

TDRI

Quarterly Review

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A young woman sets out fish to dry in the sun. Such scenes are becoming "pictures from the past," as more and more Thai women move into industry and services. See related article on page 19.

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The Role of Agribusiness in Thai Agriculture: Towards a Policy Analysis

Scott Christensen*

Thai agriculture has been at a crossroads for about a decade. It cannot rely on the two primary factors that supported its growth in the past – surplus land and stable markets abroad. These factor and market constraints have led policy makers to advocate a larger role for agribusiness in agricultural development. A perception has emerged that Thailand is losing its comparative advantage in staple food crops and that future success in agriculture will depend on the ability of private firms to create more value added and innovate technologies.

This article explores the policy implications of promotional incentives for agribusiness. It advances two sets of arguments. First, a promotional policy must recognize differences in biogenetic and technological traits between commodities. These traits thereby prescribe “appropriate” roles for agribusiness and government, which will differ from one commodity to the next.

Second, preoccupation with agribusiness as a “panacea” for agricultural problems may distract from glaring

deficiencies in the public sector’s own performance in agriculture. At issue is not the comparative advantage of Thai agriculture, but rather the *comparative advantage of the government* to intervene effectively in agriculture. *While the government cannot plan agriculture, it cannot turn over all development functions to private firms.* The promotion of agribusiness alone will not correct policies and bureaucratic weaknesses which presently harness the innovation of incentives and the achievement of needed institutional changes in the agricultural sector.

OVERVIEW OF AGRICULTURAL POLICY

Two Waves of Agricultural Diversification

During the 1950s, 60s, and 70s, surplus land and demand for food exports encouraged Thailand’s “first wave” of diversification out of rice and rubber. Farmers expanded production of upland field crops, mostly

Mechanization is only one area in which innovations can be achieved both by large firms and by small-scale farmers or entrepreneurs.



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cassava, kenaf, maize, and sugar, and also mung beans and sorghum. Expansion was achieved through extensification, though large public investments in roads and primary irrigation supported steady growth in output. Modest improvements in yields were added to many of these crops, including rice, but yields declined measurably in cassava, sugarcane, and mung beans.¹

A second wave of diversification began in the late 1970s. This wave has been marked by a shift into fruits, vegetables, oilseeds, tree crops, beef, poultry, swine, dairy cattle, and prawns. Many of these commodities require advanced processing technologies and thus yield higher value added at the processing stage. Some are import-competing commodities, and some become inputs for export-oriented manufactures. To support this shift, the Board of Investment (BOI) revised its Investment Promotion Acts in 1972 and 1977 to promote capital-intensive processing on a broad scale. One consequence of these privileges has been rapid growth in food industries, which now constitute nearly one-third of total value added in manufacturing.

Commercialization Strategy

It is widely regarded among policy makers that Thailand must succeed at completing the second wave of diversification if the country is to maintain its comparative advantage in agriculture, diversify farm incomes, and boost living standards among the rural poor. Policy makers concede that existing policies and practices may be inadequate to the tasks implied by the second wave.² But there is debate over the specific means for achieving these tasks.

National planners and officials at the Agriculture Ministry perceive the challenge as rooted in a *shortage of commercialization* in the countryside. Central to some official opinions is the idea that large agribusiness firms can act as a cardinal tool for speeding commercialization and tackling the second wave. Agribusiness, rather than government or small agriculturalists, is the innovator, the lead entrepreneur. At least three related arguments have been cited in support of promotion for agribusiness. First, large firms are better equipped to mobilize long-term capital than are farmers, middlemen, or small processors. Long-term risk capital is required for commercial expansion in ventures such as tree crops, livestock, aquaculture, and fruit or vegetable plantations. Second, many of the second-wave commodities are more research-intensive than those of the first wave. Again in theory, large private firms can absorb research costs and assist in dissemination. And third, it is said that much modern technology and other inputs elude small-scale farmers and might even exceed their acumen and skill. Contract farming between firms and farmers will channel inputs and credit to the farmer, disseminate new technologies, and make the farmer more productive.

TOWARDS A FRAMEWORK FOR POLICY ANALYSIS

The Burden of Proof

A policy that favors a greater role for agribusiness should first make a sound case in support of such an initiative. A common argument is that the model devised in poultry, which involves contract farming between firms and small producers, is a good thing because it has enhanced productivity in a new commodity, introduced new technologies, and garnered export earnings. But the real burden of proof for proponents of agribusiness promotion is to show that this would create *positive externalities*, which are the benefits of one individual's actions that spill over to others and accrue to the economy at large. Externalities create a dilemma because they involve "market failure," meaning they are difficult to price and private entrepreneurs cannot capture the gains from the benefits they yield. It becomes the job of far-sighted entrepreneurs and strategic policies to correct market failure and induce innovations which would yield net societal benefits.

The burden of proof for proponents of the privatization policy is to show that positive externalities can be created better by firms than by government, by the incremental innovations of independent farmers, or by market forces generally. Proof of positive externalities involves the identification of relevant market failures which neither farmers nor the state will have incentives to correct, but which would be cured by the resources and innovations of large firms. Promotional incentives, as one form of compensation, would help subsidize the creation of positive externalities.

Public-Private Roles: Agreement and Disagreement

The first step towards an analysis of appropriate public-private roles in the creation of net social benefits is to review what we know about the comparative advantage of private firms and government in the area of agricultural development. A most important theme in development literature is that government has a very critical role to play in agriculture. The idea that more space is needed for private firms should not, therefore, gloss over the fact that there are many policy issues in which government has a comparative advantage.

There is widespread *agreement* that the most important areas in which government must have effective policies are physical and social infrastructure (roads, irrigation, human resources), biotechnology research, extension, the enforcement of grades and standards in traded commodities, and the provision of law and order to secure contracts and property rights.³ It is regarded that the Thai state has performed measurably well (until recently) in the provision of rural infrastructure, namely

large-scale irrigation, roads, and primary education. It has performed less well in research and development (R&D) and the provision of property rights.

There is widespread *disagreement* over whether government should intervene in other areas, including the marketing and exporting of commodities through government marketing boards; price subsidies; direct controls over the allocation of credit and foreign exchange; border taxation; and the direct production and processing of commodities. The Thai state has intervened variously in all these areas of disagreement. Its interventions often have been subject to widespread scrutiny, and sometimes they have involved high-level corruption. Examples include rice export taxes; Commerce Ministry intervention in rice procurement and exporting; the transport of select crops by the Express Transit Organization; and pork slaughtering. Agriculture officials have also proposed to create a National Agricultural Council, or NAC. The NAC would oversee the actual *planning* of agricultural production. Such planning has not worked in other contexts, as the experiences of former Communist countries have made abundantly clear, and it is one area that attracts widespread condemnation among development theorists.

“While the government cannot plan agriculture, it cannot turn over all development functions to private firms.”

The debate over the comparative advantage of the state versus that of private firms centers precisely on the nature of the benefits generated by public and private innovations. On the one hand, some benefits are *diffuse*, meaning they create external economies or externalities. The benefits usually cannot be captured by the agent who invests in creating them. An example is the successful invention of a new technology by one farmer which may convey valuable information to her neighbors, thus giving the neighbors a positive externality or net gain. Such gains are often referred to as non-excludable. Some types of diffuse externalities can be made excludable by third-party intervention, as when the state patents the discovery of the innovative farmer and thus requires her neighbors to pay for the benefits yielded by its application. Research and extension in open-pollinated seeds like rice are not likely to attract the interest of private firms, and here the state must act.

On the other hand there are those benefits that are *internalized*. These benefits are excludable, meaning that the agents who create them can exclude them from others and even sell them as a priced and tradeable commodity. An example in agriculture is hybrid seeds. Because farmers cannot keep their own hybrid seeds for use in the next planting season, owing to genetic

deficiencies of hybrid offspring, they must return each season to the producer to obtain new seed. Firms that invest in hybrid research therefore have a natural lever of market control over their product. But because of research cost variance from one commodity to another, not all commodities attract hybrid research by private firms.

Though externalities are commodity-specific, the delineation of public and private roles is often open to delicate trial and error. Third-party enforcement opens a range of possibilities for the role of the state versus private firms. But clearly some types of enforcement are “inappropriate.” An example is when the state enforces excludability for private innovations which have very diffuse externalities, for example open-pollinated crops. In these instances projects are often doomed to fail. Some private firms, for instance, have attempted to create contract farming in rice, an open-pollinated seed. Contract farmers were obligated not to disseminate company seeds, fertilizers, and pesticides and to sell their harvest only to the firm. These arrangements are more suitable in crops like hybrid maize, where the farmer must return to the company each planting season for seed and inputs. Rather than “forcing contracts,” a more appropriate role for the state in rice lay in subsidizing the acquisition and dissemination of exotic rice strains by private firms, for example Basmati and Jasmine rice. Unfortunately, the Ministry of Agriculture has been slow to act on these opportunities, but it has, nevertheless, permitted large firms to attempt contract farming in rice.

The Policy Agenda: Technological and Institutional Innovation

What are the issues which call for an analysis of externalities and appropriate public-private roles? The first wave was made possible by the land surplus and investments in irrigation and roads. But public and private actors now have to address a different set of issues. Some commodities require a different organizational framework and even more centralized, hands-on management. Thailand’s typical arms-length agricultural markets may be less adequate to the task of promoting new products on both the supply and the demand sides. In poultry, for instance, contracts between firms and farmers have proven productive and efficient. In light of this example, vertically-integrated firms figure prominently in the minds of officials as a panacea to speeding commercialization.

One danger with a policy that relies on agribusiness, however, is that it invites the public sector to fall back on practices it used during the first wave while turning second wave responsibilities over to private firms. That approach is inappropriate for facing up to the challenges that now confront Thai agriculture. Development theory identifies technological and institutional innovations as

the keys to sustaining comparative advantage.⁴ Institutional innovations involve both economic and political institutions. Economic institutions refer to the rules of an economy which organize product inputs, product exchange, and product upgrading. They include property rights, product distribution networks, the mode of technological innovation (such as public research and patenting), the modern firm, credit institutions, and capital markets. Political institutions include the legal system, the bureaucracy, and the system of law enforcement. Agricultural development is a process whereby institutions undergo substantial innovation and change.

The agenda for the second wave thus involves organizational and legal reforms in the institutional framework which governs Thai agriculture. It also involves the participation of both private firms and the government in technological research and dissemination. The primary concern over the next decade is the restructuring of incentives within which innovation and productivity would occur. Institutional reforms are critical to sustaining productivity. *The promotion of agribusiness alone will not achieve the tasks at hand.* Considerable reforms are long overdue in public irrigation, commodity pricing programs, and rural property rights. There is little in the promotion of agribusiness that would encourage reform in these areas. The delivery of investment privileges to private tree farms in the absence of rural property rights reform, for example, has done nothing to improve the management of rural land and forest resources.

POLICY TASKS FOR THE 1990s

At least three different kinds of policy tasks will confront policy makers, firms, and farmers over the coming decade. One involves the delineation of "appropriate" public and private roles. The second is the critical need for reform in the public sector's agricultural policy machinery. And the third concerns distribution and equity issues, particularly where small-scale farmers and staple crops are concerned.

Commodity Specific Public-Private Roles

Development "functions" of the state and firms are commodity specific. Firms will be most anxious to invest in areas where they can capture the gains yielded from investments in new technologies. Where technological factors make the gains diffuse, the state must evaluate carefully the viability of subsidies and third-party enforcement.

Herein lies a policy dilemma. Advocates for agribusiness promotion must show that promotion would create positive externalities. But it is precisely in commodities where the gains are diffuse, or external, that firms will not have an incentive to innovate, and some types of promotion in these areas, as in the case of rice contract farming, can be inappropriate. Policy incentives

must be designed in a way as to guard against inappropriate roles and negative outcomes. It may indeed be appropriate for the state to subsidize a firm's acquisition of new seed strains, provided criteria are built into these subsidies to ensure the benefits spill over to the farmer at large. In commodities where the gains are internalized, promotions can still be appropriate. Outcomes will depend on how promotions are designed. Again, the challenge for policy makers is to ensure that firms do not capture all returns and that there is a net social gain. The state has a critical role to play here and it must rethink its own policies and performance.

The Ministry of Agriculture should take a serious look at the technology of poultry and hybrid maize and based on that evaluation assess the viability of the contract-farming model in other commodities. Furthermore, recent evidence has shown that even in the area of hybrids, firms may wait for the public sector to invest first. In maize, for example, private seed companies spend most of their resources on non-pollinated maize, and many firms are waiting for government research to yield new hybrid technologies which they would then purchase and produce.⁵ In dairy farming, too, *in vitro* embryo production offers a promising means to boost dairy yields. Private firms have expressed interest, but they also say that this area is not commercially viable. They prefer that the public research program invest in the R&D, or that the environment for public-private collaboration be improved.⁶

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Subsidies are one means to encourage R&D, but ideally they would be followed by disciplinary measures on the part of government to enforce stated policy objectives. The Thai state has always been weak in this regard, however, partly because policy objectives are usually vague, and partly because the state has little capacity or will to enforce measures on private firms. Protection for intellectual property would be another means, and maybe a more effective first step as it would not involve expenditure of resources through promotional privileges. A third and perhaps more promising avenue would be the creation of public-private research institutions in biotechnology. In the area of mechanical innovations, the private sector does quite well on its own.⁷ The government's role here would lie again in intellectual property protection. Patents are questionable because they have a 15-year protection period and

may inhibit widespread experimentation, especially in the early and intermediate stages of innovation which Thailand now occupies.

The Need for Reform in the Public Sector

These issues should not be approached in terms of an alleged “declining” comparative advantage in staple crops. The staple crops, many of the open-pollinated seeds, require more careful and effective government management, notably in the area of research and extension. A more useful lens is to evaluate the challenges of the current decade in terms of *the comparative advantage of the government, notably the state research, extension, policy enforcement, and law enforcement apparatuses*. Public sector institutions, rather than the agricultural sector per se, should be the object of reform. Concern should focus on existing laws, policies, biases, institutional capacities, and civil service practices that inhibit the restructuring of incentives in agriculture. At least three weaknesses require attention.

Research, information-management, and inter-departmental coordination capacities: There are over 45,000 officials in the Ministry of Agriculture and Cooperatives with an annual budget that well exceeds 20 billion baht. R&D, however, occupies a lowly status on the list of Ministry priorities. The budget of the Department of Agriculture, the primary research unit, ranks fifth among all departments in the ministry and constitutes, on average, some 6 percent of total ministry spending. There also exist problems in coordinating biotechnology research among government agencies and public universities in a number of fields. In some cases, private firms have been discouraged from seeking collaboration with the public sector in R&D because of these communication and coordination problems.⁸

Promotional standards in the civil service also inhibit reform and innovation. The Civil Service Commission emphasizes the *quantity* of research projects rather than the quality of research as a criterion for civil service promotions.⁹ A recent study of the Department of Agriculture found that the number of small, short-term projects has been boosted over the past two decades in order to ensure that Department researchers are provided satisfying promotions. But most biotechnology research is long-term and must be rolled over several years, and hence these projects are not encouraged by civil service promotion standards.

The Ministry of Agriculture and Cooperatives also suffers from fractious competition among its departments. Both the Department of Agriculture Extension and the Office of Agricultural Economics collect data on crop yields, production costs, and output. These agencies often compete with one another for the status of having the “correct” figures each crop season, figures which by nature are hard to derive because of variance

in growing conditions from one village to the next. Mitigating this problem would involve first, doing away with the myth that costs and yields can be calculated and their estimates used to somehow “manage” agriculture, and second, reforming the information-gathering and coordination capacities of this ministry.

Procurement, Pricing, and Delivery Systems: These areas involve policies and programs engaged in the procurement, import, export, transport, or subsidization of farm commodities. Like other industrializing countries, Thailand has been moving gradually toward supporting its farmers through price subsidies. The Ministries of Agriculture and Commerce have been most active in rice and also in subsidizing fertilizers. In these areas there is great need to create more efficiency, transparency, and accountability.

