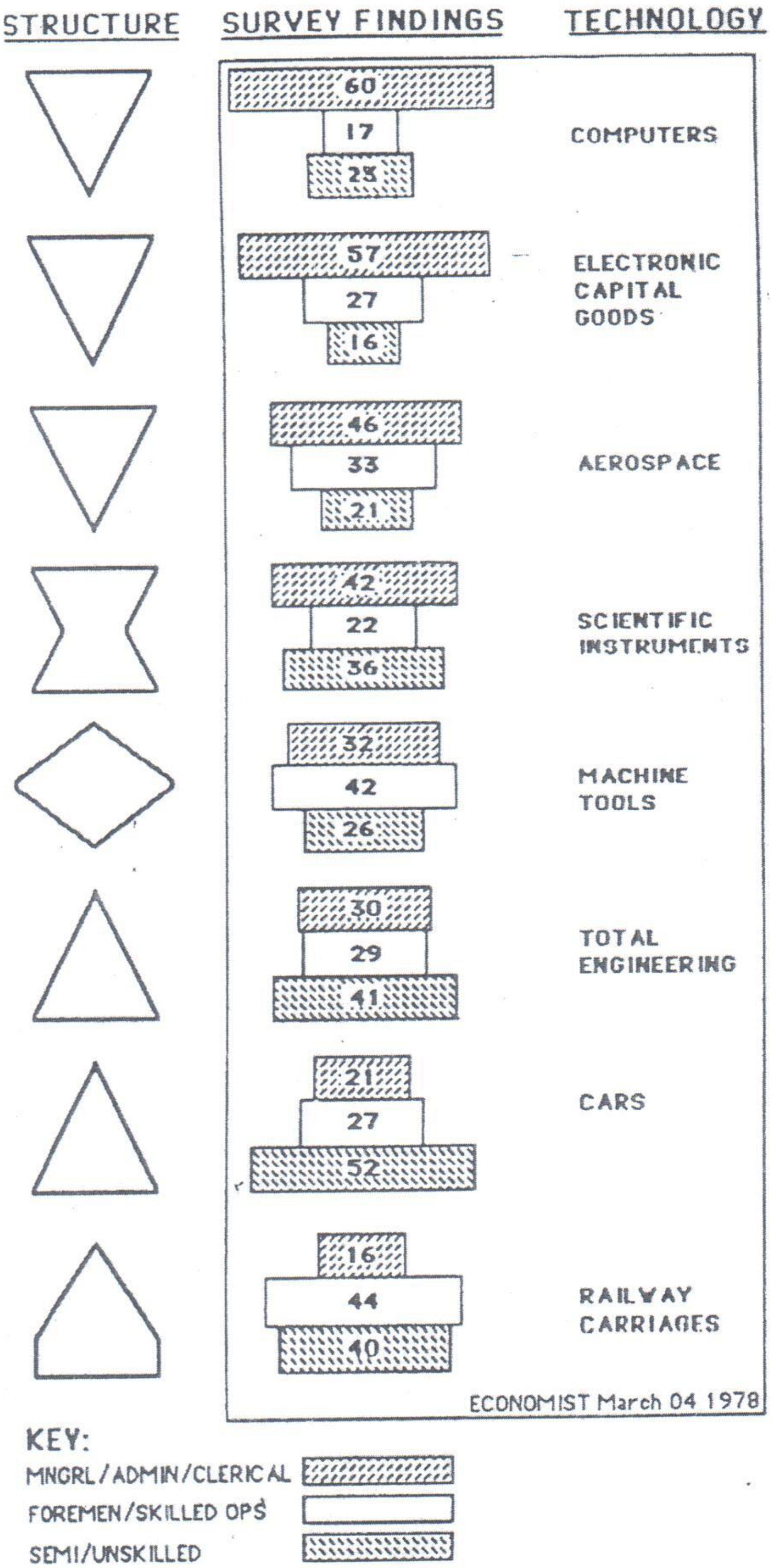
New technologies are generally expensive because they have not been refined which is synonymous with not being depreciated. Success over a period of time is synonymous with having developed a market. Many a time it is advisable to find a small use so as to permit growth to maturity, such opportunities can come through military procurement programmes.

