Thai Journal of Development Administration Vol. 28, No. 3, July 1988

TECHNOLOGY ASSESSMENT

Fredric William Swierczek*
Vuthiphong Priebjrivat*

Lecture

The words Bhopal and Chernobul have become associated in people's minds with technological disasters of the worst magnitude. As we have seen in the case people's worst fears prompt them to desperate acts such as the tantalum incident in Thailand. Perhaps, the worst examples are not the dramatic incidents but the ordinary ones of plants which have no environmental protections or safeguards for the public, which use hazardous materials in their production processes or produce pollutants as by-products. These may represent the greatest need for a strategy of technology assessment.

As new or existing technology is brought to Southeast Asia from more advanced industrial countries, environmental and other problems are brought with them. Technology is not neutral. It has impacts. The purpose of technology assessment is to determine what those impacts are and to compare different technological alternatives as they relate to those impacts.

Technology assessment dates back to 1967 in the United States. It has achieved official governmental status only in the United States and France. Although other countries in Scandanavia, West Germany, India and Japan have conducted technology assessment projects, this approach has not been used in developing countries to any great extent.

*Presented at the Executive Seminar on the Management of Technology Asian Institute of Technology, Bangkok, Thailand, March 6–18, 1989.

Definition

> Technology assessment may be defined as the systematic study of the effects on society that may occur when a technology is introduced, extended or modified, with special emphasis on the impacts that are unintended, indirect, and delayed.
>
> Technology assessment is a policy generation and analysis or decision oriented tool. Its aims, techniques, and methods are best conceived as yielding systematic input into the larger political-economic decision process (OECD, 1975 : 37).

A more recent definition describes it this way :

> Technology assessment attempts to study systematically the consequences of choices and trade-offs between : (1) short-range and long range impacts, (2) first order and higher order effects, and (3) direct benefits and costs and negative externalities, with heavy emphasis on the comprehensive identification and analysis of the full range of social, economic and environmental effects of technological inducements (UNESCO, 1984 : 11).

Technology assessment developed because of the limitations of narrow financial or economic feasibility analysis of technological decisions. As we have seen in the tantalum case, financial feasibility was not sufficient. It also developed concurrently with environmental impact analysis. Again referring to the case even environmental, impact studies are not sufficient to anticipate all the consequences of technological decisions.

Therefore, there is a need for a more comprehensive, multidimensional and time oriented approach to the analysis of technological decisions. Technology assessmnt satisfies this need.

The Process of Technology Assessment

Technology assessment is carried out through a series of stages. These include :

1. **Problem Definition,** that identifying the issues, concerns, and scope of the technology decision.
2. **Technological Description,** specifying the technical features, advantages and disadvantages of the technological alternatives.

3. **Technological Forecasting,** analyzing the projected development of new applications or extensions of the existing technological alternatives.

4. **Social Assessment or Description,** this stage examines the socio-cultural features of the context in which the technology will be implemented. Included are the relevant political and economic characteristics of the location or community.

5. **Social Forecasting,** anticipating the likely trends in the social cultural, poltical and and economic fabric of the community related to the implementation of the technology.

6. **Impact Identification,** developing measurable indicators of impact consistent with the social, cultural, political and economic features of the situation and identifying the relevant perspectives of individuals or groups involved in other words stakeholders.

7. **Impact Analysis,** gathering the relevant data. At this stage the methodologies of data collection are the key elements of technology assessment.

8. **Impact Evluation,** at this stage the process of comparison is most important either comparing alternatives in terms of how they relate to impacts or in projecting results based on before and after measurement.

9. **Policy Analysis,** as a result of the multidimensional analysis of the technological alternatives and their impacts, various options or decision packages can be presented to the relevant decisionmakers. Each alternative would have a comprehensive set of advantages and disadvantages.

10. **Communication of Results,** all the technical information developed through the technology assessment should be condensed into a simplified, brief and easily readable summary report for decisionmakers, relevant information should be made available to the news media and to the relevant or affected citizens of the community. A public forum is often the best approach.