To date, most producer support programs in rice — which usually involve a complex array of forward purchases by the Commerce Ministry and subsidies to boost farmgate prices — have failed to achieve the stated objective of raising producer incomes. The biggest challenge for the government is to design a price subsidy program which can prevent the benefits from being captured by the most influential traders, politicians, and bureaucrats who implement the programs. Researchers have found, for instance, that fertilizer allocations by the Marketing Organization for Farmers (MOF) over a four-year period generated in a net transfer of income from farmers to the agency amounting to 132 million baht.¹⁰

“There has been scarce consideration of the plausible disastrous impact such planning and coercion would have on agricultural productivity should farmer choice be strangled. Individual farmer choice has been a pillar of Thailand’s success in agriculture thus far, and there is no justifiable reason why it should be done away with now.”

The expansion of the role of the Bank for Agriculture and Agricultural Cooperatives in subsidizing producers may constitute one step toward reform of these programs, so long as bureaucratic capacities are developed at the local level to ensure that funds are delivered to the target beneficiaries, namely small-scale farmers. Another substantive step toward bureaucratic reform would involve the disclosure of all off-budget accounts of the ministries, departments, and other agencies involved with price support and procurement programs. Such a measure would precede the creation of more accountability and effectiveness in these programs.

Institutional Arrangements Governing Factor Inputs:

Natural resource constraints make more effective management of land and water inputs a most critical aspect in policy reform. Simply building more dams and promoting private firms to plant trees will not address these challenges in a constructive, much less equitable, manner. In water, the Irrigation Department needs to work at projects that will promote more effective water management at the farm level. The swift development of tertiary canal systems is an overdue task. Reform in rural property rights laws is also needed. Small-holders in forest reserves are virtually banned from obtaining formal credit because they lack title deeds. Community forest institutions lack effective enforcement capacities because the state does not recognize these institutions as legitimate juristic entities. Reforms in both water management and land tenure may even require, or need to be a part of, an overall decentralization of the central government administration.

Distribution, Equity, and Risk-Sharing

If policy reforms in agriculture are meant to raise farmer incomes as well as to sustain Thailand's comparative advantage in agriculture, then distribution and equity issues must inform the debate. In commodities where firms are likely to have a strong role, measures must be enacted to ensure that benefits are guaranteed for the farmer. Thus far, a number of contract-farming projects in livestock have converted landless farmers into credit-worthy livestock breeders, a fact which is worthy of applause. If this model is proven to be feasible in other commodities, an appropriate role for the government is to ensure that technologies and higher incomes do indeed accrue to the farmer. But the public sector has not developed any independent criteria for evaluating the distributional and equity implications of contract-farming.

In commodities where the state finds it appropriate to subsidize innovation or enforce excludability, owing to diffuse externalities, a legal framework must be designed that would guard against farmers having to bear excessive risk. Often in contract farming, firms bear no risk in the event of a natural disaster. One alternative would be the development of a comprehensive crop insurance program, which could shoulder risk for the farmer. Firms might even be asked to manage the delivery of insurance, just as they manage commercial credit, or even subsidize it for the farmer.

Perhaps the finest example of how *not* to spread risk and remove uncertainty, from the farmers' point of view, is to institute the proposed National Agricultural Council. It is not feasible, if based only on the experiences of other developing countries, to plan the agricultural sector. The NAC threatens to enforce contract-farming

obligations very harshly, despite the fact that independent criteria for judging the worthiness of these contracts eludes the regulatory framework. Farmers would bear excessive risk and their choices would be severely limited. There has been scarce consideration of the plausible disastrous impact such planning and coercion would have on agricultural productivity should farmer choice be strangled. Individual farmer choice has been a pillar of Thailand's success in agriculture thus far, and there is no justifiable reason why it should be done away with now. It is also problematic to attempt the actual planning of agriculture when the basic information-gathering and policy enforcement apparatus is not up to the task. Given the fallibilities involved with calculating cost, yield, and production data at the national level, it is not at all difficult to imagine the many troubles a national planning council would confront in attempting to manage overall production.

CONCLUSIONS

Agribusiness is not a panacea for innovation, it is a partner in what should be a transparent, public-private alliance which should include independent farmers as well. In second wave commodities, officials need to scrutinize which commodities will afford an "appropriate" role for agribusiness, based on the externalities thus generated and on the economic and political costs of third-party enforcement. While in very simple terms there can be a line drawn between open-pollinated and hybrid crops, that line is becoming increasingly fuzzy. It is likely that research programs will involve extensive cooperation among firms, public agencies, and other research institutions, including universities. The fragmentation of the public research apparatus, however, has thus far worked to discourage public-private collaboration.

In the face of factor and market constraints, institutional innovations in areas such as property rights, credit, price supports, risk-bearing (insurance), and the overall regulatory framework would provide incentives for firms and independent farmers to cope. But the public sector must get its own house in order to face these tasks. The promotion of agribusiness alone will not do the job. Institutional reform in the public sector should top the list of priorities for overall promotion of institutional change in agriculture over the coming decade. For agribusiness to become a functional partner for both farmers and the state, it must have an effective, coherent, and competent state with which it can coordinate its contribution to agricultural development. Otherwise promotion of agribusiness could lead to inappropriate roles and negative outcomes for both the government and private firms.

ENDNOTES

- 1 Onchan 1990:15.
- 2 Panpiemras 1991.
- 3 Timmer 1991.
- 4 Hayami and Ruttan 1985.
- 5 Setboonsarng 1990.
- 6 TDRI 1992:95-96.
- 7 Binswager 1986.
- 8 TDRI 1992.
- 9 Manirojana 1989.
- 10 Kaosa-ard and Manahong 1992.

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China and Economic Cooperation in the Asia-Pacific Region

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China has become a major economic actor in the Asia-Pacific region. Since Deng Xiaoping's comprehensive reforms were initiated in 1978, the country's external economic relations have become more extensive, with the regional economies as the primary beneficiaries. China's total two-way trade grew from less than US\$15 billion in 1976 to over US\$128 billion in 1990. The Asia-Pacific region accounts for about 70 percent of this trade, half of which is conducted with Hong Kong and Macao alone, and more than a quarter of Hong Kong's exports are destined for the Chinese market. The composition of China's exports has also shifted significantly as a result of reforms and the country's open-door policy. Primary products, which made up over half of China's merchandise exports in 1980, accounted for only 28.6 percent in 1989. Conversely, manufactured goods have risen from less than 50 percent of total merchandise exports in 1980 to over 71 percent in 1989.

Foreign direct investment (FDI) has contributed significantly to the development of services, oil exploration and export-oriented manufacturing industries in China. Pledged foreign investment – most of which originated in the Asia-Pacific region – grew from US\$9 billion in 1984 to nearly US\$34 billion in 1989. The unique position of Hong Kong and Macao, in proximity, language, and family ties, has contributed to the fact that these countries account for over 60 percent of total FDI in China. Hong Kong has also acted as a conduit for Taiwan investment, most of which is focused primarily in Guangdong and Fujian provinces. Efforts by the government in Taipei to encourage investments in Vietnam and elsewhere in Southeast Asia to avoid overdependence on the Chinese market suggests the importance of China for Taiwanese investors.¹ Similarly, the fact that there has been no real shift of Hong Kong investment away from China since June 1989 suggests that China remains a favorite market for Hong Kong investors.



Although Sino-Thai security relations have been extremely close over the past decade and a half, economic relations have remained insignificant. Thailand accounts for less than one percent of China's total trade, and exports to China account for less than 1.5 percent of Thailand's total. Aside from several investments in agro-industries, Thailand's investments in China are nothing to speak of. Similarly, the most significant Chinese

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investments in Thailand come not from China, but from Taiwan—the fourth-largest investor in Thailand in 1991. Chinese manufacturers do compete with Thai firms for export markets and for direct foreign investment since both countries have an abundance of low-wage labor. Nevertheless, given its growing economic integration into the Asia-Pacific region, China remains important to Thailand for political and security as well as indirect economic reasons.

This article assesses the present status of the Chinese reform process and how it shapes China's role in Asia-Pacific economic cooperation. Since China, Taiwan, and Hong Kong all became full members of the Asia-Pacific Economic Cooperation (APEC) conference at the ministers' meeting in Seoul in November 1991, the durability and progress of China's economic reforms have taken on greater significance for the region. The degree to which economic cooperation in APEC can proceed now depends largely on the extent of reforms in China. As Lardy observed, "further reforms of China's foreign trade regime, as well as related domestic economic reforms, are a prerequisite for making significant progress toward regional economic cooperation."² In discussing China's interests in participating in a regional institutional framework for cooperation, the Beijing-Taipei relationship is also considered for its impact on the viability of the APEC grouping which includes the two adversaries on equal terms.

ECONOMIC POLICY

Although certainly influenced by a shift in the precarious balance between reformers and conservatives within the Communist Party of China (CPC), the retrenchment policies imposed by the Beijing leadership in the latter half of 1988 are hardly an aberration from the cyclical nature of the Chinese economic policies.

Since 1978, China has experienced three reform cycles, in which rapid rates of GDP growth were accompanied by high rates of inflation (see Figure 1). During these periods—1978/79, 1984/85, and 1987/88—reform efforts and the relaxation of credit resulted in surges in investment, growth rates, and imports. Overheating of the economy followed, as China's underdeveloped infrastructure and lack of financial discipline contributed to inflation, resource imbalances, and trade and current account deficits. Each of these three reform cycles forced the Chinese leadership to adopt stringent stabilization measures.

Due to the political dimensions of economic decision-making in China, macroeconomic policy responses to overheating were not—and are still not—prompt. Decentralization of administrative authority has sapped control over the economy from the center and given it to the provinces, which have competing interests. Not only rivalries at the central levels, but also contention for control between Beijing and the provinces, mean that unpopular retrenchment policies have consistently been put off until the situations become serious enough that stability is threatened. This was the case in 1988 when inflation reached 18.5 percent,³ and the central and regional administrative authorities reached a commitment to guarantee that credit expansion would be curtailed, investments slowed, wage demands moderated, and fiscal contracts honored.⁴

The World Bank has estimated that, given severe bottlenecks in such critical subsectors as energy, transportation and industrial raw materials, the highest sustainable rate of national economic growth is somewhere between 6 and 7 percent.⁵ As has been witnessed during the reform cycles, rapid rates of growth above this level have led to overheating and popular dissatisfaction. The perception among the hardline faction of the CPC leadership, thus, has been that reforms and the ambitious goals set by the reformers have overextended the

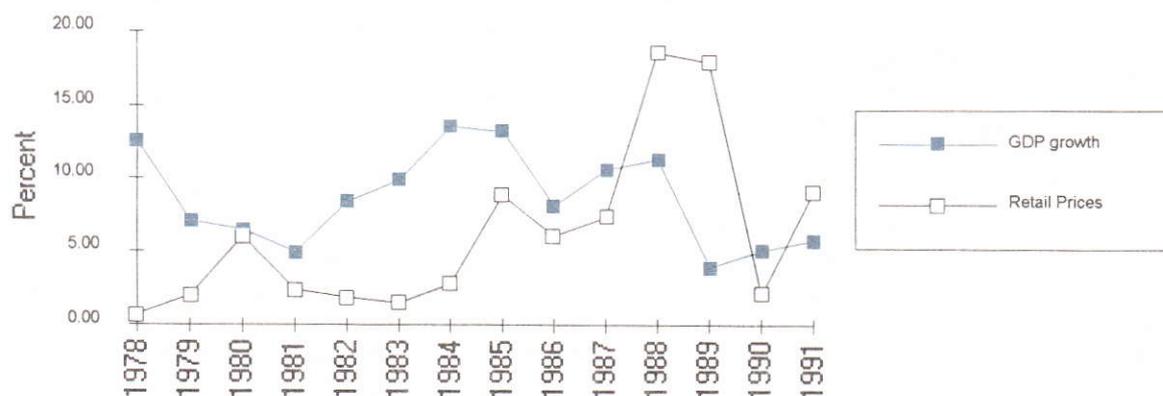


Figure 1 GDP Growth (constant 1980 prices) and Inflation

economy's absorptive capacity. Excessive inflation, in times of economic upswings, has made this faction more wary of the consequences of reforms and has galvanized its reluctance to remove the causes of inflation.

Several factors have contributed to the limited capacity of the Chinese government to stimulate growth without overheating the economy. First, the state of China's physical infrastructure, a manifestation of Mao-era policies emphasizing provincial self-sufficiency, has constrained China's growth potential. The lack of a comprehensive national transportation network has severely limited intra-provincial as well as international trade. Similarly, despite the impressive development of capacity, the country is destined to continue suffering from an undersupply of energy for the near future. China's energy planners have set targets of 7 percent annual rises in electrical output up to 1995. This, however, is unlikely to keep pace with the growth of industrial output which grew by 17 percent during the first quarter of 1992 alone.⁶ While more rational energy prices could help to improve energy efficiency, the state needs to further develop realistic sources of energy.

Second, state enterprises continue to account for over half of China's industrial output, and yet at least 40 percent of these firms are unprofitable. In 1991, the government was forced to spend 31 billion renminbi (US\$5.7 billion) to prop them up.⁷ Despite a bankruptcy law promulgated in 1991, the Communist Party is hesitant to allow state enterprises to fold for fear of social unrest. These firms constitute the only welfare system available in the country and, if they were to close, the destitute unemployed could become disruptive. Thus, instead of forcing state enterprises to be responsible for their losses, the government has allowed firms chronically in the red to continue producing inefficiently with the full knowledge that, as their budget constraints are not hard, they need not be concerned with profitability. The consequence of this situation for the economy is that there is inflation causing excess demand for investment in unproductive projects in the state sector. During times of retrenchment, the dynamic private sector is crowded out as scarce capital is administratively allocated to these state enterprises.

Furthermore, the "double guarantee" system—in which state enterprises receive preferential access to inputs, transportation, and credit in return for guaranteed tax and profit remittances—has exacerbated the situation. Part of the 22 percent increase in domestic lending in 1990 was to cover state firms' remittance obligations to prevent them from losing these privileges.⁸

Finally, decentralization has weakened the central government's control over monetary policy and has also led to competition between provinces. Beijing's ability to instill financial discipline has been drained by provincial influences over local branches of the People's Bank of China and other financial institutions. During expan-

sionary phases of the reform cycle, central bank targets for monetary expansion have repeatedly been exceeded as the individual provinces attempt to outdo each other. As mentioned earlier, the central government's inability to control the provinces has weakened its capacity to carry out macroeconomic adjustment policies in the early stages of inflation, forcing it instead to reach a national party consensus before taking more drastic measures. Similarly, the greater authority delegated to the provincial parties has resulted in local protectionism limiting inter-provincial trade. In 1990, for example, Guangdong officials complained of local officials in Hunan and Guangxi provinces blocking the movement of foodstuffs from their provinces to the higher priced markets in Guangdong.⁹ Such forms of protectionism, as well as provincial industrialization strategies which ignore complementarities with neighboring provinces, have constrained national welfare and economic growth.

STATUS OF ECONOMIC REFORMS

During transitory retrenchment periods, it is relatively easy for the reformist and hardline factions of the CPC to agree on a common cause. Following the crackdown on demonstrators at Tiananmen Square in June 1989, this was even more so the case as opposition to one-party rule forced greater cohesiveness in the CPC. However, given that the "economic rectification" policy has brought inflation back in line and has shifted the current and trade accounts toward surplus, the tide is changing. The reformers are taking greater control over economic policy with the support of Deng Xiaoping.