There are problems peculiar to small organizations inasmuch as there are problems peculiar to large ones. Some small organizations can and do act as sub-contractors to the larger. In any case policy must help to nurture or develop both types of organizations.

With advances in technology efficiencies of industrial units ie existing capital assets have been raised, not necessarily on account of direct improvements in the so called technical functions but in improvements eg in the support functions. This is specially true in medium and large units where improvements in **coordination** have helped to raise productivity. This is, in fact, an economic function in its own right. In addition more sophisticated technology (hi-tech) has generated a new set of problems. Examining conditions of fifteen years ago the London Economist reported that there have been significant shifts in the distribution of the types of personnel in organizations depending on the technology type they were involved in. Diagram 1 below indicates the decreasing percentage of foremen, skilled, semi and unskilled workers with reference to the managerial, administrative and clerical functions.

It is interesting to note that the traditional technologies including Railway Carriages, Cars and All Engineering continued with the well known pyramid structure. Whereas intermediate technologies of machine tools and scientific instruments exhibited a pinched or blown-up-in-the-middle pyramid. However, in aerospace, electronic capital goods and computers the pyramid was literally turned upside down! This is also the experience of the author who had visited factory involved in manufacturing RPVs (remotely piloted vehicles) in Europe some fifteen years ago. Out of **303** employees only **73** were the equivalent of semi/unskilled workers. The rest were professionals! When addressing ourselves to technology it should come home to us that there is no such thing as a "standar" structure to obtain results. In Pakistan this is important because the public sector has a habit of adjusting prices to cover up inefficiencies quite successfully.

Diagram 1


STRUCTURE
SURVEY FINDINGS
TECHNOLOGY
60
17
23
COMPUTERS
57
27
16
ELECTRONIC CAPITAL GOODS
46
33
21
AEROSPACE
42
22
36
SCIENTIFIC INSTRUMENTS
32
42
26
MACHINE TOOLS
30
29
41
TOTAL ENGINEERING
21
27
52
CARS
16
44
40
RAILWAY CARRIAGES
ECONOMIST March 04 1978
KEY:
MNGRL/ADMIN/CLERICAL
FOREMEN/SKILLED OPS
SEMI/UNSKILLED

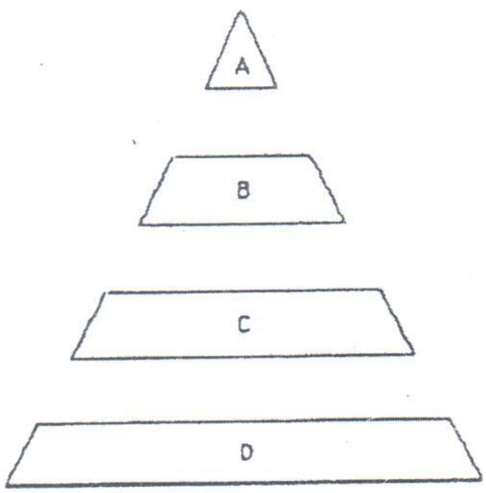
Nearer home it is of interest to look at how our governmental processes function. The three essentials are the

- Personnel
- Decision Making (Organization) Structure and
- Operating Systems & Procedures

Because we have not considered it necessary to relate the requirements of the **transition** from a law and order cum land revenue oriented economy (that we inherited in 1947) to that of a value added, developmental or a technologically oriented economy: the necessary inputs to generate adequate/correct responses from the government are missing. Amongst others an appreciation of the **Qualitative Shift (Annex I)** can help to mould thinking on the right lines. Briefly, an organizations grow in size (technological cum developmental thrust) or are involved in sophisticated technology, old methods of solving problems similar to those as in the past do not deliver the goods if only on account of increased size and size alone.

One of the results of the lack of appreciation of advances made in the world around us and the increasing necessity to remain competitive---not in primary goods but those with value added has led to horizontal stratification in the common threads of administrative effort for personnel occupying roughly the same level in an hierarchy. Refer to Diagram 2 below.