This summarizes the technology assessment approach. I would like to examine the tantalum case in the context of the technology assessment process.

A Review of the Tantalum Case.

Two types of analysis were used related to the tantalum project. The first type was an economic or financial feasibility study. The economic rationality for the project was based on the availability of raw materials close to the potential location of the plant. As the plant became more controversial, an environmental impact analysis or assessment was necessary. One was done by a governmental agency and another was conducted by the company. These studies were limited and very optimistic. There was no independent credible or comprehensive environmental analysis undertaken.

If a technology assessment had been conducted, what information would it have provided?

1. **Problem Definition,** the proponents of the project foresaw no problem. The tantalum project had a ready market, available raw materials, and good project. Problem definition would have indicated a conflict between the production of tantalum and the revenues, produced by tourism. While the project need not have been in conflict with the objectives of tourism, there were legitimate environmental concerns which were only poorly answered very late in the project. Since the anticipated economic return for the export of tantalum was only 1/2 of the current economic impact of tourism, important consideration should have been given to careful analysis of the alternatives.

2. **Technology Description,** the plant was described as state-of-the-art and proven. Were there other alternatives? Important considerations would have been the capital and labor intensity involved (related to employment possibilities) and the level of environmental protection provided. The plant was very capital intensive and the level of environmental protection seems minimal. The confidence in the technology is based on the technical features of the parts and past experience not on the realistic appraisal of the risks of the specific technology.

3. **Technological Forecasting,** there was no analysis of potential negative impacts or risk because there was an optimistic belief in the quality of the technology. There was also no analysis of potential problems if production was expanded or if there was a breakdown of the management of the plant. The favorable impacts of the plant were, naively accepted and then potential negative impacts ignored or underestimated.

4. **Social Asessment Description,** the establishment of an industrial plant in a community creates both opportunities and problems. This aspect seems to have been completely ignored in this case. The plant was a threat to tourism. It was located near a population center but provided little in terms of employment. The nature of the investment and the investors would have changed the existing political and economic network on Phuket. Further, there was very little recognition of the increasing environmental concerns of the Thai public, the threat Bhopal or Chernobyl means or the fear of loss of livelihood if tourism is affected.
5. **Social Forecasting,** because the benefits of the plant were taken for granted and no social impacts were considered, no projection of potential advantages or disadvantages were undertaken.
6. **Impact Identification,** the major impacts considered were potential export earnings and the utilization of raw materials. Environmental impacts were considered but dismissed as unlikely because of the advanced and proven nature of the technology.
7. **Impact Analysis,** this concentrated mainly on the economic or financial feasibility. Further environmental or social impact analysis was not conducted.
8. **Impact Evaluation,** totally concentrated on the accepted alternative and its expected export earnings. No other alternatives or impacts were analyzed.
9. **Policy Analysis,** this stage relies on a comparison of alternatives and the presentation of options. Only one option was considered the tantalum plant in that location. Other locations or the effect on tourism were ignored.
10. **Communication of Results,** much of the subsequent actions undertaken by the residents of Phuket were based on misinformation and fears. No opportunity was provided for their involvement until just before the plant was to start operation. The total time involved in the development of the project was approximately 8 years. The environmental studies which were done came too late with too little credibility. The damage was already done and there were no options beyond closing the plant.