Since his trip to the Shenzhen and Zhuhai Special Economic Zones (SEZs) in Guangdong province from January 19 to 23, 1992, Deng has thrown his political weight behind accelerated reforms. That he had to resort to the use of the media to get his message across, however, suggests that firm support for reforms did not initially exist within the CPC Politburo and that he had no recourse through official mechanisms. Nevertheless, reformers appear to have gained the upper hand in the Politburo, which issued a statement prior to the National Peoples' Congress (NPC), in line with Deng's SEZ pronouncements. At the national level, time appears to be on the side of the reformers as old age is taking a greater toll on the conservatives than the liberals. The passing away of Long Marchers like Li Xiannian, Deng Yingchao, and Hu Qiaomu, and the ill health of such figures as Vice-President Wang Zhen, 84, and former Beijing mayor Peng Zhen, 90, are weakening the resolve of conservatives in a system reliant on patron-client relations. As a China-based diplomat relates, these elder statesmen—often referred to as "Immortals"—should be viewed "not so much as political actors in their own right, but rather as features of the landscape; giant trees

or thickets that provide cover for the combatants. And, if the landscape gets defoliated in coming months, the fighting could very well heat up."¹⁰

Support for reform from the provincial political figures was also evident at the NPC convened in March, and resulted in a surprisingly exciting meeting in which the delegates pressured Premier Li Peng to backtrack on his annual policy statement. Li's address, given at the opening session was significant more for its omissions than for what was actually said. First, he failed to assert, as the Politburo had already done, that "Left deviationism" is a greater threat to China than that of the Right. If such a statement were made, it could have easily been interpreted as an affirmation of Li's own "mistakes." Second, he promised to "make China a powerful, socialist country standing firm as a rock in the East," but avoided Deng's commitment to "a hundred years" of reform. Finally, he did not endorse the 10 percent growth rate target endorsed by Deng,¹¹ and instead called for a more moderate 6 percent growth per annum. Li's obstinacy caused a stir among the delegates and the national press—known for towing the party line—duly printed their criticisms of the Premier's address.¹²

The reforms espoused at the NPC are extensions of those which took place under former party chief Zhao Ziyang, but are likely to be less radical given the greater influence of the conservatives in economic decision-making. The reforms are characterized by an emphasis on market forces and greater autonomy for local authorities. Differing agendas emerging from the ministries, provinces, and individuals, however, betray a lack of coordination among the reformers.¹³ The result has been an eclectic set of reform measures announced in the first half of 1992. First, price controls on most agricultural commodities, including staple grains, are to be lifted. Second, steps are being taken to make state enterprises responsible for their performance and losses. Given that the budget deficit grew to an estimated 9 billion renminbi (US\$1.6 billion) in 1990, the party leadership finds itself in a catch-22 situation. On the one hand, policies of propping up inefficient state firms are unsustainable, while on the other hand, instability like that seen in the spring of 1989 is sure to surface if these firms are allowed to collapse. The elimination of soft budget constraints is sure to proceed slowly. Third, China's currency, the renminbi, which has been devalued several times since the 21 percent devaluation against the dollar in December 1989,¹⁴ is being brought more in line with the unofficial exchange rate. The further opening of the foreign exchange adjustment centers (FEACs)—also known as swap markets—to sectors within the Chinese economy, which are not already qualified for participation, is one means of achieving the ultimate goal of convertibility. Fourth, local authorities are being offered greater autonomy from the central government as an incentive to attract more foreign investment on their own. Finally, stock exchanges are

receiving the support of the reformers. The success of the experimental bourses in Shenzhen and Shanghai have given life to new stock markets in Guangzhou, Xiamen, and Hainan Island.¹⁵ The nascent exchanges are envisioned not only as a mechanism for privatizing state enterprises, but also as an arena for floating government bonds to help Beijing overcome its reliance on the printing presses and forced savings to finance budget deficits.

The collapse of the Soviet Union and the socialist governments in Eastern Europe has taught the Beijing government a valuable lesson: without economic growth a communist government's political stability cannot be guaranteed. As one regional scholar commented, "In the next decade or so, policy-makers in Beijing will confront an inescapable reality: Support for reforms is rooted in the demonstrable shortcomings of the past economic and political system, the lack of a discernible alternative approach to economic development, and the clear benefit the reform and open policy has brought about. Thus, regardless of any ideological or political objections to its content, the reform program is not likely to be removed from its central place on the Chinese agenda."¹⁶ This was made clear when, at the Fourteenth Party Congress in October 1992, the CPC pronounced its commitment to developing a "socialist market economy." Although the ambiguity of this term leaves much room for interpretation, it is the first time that the term "market" has been etched into official party doctrine and is an indication that the CPC recognizes the irreversibility of economic reform.

REFORM AND FOREIGN ECONOMIC RELATIONS

*China is the greatest investment story in the world right now,...everyone's looking for a piece of the action.*¹⁷

China is beginning to emerge from the pariah status it earned following the June 1989 crackdown on the students assembled at Tiananmen Square. A renewed atmosphere of reform has instilled a sense of cautious optimism among foreigners doing business there. Obstacles to investment continue to exist, however. Time-consuming negotiations, an incomplete legislative framework, a backward infrastructure, and insufficient local sources of finance have all slowed the inflow of FDI. Nevertheless, such advances as the new stock markets, initiation of long-term land leases (up to 70 years in open cities and SEZs), and the Amendment to the Law on Joint Ventures Using Chinese and Foreign Investment have helped to improve the investment environment. The latter allows foreign partners to play a greater role in the management of joint ventures, and protects equity joint ventures from expropriation by the Chinese government.

The pace of reform will undoubtedly affect China's trade and investment relations in the near future and thus dictate its capability of cooperating with other regional economies. Three components of reform are of particular relevance to China's external accounts.

First, although already mentioned, it is worth elaborating further on the relation between the domestic price structure and China's external economic relations and trade. Due to government controls over prices of many raw materials, intermediate inputs, and final goods, domestic prices tend not to reflect costs of production. With such distorted prices, the central government must rely on export subsidies to encourage the sale of overpriced domestic goods in the international market. Similarly, quantitative restrictions are employed to protect the domestic production of goods in which China has a comparative advantage, but are overpriced due to price controls.¹⁸ The Chinese adopted a two-tier price system to introduce market prices to the overall structure. By allowing prices for items outside of the state plan to float, the party provides private entrepreneurs with access to necessary inputs at domestic market prices. This system, however, is fraught with incentives for corruption. Party cadres with access to, and control over, underpriced goods attained through the state supply system have been known to sell these on the open market and pocket the difference. Conservative and reformist party members understand the problems, but disagree over the means of alleviating them. The conservatives believe that the two-tier price system should be eliminated by allowing the central authorities to reclaim greater control over prices. The reformers, however, prefer a gradual reduction in price controls so that eventually a single market-driven price system will emerge. This is one issue, along with the convertibility of the renminbi, which will have to be addressed in the near future if China is to incorporate its economy into the regional community.

Second, while the growth of China's foreign trade corporations (FTCs) has acted as a stimulus to trade under the present system, several problems associated with them have appeared. The FTCs maintain monopolistic control over certain commodities and control trading rights of most goods. Relatively few production enterprises have the right to trade directly with international purchasers; most must use the FTCs as intermediaries. As they frequently are set up at the initiative of the provincial governments and have specific import and export targets to meet, and as the losses incurred meeting these targets are covered by the state, the FTCs are not sensitive to relative prices. Furthermore, because the establishment of new FTCs tends to occur in spurts during periods of decentralization, it has been difficult to find experienced and qualified personnel to staff them. The common reaction of the central government to this weakness, as occurred during the latest retrenchment period, has been to place arbitrary limits on the

growth of FTCs, to recentralize the authority to grant trade rights, and to close new FTCs.¹⁹

Finally, China's trade regime maintains a relatively high degree of protection. Tariffs, which range as high as 200 percent, discourage the import of many needed intermediate goods, leaving the economy with an inherent anti-export bias. A wide range of non-tariff barriers, the most obvious of which is import and export licensing, affect the competitiveness of a significant number of goods not included in the state plan. The impressive turnaround in the trade balance, from a deficit of US\$5.6 billion in 1989 to a surplus of US\$7.5 billion in 1990,²⁰ was not only a result of the belt-tightening policies, but also of greater control over imports and exports.

For China to genuinely participate in economic cooperation in the Asia-Pacific region, its economy must become more transparent. Progress made in rationalizing these three areas—domestic prices, the FTCs, and the management of trade—will be an important determinant of the degree to which the Chinese economy interacts equitably with the regional economies. China's membership in GATT, after all, is not being held up for political reasons. Until the government redresses the effects of its excessive intervention in the economy, questions over the equitable nature of China's economic relations will not subside.

POLICY ON ASIA-PACIFIC ECONOMIC COOPERATION

Beijing's policy toward regional economic cooperation has not been explicitly pronounced in the form of policy statements. Yet, through an examination of China's domestic and international interests, and through reports in publications which act as government mouthpieces, it is possible to speculate about the gains the Chinese expect to receive from their membership in APEC, and possibly from greater cooperation with only the East Asian economies.

Since it is faced with growing protectionism in the EC and the United States—each year China's most favored nation (MFN) trading status must be renewed by Washington and this is becoming increasingly difficult due to human rights abuses in China—there is a necessity for China to diversify its economic interests and to establish market niches in the dynamic Asian economies (DAEs). This partially accounts for the improved economic relations between China and Taiwan, and South Korea.

China's vision for the structure of APEC has its limits. As a *Beijing Review* article asserts, "the actual conditions that exist in the Asia and Pacific region will strongly impede, in the remaining years of this century, the formation of contract-like economic cooperation that is being practiced in Western Europe and North America."²¹ Thus, Beijing's model of economic co-

operation eschews any notion of market sharing in the form of a trade union. Similarly, the supranational characteristics of an economic community are anathema to the Chinese, who consistently find themselves defending their domestic policies against the interference of others. Yet, because they are faced with greater protectionism in the European Community and the United States, the Chinese are more willing to harmonize economic and trade policies provided that the sovereignty of each individual government is not violated.²²

Lardy attributes this apparent desire to be instrumental in shaping the Asia-Pacific economic environment, while remaining ambivalent toward institutionalizing the economic cooperation process further, to several factors.²³ First, China fears that Japan will become the dominant power in any regional cooperation mechanism. Apprehensions, based on Japan's historical aggression in China, have not been alleviated by the ease with which Japanese textbooks have rewritten the atrocities inflicted by the Japanese on the Chinese, nor by the passage of a law legalizing the stationing of peacekeeping troops abroad. While the Japanese represent a significant threat, the Chinese value Japan's role as an important economic leader. By forming a strictly economic forum for economic cooperation, Beijing hopes to reap the benefits of closer economic relations while avoiding any threat to its security and sovereignty.

Second, China has not abandoned the North-South framework of international relations, and believes that the North still has obligations to the South. Economic assistance is welcomed and the structure of regional cooperation should take on a form which can integrate formal equality among its members with the extension of aid and mixed credits—especially from Japan—to its developing economies in the South.

Finally, reforms have not progressed to the extent that the Chinese economy can be more fully opened to the regional market. China remains a socialist, semi-planned economy in which many components of trade are under the influence of the central and provincial governments. Until reforms of China's trade regime and other relevant domestic economic reforms—such as loosening controls over prices—proceed further, the country's trade regime will continue to differ signif-

icantly from those of regional partners, making formal cooperation impossible.

TAIWAN-CHINA RELATIONS AND REGIONAL ECONOMIC COOPERATION

The dynamics of Beijing-Taipei relations is a factor which will inevitably influence APEC and other regional cooperation proceedings. Given that direct shipping, aviation, and communications between the two sides of the straits are restricted, it would be unrealistic to envision comprehensive economic integration within the region. Nevertheless, the mere fact that China, Taiwan, and Hong Kong all became members of APEC at the same time²⁴ at the Seoul summit in November 1991 is indicative of the direction of relations between the two former adversaries, and how they relate to the region.

Although direct trade and investment in China by Taiwan residents have technically been illegal—and thus official statistics are difficult to come by—economic relations between the two have become significantly extensive. China's two-way trade with Hong Kong—the conduit for Taiwan-China trade—grew significantly in the 1980s, from US\$9.4 billion in 1984 to just over US\$44.2 billion in 1990. Similarly, Taiwan's total trade with Hong Kong grew from US\$3 billion to US\$11 billion during the same period. Growth in consumer spending among Hong Kong's 6 million people has certainly not accounted for this growth. Taiwan investment in China has been funnelled through Hong Kong toward Guangdong and Fujian provinces in particular, where the effects have been seen in double-digit growth rates since 1987. In April 1991, when it became legal, more than 2,500 Taiwan companies registered their investments in China, with a declared total value exceeding US\$660 million.²⁵

Taiwan has also become important to other economies in the region. This has especially been the case since the latter half of the 1980s, when various factors—including rising wage rates, a depreciating NT dollar, and large foreign exchange reserves—encouraged the outflow of capital directed mostly toward China and Southeast Asia.

Table 1 Taiwan Foreign Direct Investment in ASEAN

	(Million U.S. dollars)		
Country	1986	1989	1990
Indonesia	18.00	158.00	618.00
Malaysia	4.07	815.00	2,383.00
Philippines	0.35	148.69	140.65
Thailand	70.00	871.00	761.00
Total	92.42	1,992.69	3,902.65

As shown in Table I, approved Taiwan FDI to the ASEAN-4 countries has grown significantly since the mid-1980s. Between 1986 and 1989, Taiwan FDI to the region grew over 20 times from US\$92 million to just under US\$2 billion. In the following year, it doubled to US\$3.9 billion. These investments—made in relatively labor-intensive industries²⁶—have enhanced the relevance of Taiwan to Thailand and its ASEAN neighbors, and have thus made the Taipei-Beijing relationship more of a concern in the region.

The direction of relations between China and Taiwan have indeed been encouraging. The two capitals have floated their own proposals for unification, ranging from Beijing's "one country, two systems" model to Taipei's "one country, two governments" model. While in each case these proposals have been non-starters, the lifting of restrictions and the growing commerce across the straits are integrating the two in a *de facto*, if not *de jure*, manner. In May 1991, President Lee Teng-hui formally lifted the "period of communist rebellion," and declared the state of war with "Red China" to be over. The Taiwan legislature is also considering an omnibus bilateral-relations bill which will officially endorse the relaxation of restrictions on relations with China, and will likely allow the executive greater powers to improve these relations.²⁷

Formal unification, however, is unlikely to be witnessed in this century because the standards of living in China and Taiwan are so divergent that, until China's economy grows significantly, the Chinese in Taiwan will continue to be unwilling to sacrifice their way of life. The handing over of Hong Kong to China in 1997 will also act as a barometer for the Taipei government. Depending on how Beijing treats Hong Kong, and if it permits the soon-to-be former colony to maintain its system of government and market economy for 40 years, as agreed upon in the Basic Law, Taiwan's leadership will proceed accordingly on the issue of national unification. One point of concern for China and for many in Taiwan—as was made evident by the overwhelming electoral victory by the Nationalist Party in the 1992 elections—is the growing pressure from the Taiwanese population for independence. Although Taiwan is a *de facto* sovereign state, both the Beijing and Taipei regimes refuse to recognize it as such. While its means of doing so are in question, the government in China has threatened to use force to invade Taiwan if it declares itself an independent state. This has instilled a sense of caution in the Taiwan government, the result being that such an outcome is unlikely to occur.

Nevertheless, China and Taiwan are learning not only to coexist peacefully, but also to interact within fora such as APEC. Such implicit two-way recognition is further verified by the establishment of diplomatic relations between Taiwan and Grenada in 1991. Because both Taipei and Beijing reject a "two China" policy, if one of the two officially recognizes a third country, the

other automatically severs its ties with the third country. This has been the case for all countries except Grenada. When Taiwan established relations with the Caribbean state, China continued to maintain official ties. Granted Grenada is not a very significant country in the eyes of the Chinese on either side of the straits, yet the significance of this dual recognition should not be overlooked. Taipei and Beijing appear to be developing a *modus operandi*—as is demonstrated by the Grenada recognition and the simultaneous accession to APEC—which will facilitate the contribution of these two important Chinese states to the regional economy.

