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PHILIPPINES

Technical report: Opportunities for Export-Oriented Industrial Development*

Prepared for the Government of the Philippines
by the United Nations Industrial Development Organization

Based on the work of K. Chen,
UNIDO consultant and leader of the mission

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United Nations Industrial Development Organization
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This document has not been edited.

Executive Summary

At the request of the Philippine Government, the United Nations Industrial Development Organization (UNIDO) sponsored a mission to assist the Philippines to identify and assess export-oriented industrial development opportunities in the electronics sector. Emphasis was put on the involvement of the private sector from both the Philippines and the industrialized nations. The mission focused its attention on thre subareas: (1) semiconductor manufacturing, upstream from the assembly and testing activities, (2) computer software, downstream from the data entry activities, and (3) high-technology electronics and software industry development that will capitalize on Philippines' comparative advantages in her English-speaking and professionally trained human resources.

The mission took place during the period of August 24 to September 3, 1988, and spent time to consult extensively with Filipino officials and experts in industry, government, and academe, and with corporate executives and specialists from industrialized nations in the Baguio Export Processing Zone as well as in the Metropolitan Manila area.

The mission concluded that there are definite and excellent opportunities for export-oriented industrial development in the Philippines in each of the three subareas. The principal recommendations by the mission include the mounting of a systematic effort to publicize internationally about the economic conditions in the Philippines, as well as continuing reduction of bureaucracies involved in day-to-day business and streamlining of governmental approval procedures for the investment and operations of foreign firms.

In the semiconductor subarea, the mission recommends the consideration of setting up promotional offices in the U.S. and Japan to attract more high labor content export-oriented work to the Philippines, while developing a realistic long-term national plan for the Philippines to become a center of manufacturing excellence. The latter should include the development of an effective curriculum and the acquisition of approprite equipment by the Philippine universities for high-technology electronics and semiconductor manufacturing.

In the computer software subarea, the mission recommends the focusing of near-term attention to mainframe computer program documentation, conversion, and maintenance. Priority consideration should be given to the setting up of marketing offices in Japan and the U.S. with the purpose of attracting

investment by large foreign corporations which would transfer their software maintenance facilities to the Philippines. The funding for an alternative way for promoting export-oriented mainframe computer software services from, and for acquiring the necessary mainframe computer facilities for, a consortium of the Philippine software firms should also be considered.

In the subarea of high technology, the mission recommends that the Philippines should learn the process as well as the technical contents of high technology development. A particularly promising high technology to be developed by the Philippines is that of smart database, using arificial intelligence and low-cost Philippine professionals to do the corresponding coding of medical or legal articles, and of musical compact disks. The mission recommends the consideration of a visit by a Philippine group of entrepreneurs and technical people to their counterparts in a high-tech growth area in an industrialized country, as the next concrete step to explore this specific opportunity.

Background

A new policy of the United Nations Industrial Development Organization (UNIDO) in recent years is to emphasize the private sector involvement in international industrial development. This means the involvement of the the private sector in both the developing countries and the industrialized countries. Much of this new policy is being implemented through UNIDO's Division of Special Programmes and Activities.

In May 1987, Mr. Domingo L. Siazon, jr., UNIDO's Director General, accompanied by the Director of UNIDO's Division of Special Programmes and Activities, and other UNIDO officials, visited the University of Michigan to discuss UNIDO's new policy with a number of U.S. companies, public officials, as well as the administration and the faculty (especially those in the business and engineering schools) at the University of Michigan. One of the results of that visit was an agreement signed between UNIDO and the University of Michigan to provide mutual support in the activities involving the private sector in international industrial development. Because of University of Michigan's proximity to the U.S. automotive and high-technology electronics industries, the University of Michigan was encouraged to consider facilitating UNIDO's initiatives to involve the private sector activities in these two sectors. Mr. Siazon also expressed the desire to test out the feasibility of involving the developing countries in high-technology activities through private sector cooperations.

In response to the above challenge, Dr. Kan Chen, Professor of Electrical Engineering and Computer Science at the University of Michigan, accepted the invitation by the Philippine Government to visit the Philippines for three days in October 1987 to explore the feasibility and desirability of conducting two missions -- one on the automotive sector and the other on the electronics sector -- to assist both the private and the public organizations in the Philippines to identify export-oriented industrial development opportunities. Subsequently a return visit was paid by Mr. Eduardo Santayana of the Philippine Metals Industry Research and Development Center (MIRDC), who spent ten days in the United States during the month of March 1988 to further delineate the scope and the objectives of the two missions. These two mutual visits resulted in the recommendation for the electronics mission to focus on the following three subareas: (1) semiconductor manufacturing, (2) computer software, and (3) machine vision and artificial intelligence.

For over a decade, the Philippines has been engaged in the labor-intensive export-oriented assembly and testing aspects of semiconductor manufacturing. It was recommended that the mission should explore new opportunities for the Philippines to move upstream from these activities in semiconductor manufacturing toward higher value-added activities, including wafer fabrication. Similarly, data entry for computer data processing

has been a labor-intensive and rapidly growing activity in the Philippines in recent years. It was recommended that the mission explore new opportunities for the Philippines to move downstream from data entry toward the higher value-added offshore computer programming activities.

The motivation for the mission to explore machine vision and artificial intelligence, the third subarea, was twofold: to explore the feasibility for any developing country to participate in high-technology development in general; and to help the Philippines in particular to enter a new high-tech area, such as machine vision, at least on an equal basis with, if not ahead of, other Asian developing countries. It was recommended that the mission should explore those applications of machine vision and artificial intelligence which would utilize the comparative advantages of the Philippines such as her English-speaking population, the abundant human resources trained in the legal and the medical professions, and a large number of musicians who understand the American musical taste.