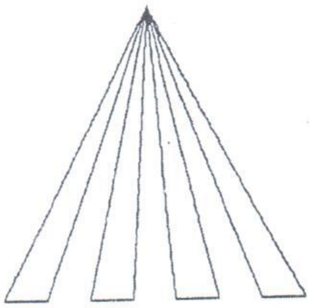
Diagram 2



This provides a visual explanation of the ease with which policy an and is changed as against the almost impossible task of altering a lowly procedure. This indicates the difficulty in moving, not so easily, from Levels A to D but with very much more difficulty (on account of one way filters that impede accurate knowledge of what is going on at the lowest levels) to those at the higher ie from Levels D to A. This another way of saying that feedback information for the higher levels is easy to present in a misleading fashion.

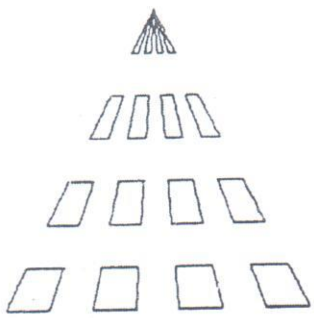
However, since there are several functional specialisms. Within each function movement is relatively efficient both up and down. Ladders of such functional hierarchies could concern accounts, finance, police, engineering, customs or excise. This situation is indicated in Diagram 3 below.

Diagram 3



When Diagrams 2 and 3 are superimposed on each other the situation is shown in Diagram 4 below:

Diagram 4



The above pictorializes the "island" or the **one and a half brick mosque"**, the way that governmental departments function.

Unless those concerned with enunciating a technology policy are prepared to consider the factors brought out above in addition to others it will not be possible to produce a coherent policy. Technologists it appears have yet to learn the language of administration for they do not appear to be articulate on this topic.

STRATEGY AND TRANSITIONAL PROBLEMS

The quicker one wishes to move the more important strategy becomes. When one wants to move from an existing Point X to Point Y in the future there are requirements which any strategy must consider:

- There must be an accurate definition of current status (Point X).
- Defining the future Point Y, there is little difficulty in defining it the further away in the future it is, the easier it becomes.
- The **transitional** problems in moving from Point X to Y so as to work out a practicable methodology and time phasing of arriving at Point Y.

Visualizing the transitional problems calls both for experience and breadth of vision. To be able to work out ways and means to take care of them calls for courage and innovation, as no precedent ie evidence is available.

All development means change which must create transitional states. Hence disruptions must be minimized so as to keep the system in a manageable condition. The interrelationships or the cross walks need to be exposed so that a planned visual of the mosaic of activities to be undertaken is kept in focus.

OTHER COUNTRIES

Whether one looks at Japan, Korea, Taiwan or Singapore, there is something in common with their technological development and that is all made a beginning by adapting technology developed outside their countries. Technological development at its best will rely on a continuous supply of academically educated individuals of a high standard, whereas on the one hand our education system has deliberately destroyed whatever good there was in it thus denying the output of original scientific work (there would, I am reasonably sure, be less than 200 indigenously produced PhDs in the country today), on the other hand our industrial and commercial policies have made it a veritable obstacle race to move in the direction of self reliance.

Why has it worked out this way? After all Korea adapted our first five year plan approach, just look where she is today! It is not just simply a matter of increasing our expenditure on R&D by fiat to a set percentage of the GNP say from the current 0.21% to 1% or even more. This relatively rich diet requires a relatively improved digestive process involving the concerned personnel, organizational structure and operating Systems & Procedures. Have the genuine difficulties of those involved in value added activities been thoroughly understood? Just take a look at the "ease" with which it is possible to enter into assembly of finished goods (after the assemblers have run a bureaucratic gauntlet which would, in a way does Darwin proud). In a protected environment it has been possible to indigenize through a homologization programme about 8000 parts of the T-59 tank of which half ie 4000 are manufactured in the private sector! So obviously much depends on the **type** of protection given is required after acquiring detailed knowledge of current status. Being an inventor can be improving but being an entrepreneur can be bankrupting. To go in for manufacturing requires a multidisciplinary approach involving

- sound relevant technological knowledge
- sound management and
- successful marketing

apart from having confidence in Pakistan's future. However, by far the most important functions is without doubt sound management. This means apart from technical, social, economic and financial feasibilities we require administrative feasibilities in a big way.