REGIONAL RELATIONS

While the tenuous relationship between China and Taiwan appears to be improving, the state of Beijing's interaction with other states in the Asia-Pacific region is becoming less certain. Although the end of the Cold War has brought Chinese complicity in resolving the Cambodia conflict, and the establishment of diplomatic ties between Beijing and Hanoi, which was preceded by a rapprochement between China and both Indonesia and Singapore, there are indicators that the relations are not eminently intimate.

The islands in the South China Sea, especially the Spratlys, have become a possible regional flash-point which could embroil China in conflicts with its Southeast Asian neighbors and Taiwan. Conflicting claims to sovereignty over the Spratlys by China, Brunei, Malaysia, the Philippines, Vietnam, and Taiwan have resulted in a standoff which has turned violent in the past. In 1988, the Chinese sank three Vietnamese naval vessels and killed 73 Vietnamese sailors in a clash over the islands. In its official 1983 map, the Chinese government claims to control three million square kilometers of the total 3.5 million square kilometers in the South China Sea. Efforts by the Indonesians to foster a peaceful agreement have had some success by eliciting unofficial assurances from the six players to cooperate. The Vietnamese even claim that they have turned down requests by foreign companies to negotiate oil exploration rights in the Spratly Island because claims to sovereignty have not been resolved.²⁸ Nevertheless, in May 1992, China signed an agreement with a United States company, Crestone Energy Corporation, to explore for oil between the Spratly Islands and Vietnam's southeast coastline. This action—possibly calculated to disrupt the rapprochement between Washington and Hanoi, or to gain territory in the vacuum emerging following the closing of United States bases in the Philippines—has caused a flurry of verbal exchanges, as the remaining five claimants resent China's expansionism.

Two issues are at stake. First, despite most of the islands being uninhabitable, their value derives from the potential of large mineral resources, and oil and gas

deposits laying beneath the surface. It is estimated that there are oil reserves of between 13 billion and 17 billion tonnes in the 310,000 square kilometers surrounding the James Shoal island alone.²⁹ Although Li Peng intimated in August 1990 that China might be willing to pursue joint development of the Spratlys, it appears that the changing strategic situation in Asia has made them more bold in securing their interests. Second, the islands occupy strategic sea lanes from the Indian to the Pacific Ocean. Southeast Asian states wary of Chinese intentions fear that Chinese control over these sea routes would give excessive power to China.

Commercial relations with the United States are of particular concern to China. According to the Jackson-Vanick amendment of the United States trade law, every year Washington must extend China's most favored nations (MFN) trade status, based on China's emigration policy. Until June 1989, the extensions were routine business. Following the crackdown on the demonstrators at Tiananmen Square, however, Democrats in Congress have seized the issue and made the extension of China's MFN status a yearly battle. President George Bush has been adamant about extending MFN to China and has received the necessary support needed in the Senate³⁰ to maintain his vetoes of bills attaching further conditions to the trade relationship.

The new administration under Bill Clinton, however, could be less congenial to Beijing. Although Clinton argues that China should not be isolated – after all, that is nearly impossible – he and the Democratic Congress are willing to place human rights conditions on the United States' trade policy toward China. Whether this means that China will lose its MFN trade status with the United States remains uncertain. The interpretation of whether human rights are being violated in China will rest on the president, who must take into account the additional side-effects of disrupting trade relations between the two economies. First, an estimated 100,000 American jobs will be lost as China retaliates by raising tariffs on American goods, for which there are substitute suppliers. Second, Hong Kong – a center for entrepôt trade between China and the United States – will be significantly hurt. The uncertainty about China's MFN status has already helped to undermine confidence in the colony in the lead-up to its reversion to China in 1997. Third, the dynamic private sector – that section of Chinese society which the United States proclaims it wants to support – will be the hardest hit. Not only will state enterprises receive discriminate support from the Chinese government in light of diminished exports, but the exposure of local entrepreneurs to foreign managers and their expertise will be diminished. Finally, such interference in China's internal affairs will play into the hands of the hardliners, who can use the United States' policy as justification for their xenophobic ambitions. The outcome of this policy debate will clearly have an impact on economic cooperation at the APEC-level.

Finally, China's relationship with ASEAN is of particular concern to Thailand. Singapore's efforts to improve relations between ASEAN and China is being countered by resistance from Indonesia, whose suspicions of China have grown as a result of China's aggressive posturing in the South China Sea. Although trade with China makes up less than 2.5 percent of Thailand's total trade, it would be prudent for Thailand to cautiously encourage a regular dialogue between ASEAN and China, while reassuring Indonesia that its interests are not being ignored.

Thailand's relations with the Peoples' Republic of China have been close since 1975 and the fall of Saigon. Common interests in containing Vietnamese hegemonic aspirations allowed for a marriage of convenience between the two erstwhile adversaries. Although the nascent peace in Cambodia and rapprochement between Bangkok and Hanoi have weakened this common denominator, the relationship remains intact. As Wong warns, however, "... if there should be a fundamental change in the power equation in Indochina, it is not inconceivable that Thailand could change its bets and the resultant Sino-Thai relations would suffer."³¹ Indeed, members of the Thai military are wary of China and its sales of obsolete military equipment to Thailand at "friendship prices." Economic interaction and competition for third markets, however, are taking on greater significance in the Sino-Thai relationship and could become a central component of it. Greater dialogue, not only at the bilateral level, but also at the Asia-Pacific level can help to assure that Thailand gains the most it can from its mutually beneficial relationship with China and its reforming economy.

ENDNOTES

- 1 *Asian Development Report*, 1991, Asian Development Bank, Manila, 1991, p. 56.
- 2 Lardy, Nicholas, "China and Asia-Pacific Economic Cooperation," in John P. Hardt and Young C. Kim, eds., *Economic Cooperation in the Asia-Pacific Region*, Boulder: Westview Press, 1990, p. 105.
- 3 It is worth noting that high rates of inflation are especially worrisome to the Chinese leadership because the hyperinflation experienced during World War II was a major factor contributing to the downfall of the nationalist regime.
- 4 *The World Bank*, 1990, "China: Between Plan and Market," Washington D.C., p. 4.
- 5 *Ibid.*, p. 3.
- 6 Goldstein, Carl, "China's Generation Gap: Massive Power Programme Fails to Match Soaring Demand," *Far Eastern Economic Review* (hereafter *FEER*), June 11, 1992, pp. 45-47.

- ⁷ Tai Ming Cheung, "Pushing the Pendulum: Deng Leads China's Economic Reformers Against Party Diehards," *FEER*, April 9, 1992, p. 47.
- ⁸ *Far Eastern Economic Review 1992 Yearbook*, p. 103.
- ⁹ Goldstein, Carl, "Opening Doors: Southern China Eyes Booming Domestic Markets," *FEER*, April 2, 1992, p. 77.
- ¹⁰ Kaye, Lincoln, "Mortal State," *FEER*, July 2, 1992, p. 17.
- ¹¹ Deng has since toned down his stand by calling for faster growth only in economically strong enterprises and regions—i.e., the coastal provinces.
- ¹² Kaye, Lincoln, "Sitting on the Fence: Premier's NPC Speech Plays Down Reforms," *FEER*, April 2, 1992, p. 13.
- ¹³ Tai op. cit., April 9, 1992, pp. 46-47.
- ¹⁴ The value of the Renminbi weakened from Rmb. 3.72 = \$1 to Rmb. 4.72 = \$1. Today the currency is worth Rmb. 5.4 = \$1.
- ¹⁵ Tai, op. cit., April 9, 1992, pp. 46-47.
- ¹⁶ Wang Jisi, "China in a Changed Global Environment," Kuala Lumpur: Institute of Strategic and International Studies (ISIS), 1990, p. 16.
- ¹⁷ Statement made by Gary Coull, managing director of Credit Lyonnais Securities in Hong Kong. Cited in Friedland, Jonathan, "Bulls in a China Shop: Fund Managers Cash in on Market Opening," *FEER*, April 9, 1992, p. 47.
- ¹⁸ Lardy, op. cit., 1990, p. 106.
- ¹⁹ *World Bank*, op. cit., 1990, pp. 84-85.
- ²⁰ The value of imports dropped by 11 percent in nominal terms during this period, while exports grew by 18 percent. See *Asian Development Report 1991*, Asian Development Bank, Manila, 1991, p. 54.
- ²¹ *Beijing Review*, March 20-26, 1989, pp. 15-17. Cited in Lardy, op. cit., 1990, p. 104.
- ²² Shen Guijin, "Trends and Proposals with Regard to China's Policy Toward Pacific Economic Cooperation," *Social Science*, Shanghai, 1987, No. 10, pp. 12-15, reprinted in *Shijie Jingji* (World Economy), 1987, No. 12, pp. 57-60. Cited in Lardy, op. cit., 1990, pp. 103-104.
- ²³ See Lardy, op. cit., 1990, pp. 104-105.
- ²⁴ To overcome the deadlock over who should join first—Beijing was unwilling to accede to APEC simultaneously with Taipei because this would account to a de facto recognition of "two Chinas"—it was agreed that China would actually sign the accession documents just before Taiwan.
- ²⁵ *Far Eastern Economic Review 1992 Yearbook*, p. 204. Aside from twice as many projects being registered than had been predicted, what surprised economic ministry officials was the fact that most of the projects were located in Guangdong province, rather than in Fujian—which is culturally and physically closer to Taiwan.
- ²⁶ See Lin, Richard C., "The Current Situation of Taiwan Investment in ASEAN," a paper presented at the Taiwan-Thailand Investment Seminar, Taipei, 1991.
- ²⁷ Baum, Julian, "Good Neighbors: Taipei Overcomes Another Barrier to Mainland Ties," *FEER*, April 23, 1992, pp. 32-33.
- ²⁸ Callo, Kathleen, "Hanoi Disputes Beijing's Islands Claim," *The Nation*, July 3, 1992.
- ²⁹ *The Nation*, November 5, 1991, p. A8.
- ³⁰ As an adequate number of senators have been behind the president on his China policy, Republicans in the House of Representatives have voted for trade sanctions—politically most expedient—knowing that they would not get by the Senate after being vetoed.
- ³¹ Wong, John, "An Overview of ASEAN-China Economic Relations," in Chia Siow-Yue and Cheng Bifan, eds., *ASEAN-China Economic Relations: Trends and Patterns*, Singapore: Institute of Southeast Asian Studies and Institute of World Economics and Politics, 1987, p. 7.

Women's Status in Transitional Societies

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It is widely held that the Thai economy's high growth rate is propelled by the manufacturing sector. Manufacturing value added at 1972 prices almost tripled between 1970 and 1980, and more than doubled between 1980 and 1990. The share of manufacturing value added in Gross Domestic Product (GDP) rose from 16 percent in 1970 to 21.7 percent in 1980, and 24.7 percent in 1990. Manufactured exports exceeded agricultural exports for the first time in 1985, and in 1991 accounted for 76 percent of total export earnings.

In a society characterized by rapid growth, one of the more relevant questions is how growth affects the welfare of different social groups. Women are often thought to belong to a disadvantaged group. This paper traces Thai women's participation in the work force and the change in their economic and social status during the last two decades.



Highly-competent Thai women make computer hard disks in a "clean room." The slightest trace of dust would ruin their product, now highly-successful and competitive on the international market.

ENTRY INTO THE WORK FORCE¹

Until 1980, Thailand was a land-abundant country, with land-man ratios actually increasing in the lower North. The commodity boom of the mid-1970s further provided incentives for land expansion. Agriculture was then the largest source of labor for both men and women. Increases in irrigated areas throughout the 1970s further fuelled the demand for agricultural labor.

In 1974, apart from agriculture, the female work force was largely absorbed during the wet season in the commerce sector, followed by manufacturing and services. The pattern of male employment was slightly different. After agriculture, men tended to hold jobs in the service and manufacturing sectors.

As the supply of land became scarce, women were the first group of household laborers released from agriculture. Between 1983 and 1988, there was a net withdrawal of female workers from the agricultural sector, even in the wet season. The easing of labor supply rendered labor-intensive manufacturing a profitable proposition. The manufacturing industries of Thailand, fostered by the protection of domestic markets since 1960, thus began to take off and became export-driven in the 1980s. Along with the structural changes outlined above, women were extensively drawn from home-based employment to outside employment.

Toward the end of the 1980s, the commerce sector remained the largest employment generator for the female work force, while the manufacturing sector emerged as an important employment source for incremental female labor. The number of incremental females joining the manufacturing work force in the wet season actually exceeded, in numbers, the incremental male labor (see Figure 1). The entry of incremental labor into manufacturing in the wet season suggests that employment in the manufacturing sector has become a

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¹ This section draws heavily from Siamwalla (1991).

Table 1 Income Status of Thai Women (1976-1988)

	Proportion of Women's Cash Income (%)	Proportion of Income in Kind (%)	Average ^{1/} Income of Women (baht/month)	Women in Total Household Workforce (%)	No. of Samples
North					
1976	22	37	904.1	52	2,334
1988	31	25	1,005.3	54	2,322
Northeast					
1976	19	46	605.7	52	3,143
1988	29	24	850.4	54	2,518
Center					
1976	27	26	960.2	54	2,150
1988	36	19	1,221.6	55	2,239
South					
1976	23	27	797.0	53	1,410
1988	29	19	1,067.8	53	1,711
Greater Bangkok					
1976	28	15	1,649.6	52	2,294
1988	38	15	2,508.6	54	2,231
Whole Kingdom					
1976	24	32	984.7	53	11,331
1988	33	21	1,329.6	54	11,021

Source: Kaosa-ard and Pholdee 1992 (Table 7).

Note: ^{1/} Adjusted by CPI (1986 = 100).

year-round activity for women. Figures 2 and 3 clearly show the convergence in both the farm and the non-farm sectors. Since the mid 1980s, rural women have become permanent members of the industrial work force.

This large pool of young, trainable, and obedient workers has become the backbone of light export industries, bringing unprecedented growth to the manufacturing sector.

CHANGES IN FEMALE ECONOMIC CONTRIBUTIONS

Consistent with the increased participation in the work force, the income contributions of women have also improved over time. Table 1 is compiled on the basis of data from Household Socioeconomic Surveys of 1976 (11,362 samples) and 1988 (11,045 samples). Both show that the contribution of women to household cash income increased between 1976 and 1988 in all regions. The increase is most apparent in the Greater Bangkok area. During this period, the shares of women's cash income increased from 0.24 in 1976 to 0.32 in 1988 for the whole Kingdom. For the North, the shares were 0.22 in 1976 and 0.30 in 1988. The same set of data (Table 2)

also shows that the largest source of women's cash income used to be in profits (47%), reflecting a high level of women's participation in commerce, shifting to income from wages and salaries (60%) in 1988. The reduction of the importance of "other" income could be a result of the expansion of the formal financial sector which, in turn, reduced interest-earning opportunities.

Table 2 Source of Women's Income in Percentages, 1976-1988

Source of Income	1976		1988	
	Female	Male	Female	Male
Wages	38.5	32.4	60.0	51.5
Profits	47.2	61.1	38.3	47.0
Other	14.3	6.5	1.6	1.5
Total	100.0	100.0	100.0	100.0

Source: Kaosa-ard and Pholdee 1992 (Table 8).

