RATE OF SPREAD OR DISSEMINATION OF SOME TECHNOLOGIES — PART II: A COMPARISON OF THE POSTULATED GENERALIZED CURVE WITH THE CASE OF NUCLEAR-PROLIFERATION

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ABSTRACT

Transfer of technology has become a subject of great interest. The rate of spread or dissemination of technologies, is one interesting aspect of this subject, which was examined briefly in Part-I of this paper, published 20 years ago, in which examination of three typical technologies of the 19th & 20th centuries showed broadly similar patterns of dissemination, with an initial fast-dissemination (one country every five years), followed by a slowing down of dissemination, thereafter. Taken together with a Technology Development Capability Index proposed in 1974, it should, thus, be possible to predict when next another country will attain nuclear capability. This is studied here in the case of 3 countries that have gone nuclear since 1986, and it is found that the results generally support the view that dissemination here, also follows the same pattern, with only a delay of 5-8 years as a result of the hue and cry regarding nuclear-proliferation. Thus, the operation of normal market forces can be seen to be operative, in this case, of this particular technology also. Moreover, the spread of a particular technology can be predicted fairly reliably by using the concept of Technology Development Index, proposed in 1974 by Qurashi.

1. INTRODUCTION

The study of technology-dissemination is of great interest. U.K. and France were leaders from 1750 to 1850 A.D., but U.S.A. and U.S.S.R. have gradually forged ahead of Europe. In an earlier paper on this topic[1], published over 20 years ago, it was shown by examining the cases of 3 relatively modern technologies that the data showed a broad and generally similar pattern of dissemination, viz:

i. A relatively fast initial-dissemination, at the rate of one country every 5 years, among the 5 or 6 countries that are technologically most advanced, spread over a decade or two, followed by
ii. A relatively slow diffusion among the next level of technologically less-advanced countries, which may be spread over a century or more.

Some graphs for the cases of (a) aircraft manufacture and (b) nuclear explosion, are reproduced here as Figure 1(a) and Figure 1(b) In an effort to produce a more generally applicable curve, the mean graph of Figures. 1(a) and (b), was postulated as a useful model for future prediction (see Figure-1a). It was hoped to follow up part I with another part, but this was delayed by 20 years.

2. THE CONCEPT OF DISSEMINATION

From the data presented in Part I, it appeared to follow that the process of dissemination of technologies has a more or less constant or fixed pattern. This pattern was presumed to be that depicted in Figure-2. The passage of events over the last 20 years, provides us with an opportunity to study and test the above presumption, particularly in the case of the so-called "nuclear-proliferation". It is worth-noting that, in this case, "the process of "dissemination of technology" has been replaced by the epithet "proliferation".

The relative positions of various countries in the growth or dissemination of technologies of relatively recent origin are shown in Table-1, reproduced from Part I of this paper. Those at the top in a column, belong to or come from the previous Epoch; four more are now added to the second column, to bring the first column up-to-date. These countries are, in reverse order:

- North Korea[2] in 2006
- Pakistan[3] in 1998
- Israel/South Africa: probably in or ~ 1985
- India in 1974

While the dates of the first two and the fourth listed above, are more or less well-known[3], the third one i.e. Israel/South Africa, can only be inferred from the various media-reports and other circumstantial evidence, that points towards the development & successful collaboration in the nuclear field between these two countries with similar world-histories. For example, there was a newspaper report[4] that as early as 1956, France had agreed to provide Israel with a "nuclear-capability", as part of secret negotiations ahead of the invasion of Egypt, and …