Given the above background and foci of the mission, which was formally requested by the Philipine Government and approved by UNIDO, the following team members were selected, with their expertise and complementary roles as indicated:

Kan Chen, Professor of Electrical Engineering and Computer Science, and Director of the Program in Technology Planning and Assessment, University of Michigan
- expert in international industrial development
- mission organizer and leader

Eugene A. Blanchette, Director of Operations, Raytheon Semiconductors
- expert in semiconductor manufacturing
- upstream from assembly and testing

Arnold R. Kent, President, Worldwide Information Services
- expert in computer software
- downstream from data entry

Damian J. Kiska, owner of KDS Enterprises, also representing Stanley Sternberg, President, Machine Vision International
- expert in machine vision and artificial intelligence
- high-technology development and transfer

Details of the background of the above experts, including that of Dr. Sternberg, are given in Appendix A. The fact that all four members of the mission are from the United States was inadvertent as the intention of the UNIDO mission was to be multilateral. In fact, attempts had been made to include a Japanese expert in the mission even though it turned out that time did not permit the fruitful recruiting of an appropriate representative from Japan. However, it is hoped that the private sector from Japan and other industrialized countries will participate in the implementation of some of the recommendations

to be made in this report.

The mission took place during the period of August 24 to September 3, 1988. Plenary meetings, small group discussions, site visits, working lunches and dinners, and debriefing sessions were held, involving high-level public officials and agencies, indigenous and multinational private firms, universities, and professional and trade associations in the Philippines. These mission activities were conducted in the Baguio Export Processing Zone as well as in the Metropolitan Manila area. The agenda of the mission activities is given in Appendix B and the persons contacted by the mission during the ten-day period in the Philippines are listed in Appendix C.

Objectives

Given the above background, the objectives of the mission were to assist the Philippines to identify and assess export-oriented industrial development opportunities in the electronics sector. The three foci of the mission were on (1) semiconductor manufacturing, upstream from the assembly and testing activities, (2) computer software, downstream from the data entry activities, and (3) high-technology electronics and software industry development that would capitalize on Philippines' comparative advantages in her English-speaking and professionally trained human resources. The mission was expected to make specific recommendations for actions to be taken by the Philippine government, industries, academic and professional institutions, and by international agencies including UNIDO and other United Nations organizations, in order for the Philippines to capture and benefit from these opportunties.

Investment Climate and Comparative Advantages

Introduction

Electronics is a global industry. For the Philippines to export goods and services to the electronics world market, some form of cooperation with foreign firms, including investment by the foreign firms in the Philippines, is usually a necessary first step. As the industrial planners and investors take a longer view and compare alternative strategies, the relevant comparative advantages of the Philippines must be considered as a basis for long-term cooperation and competition. Thus, before we get into the three specific foci of the mission, we need to assess the general investment climate in the Philippines and the country's comparative advantages that are relevant to the electronics industry.

Investment Climate

From almost everyone who has been approached recently for considering industrial cooperation or investment in the Philippines, the first question invariably is about the political stability in the country. People who have not set foot in the Philippines have a mental image derived from the news media that another political coup may erupt anytime, an image that is certainly not conducive to foreign investment. Our impression and assessment are that the Philippine political situation is much more stable than what the news media tend to project. Unfortunately, this discrepency between the common image and realities have persisted not only among those foreign executives who have never been to the Philippines, but also between the decision makers at the headquarters of the multinational companies investing in the Philippines (who are frequently jolted by the political news) and the expatriates running their operations in the country (who have much more confidence in the Philippine investment climate).

Perhaps the strongest votes of confidence in the Philippine investment climate have been casted by the actual investment decisions of a number of multinational companies. Many of these companies which have had operating experience in the Philippines are either increasing their investment or returning to the country if they have withdrawn in recent years. For example, Toyota has recently decided to return to the Philippines, from which it withdrew five years ago after two decades of major presence. The newly-formed joint venture between Toyota and the Philippine interests will start assembling automobiles in early 1989, with an initial capital of about $10 million.

In the electronics industry, Texas Instruments (TI) started its operations in the Baguio City Export Processing Zone in 1979. Its investment in that facility has increased every year and has accelerated since 1986, the year in which the current government

took over from the previous regime. Its cumulative investment has actually increased from $53.8 million in 1986 to $66.8 million in 1987, and is expected to amount to $88.4 million by the end of 1988. As a result, some of the most advanced and sophisticated assembly and testing equipment in the world for integrated circuits are now in the TI plant in Baguio. Another example is Motorola, which plans to quadruple its production space, again for assembly and testing of integrated circuits, in the Metropolitan Manila area over the next three years.

It should be noted that the increasing investment of the multinational companies in the Philippines, although no news to the people who have already invested in that country, is not well known to the rest of the world. Obviously, some systematic publicity about such facts outside of the regular news media would be helpful to change the poor and inaccurate image of the investment climate in the Philippines.

The mission members also reviewed a great deal of data collected by the Philippine government that are indicative of the investment climate in the Philippines. Among the most noteworthy data are the substantial restoration of labor stability as reflected by the sharp decrease of mandays lost from strikes since the unsettling year of 1986.