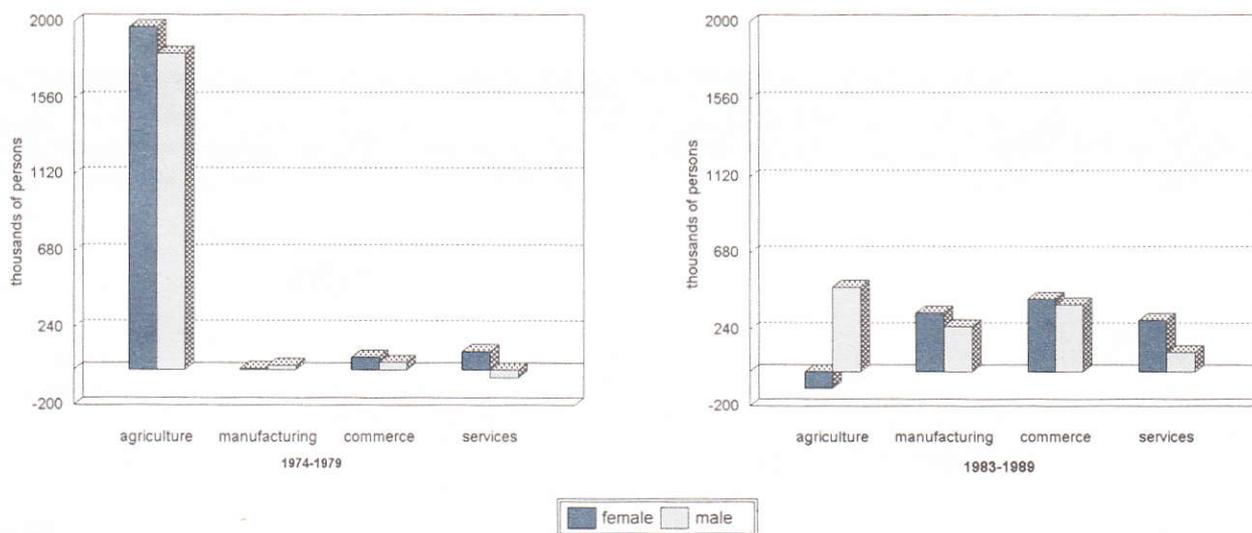


Figure 1 Incremental Labor in the Wet Season

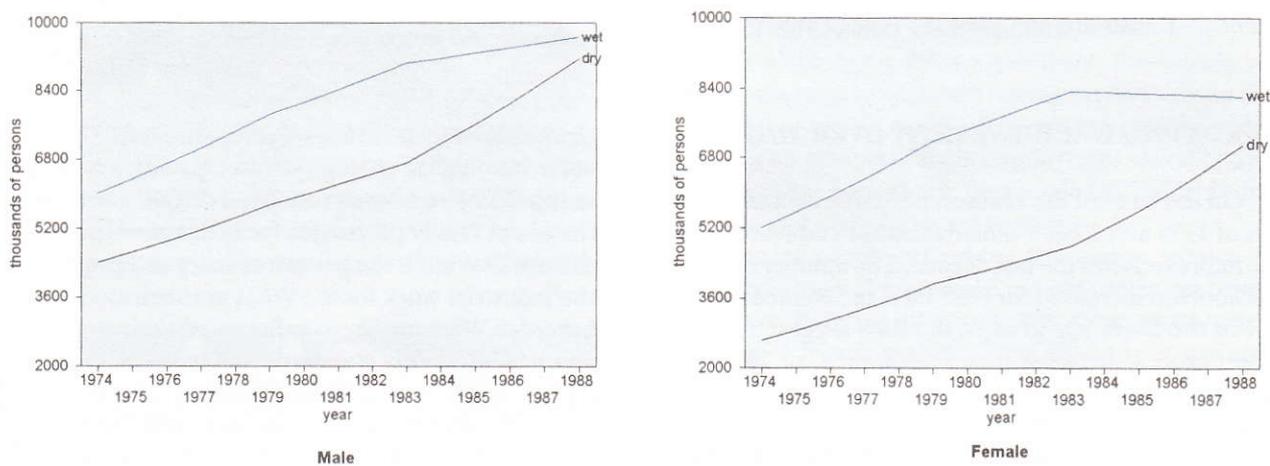


Figure 2 Trends in Workforce Gap Between the Dry and Wet Seasons in the Agriculture Sector

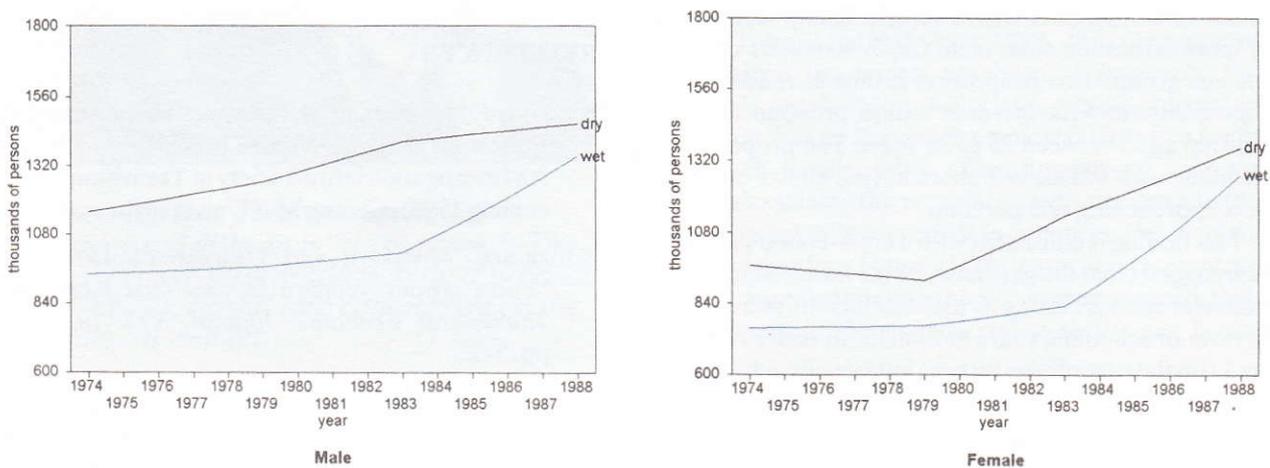


Figure 3 Trends in Workforce Gap Between the Dry and Wet Seasons in the Manufacturing Sector

Table 3 Years of Education, Classified by Age Group and Gender (1976-1988)

Age Group	Years in School		Number of Samples		Proportion of Families with Higher Education for Females
	Female	Male	Female	Male	
Less than 25					
1976	7.38	7.71	1,562	1,827	0.86
1988	8.75	8.91	1,077	1,171	0.92
25-35 years					
1976	8.53	9.31	191	503	0.38
1988	10.96	10.74	325	519	0.63
36-50 years					
1976	5.45	7.46	187	489	0.38
1988	8.98	10.19	146	438	0.33
More than 50 years					
1976	4.87	8.10	44	193	0.23
1988	5.63	7.71	89	302	0.30

Source: Kaosa-ard and Pholdee 1992 (Table 1).

EDUCATIONAL ACHIEVEMENT OVER TIME

On the basis of the Household Socioeconomic Surveys of 1976 and 1988, women's access to education has also improved over the last decade. The number of years in school has increased for both men and women (Table 3). For the lower age groups, the data suggest a catching-up process between men and women. In 1976, for example, household members between 25 and 35 years of age were reported to have a maximum education of 8.5 years for females and 9.3 years for males. In 1988, these figures increased to 10.9 and 10.7 years, respectively. The catching-up process is found in all age groups and is especially pronounced in the younger generation. The last column in Table 3 was derived by comparing the number of households where female family members had more education than male family members of the same age group. This proportion is thus increasing for all age groups and the increase is most pronounced for the group aged between 25 to 35 years. The proportion of families with female members having higher education is approaching one percent.

This finding is consistent with a cross-country study, which suggests that the gap between the male and female enrollment ratio is closing as national income increases. The ratio of schooling years of females to males ranges from 1.0 in the case of high income industrially-advanced countries to 0.83 for East Asia, excluding Japan, and 0.45 for South Asia (Schultz 1990).

While the macro and long-term data both show the improving status of Thai women, many questions are still unanswered. Why do Thai women, for example, have a

significant role in services and commerce? Do women enter into higher paying or lower paying jobs in these industries? Are women restricted de facto or de jure to the use of family properties for investment in non-farm activities? What is the pattern of entry and promotion in the industrial work force? What are their occupational hazards? What are the conditions of their work places and how are safety standards? How is the social bond that protects women in rural societies broken by city migration and how is the social status of women changed as they enter their new roles? Systematic research into these problems would greatly facilitate a more logical and balanced approach to the further development of women in Thai society.

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Public Services in Thailand: The Role of Information Technology

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Information technology (IT) is rapidly gaining the center stage for future world economic growth and development. IT has become of strategic importance to the services industry, which is predominantly associated with information or knowledge-based activities. It has also enabled an increase in productivity and enhanced product quality in the manufacturing industry. IT has also been instrumental in integrating the previously distinct domains of manufacturing and service activities. As the trend of customized production gains momentum, therefore, the relative cost share of material processing per unit of output will decline, whereas the share of gathering information for R&D, design, marketing, transport, and delivery of goods and services will grow. Modern economies are thus shifting steadily toward service economies.

While IT is gaining prominence as an engine for economic growth, it also promises to have far reaching potential for the delivery of social services, enhancing the effectiveness of government administration, and generally raising the quality of life for mankind.

In government, IT can be used to improve various key areas of public-sector management and policy formulation in tune with ever quickening changing macro-economic and social conditions. This will enhance the convenience to citizens in obtaining public services. At the same time, its misuse can easily violate personal privacy.

In education and training, IT can improve education management, provide novel approaches to learning and training, and become an effective tool to realize education for all.

In public health, IT will continue to play a considerable role in raising the standards of public health services delivery, with current applications ranging from collec-

tion and statistical analysis of data for health and family planning indicators, epidemiology, demographic and medical research to information systems for health care delivery management, such as maintaining patients' records and pharmacy logistics control.

In the future, advances in IT will enhance the efficiency of current applications, spreading the benefits to a wider section of the population, and will also open up many more novel applications for improving the quality of life of mankind. IT is likely to revolutionize the way one lives and works, with a host of new service concepts such as tele-working, tele-education, tele-banking, tele-health care, and tele-entertainment, some of which are already taking place to the greater benefit of consumers.

This paper will share some experiences with regard to the role of IT in the provision of public services in Thailand, and serve as a platform for further discussions in the three important areas of public administration, education, and health care.

TELECOMMUNICATIONS FOR ALL: THE BASIC LINKS

Most social and economic development activities require services from infrastructural networks in transport, power, water, and telecommunications; the latter is also important, but less well understood. Many thinkers and researchers, such as Pool, Parker, Webber, Hudson and others (Saunders, 1983), contend that while commerce is about the communication of information among parties concerned, telecommunications is a prime means to achieve social and development goals, including the supply of education, health care and other social functions, and hence is a basic link to a better

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quality of living for all. While land, sea and air transport has lowered location barriers, it is the advances brought about by IT or the convergence of computers and telecommunications that have made location, time and distance almost irrelevant.

As in most developing countries in the world, Thailand has placed emphasis on developing transport, power, and water infrastructure networks during the past 30 years of national development. It is only recently that greater emphasis has been targeted to improving the country's much underdeveloped telecommunications network. Even so, priority in telecommunications investment has mostly been dictated by direct benefits in revenues. At present, the distribution of telephones in Thailand is highly concentrated in and around Bangkok and a few other regional centers. According to the 1990 census, 38 percent of private households in the Bangkok Metropolis had telephones, while the relatively well-off central region averaged 7.2 percent, and the poor northeast a mere 2.6 percent. As shown in Table 1, statistics from the Telephone Organization of Thailand (TOT) for 1991 revealed that the number of telephones per 100 population nationwide stood at 2.88, of which the figure for the metropolitan area was 14.45 and the provincial area 1.03, with a waiting list of more than 1.3 million applicants.

The current projects to add three million telephone lines, two million in the metropolis and one million in provincial areas, are a clear example of how important the country views the need for better telecommunications. Many value-added services, such as cellular telephones, paging and data communication networks, have been given to private-sector operators under concessions from state agencies. A number of other major projects are well under way or being planned. They include ISDN services, a teleport to complement the Eastern Seaboard Development, an optical fibre network along railway routes, and the launching of a Thai communications satellite.

Almost all of these projects and plans, however, will primarily benefit the Bangkok Metropolis and to a lesser extent provincial cities and district towns. There has been little focus or discussion of the role of telecommunications in promoting the development of rural areas. Of over 60,000 villages within some 5,300 tambons (sub-districts), only 1,813 tambons and about 3,000 villages have access to public telephone services. Over the next five years, a further 4,500 locations, covering the remaining 3,500 tambons, will be provided with public telephone services. The remaining villages, numbering more than 50,000, will have to wait until 2001, according to the Ministry of Transport and Communication's Ten-year Master Plan. The Plan specifies that public telephone services should penetrate nationwide, raising availability from 0.05 per 100 population in 1991 to 0.86 per 100 population in 1996. In contrast, at the end of South Korea's 10-year rural telephone network modernization

program (1978-1987), all villages with more than 10 households (some 24,111 villages in total) and all 491 islands with more than 50 inhabitants each were connected to the nation's automated direct dialing telephone network. In so doing, South Korea achieved a more balanced social development and a more equitable distribution of economic activities and income (Jun, 1991).

With recent advances in satellite technology, it is now both economically feasible and justifiable to provide the benefits of telecommunications to a wider segment of society—even if they are small and remote villages or difficult to reach mountain communities (Hudson, 1990)—because of certain technical and economic advantages of communication satellites. One advantage is the ability to provide reliable telephone and data communications between two points anywhere in the world, irrespective of intervening oceans or terrain. Also, low cost satellite earth stations have been developed that can be installed wherever needed, on customer premises, in isolated and remote villages, at disaster sites, or even on trucks and ships. Another advantage is that satellite communications are cost-insensitive to distance, unlike land-based communications technologies. In addition, communications satellites are particularly appropriate for such broadcasting services as current and financial news, weather reports, and so on.

In the future, optical fiber systems are destined to replace copper cable in existing telecommunications networks and become the backbone for the very heavy traffic routes of future telecommunications networks around the world, while satellite systems are clearly cost-effective solutions for international telecommunications services in developing countries (Saunders, 1983). Satellite communications have also been used by some developing countries, such as Indonesia, to extend domestic service to otherwise inaccessible locations. Also, the wide broadcasting ability of a satellite makes it a cost-effective means to deliver education to all, whether formal curricula from primary to university education, or non-formal and continuing education programs.

It can only be hoped that, by 1994, after the launch of the first Thai communications satellite, the government will make serious efforts in using it to extend basic telephone services, as well as to broadcast useful information services, and not just entertainment programs, to all parts of the country.

Finally, although the country so far has clearly demonstrated its resolve to improve communications and seems well on its way to building up a much needed modern telecommunications infrastructure—albeit aimed primarily at the economic sector residing mainly within the Bangkok Metropolis and a number of regional centers—plans or intentions for other equally if not more important and pressing requirements are, however, unclear at present. Notable is the severe shortage

of IT and a wide range of other technical professionals that threaten to place a serious constraint on the country's ability to reach its economic and social development goals.

INFORMATION TECHNOLOGY AND PUBLIC SERVICES

An Overview

Government, at one time the leader in the use of IT, has now been outpaced by the private sector and the gap is likely to widen further. Leading firms, particularly within the services and financial sectors of the economy and some of the larger industrial firms, have been investing substantially in IT to improve productivity and to enhance or maintain comparative advantages over rival firms. In contrast, only a few large public agencies have come close to the forefront in exploiting available state-of-the-art technologies in IT. Moreover, the nation's overall growth in IT investment seems unsatisfactorily low, compared with its outstanding economic growth performance throughout the past decade. For example, based on a sample of 13 leading private firms and 16 public sector organizations, about every three employees share one telephone line in the sample firms, and eight share one in the public organizations. This compares to the national average of 40 persons per telephone. Similarly the number of employees per one personal computer (PC) in 1988 was about four for the sample firms and 40 for the public organizations, compared to over 300 persons nationwide (TDRI, 1992).

Public Administration

There are instances where the potential of IT have been or could well be exploited in public services provision. Foremost among these is the example of the Central Population Database (CPD), a project which began in 1983 and is currently being undertaken by the Local Administration Department (LAD) of the Ministry of Interior. The project gained wide recognition recently when it won the 1990 Computerworld Smithsonian Award in Washington, D.C., as "the world's first population database" and "for the transformation of IT to the benefit of mankind." By 2006, CPD mainframe computers will be linked to some 12,000 terminals across the country, providing instant access to files on an estimated 67 million people for such personal data as details of immediate family members, names of all people who share the same family name, records of marriages and divorces, details of adopted children or persons under custody, records of firearms in possession, and details of eligible voters, among others. The CPD system will also be linked to databases maintained by the Policy Department for Criminal Records, the Finance Ministry's Revenue Department, the Foreign Ministry's Passport Divi-

sion, the Interior Ministry's Land Department, and the Land Transport Department's Driver Licensing Division.

