

**SCIENCE AND TECHNOLOGY DEVELOPMENT AND PROMOTION
IN THE PRIVATE SECTOR: SOME ISSUES
AND RECOMMENDATIONS FOR POLICY RESEARCH***

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Debunking our Timidity

In this paper, I will discuss mainly the technology aspect of the topic. On science, I have just one point to make--the need for scientific research. We seem to address this need with much timidity. This timidity does not complement our aim to be a newly industrializing country (NIC) by the year 2000. If we are serious about being an NIC in the next decade, we should encourage and support both basic and applied research--now. In fact, we are already late in acting on this need. But perhaps, it's better late than never.

It should be our policy to conduct even just a modest level of activities on basic research if only to attract Filipino scientists to stay in our country rather than enrich, with their knowledge and skills, research laboratories in industrialized countries. Given our limited resources, the challenge before us is to identify priority areas for research so that we may maximize its benefits. A local, unique problem demanding attention or a subject that offers a potentially high comparative advantage in the world market are but some possible areas for research.

On the technology aspect of this paper, I would like to focus on one particular industry--the information technology industry--so that I may treat the topic with some depth. Using this case, I will identify issues, concerns,

*This is an updated version of a paper delivered during the seminar-workshop on S&T, sponsored jointly by the Philippine Institute for Development Studies and the Department of Science and Technology, 5 May 1989 held at the NEDA sa Makati Bldg., Metro Manila. The author gratefully acknowledges the support of the Asia Foundation for the research on the information technology case used in this paper.

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and policy research areas that may apply as well to many other industries and technologies.¹

Information technology (IT) belongs to what some refer to as high, new, advanced, frontier, emerging, or superior technologies. I chose this technology because of another timidity that we have--the timidity to develop new technologies in favor of what we call indigenous technologies (which, in many instances, seem to focus on technologies that are relatively easy to develop in our backyards, for example, soap-making).

Many of the new technologies, such as microelectronics, laser technology, and IT can help build necessary infrastructure and delivery systems that will allow us to develop, promote, and utilize indigenous technologies. These new technologies, therefore, deserve our attention and policy research.

Where Policy Applies

One of the first important tasks in policymaking is to identify the proper domain of policies. This task requires identifying variables that government, as policymaker and Implementor, can and cannot control. The variables that it can control are the proper subjects of policies and policy research. Those that it cannot control are potential subjects for monitoring type of research as they may influence the implementation of policies.

For IT and other types of technologies, some of the key uncontrollable or uncertain variables are technological changes, market conditions, private sector activity, and labor force stability and strength. These uncertain variables may be affected by government policies. But, to a large extent, they cannot be controlled by government. However, they influence the successful development and promotion of a technology. We, therefore, need to monitor them.²

The principal controllable variables are the policy instruments themselves such as S&T, economic and industrial policies, institutional mechanisms, and capital-labor relationship.

One research topic is to identify these two types of variables for a particular technology so that we may know which should be controlled by policies and which need to be monitored only.

1. Corazon PB. Claudio, "Information Technology Development and Promotion: Some Trends, Strategies Issues and Recommendations," pp. 55-57, 120.

2. *Op. cit.*, p. 51.

Some Important Variables in IT Policymaking

I will briefly comment on two uncertain variables that influence the development and promotion of IT--technological changes and market conditions. I will also discuss the principal controllable variable--the policy instruments.

Technological changes and market conditions

Let us first understand the way IT has evolved with the help of a three-wave model of technological development in IT (Figure 1).

The *first wave* started in the early 60s. It was the time when IT was generally proprietary -- entry into the market was very expensive. The *second wave*, which started in the 70s, allowed cheaper market entry but was still a killing game for many. It was during this wave that reverse engineering emerged. From the early 70s, many countries started to disassemble electronic components to understand how their parts work and to copy them.