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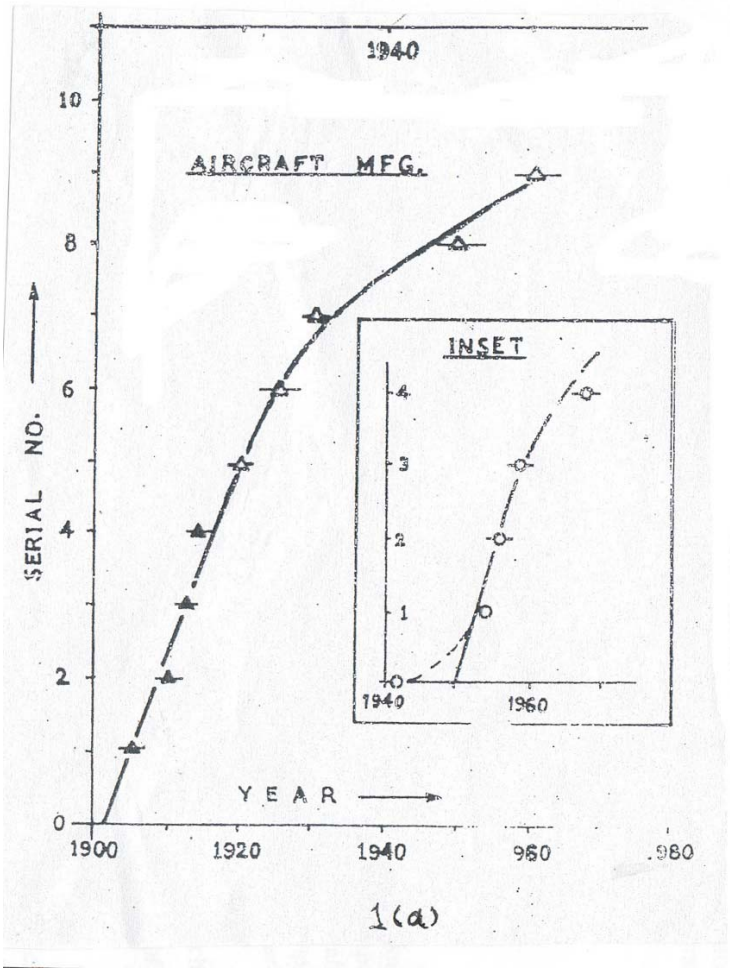

Figure-1(a): Plot of year of starting aircraft manufacture, for the first nine countries to do this, versus the year, showing an initial fast rate of dissemination. Inset: Inset showing the corresponding plot for rocketry (I.R.B.M.).

Table-1: Comparative Chart Showing the First Five Countries to Take up Various Recent Technologies

S.No.	Nuclear Explosion	Nuclear Power	Aircraft Manufacture	Steam Railway	Steam Engine
	1944-64	**(As in 1981)**	**1905-1920**	**1804-1850**	**Steam Engine**
1.	U.S.A. (1944)	U.S.A.	U.S.A.	U.K.	U.K.
2.	U.S.S.R. (1953)	U.S.S.R.	Germany	France	Czeck
3.	U.K. (1957)	U.K.	U.K.	U.S.A.	Belgium
4.	France (1960)	France	France	Germany	France
5.	China (1964)	Japan	Italy	Switzerland	