The total investment in the Philippines has been increasing substantially. In 1987, the Philippine Board of Investment registered a total of nearly 1,500 projects with an aggregate project cost of about $250 million, a more than threefold increase over 1986. For the electronics industry, the investment in 1988 is expected to double that in 1987. By far the largest fraction of investment has been coming into the country from Japan, Taiwan, and South Korea.

From a dismal -14.1% growth rate in 1985, Philippine exports registered positive growth rate of 4.6% in 1986 and 17.6% in 1987. For the first four months of 1988, export earnings increased by 27% to a total value of $2.1 billion, compared to $1.6 billion a year ago. The current rate of exports from the electronics industry is estimated at $400 million.

On the other hand, one should not read from the above paragraphs that the investment climate in the Philippines is entirely rosy. The heavy burden of foreign debt (in the order of $25 billion), the still relatively high population growth and unemployment rate (in the order of 7%), and the countryside insurgency problem, are all dark clouds casting shadows on the business and investment climate. The major point we wish to make here is that the real situation is not nearly as bad as the very negative image conveyed by some of the news media.

Comparative Advantages

The Philippines ranks as one of the richest countries in

Southeast Asia in terms of natural resources, second only to Indonesia because of the substantial oil reserves of the latter country. However, as far as the electronics industry is concerned, the extensive agricultural lands, the vast forest reserves, the rich mineral deposits (especially gold and copper), and the hydro and geothermal energy resources of the country, are not nearly as important as the Philippine human resources.

The Philippines is considered the third largest English-speaking country in the world, after the United States and the United Kingdom, and English is the primary language used in its school and college curricula. The highly literate population provides an important human resource. The multinational companies with operations in the country have all praised the work ethic, the diligence, and the trainability of the indigenous work force. The wage and salary levels of the excellent manpower are quite low. Even with the integration of the cost of living adjustments (COLA) into the basic wages, the pay rates for semi-skilled and skilled labor in the electronics industry are still significantly below that in other ASEAN countries, and the starting salaries of engineering graduates are still in the order of $150 per month.

Concomitant to the English-speaking background, the Philippine population as a whole also has a very good understanding of the Western world, especially the United States. There is a great deal of commonality between the Philippine and the American social systems - legal, political, economic, educational, religious, and cultural. No doubt this affinity between the two countries has its roots in their historical ties. However, the relative depth of the Filipinos' understanding of the Western world, as compared to other Asian countries, has not been explicitly and sufficiently recognized as a comparative advantage for export-oriented industrial development.

There are a number of higher educational institutions in the Philippines. The mission members have visited the top three universities - University of the Philippines (UP), De La Salle University, and Anteneo de Manila University - all of which have departments and programs graduating scientific and technical people for the electronics industry. As the comprehensive state university, UP attracts the best students in the country and has seven colleges including Engineering, Law, and Medicine. Its large campus in the suburb of Manila has plenty of land for expansion. De La Salle and Anteneo are located in the business districts of Manila. In addition to regular university departments, these two universities also offer post-graduate and continuing education programs for computer and information technology. The three universities provide hundreds of graduates per year in the areas of electrical engineering and computer science. Many of these graduates go abroad to pursue advanced degrees or receive additional training. While the curricula in these universities appear adequate, their equipment is understandably deficient for state-of-the-art technical training, especially in the areas of mainframe computers and integrated

circuit design and manufacturing.

According to government and industry sources, there are about 25,000 people in the Philippine semiconductor electronics industry. With over 12,000 computer installations in the Philippines, there are about 3,000 persons experienced in mainframe computers, and 5,000 in minicomputer, supermini, and supermicro operations. This English-speaking, hard-working, capable and low-cost human resource pool continues to grow and provides perhaps the most important comparative advantage for the Philippines in the electronics industry.

Semiconductors and Electronics Manufacturing

Introduction

Semiconductor export sales at $1.1 billion in 1987 accounted for a significant fraction of total electronics exports from the Philippines. These semiconductor sales were generated, almost exclusively, by the assembly and testing of semiconductor devices which are the most labor intensive and reputed to be the "lowest-tech" of all semiconductor manufacturing operations. The general objective of this phase of the mission is to recommend "higher-tech" areas of electronics manufacturing for Philippine exports, with special emphasis on higher technology areas of semiconductor manufacturing, including possible plans and/or comments on wafer fabrication opportunities in the Philippines. Before we present our observations and conclusions, let us first put the current Philippine situation into historical context and look at its future trends.

Semiconductor Manufacturing in the Philippines

The Asian semiconductor assembly industry began in Hong Kong in about 1964 when Fairchild decided to compete on the basis of low labor cost against Texas Instruments' much larger attempts to automate semiconductor assembly in the United States. Motorola followed Fairchild's lead by going to Korea in 1966, National Semiconductor was in Singapore by 1968 and several smaller U.S. companies were beginning to use Hong Kong subcontractors by late 1968. By the mid-1970's multinational companies (including Texas Instruments) were well entrenched in South Korea, Taiwan, Hong Kong, Singapore, Malaysia and the Philippines with some activities in Indonesia and Thailand. Local entrepreneurs providing assembly subcontracting services had also begun to appear by the mid-1970's.

The electronic watch boom of 1975 and 1976 cushioned the subcontractors from the general semiconductor industry recession in late 1974 and 1975 and positioned several assembly subcontractors to handle the overflow from the large multinational semiconductor manufacturers and the small U.S. and European manufacturers from 1977 through 1984. The Philippine subcontracters particularly benefited from these trends and developed large semiconductor assembly subcontracting companies such as Stanford Microsystems.