JAPAN

Those familiar with Japan recognize the four stages leading to their current pre-eminent position. Stage 1 (1868-1912) was familiarization with what the more advanced nations were doing, as Japan's goal. The Sino-Japanese and Russo-Japanese wars hastened this process. In this period the early structure for S&T research was laid.

In Stage 2 (1919 onwards) Industrial output exceeded their Agricultural. Several councils/Research Institutes were set up (by 1968 some two hundred institutes were attached to the Universities). In this effort Japan concentrated initially on its home market.

In Stage 3 the post war period (1955 onwards) importing of relevant technology was encouraged. The cost of such imports was thirteen times greater in 1979 compared to 1957. Assimilation was possible because of a well prepared infrastructure to digest technology from abroad, of which 80% related to machinery and chemicals.

In Stage 4 (1970 onwards) attention was paid amongst others to fine tuning including developing **Total Quality Management** (TQM) originating out of Dr Shewhart's work on statistical quality control taken to the USA by Deming, who then introduced Japan to the same. TQM concepts were indigenized which also resulted in Quality Control Circles. The results have been so good that in a coals-back-to-Newcastle fashion, the USA has been forced by competition to relearn what they had exported so many years ago!

Stage 5 (now onwards) has more or less commenced as evinced in the recent White Paper "New Developments in Japanese Science and Technology Policy in the new era of Heisei". In addition to other characteristics attention is being given to R&D, the aim being to put less stress on acquiring research from abroad. More of what will be "within" will involve Japanese effort in facilities located in Europe and the USA. About 23% of Japanese companies feel their technical capabilities are superior to those of the Europe and the USA, while 60.6% consider themselves at par (C&EN Jan 29 1990).

Japan has of course had a central political system and all along a sense of unity. It improved its already high standards of education, accumulated capital through savings and was prepared to encourage coexistence of the traditional and modern industries.

KOREA

Korea made use of the latecomers advantage starting with light labour intensive industries with an eye on hi-technology. Both import substitution and export orientation, on account of the small local market, was encouraged actively by the government. Success came on account of the:

- successful training and absorption by workers
- close relations with USA and Japan
- adaptability to global economics and

- taking on the latecomers advantage.

Korea started by importing technologies and then modifying so as to improve upon them. This assimilation process needed careful nurturing through stable and motivating policies. It can hardly be said that encouragement is being given to an indigenous manufacturer of the pick up named Proficient if what one reads what has appeared in the literature and media!

In 1966 the Korea Institute of Science & Technology (KIST) was set up as a multidisciplinary industrial research institute. KIST served as the middleman between industry and academia. As industry grew several independent support functions for shipbuilding, electronics, telecommunications, machinery and energy were set up. To help further technology advancement, development and financing corporations were set up. By the early 70s the Korean economy could be said to have been industrialized. At this stage attention started to e given to basic sciences.

In 1967 the Ministry of Science & Technology was set up as a totally effective central policy making, planning, coordinating and promotional body. This body was able to see through the implementation of programmes it had laid out.

In 1971 the Korea Advanced Institute of Science was set up as a mission oriented post graduate school, in addition several vocational institutes and schools were established to meet the exponentially rising demand for skilled workers and sub-professionals.

Several laws were enacted to provide the required legal back up or support for so many of the processes that had been set in train by the Ministry of Science and Technology. The result of all this has been a conscious and deliberate movement towards developing technology in a tradition bound society particularly concerning economic patterns and customs.

However, progress both in Japan and Korea met what technology demands ie personal discipline, proper systems architecture and sympathetic operating Systems and Procedures. These three elements were actively energized and implemented.

On account of the success of several Pacific rim countries the USA and UK commissioned specific studies to find out what was ailing their economy as the foundations had been laid on the basis of technological excellence.