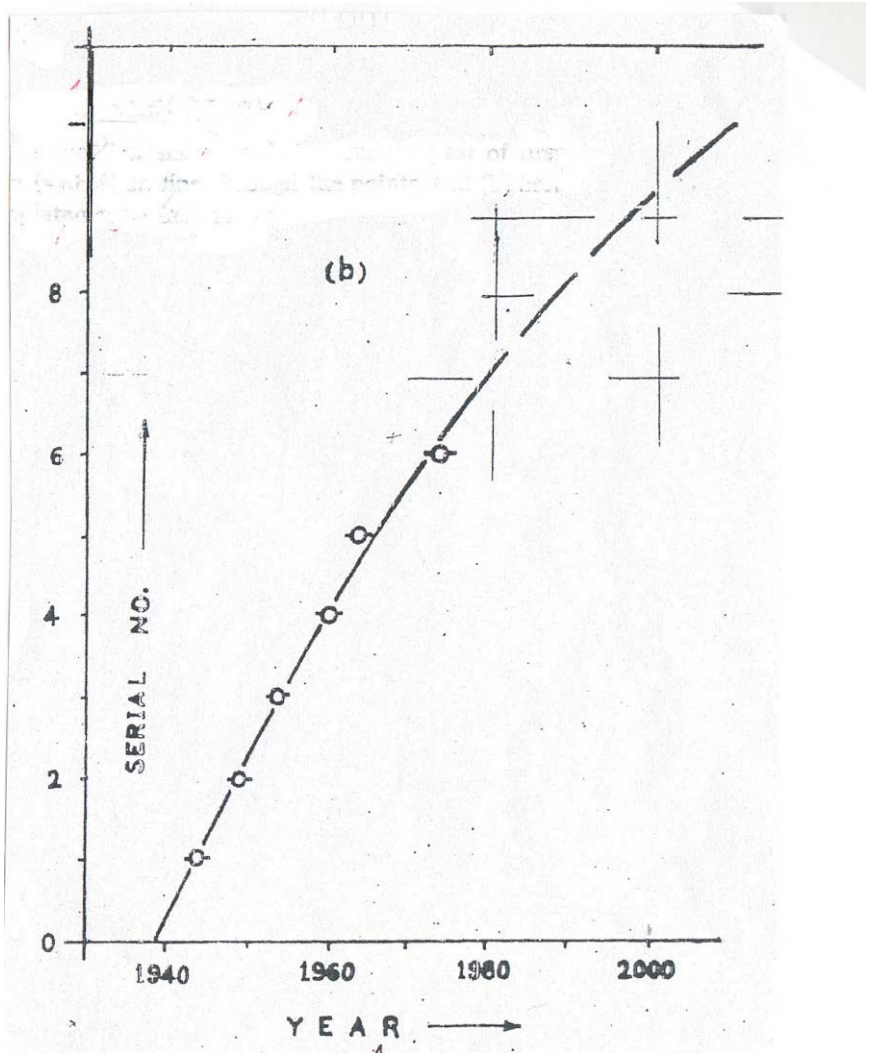

Figure-1(b): Plot of year of "going-nuclear" for the first six countries versus the year of first making an atomic explosion, with best curve-fitting the points and extrapolated as broken-line.

3. DISCUSSION OF THE DISSEMINATION/ PROLIFERATION OF NUCLEAR-WEAPON TECHNOLOGY

Here, it is important to note that the successful transfer or dissemination of any particular technology, requires at least two pre-requisites:

a. The minimum appropriate S&T capability in the recipient, and
b. A channel & arrangements (sale, donation or indirect), regarding transfer of the basic technology. This second requisite is of course governed by market-forces and the "felt-need" for the technology in the recipient country.

We can now replot the graph of Figure 2 and extend it with the help of the three additional points just noted. This replot is shown in Figure 3, where the solid-line has been continued as a chain-dotted line through the additional plotted points, while the broken line shows the extrapolation based on the best guess/estimate made two decades ago.

Comparison of the broken-line with the solid-line continued as chain-dotted beyond 1985, is instructive in two ways. First, it shows that proliferation or dissemination of nuclear-weapon technology has continued unabated, although at a

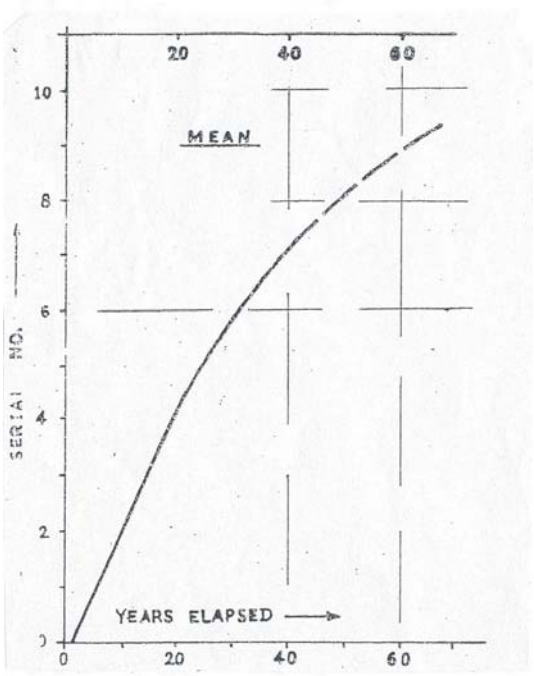

Figure 2(a): Mean of the two curves from Fig. 1(a) and Figure 1(b), giving the most likely curve for rates of dissemination to the first ten countries or so. Compared with the actual dissemination after 1975 [Figure 2(b)].

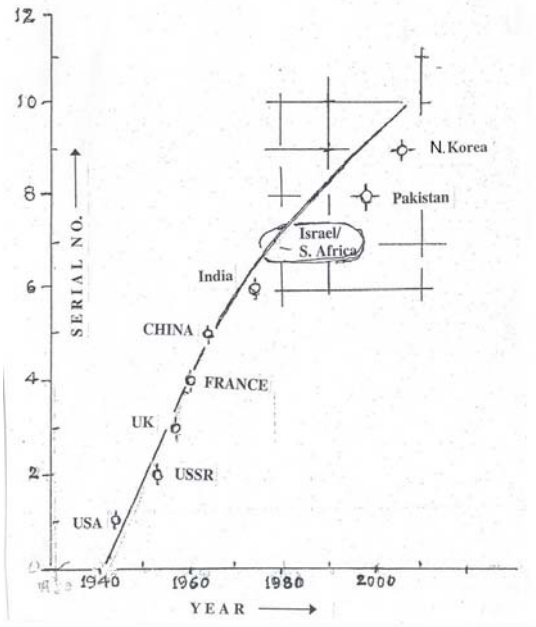

Figure 2(b): Plot of year of "going-nuclear" with best extrapolated curves (as in Figure 1(b), together with circles with crosses through them, for S. Korea and Pakistan, with ellipse as estimated for Israel and S. Africa. The portion beyond 1985 shows the delay of 5-8 years as against the predicted curve.