Ultimately, the system when completed will be able to identify any citizen, anywhere, through his or her fingerprints and will give instantaneous information on whether a person is legally eligible to, for example, buy a piece of land or to register for marriage. It will drastically cut the time it takes for a Thai to get a citizen's ID card from about two months to only 15 minutes at any local administration office nationwide. Household registration will also be easier, as people who move from one house to another can register their new addresses with local offices in their new neighborhoods, without having to return to their former local offices to have the old registration deleted as they do now.

In principle, the system should maintain accurate demographic information and statistics useful for population control, voter registration, and other social and economic planning.

While the director of the CPD claims that the nationwide computerized information system is for the protection of Thai citizen's rights, many local and international human rights groups have strongly expressed concern over possible abuse of personal information and invasion of privacy, and over the possibility that the information could be abused for political purposes (Tunsarawuth, 1991). Such key questions as "Who, and to what extent, has the authority to access this information?" and "What safeguards are there to ensure the integrity of the information and to prevent abuse of authority?" need to be raised and openly debated by the public.

Nonetheless, it is hoped that public service agencies, dealing with less controversial areas of information, will at least be prompted by the current CPD effort to begin to seriously examine their own information systems and how best to exploit the benefits of IT to enhance productivity and improve public services. Currently, public information is scarce, outdated, or inaccurate either for the agencies own or for public consumption. Available information is often difficult for the public to access; and frequently the public simply does not know to whom to turn for the information needed. One rural development non-government organization (NGO), for example, has complained about the great difficulty it faces in obtaining information needed to carry out work to improve the living conditions of the country's poorest northeastern villagers.

Another good example of the use of IT lies with the employment of satellite technology in remote sensing for land title surveys and mapping. Through a 200 million baht grant from the Australian Government in 1985, the Land Department is aiming to complete, by the year 2000, the task of issuing land titles to all rightful owners and to build up a "Land Information System" database that will give details of current land prices throughout

Table 1 Selected Telephone Statistics of Thailand

	1986	1987	1988	1989	1990	1991
Investment (million baht)	5,799	3,355	6,098	8,042	9,802	10,664
Line Capacity Increase ('000)	177	244	134	108	192	184
Main Telephone Stations/ 100 population	1.54	1.67	1.84	2.09	2.41	2.88
- Bangkok Metropolitan	7.69	8.20	9.14	10.39	12.11	14.45
- Provincial	0.56	0.62	0.68	0.76	0.90	1.08
Public Telephones/ 1,000 population	0.34	0.37	0.38	0.39	0.40	0.46
- Bangkok Metropolitan	1.86	1.92	1.94	1.91	1.93	2.14
- Provincial	0.10	0.12	0.13	0.14	0.16	0.20

Source: Telephone Organization of Thailand, Telephone Statistical Reports 1991.

the nation. Satellite remote sensing is also being employed in numerous other applications. Data from three satellites—Landsat 5, SPOT, and MOS 1—currently provide information on soils, climate, land use, forest reserves, vegetation mapping, water resources, and other natural resources. As a result, Thailand realized that on-going deforestation would be unsustainable, prompting the Royal Forestry Department to first implement a reforestation program and later, in 1989, a total ban on logging following the flood disaster in the south.

Education

Currently, the Ministry of Education relies on TOT's microwave communications networks to relay up to 56 hours per week of educational programs to its 11 regional radio network stations. The Ministry claims that its radio educational program is gaining in popularity over its other two programs of self-study and attending evening classes.

While the Ministry of Education uses radio broadcasting networks to provide up to secondary-level

Table 2 Example of the Impact of Information Technology on Public Services

Specific Technology	Implications
• Satellite Remote Sensing	<ul style="list-style-type: none"> • Optimal use of natural resources • Early disaster warning • Mineral survey and oil exploration • Land title survey and mapping
• Telecommunications	<ul style="list-style-type: none"> • Improved disease surveillance and epidemic control • Rural/remote region development • Speedy/efficient logistics in case of disaster • Improved market efficiency • Combat traffic congestion and pollution
• Distance education	<ul style="list-style-type: none"> • Means to education for all • Highly cost-effective
• Computer-Aided Instruction	<ul style="list-style-type: none"> • Making learning more interesting and easier • Learning possible at individual pace, time, and place
• Tele-nursing/Treatment	<ul style="list-style-type: none"> • Remote monitoring of the aged/sick • Timely emergency help • Sharing of expertise remotely between renowned physicians and surgeons

education, two open universities use both radio and television broadcasting to deliver selected undergraduate courses, as well as general adult education on a much smaller scale. Ramkhamhaeng University uses a radio network of 38 AM/FM stations and the state television Channel 11 to provide lessons for selected subjects with large enrollments.

Ramkhamhaeng University, the larger of the country's two open universities, is also using IT extensively to cope with the administration of student enrollments, now in excess of 300,000. Apart from using computers to develop and provide computer-aided instruction (CAI) packages, the university has fully computerized its registration, examination, and library services. With an ID card, a student can obtain such information and services as registration, examination timetables, examination results or grades, and library and campus news from the five terminals currently on campus. In addition, the university has developed a voice-response system so that students outside the campus can access the same information via telephone. The university is also in the process of negotiating with one or more participating banks to offer tele-registration by telephone.

The other open university, Sukothai Thammathirat Open University (STOU), is making greater use of distance education for teaching at the certificate and Bachelor degree levels. Apart from mailing texts, exercises, audio tapes and pictures, radio and television programs are broadcast for most subjects. The STOU plans to establish one-way video and two-way audio classes at a number of Education Service Centers throughout the country in the near future.

A nationwide cable and wireless information infrastructure firmly in place would not by itself be sufficient to ensure good education for all. The country has to tackle the other major bottleneck, that of manpower and the expert skills required to produce educational materials (or software) for electronic delivery on demand to the home, workplace, or school. It has been estimated that the preparation of programmed educational material is perhaps two orders of magnitude as involved as the more conventional method of teaching in front of a class. It takes up to 100 hours to prepare an hour of software instructional material; and it requires special skills, not merely knowledge, to prepare quality software. Most of all, acceptance of this concept by the education administration and the public is the first and very important step.

A nationwide information infrastructure by the year 2001 would lay the basic infrastructure for new and exciting opportunities in education. The current development of multimedia technology, interactively incorporating computer, communications, video, HDTV (high-definition TV) and other man-machine interfacing technologies, offers varying computer-assisted instruction

options, suitable to particular learning needs—individually and at a time, place, and pace chosen by the student. Advancements within IT also offer novel means to interactively present and demonstrate hard-to-grasp concepts and theories through a combination of simulations, text, graphics, diagrams, and audio and video presentation.

Health Care

In providing health-care services to over 56 million Thais, IT can play a vital role in improving the efficiency and effectiveness of delivery. Often the ability to obtain and provide prompt and accurate information can well be a matter of life and death, as with epidemics and other medical emergencies. Thus, both computers and telecommunications are imperative.

The use of IT in Thai health services, however, has been rather minimal, although the Ministry of Health is doing its best to make use of its very limited IT capabilities. Currently, the Ministry's computer system consists of two low-capacity low-speed minicomputers (installed since 1983), one super-microcomputer, two LANs, and a small number of workstations and PCs. One minicomputer is dedicated basically to the processing and statistical analysis of up to two million records a year of raw data on epidemiology, generating output reports on a weekly basis. The other serves essentially as a decision-support system, providing vital analytical and information support for planning and health-care delivery management, which includes, among other things, weekly reports that track the status of some 40 diseases, including AIDS, where details of patients, time, and location are fully documented. The super-microcomputer is used for training Ministry staff.

The Ministry submitted a computerization master plan to the government last year, for implementation in 1992, in an effort to reap the benefits of computer networking throughout the country. The plan will link, in stages, provincial health administrative offices and major hospitals to the Ministry's host computer by the year 1996, in an effort to raise the standards of public health services and significantly contribute to the Ministry's goal of achieving "Good Health Care for All by the Year 2000."

In the future, one can expect to see new ways of bringing health care directly to the homes of the aged, of the handicapped, and to other patients. Through remote monitoring of attached sensors, patients can go about their daily routines or rest at home, while being constantly monitored. Thus, they will be able to receive immediate attention and aid when necessary. In emergencies, two-way voice and video communications can provide, on a case-by-case basis, step-by-step instructions while awaiting the arrival of ambulances or health officers. A nationwide information infrastructure can be

an effective vehicle to raise public awareness and knowledge of preventive health care, provide step-by-step first aid, or rescue the injured. It can also be effectively used in distant-learning programs to upgrade the skills of and provide up-to-date knowledge to rural health workers, nurses, and physicians. For instance, a U.S. company has developed a courseware based on personal computers, robotic sensors, and video disc that teaches doctors how to perform orthoscopic surgery on joints. With video-conferencing, expert surgeons can assist counterparts at rural or remote hospitals in performing difficult operations remotely from their own hospitals. These and many other possibilities are just part of the future scenario of medical and public health services attainable through IT to help "Good Health Care for All by the Year 2000" become a reality.

GETTING FROM HERE TO THERE

The scenarios depicted are not impossibly futuristic. With a few exceptions, the technology is already available. In the exceptional instances, it will be available within the century.

On the cost side, a major component will be the modernization and, above all, the expansion of the current communications system in Thailand. This is where a major commitment of resources will have to take place. Current plans for the massive expansion of the telephone network will merely make up for the backlog of demand for voice telephones. It appears that the government has become exhausted by the effort that went into launching this expansion plan, and into resolving some of the controversies that surrounded it. However, given the rapid pace of technological change and the growth in demand, another period of expansion should fall due within the next few years, and the government should ensure that it does not allow another backlog to develop. Given the

expected high return from such an investment, it is not expected that there will be any financial constraints to the needed expansion.

The central bottleneck lies with the human resources needed for the technology to yield fruit. IT is not completely "footloose" — the hardware may be, but not the software. There is need for adaptive development on the software side. Currently, there is a severe shortage of technical personnel to implement the new technology.

Overriding these problems is an inadequate understanding among policy-makers of the new technology and the benefits that it can bring. A better understanding is needed so that resources can be more adequately committed to upgrading the communications system and to developing the human resources necessary to utilize the new technology.

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GPS and GIS: From Forests to Factories

Paul Hastings*

The single largest factor affecting the success or failure of a Geographic Information Systems (GIS) project is usually data – without it a GIS cannot but fail to meet its intended objectives. In most professional GIS agencies, data capture and quality control are tasks with high institutional priorities. Great expenses are incurred in equipment and staffing to provide high-quality data. In TDRI's case, on average, almost 70 percent of project time and budget is usually devoted to data-gathering tasks. It is, therefore, not surprising to find many GIS agencies in a constant search for ways to improve data-capture efficiency and quality.

Many GIS organizations devote much of their data-capture efforts to the automation of existing map manuscripts. Often, however, new, previously unmapped information must be gathered, or out-of-date maps updated. In many line agencies, this gathering of new data is routine. The Department of Land Development's (DLD) land use maps, for example, are updated periodically, according to priorities and budgets. Other agencies, such as TDRI, must rely on outsiders to provide this service – with sometimes questionable results.

GIS users looking for solutions to their data problems usually look to the heavens for answers – remote sensing techniques of one form or another. Remote sensing, in theory, allows the gathering of spatial data over large areas at a reasonable cost. Experience, however, conflicts with this theory – data supply queues are long, clouds often obscure the earth's surface at critical times, image interpretation is still more of an art than a science, precision geocoding is difficult and time consuming, actual production surveying costs are high, and important attributes of many spatial objects are undetectable using remote sensing techniques. Remote sensing techniques, despite practical difficulties, are still appropriate solutions in many, but not all, situations. In searching for an adjunct or replacement for remote sensing, people still look skyward, but they are now turning towards NAVSTAR satellites and Global Position System (GPS) technology.¹

GPS, often called the *survey technology of the nineties*, is a military-developed system. In its final form it will consist of 24 orbiting satellites and three spares, that can deliver accurate navigation information to anyone possessing a GPS receiver anywhere on the surface of the earth. It is a passive receiver system – the information flow is one-way, from satellite to receiver. There are, therefore, no fees associated with receiving the GPS signals. The GPS consists of three elements:

Space segment which, at the moment, consists of about 16 satellites, or space vehicles (SVs), orbiting the planet at an altitude of 19,600 kilometers. Each of these SVs contains highly-accurate atomic clocks (one second in every 30,000 to 300,000 years). Each satellite continuously broadcasts its exact time of transmission.

Ground segment consists of user-operated receivers. Once a receiver picks up a NAVSTAR time broadcast, it can calculate its distance to the transmitting satellite, based on the delay in the radio signals. The signals are time stamped by the satellite and the receiver can simply calculate the distance light would have had to travel since that time. Once time signals have been received from three or four SVs, the receiver can calculate its position, based on the orbital information of each SV.

Control segment is the final component of the GPS. This is operated by the U.S. military and includes a master clock in Colorado, with which all SVs clocks are synchronized. Each satellite's orbit is observed and that data is passed up to the SV, which in turn broadcasts it back to the ground segment.

This paper presents a brief look at how TDRI uses GPS technology in its GIS work. Two current TDRI projects will be discussed: The Uthai Thani Provincial Natural Resources Information System, including the Huai Kha Khaeng World Heritage Site; and the Environmental Quality Information System (EQUIS) for Samut Prakan province.

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UTHAI THANI NATURAL RESOURCE INFORMATION SYSTEM

The Canadian International Development Agency (CIDA) is funding an attempt to develop a prototype provincial-level Natural Resources Information System (NRIS). Uthai Thani province, the site one of Thailand's three World Heritage Sites, Huai Kha Khaeng, was selected as the site for this project. There were several reasons for selecting this province as a test bed. Foremost among them is that Uthai Thani is the site of many well-known environmental *hot spots*. The province is also economically under-developed, making it a potential social *hot spot* as well. Uthai Thani is thus an excellent test tube for discovering what impact information technology can have on environmental issues at the provincial level. In addition, it can be argued that the province's more environmentally-sensitive sites will directly benefit from having a well-developed GIS database available. TDRI, the former National Environment Board (NEB), Ministry of Interior (MOI), Royal Forestry Department (RFD), and Uthai Thani's governor's office are the principals involved in this effort.

The Huai Kha Khaeng World Heritage Site is globally unique in its bio-diversity, location, and evolutionary heritage, as it intersects three Asian evolutionary zones. As one of the last remaining fully-functioning forest ecosystems in the Kingdom, its value to Thailand is immeasurable. Culturally it is also important, as it contains numerous important Thai-Burmese archaeological sites of the Ayudthaya Period, many yet to be fully-investigated. It is also very large, covering an area of over 1.7 million rai.² From north to south, the site measures some 88 kilometers, and 43 kilometers east to west.

This project was developed in close consultation with the province's governor to serve his primary natural resources management needs. In addition, RFD staff within the Huai Kha Khaeng (HKK) Sanctuary were canvassed as to their information needs in managing and protecting this World Heritage Site.

The work to date has concentrated on information within HKK, primarily because the roughness of the terrain and the rainy season make work difficult and eventually impossible. The remainder of the province is scheduled for the next phase of the project. The following section will, therefore, concentrate on work done inside the HKK World Heritage Site.