While the semiconductor industry was growing steadily during this period, the communications industry (e.g., Rolm in the U.S.), the games industry (e.g., Atari in the U.S.), and the microcomputer industry (e.g., Osborne and Apple in the U.S.) were experiencing explosive growth. These companies (and others like them) turned to Hong Kong (the free port) on an urgent basis for board-stuffing labor and then for completed boards quoted on a finished and tested basis. Such activities were virtually

impossible to undertake in "tariff" countries while the sourcing procedures were being developed.

As the Hong Kong Chinese learned the techniques of buying, board stuffing, and "in board" testing, these activities were transferred to joint ventures and subsidiaries in lower cost Taiwan. By the late 1970's both U.S. and Japanese manufacturers were purchasing "stuffed boards" from Taiwan and the early Taiwanese "semiconductor subcontractors" had by the early 1980's become full-fledged OEM (original equipment manufacturers) suppliers of completed electronic boxes such as personal computers, video games, telephones, private branch exchanges, and others. The domestic Taiwanese demand for molded plastic parts, sheet metal fabrication and printed circuit boards, together with stable political situations and a booming economy, was sufficient impetus for these support technologies to be funded by multinationals and by entrepreneurs, such that a solid infrastructure of support industries and purchasing power was developed by the mid-1980's. The pattern in South Korea and Singapore was similar to the Taiwanese experience, making allowance for the (then) higher wages in these countries and for the cultural differences between these three entities.

During the early 1980's, the Philippines was one of the most successful of the Asian countries measured purely on semiconductor assembly sales growth. The difficulty of doing business in the Philippines on anything not consigned from the "parent", the generally truculent attitude of Filipino Customs authorities and the increasing difficulties of the late Marcos years, discouraged Hong Kong and Filipino entrepreneurs from branching out into activities which entailed acquiring electronic components from multiple sources, landing them in the Philippines, assembling them and exporting them. Even today, many private companies continue to be concerned about the situation with respect to the Philippine customs.

When the semiconductor industry crashed in 1985/1986 the Philippines had no cushioning effect from diversification into other electronic products as did South Korea, Hong Kong, Taiwan and Singapore. The semiconductor crash together with the revolution mortally wounded many Filipino electronics entrepreneurs, severely injured others and set back the indigenous Filipino electronics industry nearly a decade. The revolution itself caused U.S. multinationals to reassess their expansion plans and virtually stopped all Japanese investments for about two years.

The rise of the South Korean, Taiwanese, Hong Kong and Singaporean currencies versus the U.S. dollar, together with the dramatic rise in the value of the Japanese yen, has caused electronics manufacturers from these countries, and most particularly Japanese manufacturers, to move or expand manufacturing to lower wage countries. The main recipients of these investments have been Thailand and (secondarily) Malaysia. As perceived by foreign companies, the political instability,

inconsistent government policies, and labor unrest have all conspired to virtually exclude the Philippines from this investment stream and to severely limit the use of Filipino subcontractors by Japanese and other foreign manufacturers.

As the world electronics boom continues, as Thailand is now struggling to cope with its deluge of new investments, as the Philippine political system is seen to be stabilizing and labor unrest diminishing, the Philippines is again beginning to look attractive for new investments and for the use of Philippine subcontractors. The Uniden/Wescon move into Manila from Taiwan, the use of Philippine subcontractors by NEC, the expansions of Texas Instruments and Motorola are hopefully harbingers of a brighter era given proper encouragement by the Philippine government.

Future Trends

While the Philippines has been struggling with her unique problems, electronics manufacturing has continued to evolve rapidly. In the following subsections, we will examine separately the trends in semiconductor assembly, testing, wafer fabrication, and in non-semiconductor electronics assembly.

Semiconductor Assembly:

The old "sweat shop" of manual semiconductor assembly (where bonders cost $500) has been evolving into a semiautomated world of high speed $100,000-$200,000 machines. Japan's automated semiconductor assembly plants are more cost-effective than virtually any subcontractor anywhere in the world for high-volume production. U.S. semiconductor manufacturers are automating their own off-shore assembly plants. The demands for 100 parts-per-million failure rate coupled with just-in-time inventories are forcing assembly and testing plants into geographical proximity. It is probable that the stand-alone semiconductor assembly plant is an obsolete concept for large multinationals.

The rapid move towards very large scale integration (VLSI) chips and surface mount technologies (SMT) for printed circuit boards is another driving factor towards greater capital investment in semiconductor assembly plants and in the obsolescence of older equipment. As in memories, so in all aspects of semiconductors, bit demand is skyrocketing, unit demand shows modest growth due to chip density growth, average unit selling prices are rising, and customers are demanding to have their products built in the most up-to-date factories. These trends will:

(1) eliminate all but the most highly automated subcontractors who, in turn, will manufacture (and probably test) for smaller specialized semiconductor companies and do overflow work for large multinationals,

(2) favor the assembly/testing plant located close to the customer (e.g., if Matsushita televisions are built in Thailand,

the country will be favored for an assembly/testing plant, all else being equal), and

(3) create a demand for all manners of support trades -- air conditioning, plumbing, tools and dies, plastic molding, equipment maintenance, electrical wiring, and so on.

Semiconductor Testing:

While semiconductor assembly technology has evolved rapidly, there has been a revolution in semiconductor testing technology. It is theoretically possible to utilize the same machines to assemble 1 kilobit DRAMS (dynamic random access memories) and 1 megabit DRAMS, but it is impossible to utilize the same testing equipment and the same testing techniques. The advent of VLSI chips during the last decade has forced a radical change in testing technology -- automatic test equipment (ATE) controlled by powerful CPU's (central processing units) now cost a minimum of $1,000,000 each, and are used by the dozens in large semiconductor companies. These machines generate data at a far greater rate than the industry has learned to efficiently assimilate such data.