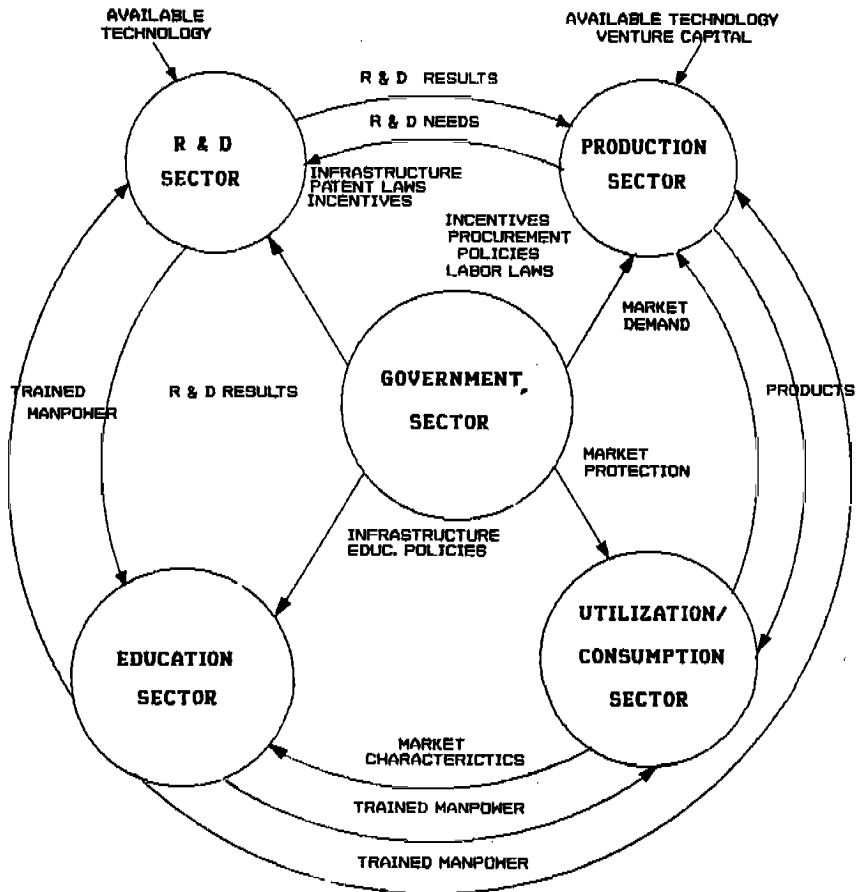
The *third wave*, which started in the 80s gave rise to the emergence of product integration: many companies started to share their product specifications under licensing agreements. During this period, we also started to see the development of forward engineering.

In the *third wave*, *technology and product cycles have become shorter*. There was, thus, little time to reverse products and copy them. By the time one succeeded in reversing anything, the rest of the world would be into another cycle. Fortunately, one no longer had to know everything to participate meaningfully in the world market. This was because technology during this wave was also more open. For example, central processors and peripherals became open to vendors other than those who designed the hardware system. Data processing networks also became open to products of third party vendors. The increasing diffusion of cheaper and more powerful machines now have forced suppliers to give up their original strategy of locking in customers through proprietary operating systems.

With the *openness of the technology*, one can now enter at some stages of the technological cycle. One does not have to start with the end product and disassemble it. Openness of the technology allows one to do some parts of the technology in a forward engineering way.³

3. See Mario D. Ripper's oral presentation at the International Symposium on Technology Policy in the Americas, Stanford University, 1-3 December 1988, and Edward Steinmueller, "Public Policy Implications of the Economics of Information Technology Industries," n.d.

FIGURE 1
KEY SECTORS FOR
INDUSTRIAL DEVELOPMENT



* ADOPTED FROM KAWAMURA & SILVA (1984)

Industrialized countries have led the world in the third wave. But many developing countries are still in the first or second wave and are, thus, being left behind in technological development.

It is important for us to understand how a technology is developing worldwide, such as IT, to assess where we are in the technological evolution process. This will allow us to know what strategy will make sense. This assessment is an important policy research topic.