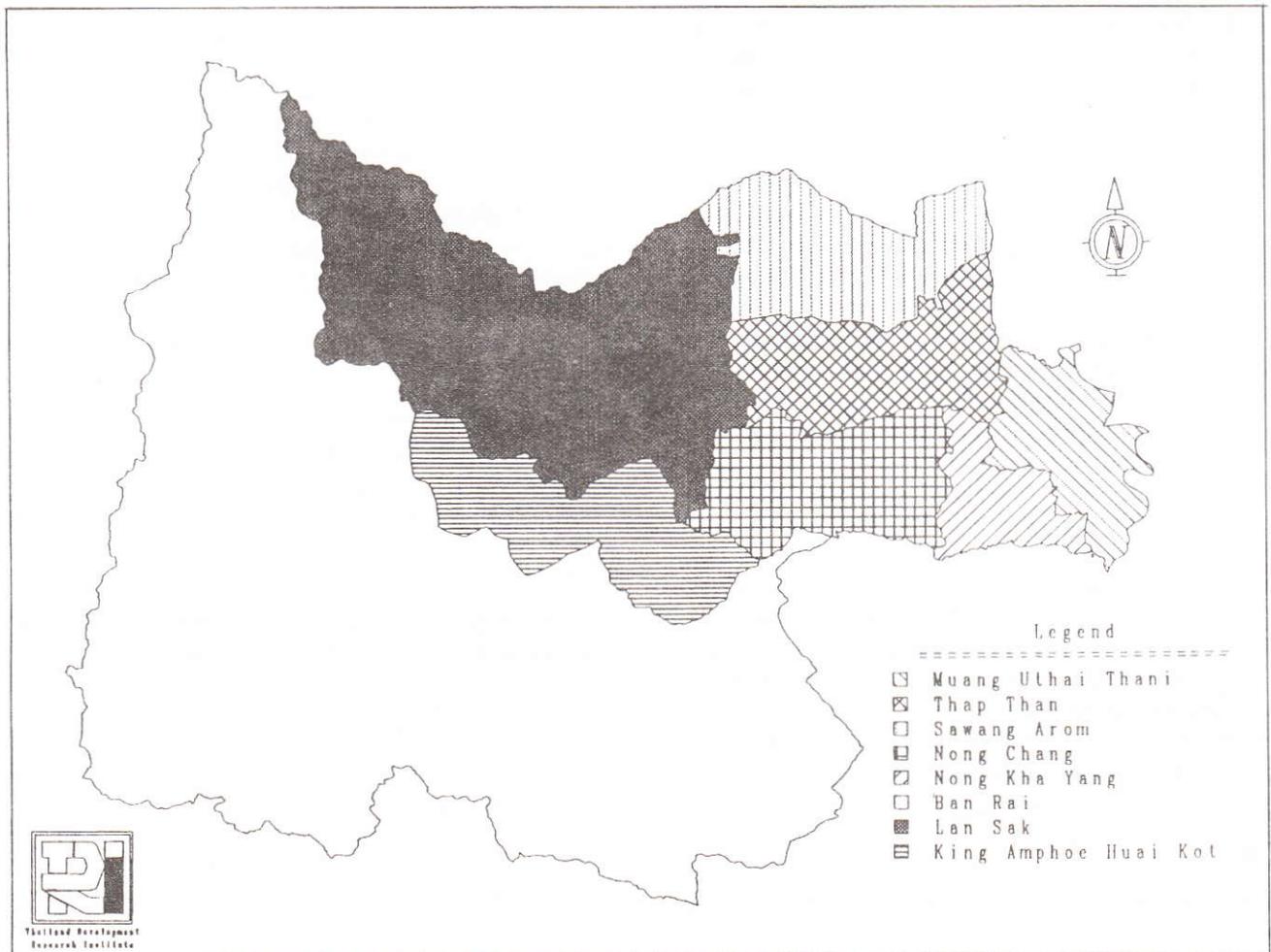


Figure 1 Uthai Thani: Amphoe

Spatial Information

HKK, while rich in bio-diversity, is relatively poor in information content. Very little is actually known about the site beyond some basic data layers, such as topography and surface hydrology, a basic wildlife listing inventory, and some ad hoc wildlife surveys. All of the available data is on a scale of 1:50,000, the same scale as the Kingdom's topographic base maps, and adequate for most management needs. Table 1 lists some of the major spatial data layers over the site.

Prior to this project, there was very little detailed, comprehensive data on the area. The main thrust of the RFD's efforts in this area have been policing. Poaching and illegal logging were serious problems in the recent past. The situation has now more or less stabilized and RFD is turning its attention to other tasks.

In assessing the available spatial information over HKK and the information needs of the RFD officers charged with protecting and managing this important site, the TDRI research team determined that there was a serious lack in content and *accuracy* of important management information layers. The locations of many roads, for example, were later found to be as much as 1.5-2 kilometers in error. Considering that many of the interior roads are very deep, under solid forest cover, this is perhaps to be expected. However, if one also considers that some of the roads on the site's periphery were being used as de facto boundary markers, the seriousness of these kinds of errors should become apparent. Several salt licks used by **elephants**, very important to the site's ecology, had never been mapped, while others were inaccurately mapped. Spatial data over the five kilometer **buffer zone** along the eastern borders of the site—which may well hold the key to the future of this site—was also deficient.

GPS to the Rescue

The TDRI research team brought GPS technology to the project to supplement these data needs. In examining the available survey options—theodolite ground survey, aerial photo and satellite image analysis—no other technology approached GPS in flexibility, speed, ease of use, position accuracy, survivability³ and, perhaps most importantly, **attribute** integration. It was the choice in terms of cost effectiveness.

There are no data queues for users to languor in when using GPS-based surveying. NAVSTAR satellites do not take holidays or long weekends. With the exception of some *windows* of low SV availability, GPS is generally ready when you are.⁴ When the full suite of SVs are launched, there will be world wide, 3D coverage, 24 hours a day. This offers users unparalleled freedom of choice in surveying tasks, unconstrained by the whims and glacial pace of various agencies. Agriculture areas

encroaching on the site, for example, were surveyed along a line of more than 110 kilometers in a leisurely four days, using a helicopter from the Agriculture Aviation Division and vehicle-based cross checking. The HKK and RFD staff were acting on this data by the fifth day.

As survey conditions and needs change, so can GPS-based surveys. The flexibility presented by GPS technology lends itself to any situation where unforeseen survey opportunities might arise. While surveying the roads in the interior of HKK, for example, TDRI's survey team often encountered various wildlife, many of them rare or endangered. These unplanned sightings were *instantly* mapped, without interfering with the *planned* purpose of the survey. These sightings will help form the basis for a full wildlife survey that will be conducted by HKK site staff.

In *absolute* accuracy, GPS surveys, especially differential surveys, usually provide accuracy and resolution beyond that needed for a 1:50,000 scale database. This proved to be troublesome at the beginning of the survey period as a GPS has very high *absolute* position accuracy but low *relative* accuracy. It took some trial and error before the survey team was able to come up with a suitable, common coordinate database. Differential GPS surveys, it was determined after some experimentation, were unnecessary at the project scale of 1:50,000. One stretch of road, for example, was surveyed using two GPS receivers. One was configured as a base, the other as a *rover* that actually surveyed the road. Corrections of from less than one meter to a maximum of 27 meters were made after applying differential corrections. These sorts of results were found consistently over a variety of terrain types and times. At a scale of 1:50,000, such errors can usually be safely ignored. Map scales greater than 1:50,000 would require differential GPS surveys if accurate data were expected.

One important benefit of GPS surveys, at least to the TDRI research team, was the ability to quickly and accurately assess a spatial object's **attribute data** as it was being mapped.⁸ Having all of an object's features recorded and linked in one digital database while in the field, provided large time savings and high-quality data. A bridge's dimensions, construction type and material, for example, could be quickly recorded and tied to that bridge's position as it was being mapped. In the case of villages in the site's 5 kilometer buffer zone, the village's location, name, head man, population and any relevant notes were all recorded at the same time in the field while still in the village. This provided one continuous and, therefore, accurate link between the actual information in the field and the final form within the project's database. Attribute and locational data never went astray, never diverged from one another, as sometimes happens in large, complex surveys using manual methods.

Table 1: Major Data Layers in HKK

Layer	Description	Source
Elevation	Contours and spot elevation	RTSD topographic maps ⁵
Slope	GIS derived from elevation	
Aspect	GIS derived from elevation	
Streams	Annual <i>versus</i> non-annual names	RTSD topographic maps,
Roads	Condition, name	GPS survey
Bridges	Length, width, material	GPS survey
Forest	Forest type, 1986 data covering portion of site	RFD
Topographic land use	1969 land cover derived from topographic maps	RTSD topographic maps
Land use	1984 land use	DLD ⁶
Soil	Soil names and properties, mainly in buffer zone	DLD
Archaeology	Ayudthaya period ancient sites	GPS survey
RFD stations	HKK sanctuary stations, staffing, weapons, etc.	GPS survey
Boundary	HKK site boundaries	RFD, GPS survey
Guard	Perimeter guard station	GPS survey
Encroachment	Agricultural areas encroaching on the site	GPS survey
Salt licks	Type (water or land), principal users, name, etc.	GPS survey
Wildlife sighting	Live sighting, tracks, droppings, etc., animal type, etc. mainly <i>ad hoc</i>	GPS survey
Habitat	Slope, aspect, elevation, forest cover, proximity to salt licks and year-round water supplies, etc.	GIS derived
Concessions	Department of Mineral Resource (DMR) mineral concessions, land cover, forest quality, etc.	DMR, GPS survey
Villages	Buffer zone villages, name, population, etc.	GPS survey
Video	Locations, timing, tape counters, and content of video images	GPS survey
Climate	Rainfall, temperature, wind speed and direction, storm events, radiation, etc.	MET ⁷

It was discovered during the course of this survey that there was one village positioned exactly on the Sanctuary's boundary, a dangerous situation. This surprising discovery proved to the HKK site staff, beyond doubt, the usefulness of GPS surveys as realistic day-to-day management tools. The people who have migrated to the areas around HKK come from the Central and Northeastern regions. They bring their local culture with them. Villages in the buffer zone, therefore, take two different forms—higher density, clustered Northeastern-style villages and less dense, spread out Central-style. It should be noted that the villages which appear to be outside the buffer zone actually have some portion of the village within the buffer zone. These are all Central-style villages.

Proposed Canal Project

GPS technology also provided an excellent *ad hoc* survey tool to answer questions arising during the course of the project work as RFD perceptions and attitudes about information needs changed. During the project's field work, a plan was suggested to construct a canal

from Huai Kha Khaeng stream to Huai Thap Salao stream to supplement water in the Huai Thap Salao Reservoir. The study team was able to supply critical information on the proposed route of the canal within days:

- Elevation, slope, and aspect
- General wildlife signs by GPS survey along the canal route. It was found the proposed canal would cut several heavily-traveled elephant trails
- Forest type and quality by GPS survey
- Cut volume calculations
- Excavation budget estimates (7, 4, and 2 billion *baht* respectively for 100, 50 and 20 meter wide canals)
- Three dimensional views of the area before and after construction of the proposed canal

The combination of the GPS survey and GIS analysis provided a factual basis for evaluating this proposal.

Practical Suggestions

GPS surveys were carried out on foot, from four-wheel drive vehicles, helicopters, and boats, and covered every practical situation conceivable. Overall, more than 1,000 surveys were carried out in a period of less than two months. From this work, some practical guidelines were developed:

You can never have enough GPS batteries. Using only a single GPS battery, or having only one spare, proved a logistical nightmare. Batteries were never adequately charged, surveys had to be cut short of planned targets, staff time at night was occupied with arranging batteries and charging equipment rather than resting or evaluating the day's survey work, etc. Fortunately, video camera batteries proved excellent and affordable substitutes after some wiring modifications. The team usually used seven batteries, three in the field and four at base being charged. On longer surveys, without the option of charging along the way, all batteries were used for survey work and a day devoted to charging before and after the survey.

Walking is always better. GPS signals, being microwaves, are disturbed by trees, bamboo in particular. Under heavy forest canopy, vehicle-based surveys were almost never satisfactory, simply because the truck went too fast. It was found, however, that by slowly walking over the same ground, we could almost always achieve reasonable results. To carry out this foot survey, the survey team needed to be physically separated from the vehicle. Psychologically, being *tied* to a vehicle almost always prevented the team from getting good data. They usually gave up after a few minutes and got back in the vehicle. Removing the vehicle removed the problem.

Make use of the materials around you. In areas where signal reception proved impossible, attaching the GPS antenna to a long bamboo pole cut from the surrounding area and raising this above or near the canopy roof proved successful. The bamboo could be discarded when finished and need not be carried to the next survey position. If bamboo was lacking (this was rare), climbing a likely tree with the antenna usually worked. A cable of about 30 meters was used for this purpose and proved adequate.

1:50,000, 1 GPS. As mentioned above, the TDRI research team found that at scales of 1:50,000 or smaller, differential surveys were not normally required. If surveys are to be carried out at mixed scales (1:5,000 and 1:50,000), the second GPS unit can be used to survey in parallel when not needed for differential survey work. Note that this does not include monument surveys, where benchmarks, control points, etc., will be

established. Differential GPS surveys will almost always be required in these types of surveys.

A picture is worth a thousand words. One of the most powerful pieces of equipment used in the GPS surveys was a lightweight video camera. By synchronizing the date and time stamped on the video image with the GPS receiver's time, this allowed the survey team to conduct fast and effective airborne reconnaissance of large areas. The time/date link also allows the user the ability to include video images as part and parcel of the GIS database by specifying the exact location of that image. If any of a surveyed feature's attributes are called into question, a video can sometimes provide answers.

It's always later than you think. Helicopter-based GPS surveys are simple to plan if one keeps in mind two things: the helicopter is traveling at 100-200 kilometers per hour, therefore waypoints that are too close together (less than 10 kilometers apart) are usually impossible to visit and helicopter pilots are quite literal about directions—if you tell him a certain course he will almost always fly that course no matter what the conditions ahead. You can avoid rough rides by planning courses around high mountains whenever possible. One certain way to waste valuable helicopter time and enrage a pilot is to keep the aircraft flying in useless circles looking for the last waypoint. It is simpler to space them farther apart. Sharp, sudden course changes should be avoided when possible, as the body of the helicopter will rotate and block the GPS signal.

Use the almanac. In light of battery constraints, windows of no GPS availability, and survey targets, planning is essential. The GPS's predictability, provided by downloading the orbital almanac, can be of great use in planning surveys. Good GPS planning software should also let the user play *cat and mouse* games with the planned survey routes by blocking various elevation ranges and azimuths to simulate mountain ranges, buildings, etc.

Conclusion

The above is a brief look at the various ways TDRI used GPS technology during its Huai Kha Khaeng database building efforts. It should thus be obvious that GPS has an important place in almost every similar GIS project. It provides high-quality location and attribute data in a quick, flexible, and easy to use manner. Few GIS shops would not immediately benefit from using GPS technology.

The following section will examine the ways TDRI put GPS to work in an entirely different GIS project setting, in the industrialized province of Samut Prakan,

mapping factories, waste water, and the other attendant ills of a modern industrial area.

ENVIRONMENTAL QUALITY INFORMATION SYSTEM IN SAMUT PRAKAN

The face of Thailand is rapidly changing. In many cases, we are able to see it occurring before our eyes. Everywhere one looks, one sees changes. Farms are being replaced by housing estates and fish ponds by factories. The recent economic boom is the root cause of this shift in land use away from an agriculture-based economy toward a more urbanized one. The rapid growth in Thailand's economy is also reflected in rapid changes in the quality of the environment. Population shifts occur quickly as more rural people come to live and work in urban areas.

Abrupt land use changes tend to be unplanned. Serious damage to the environment and a lowering of the quality of life usually follows. Overcrowding and traffic jams; noise, air, and water pollution; floods, fires, and worse, can and do result. Like the paddy lands of the highland areas, urbanized land has a finite carrying capacity. The amount of people and pollution it can absorb is limited. It can collapse and become uninhabitable as easily as the highland areas. Urban land's carrying capacity can be improved by upgrading public infrastructure (analogous to improving the farming techniques of the hilltribes to improve paddy yields), and by reducing the amount of privately generated waste being dumped into public air, water and land.⁹

To strike a balance between population, economic activity and environmental quality, planners must possess information. *Where do people live? How many people live there? In what directions is the city spreading? How has land use changed with time? What are the dimensions of urban spread? What is the quality of water flowing out of this municipality? Is the air here safe to breathe? What is the state of the environment here?* A thorough understanding of the state of an area's environment is fundamental to solving its problems in a timely and efficient fashion.