Methods of Technology Assessment

A variety of different techniques and approaches have been developed related to the different stages of technology assessment. These include:

1. **Brainstorming,** this technique uses a group of relevant individuals usually experts and allows them a free-ranging opportunity to explore issues and potential consequences. **Stages** : Problem Definition or Impact Identification.
2. **Modeling,** using graphic techniques, mathematical or econometric techniques to explore probabilistic relationships between alternatives and potential impacts. **Stages** : Technology Description or Technology Forecasting.
3. **Forecasting,** using estimation, trend or extrapolation techniques to anticipate potential impacts. **Stages** : Social Forecasting, Impact Identification or Impact Analysis.
4. **Survey and Group Techniques,** these method include attitudinal questionaires, Delphi, Nominal Group Techniques and Multiattribute Utility Rating. these techniques are useful for quantifying values, beliefs and opinions. **Stages** : Social Forecasting, Impact Identification or Impact Analysis.
5. **Scenarios,** using possible alternative solutions or situations to explore likely or preferred impacts. **Stage** : Impact Evaluation or Policy Analysis.
6. **Checklists or Inventories,** this approach is useful for analyzing already collected data particularly on performance. The sources of data are usually organizational records. **Stages** : Impact Analysis or Evaluation.
7. **Decision Techniques,** these include decision trees, benefit-cost analysis, and linear programming among others. They focus on comparing and evaluating different alternatives. Depending on the level of analysis, these can be used for social or economic impact analysis. **Stages** : Impactl Evaluation or Policy Analysis.
8. **Survey Feedback, Teleconferencing, or Town-meetings,** these techniques focus on information sharing praticipation of relevant actors and feedback. They concentrate on increasing the awareness of the public and assessing potential problems. **Stages** : Policy Analysis and Communication of Results.

Technology Assessment includes multiple impacts, social, economic environmental and political. In order to determine this range of impacts multiple methods are required appropriate assessment would focus on a good design for information gathering and analsis which would cover each stage of the process.

In reality however, expert opinion seems to be the preferred approach in most examples of technology assessment. The limitations of this approach are

readily visible in the tantalum case. Experts share a narrow view and are often tied to their discipline Assumptions bias their perspective.

Risk Assessment

As technology assessment has come to include the dimensions of economic feasibility, environmental impact and social impacts, another related area of assessment has also emerged which concentrates on hazards and their potential impact.

Risk assessment concentrates on specific environmental health or physical impacts which might result from a technological choice. It includes, 4 stages :

1. Determining an acceptable level of risk, this level is one in which minimum hazard is probable. **Baseline measures.**
2. Assessing the probable level of risk associated with a technological assessment. **The estimation stage.**
3. Comparing the likelihood of risks with the accepted level of risk, that is, an evaluation of actual risk with relatively risk free baseline data. **The evaluation stage.**
4. Minimizing Risk, based on the evaluation of risk potential, corrective actions would be proposed. For example, in a tantalum plant if the accident rate is 10 per week and an acceptable rate is 5 per week (based on an industry average) greater training or a better safety program should be instituted. **The decision stage.**

Data on risk is available from manufacturers or from industry statistics. Independent testing facilities or laboratories are another potential source.

Risk and the Tantalum Case

Optimistic assumptions were made in this case concerning the safety of the plant in terms of potential hazards and acid spills. There was an acknowledgement of potential problems because of human error. In the situation in which the plant was located in an environmentally sensitive area, close to a major population area, and with an economy based on tourism the accepted risk might be much less than might be accepted in another area. This is confirmed by the new location for the plant in an already established industrial zone. The risks were not objectively determined therefore fear took over with expensive and negative consequences.

Who Should Do Technology Assessments

The point has been made with some certainty that technology assessments should be made of projects likely to have major social, political, economic, environmental or hazardous impacts. Should this be a governmental responsibility, a private company responsibility, or the responsibility of some independent body such as a university, think tank or consulting firm? Governments are not likely to have the resources. Companies have too much self-interest. An independent source would be the best solution.

In a major project such as the tantalum plant in which millions of dollars are invested by banks including international lenders, the economic feasi bility is certainly examined and the environmental impacts are assessed, would it not have been worth it to have done a more comprehensive technology assessment. The savings could have been dramatic.