Another market trend for IT is the *internationalization of the technology*. Companies in the United States have been moving into Asian countries. On the other hand, some Asian countries-- Korea, Taiwan, and Japan--as well as European countries have been moving into the United States.⁴ In Silicon Valley, for instance, the Japanese, Korean, and Taiwanese companies have been increasing in the past years.⁵

The Philippine government may respond to this market trend with policies that can attract to our shores some of those investments. But we must know, through research, how the market is developing and how competitive we are in attracting investments and technology transfer.

Another interesting trend in IT affects research and development. *R&D had become more complex, extremely costly, risky, and has involved more actors*. As a result, many companies and countries now work cooperatively through international and regional networks and alliances. An example of the cooperative initiatives that have developed is the formation of regional networks and alliances in the European Economic Community (EEC). Some of these are established with the strategic aim of penetrating restricted markets such as those of India, Brazil, and the countries belonging to the Organization of Oil Producing and Exporting Countries.⁶

In the region covering the Association of Southeast Asian Nations (ASEAN), one cooperative project on R&D is the ASEAN/Australian Cooperation Project on microelectronics research. This project involves the University of the Philippines (UP) and other schools.

The increasing international trend toward cooperative alliances makes it difficult for me to understand the concept of technological self-reliance in

4. Charles Edquist, "Technology Policy--Conceptual Remarks and European Experiences," n.p.

5. Terutomo Ozawa, "Japan as a Late Starter in Computer Industry: Major Characteristics and Policy Implications for LDCs," n.p. ; and Pyung Yu Il, "The Role of Government Policy and the Development of Computer Industry in Korea," n.p.

6. Edquist, n. p. ; and Peter Schulze, "Bridging the Technology Gap: The Policy National and Community R & D/T- Programs in Europe: Inter-Firm Cooperation, ESPRIT and the Eureka Initiative," n.p.

IT. If this concept means doing away with imports, then we are going against the worldwide trend of mutual, healthy interdependence. What we should aim for is not so much technological self-reliance but the technological capability, if possible, a unique one that will allow us to participate in the international market in a meaningful and significant way. This suggested aim implies continuing technological imports; it also means increasing technological exports of products that give us a competitive edge in the world market.

For instance, we may have to develop IT components that can fit into bigger systems integrated by another country. We need not develop entire systems in order to participate actively in world trade. But the component that we should decide to develop, we should develop well.⁷

Another important market development in IT is in labor. *Comparative advantage is veering away from cheap labor* since IT now requires decreasing labor. Some new IT components require only five percent labor. If we continue to depend on cheap labor as our comparative advantage, we may not succeed in world trade. To many foreign investors, tax exemptions may be more attractive than cheap labor.⁸

The more important issue of competitiveness in IT seems to be technological innovation. Unfortunately, this means developing countries which lack resources to innovate may be left behind in the competition.⁹ But what one lacks in quantity of resources, one may perhaps make up in quality. We, thus, need more creative people who can innovate.

We must understand these and other international technological and market trends in order to compete effectively in the world market. We cannot afford to look just inwardly. And, in order to understand, we must conduct continuing research on these subjects.

Policy instruments

We must first know, what policies have worked and failed elsewhere. We should not reinvent the wheel. But if we should adapt policies that have succeeded in other countries, we should do so with due consideration of our own social and political environment.

At least two types of approaches to public policymaking in IT have been used by other countries. One is a fundamentally interventionist approach; another is a *laissez faire* or a more liberal type of intervention. Some of the intervention measures are designed explicitly to influence technical

7. Claudio, *Ibid.*, n.p.

8. Claudio, *Ibid.*, n. p.; and Ozawa, n.p.

9. Claudio, *Ibid.*, n.p.

change such as subsidies for R&D. Others are more implicit such as trade, exchange rate, industrial, and fiscal policies. Industrialized countries, in general, have adopted interventionist policies, with some periods of *laissez faire*.¹⁰

Moreover, IT policies in many countries are either explicitly protectionist (using tariffs, for example) or avowedly strategic (adopting subsidies, for example). They put heavy emphasis on infant industries which tend to protect existing industries on a permanent basis.¹¹ Policies are also generally reactive rather than proactive.¹²

Almost all countries support a technology-push approach.¹³ Many developing countries are increasingly emphasizing technology transfer.¹⁴ Which of these policy approaches may better apply in our country is another possible subject for research.