The demand for statistical process control (SPC), the necessity for trend data, and the transmission of meaningful data back to the manufacturing processes have created an almost insatiable need for test programmers, application programs, diagnostic technicians, maintenance technicians, statisticians, and so on. Testing departments of semiconductor companies are the greatest users of white collar knowledge workers in semiconductor companies. Such employees are in the forefront of technology and are in great demand throughout the industry. Filipino electrical engineers and technicians can begin to fill some of the local demand as the Philippine universities begin to understand the requirements.

Semiconductor Wafer Fabrication:

Of the three major semiconductor manufacturing technologies (wafer fabrication, assembly and testing) wafer fabrication is the most capital intensive, utilizes the least direct labor, and probably becomes obsolete the fastest. The rate of change is so fast and the processes so product-specific that there has so far been no successful pure foundry anywhere in the world. A few very small "boutique" foundries serving small applications have existed from time to time in the heart of Silicon Valley, but none of them have survived on purely foundry service work alone.

The vertically integrated semiconductor companies in South Korea began with foundry work while they debugged their processes and designed their own products; all of them are now selling their own products and some of them are providing standard products in high volume to U.S. companies which are reselling the products. Samsung of South Korea began investigating wafer processing in the early 1970's, and came on stream in the mid-1980's.

The Taiwanese foundry is a joint venture with Phillips and has had a gestation period of about fifteen years.

In summary, almost all foundry services to date have been provided by suppliers whose wafer fabrication operations are part of a vertical semiconductor company which is selling its own products, and not by independent subcontractors as has been done by the independent assembly subcontractors.

As time goes on, and as the industry matures, it is possible that independent wafer fabrication subcontracting could become viable and that the Philippines could be one of the countries where it could make sense; it is all the more likely for this to happen if the Philippines had a viable electronics manufacturing base to support a wafer fabrication manufacturing operation.

The paragraphs that follow are intended to illuminate some of the common questions surrounding wafer fabrication operations. (The statistics provided are by the courtesy of Mr. Dan Hutcheson, President of VLSI Research, a consulting company in San Jose, California.)

It is estimated that the capital cost to bring on stream a submicron medium-sized 8-inch wafer fabrication facility in the early 1990's is in the region of $250 - $300 million. The cost of wafers out of such a facility would be in the region of $500 each, the depreciation cost would be in the region of 60%-70%, the direct labor cost would be less than 10%, and the material cost would be in the region of 10%. The remaining 10-20% would include power, gases, supplies and indirect labor. Annual revenue from such a factory would be between $50 million and $150 million based on answers to the questions: 1) what process, 2) what product, 3) which customers, and 4) what factory loading.

On the other extreme, a 4-inch wafer facility using obsolescent equipment capable of doing 3-micron (3×10^{-6} meters) line width can be brought on stream in about 18 months given enough power, water, expedited import licenses, etc., for about $20-30 million. The questions now become even more acute:

1) Where would a Philippine fabrication house find a customer on obsolete technology? What price would it take to induce such a customer?
2) What is the purpose of such a facility? Who would run it? Is it meant to be commercially viable?

Based on the answers to these two questions, the annual revenue could be anywhere from $0.5-20 million.

The (almost) extreme examples given above illustrate the difficulty of planning a viable wafer fabrication operation without a clearly thought-out long-term strategy. The fact that no large multinationals have yet invested in wafer fabrication operations in developing countries should indicate the difficulty of justifying such an investment.

Electronics (non-semiconductor) Assembly:

The assembly of electronic components (semiconductors and other components) on to printed circuit boards and then into "boxes" is what fuelled the Japanese, South Korean, Hong Kong and Taiwanese expansion. These "boxes" perform the well-known functions of computing, communicating, entertaining, and many other electronic systems. In short they serve the industrial and consumer markets.

Because of the rapid changes in semiconductor component technology and in the market which these boxes serve, it has been difficult to automate their manufacture. Only in the manufacture of very high volume standardized functions (certain televisions and microcomputers) has automation, and therefore heavy capital investment, been feasible.

The continued changes in component technology, and particularly in market demand, will continue to require extreme flexibility from the manufacture of electronic boxes and data storage devices. As an illustration of the trend, IBM procures many of its subassemblies from the Far East, Unisys is in the process of moving its hard disk drive manufacturing into Singapore, as are Conner and Maxtor. All the recent Japanese electronic investments in the Philippines and in Thailand are "box" related.

While the assembly of knobs, printed circuit boards, sockets and cathode ray tubes into boxes will continue to be manual, the assembly of semiconductors on to printed circuit boards is beginning to be automated. This process is proceeding at a modest pace, but the pace is accelerating.

The requirement for flexibility in electronic assembly is driving Japanese "box" manufacturers to subcontract semiconductor assemblies to Filipino factories. The latter, who are now finding it difficult to compete with semiautomated semiconductor companies, are continuing to invest cautiously in semiconductor automation while they hedge their bets by setting up labor intensive, very flexible "box" assembly lines. The Japanese with their attention to quality are sending over teams of engineers to train Filipino assemblers to manufacture the boxes in "the Japanese way".