Summary

Technology assessment offer a comprehensive methodology to analyze the impacts of technological decisions. This methodology is very beneficial to companies investing in plants which have some degree of political, economic, social or environmental risk and in which the impacts may have nagative consequences. There is much greater benefit to determining these impacts before major investments are made. The costs of not doing so are quite high. Government agencies should also become more aware of technology assessment for major infrastructure projects potentially controversial projects like the tantalum plant. The techniques are available. The methodology is applicable in a variety of different ways from the simplest format to an intensive multiple impact research project.

Technology Assessment

Resources

Environmental Monitoring and Assessment Impact Assessment Bulletin.

Journal of the International Society for Technology Assessment.

Risk Analysis.

Technology Assessment.

Technological Forecasting and Social Change.

Bernhold, T. (1988), *Technology Assessment Management Conference ;* Vol. 6 : *User Interfaces*. New York : Elsevier.

Bernhold, T. (1986) (ed.), *Technology Assessment and Management, Vol. 2 : Expert systems and knowledge Engineering*. North Holland : Elsevier.

Coates, V. & T. Fabian (1982), "Technology Assessment in Industry : A Counter productive Myth," *Technological Forecasting and Social Change*. 22 : 3-4, 331-341.

Coates, V. & T. Fabian (1982), "Technology Assessment in Europe and Japan," *Technology Forecasting and Social Change*. 22 : 3-4, 343-362.

Donovan, P. & G. Gaspari (1982), "A Management Overview Methodology for Technology Assessment," *Technology Forecasting and Social Change*. 22 : 3-4, 223-237.

LaPorte, T. (1981), *Technology as Social Organization : Toward Improved Technology Assessments*. Berkeley : University of California.

Laulan, A. (1986) "Social and Cultural Conditions in the Acceptance of New Technologies" pp. 81-92 in T. Bernhold (ed) in *Technology A*

assessment and Management : Expert Systems and Knowledge Engineering. New York : Elsevier

Lee, A. & P. Bereano (1981) "Developing Technology Assessment Methodologies : Some Insights and Experiences" *Technological Forecasting and Social Change*. 19, 15-31.

Maloney, J. (1982) "How Companies Assess Technology," *Technological Forecasting and Social Change*. 22, 321-329.

Mayo, L. (1982), "Thoughts on the Adequacy of Performance of Technology Assessments," *Technology Forecasting and Social Change*. 22 : 3-4, 267-298.

O'Brien, D. & D. Marchand (1982) (eds), *The Politics of Technology Assessment*. Lexington : D.C. Heath.

OECD (1975) *Methodological Guidelines for Social Assessment of Technology*. Paris : OECD.