Other Issues and Concerns

Successful development of policies for any technology requires a clearly defined *role for government*, with set priorities and limits for such role. Policy research should address this issue. For IT, some possible roles for government include providing market entry, removing barriers to entry, providing access to resources and markets, serving as a major purchaser of the technology, and setting up the needed infrastructure.

Another issue that we have not paid any attention to is what our Technology and Risk Assessment and Management Program at UP now addresses: risks associated with technologies.¹⁵ These are mainly *environmental, safety, and health risks* as, for example, risks associated with the nuclear power plant. These risks will take significant toll in human lives and in our environment unless we address them adequately. In particular, hazardous and toxic risks associated with technologies are now increasing rapidly.¹⁶ They need to be controlled with appropriate policies. One or two

10. Steinmueller, n.p.

11. Op. cit.

12. Edquist, n.p.

13. Steinmueller, n.p.

14. Gene Weighton, "The Status of DP and Semiconductor Industries in Latin America," n.p. ; and Paulo B. Tigre "How does Latin America Fit into High Technology?," n.p.

15. Corazon PB. Claudio, "Risk Assessment and Management: The Philippine Case," n.p.

16. Claudio, "Risks of Toxic Substances; Cultural Considerations, Management and Policy Development in the Philippines," n.p.

legislative initiatives on this topic have been developed but much work still needs to be done.

We have to be concerned also with *risk transfer* in addition to technology transfer. Some developing countries are now looked at as haven for technologies that have been rejected by industrialized countries.¹⁷ How to control risk transfer is one important topic for policy research.

Another study area is the *diffusion of a technology*, that is, how a technology is actually being applied. One example is the Asia Foundation-supported research that we are now conducting: a diffusion study on microelectronics technology. We are studying how this technology is being applied in various sectors of the economy and analyzing the relationship of that diffusion with the development and implementation of social and economic policies.¹⁸ Figure 2 shows the key sectors that we are studying and their linkages. Our goal is to recommend policies that will enhance the diffusion of microelectronics toward the direction that is most supportive of our country's development objectives as, for example, to become an NIC.

Policymaking often overlooks some concerns such as the following: the *role of culture* in technological development. And, there is not only one culture to speak of. We have the urban and rural cultures; the cultures of the Visayans, Ilocanos, and other groups; and of course, S&T culture which is perhaps the most underdeveloped of them all.¹⁹ These cultures can have a big influence on the development and promotion of a technology.

Another concern is the *role of women*. In the field of science, women seem to be doing quite well: 45 percent of scientific professionals are women. Of the total number of registered engineers, however, only 12 percent are women. Of those in managerial positions, only eight percent are women.

The total industrial labor force constitutes about 75 percent women. The percentage may be higher in the IT industry. If we want to improve productivity, therefore, we must recognize women. Policies that can address their concerns must be devised.