The objective of this CIDA-funded project is the development of a **user-responsive**, GIS-based Environmental Quality Information System (EQUIS) for the province of Samut Prakan at a scale of 1:50,000. Samut Prakan province was chosen because it is industrialized, yet retains fairly large areas devoted to agriculture and aquaculture.

The end users of this information system are the Office of the National Environment Board (ONEB), Department of Industrial Works (DIW), Samut Prakan provincial officials, private-sector users, non-governmental organizations (NGOs) or others interested in **factual** information about the state of Samut Prakan's environment.¹⁰ A major by-product of this system will be

technology for the assessment of **pollution taxes**, following the present government's policy of "the polluter-pays." Once developed and thoroughly tested, this system will serve as a model for other systems around the Kingdom.

Case of the Missing Factories

In contrast to the dearth of information over Huai Kha Khaeng, there is a wealth of data for Samut Prakan province. Because of its proximity to Bangkok, it has been the subject of numerous national and international studies. The industrial areas of the province were mapped as recently as 1989. There is also a large tabular database of factories that includes attributes for name, ownership, products, raw materials, workers, capital, waste materials, etc. to complement this spatial data.

In developing an environmental quality information system, pollution sources, especially hazardous, industrial ones, must be precisely located and identified. Their spatial relationships to nearby human settlements and the demographics of those settlements must also be known. The rules and legal guidelines applying to each factory will also come into play. Exact locational data is, therefore, a prerequisite for developing this type of information system.

Despite this relative wealth of data, there is, however, a fly in the ointment. Much is known about the main sources of hazardous waste from this province's registered factories. But their locations are not known. While a land use map can cover the areas that appear to contain some type of factory, it cannot provide details about the individual factories within each area. It lacks the necessary attribute information. The tabular factory database does provide some addresses, but anyone trying automated address matching in Thailand will soon find that many of the street addresses do not follow any noticeable logic. In general, address matching usually fails in industrialized areas. Furthermore, the factory database contains only legal, *registered* factories. Yet there are many unregistered factories polluting the environment which need to be identified.

GPS: Once More Into the Breach

To fill this gap in the system's database, the TDRI research team applied GPS technology in a survey designed to establish a factory database with precise locations. This database was related to the existing tabular database to determine needed attributes. Over a period of about two weeks, more than 1,000 factories were surveyed. Beside the position of each factory, its name, street position, and any other noticeable attributes were recorded in the field.¹¹ As a bonus, tens of kilometers of new roads in the province were also surveyed.

Since much of the data over Samut Prakan comes from a variety of sources, with a corresponding variety of spatial location problems, about two dozen road intersections around the province were also surveyed to serve as "tics," or identifiable road intersections. These tics were then used to transform the system's various coverages to one common and accurate coordinate system.

Not unexpectedly, the biggest obstacle to this type of urban survey was traffic. The survey team estimated that the heavy congestion almost doubled the survey time. The survey vehicle's power supply was used to supplement the GPS's batteries, therefore batteries were not a problem for this survey, in contrast to Huai Kha Khaeng.

The final phase of this project's GPS survey work involves a survey of the province's canals. The survey team will travel by boat along the major canals and sample the water's color and, by implication, the state of the canal's water. This should take about one week.

Conclusion

GPS played an important, even crucial role in this GIS project. It provided an economical means to identify pollution sources and to develop a factory database, appropriate for inclusion in an environmental quality information system (EQUIS). It will also be used to develop information concerning the water quality of the province's canals. By supplying precise coordinates for identifiable road intersections (*tics*) around the province, a large, multi-source and spatially-questionable database was brought into a common and more accurate coordinate system.

This project and the work carried out in Huai Kha Khaeng should amply demonstrate the facility of this technology in solving one of the more serious problems in the GIS profession today, data. GPS-based surveys can cost-effectively supply high-quality position and attribute data in a rapid, flexible, and *user-friendly* fashion. It is worth repeating that there are very few GIS shops that would not immediately benefit from using GPS technology.

ENDNOTES

- 1 NAVSTAR: Navigation Satellite Timing and Ranging
- 2 6.25 rai is equivalent to one hectare.
- 3 A GPS's ruggedness is extremely important, especially if one is surveying in rugged and remote areas like Huai Kha Khaeng. Survey equipment is constantly being drenched, falling off things, and having things fall on it, the equipment used should at least be as survivable as the people carrying it.
- 4 As mentioned above, you need a minimum of three SV to calculate a 2D position fix. For 3D fixes, four satellites are needed.
- 5 RTSD: Royal Thai Survey Department, a military agency charged with developing and maintaining the Kingdom's base maps.
- 6 DLD: Department of Land Development, the agency tasked with developing soil and land use maps in Thailand.
- 7 MET: Meteorological Department.
- 8 Bridges at the project scale were point features and surveyed by point averaging for about three minutes.
- 9 TDRI, 1990, *Urbanization and Environment: Managing the Conflict*. 1990 TDRI Year-End Conference Research Report No. 7.
- 10 And by extension the remainder of the BMR's environment.
- 11 The accuracy of the GPS often did not allow the survey team to satisfactorily locate which side of the street a factory was on, even an error of 5 meters could place the factory on the wrong side of the road. In addition, one survey point might contain from one to five factories. This attribute was, therefore, recorded in the field and each factory *hand* moved to its proper location using the GISs editing features.

The Development of Thailand's Technological Capability in Industry*

Executive Summary

In recent years, Thailand's economic growth has been impressive, with Gross Domestic Product (GDP) rising from 3.5 percent and 4.5 percent in 1985 and 1986 respectively, to 8.4 percent and 11 percent in 1987 and 1988. According to the National Economic and Social Development Board (NESDB), the sectoral shares of GDP in 1988 reached 16.6 percent for agriculture and 24.8 percent for manufacturing.

Growth over the last decade has been attributed to the country's macroeconomic stability and to a steady shift from that of a traditional-commodity-based economy toward one that is manufacturing and services oriented. Factors favorable to the current economic boom are generally perceived as being short-term trends. These include a relatively efficient and low-wage labor force to gain price competitiveness, as well as some strong pressures to shift and relocate manufacturing bases away from Japan and many Asian newly industrialized economies (NIEs). As continual and sustained growth would normally entail producing high value-added products and services, in turn requiring the introduction of new or more-sophisticated production techniques, equipment or services, there is rightly cause for concern that, without such diversification away from the country's traditional primary products and simple, labor-intensive exports, Thailand may soon be faced with intense competition from the many less-developed nations with cheaper labor.

That technology is an increasingly important element in international competitiveness, necessary to sustain a nation's economic growth, is well understood and widely accepted. It is, however, not merely a question of having the right technology alone. There is also the problem of being able to effectively absorb and deploy technology, and to make efficient use of available resources to produce better quality and lower cost products and services or, where demands arise, new types of products and services.

Thus, the question of the technological capability of a nation and its industry, and the strategies for enhancement of its technological capability to meet new demands, are of vital importance to maintain international competitiveness and to sustain healthy economic growth.

To this end, it is the central aim of this study to provide insights into the present status of technological capabilities in Thai industries, as well as to present a number of useful measures for determining the appropriate science and technology (S&T) strategies for Thailand.

AN ASSESSMENT OF THE TECHNOLOGICAL CAPABILITY OF THE FIRMS SURVEYED

A sample of 119 firms across three industrial sectors, which use the key technologies in biotechnology, materials, and electronics technology, was employed in this study. The technological capability (TC) of these firms was assessed by categorizing some 20 components into four types of TC: acquisitive, operative, adaptive and innovative, and by rating each with a score of between 0 and 5.

Acquisitive capability rated a firm's ability to search, assess, negotiate and procure needed technologies, and to install and start-up production facilities. Operative capability appraised the operation, control, and maintenance of production facilities, as well as skill development, production planning, and quality control. Adaptive capability concerned technology digestion and minor product and process modifications. Finally, innovative capability assessed the capacity to make radical product and process modifications, to carry out in-house RD&E, and to invent new products and processes.

Of the four technological capabilities, operative capability was generally found to be the highest, followed

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closely by acquisitive and adaptive capabilities, while innovative capability not only fared poorest, but lagged far behind the other three. Such a pattern holds true for all the three industrial sectors.

FIRM ATTRIBUTES AND TECHNOLOGICAL CAPABILITY

Overall TC ratings appear to be affected more by type of industry, size, and ownership than by market orientation and Board of Investment (BOI) promotion status.

Large firms tend to possess higher overall TC than small- to medium-sized firms. In particular, large size appears to have significant associations with higher operative and adaptive capabilities, but only a marginal effect on acquisitive and innovative capabilities.

Joint-venture and foreign-owned firms tend to have the best operative capability. The same, however, cannot be said of the other capabilities. Many foreign subsidiaries and joint-venture firms rely on their parent firms to carry out the various innovative and acquisitive activities abroad. As a result, they tend to perform somewhat poorly in innovative and acquisitive capabilities compared with the average Thai firm, particularly in the electronics sector and to a lesser extent in the materials sector.

While both operative and adaptive capabilities tend to be influenced by firm size and ownership, innovative capability is influenced somewhat by ownership and market-orientation. The study found that firms producing mainly for the local market tend to possess better innovative capabilities in the materials and electronics industries, while the opposite is true for the biotechnology sector. On the other hand, acquisitive capability does not appear to have any clear pattern of association with firm attributes. Finally, the study found no significant difference in TC ratings between BOI-promoted and non-promoted firms.

MAJOR PROBLEMS IDENTIFIED

In the course of the study, a number of problems and limitations became apparent, which may directly or indirectly have a bearing on the technological capabilities of the industries under study. They are:

Inadequate Supply of Technical Human Resources

There appears to be a general shortage of S&T personnel, in particular of engineers, while the ability of S&T personnel is questionable, as newer technologies proliferate and push many existing technologies into obsolescence.

Inadequate Technical Information Services

The present technical information is inadequate, while available information is spread over many different sources, making access to information difficult. This is detrimental to the acquisition, adaptation, and development of technology, and to the upgrading of human resources.

Inadequate Technical Services

Most small- and medium-sized firms need, from time to time, outside assistance to assess technology, install and start-up new production equipment, as well as to provide relevant testing, analysis, and certification of products and processes. Available consultancy and technical services generally lack adequate standards and coverage.

Tax Structure

Import tariffs on testing and laboratory equipment for adaptive and innovative activities are prohibitively high, making them less readily affordable, particularly to small-sized firms. Furthermore, multiple taxation is widely seen to deter subcontracting, which in turn considerably reduces the levels of industrial linkages and technology transfer.

Linkage to the S&T Community

Industrial firms tend to doubt the effectiveness of universities and public technical institutes to solve practical industrial problems. As a result, the latter have not been given sufficient opportunities to gain the relevant experience. Most of the S&T community's research and development (R&D) activities, therefore, continue to be mainly for their own academic interests or for public and state benefits only.

Attitude of Entrepreneurs

There seems to be a widespread absence of a proper perception of the benefits of human-resource development, preventive maintenance practices, R&D activities, and modern management techniques. Also, protected industries tend to be complacent because of the lack of competition.

MEASURES TO ENHANCE EFFORTS TO ACQUIRE AND IMPROVE TECHNOLOGY

S&T Manpower Development

Apart from finance and infrastructure, human resources are another critical component of developing technological capability, as technological capability is,

after all, essentially embodied in people and not in machines.

To reduce current shortages and increase future supplies of S&T manpower, several measures, both immediate and long term, were put forward. The immediate measures proposed include: provision of special training courses to enable scientists and technicians to handle engineering tasks; making it easier for foreign engineers to work in Thailand; lifting the 2 percent growth ceiling for engineering and science teaching positions in state universities; and organizing a major campaign to boost S&T under-graduate enrollments and improved remuneration systems to attract and retain high-caliber academic staff. Long-term measures involve recommendations for substantial investment to train more and better science and engineering graduates; the granting of some 800 overseas study scholarships, particularly in the three priority technology areas in this study; initiation of an on-going upgrading of the curricula in science and engineering; and encouraging management to accord better recognition and remuneration to deserving scientists, engineers, and skilled technicians.

Creating Competitive Pressure

Allowing free market competition is a most effective means of forcing firms to develop much-needed technological strategies to increase efficiency and lower production costs, enhance quality and improve reliability and develop new designs, so as to be competitive both domestically and internationally. It is important that tariff protection be removed, or reduced to the minimum possible.

Conditions for Direct Foreign Investment

So far, foreign investment has not proven to be a sufficiently effective means of technology transfer. A more selective approach is required to ensure that new investments truly create jobs, and yield genuine technology transfer and net income to Thailand.

Promotional conditions could perhaps contain stipulations, for example, to conduct regular on-going training programs for firms' personnel, using foreign and local experts, to set up research development and engineering (RD&E) facilities, carry out in-house RD&E activities, and other measures that would bring about real transfer and accumulation of technology and knowledge.

Assistance to Small- and Medium-sized Firms

The less resourceful small- and medium-sized firms need to be given assistance, without creating adverse effects in the way, for example, that protection barriers

do. These may include: soft loans for process and technology upgrading, dissemination of vital technical and business information, technology transfer through the provision of appropriate consultancy services, training in quality control and productivity improvement, as well as special skills upgrading.

Creation of an Environment Conducive to Subcontracting

The multiple taxation system has severe drawbacks, making subcontracting work less attractive. Such a system is seen to favor vertical integration manufacturing, and deter the subcontracting that is particularly suitable for small- and medium-sized firms. Thus, the government's implementation of a value-added tax (VAT) system should be fully supported, while incentives should be considered to encourage collaboration between large firms and subcontractors.

Firm-level Human Resource Development

The government should be instrumental in arranging for experts from universities, government agencies, and private organizations to conduct training programs specializing in technical and general human resource development for the private sector, in particular for the most needy small- and medium-sized firms. Furthermore, incentives should be considered to encourage such human resource development efforts.

Support for Firm-level RD&E Efforts

The pending legislation for the promotion of technology development and RD&E efforts should be fully supported and speedily introduced.

Moreover, RD&E funding to state universities and research institutes should be re-examined with a view to achieving a balance between basic and applied/industrial research, with the latter specifically aimed at tackling the needs of industries. A spill-over effect would mean the forging of better and closer linkages between public S&T institutes and the production sector.

MEASURES FOR STRENGTHENING TECHNOLOGICAL INFRASTRUCTURE AND SUPPORT

If an environment conducive to encouraging the production sector toward much greater technological efforts is created, then an adequate basic S&T infrastructure and support system becomes necessary to enable producing firms' technological efforts to be more fully developed and realized. Major infrastructure

which needs to be strengthened or established is as follows:

- Information center with extension services
- Science and technology park
- Centers of excellence
- Systems of metrology and industrial standards
- Dissemination of technology
- Intellectual property protection

CONCLUSIONS

A key to enabling the enhancement of technological capability is to increase the level of competitive pressure, while at the same time making sure that the essential supportive S&T infrastructure is firmly in place to support producing firms' technological efforts. This undoubtedly calls for a well-conceived national S&T devel-

opment plan with appropriate policy measures, incentives, or penalties, and for a strong and adequate technical human resource base.

While innovative capability is a very important element, human and financial resources must be prioritized and skillfully managed for maximum returns. RD&E efforts should be targeted at programs that yield ready benefits to the country's immediate development efforts. Only then will more and more firms begin to realize the necessity for and the benefits of RD&E, and hence readily subscribe to undertaking RD&E themselves.

Finally, a clear and well-conceived S&T development strategy must be mapped out to complement or supplement other national plans, and must not be planned in total isolation. Subsequent implementation plans must be accompanied by constant monitoring and control, and timely changes should be made, where necessary, to respond to unforeseen environmental, economic, major policy, or other changes that may arise later.

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