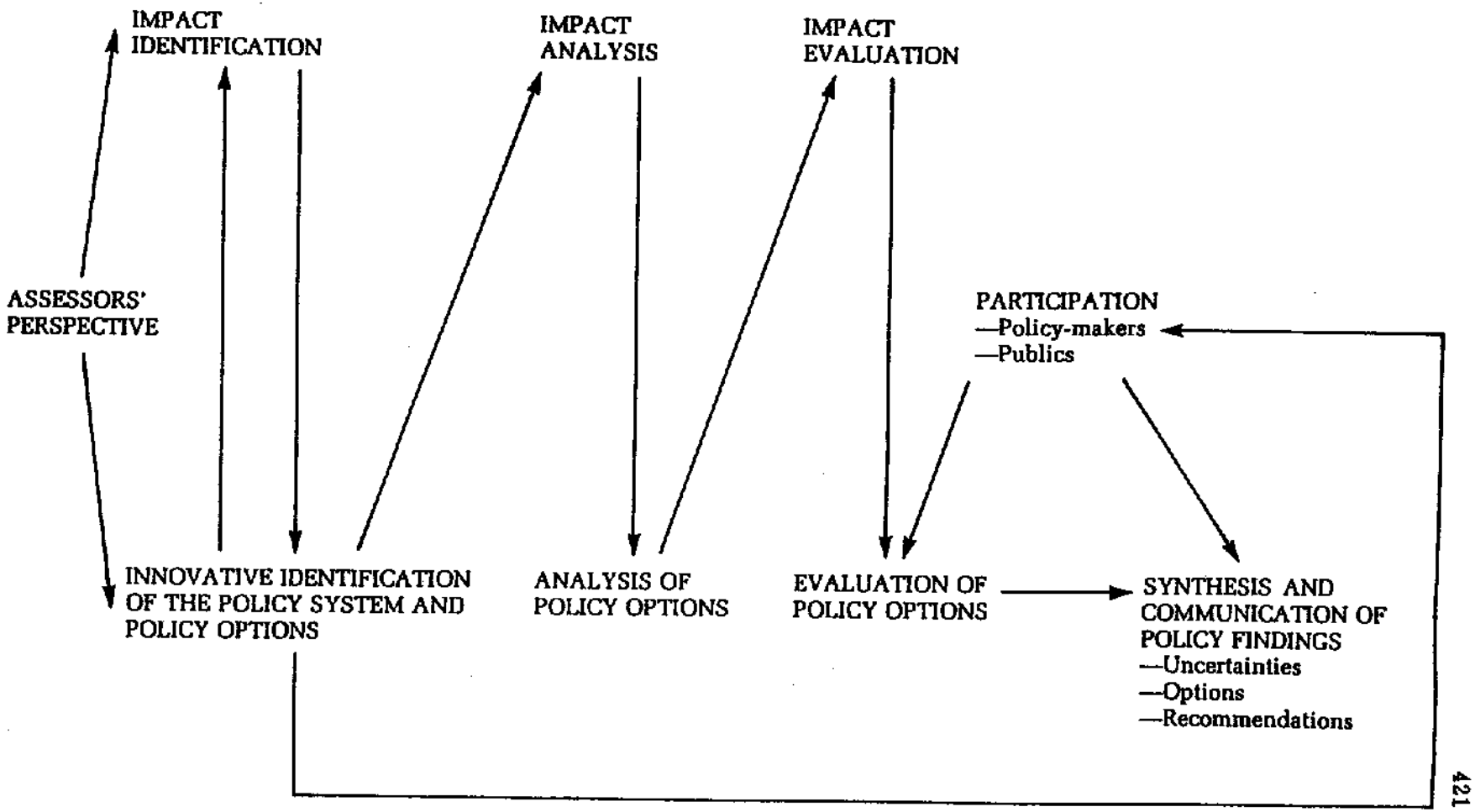
Porter, A. & F. Rossini (1983), *Integrated Impact Assessment*. Boulder Westview Press.

Porter, A. et. al. (1980), *A Guidebook for Technology Assessment and Impact Analysis*. New York : North Holland.

Randolph, R. & B. Koppel (1982), "Technology Assessment in Asia : Status and Prospects," *Technological Forecasting and Social Change*. 22, 363-384.

Wad, A. & M. Radnor (1984), *Technology Assessment : Review and Implications for Developing Countries*. No. 61, Paris : UNESCO.

White, B. (1988) *The Technology Assessment Process*. New York : Quorum.



A strategy for policy analysis in TA/EIA

CONFERENCE ON
THE MANAGEMENT OF TECHNOLOGY
AIT
TECHNOLOGY ASSESSMENT
Case Study

The Thai German Tantalum International Company has just completed construction of a 44 million dollar plant to produce tantalum. The Plant was planned seven years ago, construction began three years ago. Part of the reason for the slow process has been the declining price of tin (which is a key raw material in tantalum) and the high cost of mining tantalum ore. Because of these two trends, the alternative method of producing tantalum which is accomplished by the refining of tin slag (a waste product from tin mining) has become economically attractive.

Tantalum is :

> A precious refractory metal with unique
> electrical, chemical, and physical properties.