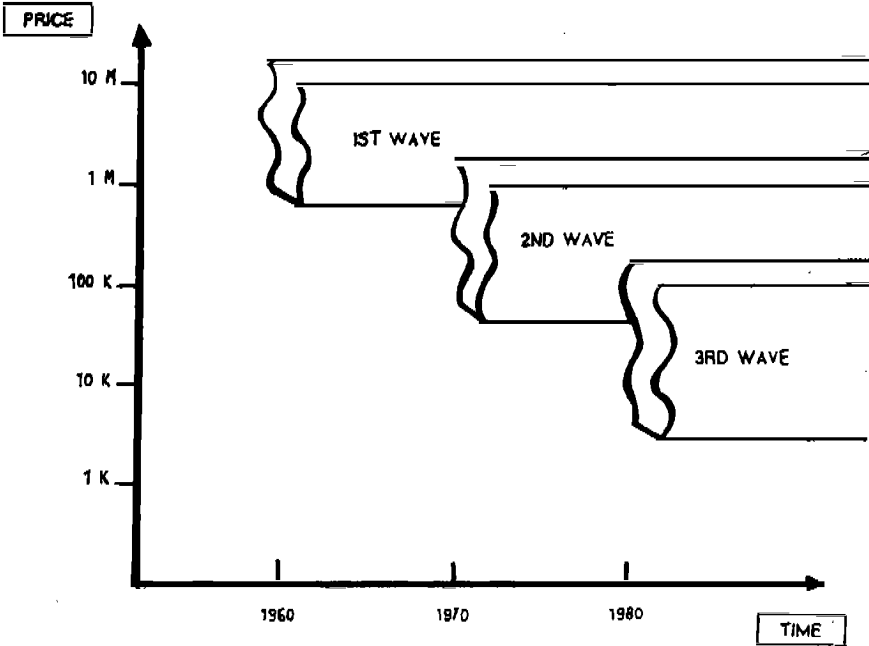
The *role of S&T in rural development* is another important topic for policy research. All efforts in S&T will be in vain unless we touch the life of

17. Claudio, "International Transfer of Risks," n.p.

18. Cayetano Paderanga Jr. and Corazon Claudio, "Microelectronics Technology Diffusion and Economic and Social Policies in the Philippines and in Selected Countries Within and Outside the ASEAN," n.p.

19. Claudio, "Are you Cultured?," n.p.; and Jose Sionil, "The Philippines: A Sociocultural Perspective," n.p.

FIGURE 2
THE THREE-WAVE MODEL



the common man in rural communities. Policies that will enhance S&T dissemination in rural communities need to be developed.²⁰

Other important issues and concerns related to technology development include how to deal with dislocations arising from accelerated industrialization, rapid creation and obsolescence of human capital, organizational disruption, increasing trade friction, and technology transfers.²¹ As we become industrialized, problems arising from these issues will increase. It is a big challenge to policy researchers to anticipate and address them with policy recommendations.

Proposed Policy Research Topics

In summary, some suggested topics for policy research on S&T are as follows:

1. Where to focus basic and applied research and what policies can enhance our research capability.
2. The relationship between new and old, or low and high technologies. (For example, how a "high" technology enhances and possibly supports the use of a "low" technology. Also, the relationship between new technologies and productivity. Studies of these relationships must be part of technology assessment studies.)
3. The important controllable and uncontrollable variables in S&T policymaking and how to monitor the uncontrollable, uncertain ones.
4. The technological development of a specific technology and where the Philippines is positioned in that development process.
5. The applications of forward and reverse engineering.
6. International market trends and strategies affecting a particular technology.
7. Other countries' policies on S&T--what have worked, what have failed, and how the policies are evolving.
8. The diffusion of technologies.
9. Risks associated with technology and risk transfer.

20. Claudio, "Information Technology Development and Promotions: Some Trends, Strategies, Issues and Recommendations," n.p.

21. Raphael Kaplinsky, "Industrial Restructuring in LDCs: The Role of Information Technology," n.p.

10. The role of culture and women in S&T development and the role of a technology in rural development.
11. Unresolved issues associated with S&T development such as dislocations arising from accelerated industrialization.
12. An integrated approach to S&T development and promotion.

The last item requires that we develop S&T with proper regard for our values, objectives, and political and social concerns. This need is apparent now in the communications sector. Some investors are ready to introduce new and superior technologies for telecommunications. But some political and social concerns, such as the social implication of cross-ownership of media bar such investors' entry into the market.²²

We must relate S&T policies to other policy instruments such as fiscal, monetary, regulatory, trade, exchange rate, capital market, investment, and labor policies. We also have to identify missing or weak links in policies. For example, urban development policies, specifically those covering zoning of land, are often inconsistent with other policies such as environmental policies.²³

"Technology by itself might be the least important in its successful utilization. It is understanding of all the others and putting them together that might matter in the end."