These fledgling electronic assembly lines, if nurtured by Filipino entrepreneurs and academics, have the potential to seed explosive growth in the Philippines. The support industries required include printed circuit boards (PCB) manufacturing, plastic molding, tool and die shops, plating shops, test equipment manufacturing, PCB design using computer-aided design (CAD) tools, and lastly the installation of semiautomatic manufacturing and testing of completed PCB's. These support industries are very similar to those required to serve semiconductor assembly and testing factories; the demands on these support industries tend to be less stringent than the

demands of the semiconductor industry.

Key Observations

1. Philippine entrepreneurs engaged in semiconductor assembly (e.g., Complex, IMI, FMCI) are now (1988) also heavily involved in the assembly of disk-drive component and board stuffing for Uniden, NEC and other Japanese companies. Taiwan and Singapore began such activities over a decade ago primarily for U.S. companies. These activities laid the base for Taiwan and Singapore to add completed disk drive to their high labor content activities and led these entities to become attractive sites for U.S. and Japanese companies to procure finished products, and to install joint ventures or wholly-owned subsidiaries to manufacture completed products such as computers, telephones, and private branch exchanges.

2. Multinational companies, which account for some 75% of all semiconductor exports from the Philippines are again beginning to expand their operations in the Philippines. Technologies utilized by some of these companies (e.g., Texas Instruments) in the Philippines are among the highest of high-tech semiconductor manufacturing technologies. These technologies include high speed computerized testing using the most sophisticated automatic test equipment (ATE), and semiautomated bonding, molding and finishing operations utilizing some of the most highly advanced high-speed tools and computer-vision assisted technologies found on any manufacturing line aynwhere in the world. While virtually all software support and tool-and-die support presently are imported from the U.S. (and/or Japan), these support industries are suited to the natural strength of the basic Filipino culture and economy. In particular:

(a) ATE is not currently standardised. Every major installation requires custom software for data reduction, statistical processing, data storage and data transmission. Meeting these needs should be a primary goal of Philippines universities.

(b) Precision machining for appropriate tool-and-die support does not require the massive quantities of power, water, process gases and process chemicals needed for process industries such as semiconductor wafer fabrication. Thus, priority should be given to developing small sophisticated machine shops to service these requirements.

3. Wafer fabrication foundries have a very low labor content, are extremely capital intensive, require a sophisticated infrastructure and are high risk propositions. A perfect consensus exists among all Filipino entrepreneurs contacted who are currently involved in semiconductor manufacturing that

(a) Wafer fabrication should be left to large multinational semiconductor companies, and

(b) Other and more promising high-tech support industries (tool and die, gold wire, molded plastic parts, printed circuit

boards, etc.) should be encouraged in order to upgrade the general technology level of indigenous companies.

Multinationals contacted agree that the high education level and easy trainability of Filipino engineers would make wafer fabrication feasible in the Philippines once the power, water, and general "maintenance" issues were resolved. Notably, all U.S. multinationals contacted were highly complimentary about their experience in the Philippines, and would be comfortable in recommending wafer fabrication installation in the Philippines if the "numbers made sense". This usually implies some kind of unusual government incentives, or the introduction of obsolescent products to be "wafer fabbed" in the Philippines (as Fairchild has done recently).

Conclusions

1. Multinational semiconductor companies operating in the Philippines are utilizing extremely high-tech semiautomated assembly and testing manufacturing procedures. These companies are creating significant markets for local producers of software, precision machined parts, tools and dies, plating shops, molded plastic parts and other small high tech items.

2. The best opportunities for joint venutures and other cooperative ventures with other countries in the private sector lies first in the manufacture, then in the marketing, and next in the design of electronic "boxes". These equipments include disk drive components, disk drives, private branch exchanges, micro computers, telephones, and similar consumer and commercial products built initially under foreign supervision for export markets. Attracting these industries and teaming them up with Filipino universities and the national science and technology programs would rapidly build up a domestic demand for printed circuit boards, plastic molded parts, precision metal parts, software, and electronic components of all kinds.

3. There is no natural strategic fit for commercial semiconductor wafer fabrication in the Philippines in the early 1990's. Wafer fabrication facilities are highly capital intensive and product specific, and thus strategically belong to those places which are geographically close to the user market. However, the Philippine academic and government community need to begin the study of semiconductor process technologies, the economics of wafer production, and the market forces impinging on semiconductor wafer production, so that meaningful long-term plans can be generated for this important manufacturing technology.

Computer Software

Introduction

The original objective of this mission was to identify areas in which the Philippine data processing community could expand its position in the world, in the area of off-shore programming. From a strictly esoteric position, this objective can be construed to include the writing and marketing of programs developed in the Philippines, including those programs developed for local usage and then sold to foreign users.

In 1987 a contingent of local vendors, supported by certain interested parties, such as IBM, the Philippine Computer Society (PCS), and others, developed an impressive video tape presentation. This presentation was then brought to the United States in order to sell Philippine data processing programming services to the U.S. marketplace.

This promotional trip did not turn out as successful as one might expect, judging from the result that no really significant contracts of programming were obtained from the trip.

The Divisions of Computer Software

In order to understand the software market in both the Philippines and the rest of the world, one must understand the basic differences between classes of hardware and software.

There are basically three major categories of computer equipment, these being:

Microcomputers
Minicomputers
Mainframe Computers

The basic difference among these three classes of equipment is their size, and more importantly their level of sophistication, speed, and the types of peripheral devices that can be connected to them.

Software development obviously requires availability of the relevant computer systems, either locally, or at least available via telephone lines.

For the most part, only the first two types of computers (micro and mini) are available in the Philippines. That is not to say that there are no mainframe computers, however there are very few of them, and they are basically utilized by large corporations in the course of their business.