UK had been affected by its feudal inheritance coupled to a pre-eminent international position up to World War II, whereas the USA having consolidated its technological base during World War II was able to reap the benefits through sound managerial practices. Europe at one time was afraid of economic colonialism as brought out in the famous book. The American Challenge, that alter American industry in its home country the next giant would be American industry in Europe! When Japan got into the act this expected course changed. Europe's answer, appears to be unification so as to work towards a large market not impeded by national boundaries by 1992. Europe has served notice it intends to take on both the USA and Japan technologically. Technology is after all the basis for material growth.

USA

In 1980 President Carter asked the Department of Education with assistance from the National Science Foundation along with experts in various fields to assess how they could increase their productivity. It was recognized that the educational system is the key to technological excellence which helps make for world leadership. When compared to Japan and Korea of the earlier years USA had a relatively good basic sciences foundation and of course a yet better technological application. So there is little that Pakistan could learn for immediate application from the Oct 1980 study on "Science & Engineering Education the 1980s & Beyond" particularly when the cooperation between industry and academia in the USA is so close.

It may be of interest to know that in a study made on invention in the USA in 1965 by the Department of Defence to determine what clicked (or didn't) in the 1945-63 era to bring in cost effectiveness in a range of 20 systems examined by 13 teams with mixed government, industry and nonprofit corporation scientists. They concluded that **advancing technology was much more in the area of minor improvements** than in major scientific discoveries. This study concentrated on invention itself. Another study indicated that invention arose out of developing knowledge that had been generated 30 years or more earlier including magnetic ferrites, the video tape, oral contraceptive pill, and the electron microscope. This certainly gives hope to an undeveloped country such as ours that R&D property organized can led to application as the route to self reliance.

UK

In 1980 the Finniston Report was issued, it inquired into the Engineering profession and reviewed the requirements present and future of British manufacturing industry and the role of engineering institutions educationwise both for Engineers and sub-professionals. The legal aspects of statutory registration and arrangements in other major industrial countries were also examined.

The Finniston Report identified the better features of encouragement of technologists in the USA in industry, including its encouragement facilitation, recognition and reward systems even though there was less security of tenure. It was found that application of a system of challenges and opportunities coupled with a pattern of rewards and incentives was very common. The report also pointed out the process of constant interplay and feedback between the marketing, design and manufacturing functions to better reflect the customers product requirements. In Britain these functions operated in isolation in series which provided loss customer satisfaction.

However, even with a more responsive system in the USA than in Britain, the USA fell behind Japan.

What had happened in Japan is summed up in a few words in the Finniston Report when it says "we saw evidence of ... (a higher general standard of education and).... The ability of operatives to stand up and give technical presentations of their work and in the extent to which they were able to cope with high levels of automation and other sophisticated production methods". No wonder productivity is higher, no wonder of TQM works so well. This is what technological success is all about! With fine tuning (including TQM) Japan has outstripped the USA. As a part of TQM continuous attention is devoted to lowering of costs involving all concerned at all levels. Very much like the Sunday Soviets held in the UK during World War II when a technician could get up in a meeting and criticize an Air Marshal!

INDIA

The time that it took India to develop expertise to set up their first atomic reactor should also provide food for thought. Bhabha decided that there was little merit in attracting scientists from existing institutions so he developed the freshly qualified for about eight years. Thereafter the development phase took about the same time. It, therefore, took 16-

17 years before the fist reactor was made even though the controls were not sophisticated. To be remembered is that even though it did take so much time that Bhabha was heading the Atomic Energy Commission and the Research Establishment at Trombay (now named after him) as well as the Tata Institute of Fundamental Research (TIFR) in the private sector, apart from being Secretary to the Government.

After the special arrangements for the transitional state lead to achievement of the objective it is possible to change administrative gears and routinize matters. Such are the dictates of technology if results are to be expected in good time.

PAKISTAN

Lack of consideration of the characteristics of technology has also led to ignoring the need for overlaps between applied research and development, between development and educational production, between educational production and routine/mass production. The cost of not having overlaps makes for difficulties in the necessary back and forth movement of information (the basis of preventing misunderstandings), hence the objective of industrial production. A lot of resources have gone down the drain on account of such isolated or fractured thinking. It may be added, apart from a Research and Development policy equally important, for government owned facilities is a Development and Acquisition policy.