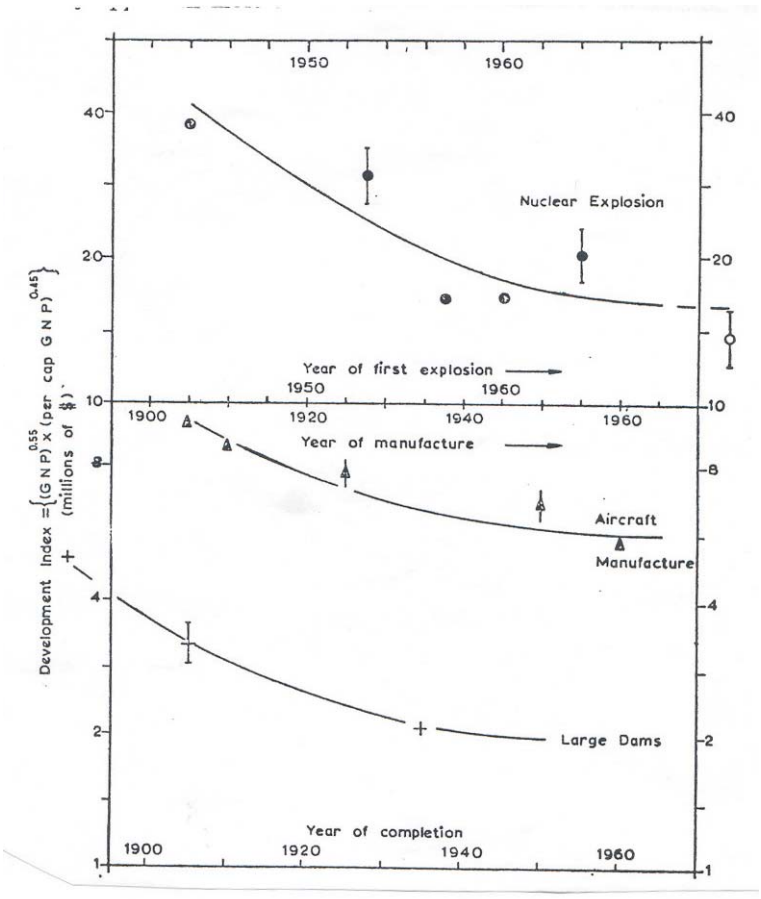

Figure - 3: Semi-logarithmic plots of the variation of the "Development Index" with δ = 0.05, {i.e. $(G.N.P.)^{0.55}$ (per cap. $G.N.P.)^{0.45}$}, with successive repetition of a project by various countries, for three categories of project, viz. nuclear explosion (top), aircraft manufacture (middle), and large dam construction (bottom). The limiting minimum value is in each case about half the initial value of the index

slightly slower rate than that estimated by extrapolation from the first six countries to go nuclear.

Secondly, it is seen that all the overt and covert efforts of the developed countries to prevent the so-called "nuclear-proliferation", have only succeeded in delaying the technology-transfer by five years in case of Pakistan, and 8 years in case of North Korea (See Figure 2(b)).

4. CONCLUSION & DISCUSSION

From the above analysis, it can be concluded that the case of nuclear-proliferation is also governed essentially by the market forces, which include the basically important factors of demand & supply and the capability to work up the technology indigenously. Reference may be made in this context to a much earlier (1974) paper[5] by the author, entitled "Formulation and Testing of a Technical Development Capability Index for use in Technology-Transfer". Starting from some general considerations of research and technological capability, an index was developed in the form:

Development Index = $(G.N.P.)^{0.55}$ (per cap. $G.N.P.)^{0.45}$.

It was found for three different technologies, that the values of this index lie on a smooth curve, showing a rapid initial drop for each succeeding repetition, followed by an asymptotic approach to a limiting-minimum, that is about half the starting value (for the first country in the field). The index value was (then) estimated to be reliable within 20%; accordingly, it was presumed that the index could be used to predict what technology a country can develop, and when.

Several conclusions follow from this, e.g.:

a. Transfer of technology from one country to another does follow certain general laws;
b. These laws are broadly the same for highly sophisticated technologies, as for the less sophisticated ones;
c. Also the likelihood of any technology being transferred to and developed by a particular country, is determined mainly by the Development Index of the recipient country.

As a corollary to the above statements, we may, on the basis of the present analysis of the spread of nuclear weapon technology, add that the international pressures of various sorts have played only a marginal role. This is seen in delaying the acquisition of nuclear explosion by a few years, viz. 9 years in case of Pakistan, and 8 years in case of North Korea. This is a fact that should be accepted by all concerned.

Another interesting fact is that, excluding USSR and China, this Nuclear-Weapon Technology has reached Asian countries about 36 5 years after Europe.

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