The resulting lack of mainframe proliferation has naturally resulted therefore in the development of software companies which

program and sell software to be utilized on the mini and micro lines of computers.

Software Marketplace in the United States

The United States is extremely literate in the area of computer systems, and the availability of both hardware and software. The software marketplace is saturated with companies at all levels of society, and in every geographic location, writing and selling software of all types.

In addition, the saturation of computer stores has created a glut of low-priced hardware and software, often sold at extremely low prices in order to allow the retailer to keep his doors open -- a small or marginal price is a better alternative to no sales. The U.S. marketplace has also seen a rapid growth of software-only stores, many of which represent themselves as discount stores, offering even greater price reductions than can be obtained from the normal computer chains.

Supply and Demand

With the prolific supply of software, and its increasing demand, it is apparent that in order to sell microcomputer-based software, developer must be able to sell the software at greatly reduced prices from retail price. In addition, the software developer is precluded from selling the software directly, and must sell through distributors, who in turn supply the retail marketplace.

The market for minicomputer software is significantly narrower in terms of the number of available users. It is, however, characterized by very specific applications, typically serving a narrow use, such as banking, hospitals, restaurants, etc.

While the demand for minicomputer software is smaller in terms of the number of users, this market is also characterized by a large number of suppliers. A characteristic of the mini marketplace is that the software is typically more specialized, is usually customized to the unique needs of the user, and requires a significant level of support, in the areas of continued changes, maintenance, and user training.

Marketing Off-Shore Software to the Mini and Micro Marketplace

As experience has shown, the software vendors in the Philippines have been unable to effectively market their software products in either the United States or Europe basically due to the following two factors:

1. In order to compete, microcomputer software companies

must be willing to first accept a very small return on each version of the software, in return for the opportuntiy to sell many copies. In order to have software supported by a distributor it must be submitted and evaluated. Since large numbers of individuals and companies constantly bombard the distributors to market their product, the chances of being represented by a distributor are extremely low.

2. Minicomputer software sales typically requires that the vendor be geographically adjacent to the customer in order to provide the normal support required for this type of software.

Based upon the previous description of the world market for software, and the fact that the only major software capability that exists in the Philippines is for minicomputer and microcomputer software, it becomes apparent that no reasonable market exists for the software vendors as they exist today.

A Solution to the Problem

In order to rectify the inability to develop and sell minicomputer and microcomputer software, one must also recognize that services in the mainframe computer area are far more flexible, primarily due to the nature of the software developed, in terms of cost, and the fact that the software is typically required by large companies, who will always consider lower-price alternatives to high development costs. As a result, it appears that mainframe computer software services are the best alternative to the Philippine marketplace.

Unfortunately, however, we are still confronted by one major problem, that there are a relatively small number of mainframe computers available in the Philippines, and the experinece and capability of Filipino programmers to utilize these machines is also limited.

How can we establish a capability to provide services when the major resource (mainframe computer) is scarce, and the personnel (mainframe computer programmers) to support it are not properly trained? We believe that the alternative is to find a resource for whom the investment in the development of the two key resources will provide significant cost savings, without a significant capital investment. We propose the following three alternatives:

1. Identify a large Philippine company with an existing mainframe computer and a staff of trained personnel.

   The government, in conjunction with the company, jointly establish a programming center, initially supported by the company's mainframe computer. The venture would expend the resources required to train

local programmers. When the training is completed, the venture would enter the foreign marketplace to offer various off-shore services.

While this is a practical alternative, it would require capital infusion by the government, and we believe that such an investment may require a long lead time to obtain a return on the investment. In addition, it would require the identification of a local company willing to enter into a joint venture to offer software services, which would most likely not be consistent with the charter of most large companies.

2. All the minicomputer and microcomputer software vendors could be brought together to form a consortium of suppliers, who would be funded by a grant from the Philippine government and international agencies. The venture would acquire a computer system and train personnel similar to the first alternative.

While we believe this second alternative can be achieved, it also is plagued with the problem of major capital investment, which would not see a return on investment until the venture started to obtain software services. In addition, it would be further burdoned by the lack of trained personnel, requiring significant investment in training. Another problem area would be the requiremnt for existing competitive vendors to join together for a consolidated sales and marketing effort. We believe that, although this can be accomplished, it would be a major hurdle which the venture would have to overcome.

3. Induce the investment in the Philippines by a large foreign corporation which would transfer its software maintenance facility to the Philippines. Historically, the cost of maintenance for software has equaled the cost of development. In addition, while the task is important, its level of criticality to meet rigid deadlines is less than that of the program development cycle.

Most large corporations often have many hundreds of programmers, with over half of them assigned to the maintenance tasks. We believe the foreign company could set up a maintenance programming facility, possibly supported by transferring an existing mainframe computer from its inventory of equipment. The facility would be managed by the foreign company, or a local Filipino organization with whom the large company had contracted with. Once the local programmers were trained in the use and support of the company's software, the installation would be self sufficient. This self-sufficient installation, with its installed mainframe computer and trained staff would then become the base from which

additional services could be offered to other foreign companies.

We believe the Philippine government could encourage the third alternative by offering significant tax and investment advantages to the company which is far sighted enough to pursue this alternative.

Major advantages of the third alternative would include:

- o No capital investment required by the Philippine government.
- o Large infusion of foreign equipment
- o Increased capabilitiy of Philippine programming staff.
- o Installation supported by its own existence, by virtue of the fact that it pays for itself due to its contribution to the "bottom line" or net profit of the foreign company.