22. Claudio, "Against International Trends," n.p. and Claudio, "Trade-Offs in S&T," n.p.

23. Claudio, "A Second Look at Zoning," n.p.

REFERENCES

- Creighton, Gene. "The Status of the DP and Semiconductor Industries in Latin America." Paper read at the International Symposium on Technology Policy in the Americas at Stanford University, 1-3 December 1988.
- Edquist, Charles. "Technology Policy--Conceptual Remarks and European Experiences." Paper read at the International Symposium on Technology Policy in the Americas at Stanford University, 1-3 December 1988.
- Kaplinsky, Raphael. "Industrial Restructuring in LDCs: The Role of Information Technology." Paper read at the International Symposium on Technology Policy in the Americas at Stanford University, 1-3 December 1988.
- Kawamura, Kazuhiko, and Wainer Da Silveira E. Silva. "On Developing the Microelectronics Industry: A Systems Approach." *In Systems Research*. London: Pergamon Press Ltd., 1984.
- Ozawa, Terutomo. "Japan as a Late Starter in the Computer Industry: Major Characteristics and Policy Implications for LDCs." Paper read at the International Symposium on Technology Policy in the Americas at Stanford University, 1-3 December 1988.
- Paderanga Jr., Cayetano W. and C. Pe Benito Claudio. "Microelectronics Technology Diffusion and Economic and Social Policies in the Philippines and in Selected Countries Within and Outside the ASEAN." Research proposal. Manila: Asia Foundation, 1988.
- Pe Benito Claudio, C. "Information Technology (IT) Development and Promotion: Some Trends, Strategies, Issues and Recommendations." *In The Philippine Computer Society Yearbook 1989*. Manila: Philippine Computer Society, 1989.
- _____. "Risks of Toxic Substances: Cultural Considerations, Management and Policy Development in the Philippines." Paper read at the International Conference on Risks of Toxic Substances in Developing Countries: Implications for Women and Children, in Bangkok, Thailand, November 1988.
- _____. "Risk Assessment and Management: The Philippine Case." *Proceedings of the 2nd US-Japan International Workshop on Risk Assessment and Management*, In Suita, Japan, October 1987.
- _____. "Are You Cultured?" *Business Star*, 13 July 1989.
- _____. "Against International Trends." *Business Star*, 13 July 1989.
- _____. "Trade-Offs in S&T." *Business Star*, 27 April 1989.

- _____. "International Transfer of Risks." *Business Star*, 8 September 1989.
- _____. "A Second Look at Zoning." *Business Star*, 11 August 1988.
- Ripper, Mario Dias. Oral presentation at the International Symposium on Technology Policy in the Americas at Stanford University, 1-3 December 1988.
- Schulze, Peter W. "Bridging The Technology Gap: The Role of National and Community R&D/T-Programs in Europe: Inter-Firm Cooperation, ESPRIT and the Eureka Initiative." Paper read at the International Symposium on Technology Policy in the Americas at Stanford University, 1-3 December 1988.
- Sionil, Jose F. "The Philippines: A Sociocultural Perspective." Paper read at the 19th World Congress of the International Association of Financial Executives Institutes in Manila, October 1988.
- Steinmueller, W. Edward. "Public Policy Implications of the Economics of Information Technology Industries." Paper read at the International Symposium on Technology Policy in the Americas at Stanford University, 1-3 December 1988.
- Tigre, Paulo Bastos. "How Does Latin America Fit Into High Technology?" Paper read at the International Symposium on Technology Policy in the Americas at Stanford University, 1-3 December 1988.
- Yu, Pyung Il. "The Role of Government Policy and The Development Of Computer Industry in Korea." Paper read at the International-Symposiumon Technology Policy in the Americas at Stanford University, 1-3 December 1988.