TIME SCALES

Project time scales could exceed the normal tenure of individuals. Some examples of time scales are given below:

Position		**Years to Project Completion (Transitional Period)**
A	Buildings, plant machinery and personnel Available Technology purchased	1-2
B	Technology known but facilities to be created	3-5
C	Copy technology	
	i) Development/Testing	2-3
	ii) Volume Production	2-3
D	Development of a new product followed by	

	Volume production	5-7
E	Where R&D and new concepts involved leading on to volume production	7-8
F	Developing a new type of rice	15

To give an idea of the massive effort required where literacy is lower than we think, where complexities unique to developing countries exist eg traffic on a main road could vary from 2-3 mphs to 60 mph on account of two and four legged creatures or two, three, four, six or sixteen wheeler traffic. Control, clearly has added dimensions as compared to developed countries where such a range would never be encountered on a main road.

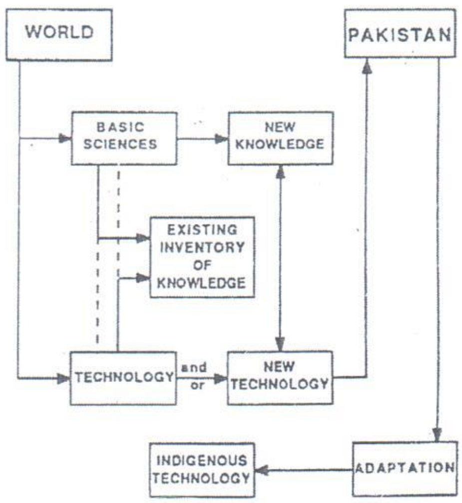
A result of successful development of technology has resulted in a decreasing percentage of population in different countries making a direct living out of agriculture.

	%		%
Pakistan	70	Australia	4
Eire	12	Canada	3
New Zealand	7	USA	2
France	6		

The transitional problems in applying the results of scientific effort are certainly within man's competence but require several relevant inputs.

The relationship of various factors for generating indigenous technology of whatever size it may be is shown in Diagram 5 below:

Diagram 5



If we were to consider cotton textile technology there is very little or no basic science required by us. In many ways an indigenous technology has evolved, in that there are both sick and healthy units operating under similar conditions both indigenous and international. It is to our eternal shame that there is nothing worth manufacturing-of-equipment mention which should have developed in a big way in the last twenty years. The technologist needs to work out by-passing strategies to engineer achievement. "Original thought cannot be expected in a review, the object of which is purely historical" Iqbal (1907). The Development of Metaphysics in Persia, Introduction to. Hopefully we may move on to creative thinking.

SUMMARY OF IDEAS DEVELOPED

Several ideas concerning technological development have been expressed. Technology being in the know-how to solve problems all sorts in man made systems. Technology has been characterized by:

1. Incremental development, not necessarily with an understanding of science, but necessarily with a high level of detailed knowledge of lowly detail.
2. There is a two-way street between technology and science, that technology can drive science.
3. The creative technologist deals with physical and economic efficiencies, takes responsibility for failures and can talk the language of administration. He takes into consideration cultural factors to ensure success.
4. That coordination is an economic function that needs technological inputs.
5. That the three essentials of organized endeavour are
    - Personnel
    - Decision Making (Organization) Structure and
    - Operating Systems & Procedures

    Refusing to understand the Qualitative Shift, leads to administrative islands and consequently procedural emphasis which has nothing to do with obtaining results.
6. That transitional problems are associated with development on account of technological progress. Special consideration needs to be given as to how to

deal with such problems differently from routine work ie with a task force approach.

7 Depending on technological considerations, organizations for efficient working, adopt different structures.

8 The progress made by Japan and Korea lays emphasis on the educational and training systems and the types of protection given to move in the direction olf self-reliance.

9 The attention the USA and UK have been forced to give to Japan.

10 The measure of transitional periods in various stages leading up to successful market penetration has been shown to vary from two years to eight to fifteen.

Framing technology policy can, therefore, always be termed as a compromise between what one would like to expect and the forces (including vested interests) currently at play. However, consideration of some of the ideas brought out may help in avoiding some errors or in providing more confidence in expected results.