It is used in electronic capacitators, metal working machines, chemical equipment and nuclear-reactor components. The tantalum factory is the first in Asia. It is using state-of-the art proven technology from a German company which is one of only four tantalum processors in the World. This company has agreed to take 50% of the annual production of 600,000 pounds of tantalum. This level of production would be one-fourth the estimated demand for this metal. The value of exported tantalum would be approximately 20 million dollars.

The financial feasibility of this project was determined jointly by the International Finance Company (IFC), the investment arm of the World Bank and the Industrial Finance Corporation of Thailand (IFCT), which is a quasi-government development bank. the feasibility was largely based on the availability of raw material locally, in Thailand and Malaysia. It was located on Phuket Island, a well known tourist resort because there was an existing tin smelter, available slag and ease of transportation. It was conveniently located to one of the largest towns on Phuket.

Investors in the company included the IFC, 12.5%, IFCT, 5%, a largeminerals company, 45% gronp of banks, 14%. The remaining was invested by three tin-mining families aud the President of the Thai German Tantalum International who is a well-known former politician from Bangkok from a famous and well-connected family.

Recently, there has been considerable controversy about the plant. Environmentalists have expressed strong concern over potential hazards related to

hydrofluoric acid used in processing and the level of radioactivity in the tin slag and the tantalum. Local residents fear that pollution could damage the island and reduce tourism which brings in over 40 million dollars to the local economy.

Both the government and the company have produced environmental impact studies. The government report stated :

> The hydrofluoric acid is not pressurized. It is contained in underground concrete tanks. Tubes, pipes and containers through which the acid flows are made from flows are made from corrosion-resistant materials which makes any leakgae unlikely. The tin slags have naturally low radioactive levels. This is not hazardous. The process of extracting tantalum has nothing to do with radioactivity.

Similarly the company study outlined the issues :

> The plant utilizes what are considered the best availabel technologies for plant processing, handling operations, and pollution control. The technologies have been tested elsewhere, over many years wihch has demonstrated that the plant can be operated without unnecessary risk or hazards to employees, nearby residents or to air, land or water. However, it is recognized that the quality of operation and, maintenance particularly of pollution control is difficult to manage and to insure acceptable efficiency unless special precautions.

The complaints about the plant increased to such a great extent that the Minister of Industry under-took a fact-finding tour. This trip took place shortly before the plant was to begin operation and a month and a half before a general election. This trip excited a considerable turnout of residents. An estimated 50,000 out 84,000 people on Phuket participated. The demonstration soon got out of hand. Considerable damage was done and the plant was completely destroyed beyond repair.

Investigation revealed that the destruction of the plant was a deliberate act of arson and industrial sabotage. Key parts and documents were stolen. The perpetrators were a rival family from a different palitical party than the President

of the Thai-German Tantalum Company and they felt their own business interests were threatened.

The consequences of this situation were severe. The replacement cost of the plant was expected to be over 30 million dollars. The loss to investor's was in excess of 40 million dollars. Investor's confidence in Thailand was strongly shaken. The reputation of Phuket suffered.

Residents felt that they were duped or manipulated. They didn' tknow what tantalum was but they were led to believe that it could cause another Bhopal or Chernobyl to happen on Phuket. They didn't want such a disaster. The IFC blamed the Thai government for inadequate preparation and study preliminary to building the plant and for poor communication to the residents. Secondarily, the company was at fault. A new plant will be built in the Eastern Seaboard Development Zone.

References

Sricharatchanya, P. (1986) "Danger in Paradise? : Residents Oppose Efforts to Open a Tantalum Plant in Phuket," *Far Eastern Economic Review*, 26 June, 73–74.

Sricharatchanya, P. (1986) "Fire Over Phuket," *Far Eastern Economic Review*, 3 July, 12–13.

Sricharatchanya, P. (1986) "Phuket 'Scapegoat'", *Far Eastern Economic Review*, 10 July, 16.

Sricharatchanya, P. (1986) "An Unlikely Phoenix : Thailand Decides to Help Re-build a Destroyed Tantalum Plant," *Far Eastern Economic Review*,