In addition, we believe this third alternative would provide the base from which the installation could then approach the world market for off-shore software services. Since the facility would be self sufficient, and not require the generation of sales to justify its existence, it would eliminate the demands normally placed upon a business to quickly enter the marketplace to sell services, otherwide the venture will be shut down due to losses.

In summary, we believe the last (the third) alternative would offer to the Philippine government, people, and data processing community the best alternative to generate jobs, increase the flow of foreign investment and inflow of capital. It would provide the most direct path for the Filipino data processing community to become a significant player in the international software activities.

High Technology

Technology as both Product and Process

For any country to participate in high technology development, it is necessary for that country to gain a clear understanding of the process of high technology development, as well as to have the technology itself in terms of the practical knowledge, knowhow, skills, and artifacts that can be used to develop new products and services. One must dispell the misconception that technology is only a product, which once acquired, will lead to knowledge of and further development of the technology involved.

High Technology in the Philippines

In the Philippines, there are a great many of very high-tech devices and equipment at various semiconductor assembly and testing plants. These products of high-tech development have been in the Philippines all along, but the country has only been marginally empowered for further development of these high technologies. One of the objectives of the mission is therefore to explore innovative approaches to involving the Philippines in the process of high technology development. In this way, any products that were developed would be known to the Philippine group that developed it, and could be modified and enhanced as the need for the technology changes.

Furthermore, the process of developing new technologies from "the ground up" would reside in a Philippine working group and/or company. That knowledge could then be applied to the development of other technologies as well as passed on to other Philippine groups. The Philippines would thereby be empowered to participate in the process of high-technology development, without having to incessantly provide "cheap labor for somebody else's machines."

It was observed that the Philippines had, at one point, been competitive with other ASEAN countries in its knowledge of computers and other technologies. Due to various reasons, that peer status had been lost. If the Philippines focus only on the acquisition of advanced technologies without understanding their development and basic nature, there is the risk that another "moment in the sun" would be followed by a loss of competitive edge. Technology is a moving target. Those countries which will remain competitive (in the long run) will be not only knowledgeable of today's working technologies, but also able to modify existing technologies while creating new technologies for tomorrow.

Also noted by the mission were occasional and implicit suggestions that the Philippines can only provide low labor cost rates for existing technologies. In some circles there is a

willingness to perform only the "lesser" tasks such as simple operations and maintenance of existing technologies. The emphasis here is on obtaining work (at any price) in the short term in order to create badly-needed employment and foreign exchange earnings. Our opinion is that this kind of mindset must be changed, and the direct involvement of Filipinos in the process of high technology development will help.

Transfer of High Technology to the Philippines

While the need for employment and foreign exchange in the short term are clearly recognized and acknowledged, the process of genuine development requires a long-term vision and strategy. Part of this vision and strategy is to break out of the trap of low labor cost and low level work in a practical way to complete projects which are empowering and have significant "spin-off" value both economically and culturally. Part of this development process is to redefine technology transfer from industrialized countries so that the process of technology development as well as the technology itself will be effectively transferred.

Traditional technology transfer as has often been attempted in the past with limited success, and has focused mainly on the transfer of machines or technical processes by multinational corporations to the developing countries. After becoming familiar with the function of these machines, usually by manning them with cheap labor, the developing countries would then branch out into areas of support for that technology. Eventually, as the traditional scenario goes, the developing countries would then develop indigenous companies which would take advantage of these technologies to compete with their former leaders. This process of technology transfer is time-consuming at best, and may never be effective.

Since the traditional means of technology transfer would lead a developing country into high-tech development only in the long term and then only after significant commitment of scarce resources and "dues paying", perhaps a more innovative means of initiating a Filipino high-tech presence is in order. One possibility is to initiate a company in the United States with a small group of, say 3 to 5, Filipinos and immerse them directly in the process of high-tech development and running their own company. Within this group a "corporate culture" could be created which is both supportive and effective.

In order to enhance and guide the development process, a product would be chosen which will utilize perhaps the most important comparative advantage in the Philippines, namely, its English-speaking professional people. With that product as the goal, and in a supportive atmosphere possible in the United States, the result will be a Filipino company well-versed in developing technology as well as initiating and running a company.

That group would then be moved back to the Philippines for production of the product, and possibly reproduce itself in the form of another working group. The primary focus of this venture would thus be to transfer the process of technology development. Although the product, or the product area, chosen would be of secondary importance to the transfer of the experience of technology development, the product will be so chosen that it can only be produced cost-effectively in the Philippines.

Exploration of Specific High Technology Product Areas

For the above-stated purpose, the mission has considered a wide range of specific product areas, including industrial machine vision, biomedical image and information processing, and smart database using the combination of information sciences and knowledge engineering in artificial intelligence. Of all of these possibilities, the last one (smart database) is considered most appropriate for the Philippines because it will heavily utilize the following Filipino comparative advantages:

1) Relatively low labor costs
2) Well-educated, English-speaking population
3) Significant medical and legal expertise
4) Well-developed musical acumen and appreciation

The latter two advantages would correspond, respectively, to possible knowledge engineering applications of computerized reading guides for medical and legal professionals, and buying guides for musical compact disk consumers in the U.S. and other international markets. Furthermore, the knowledge engineering field is the least capital-intensive.

Specifically, this venture would involve 3-5 Fillipinos going to Ann Arbor, Michiogan (or another equivalent environment) in order to:

1) actively enroll in high-technology classes at the University of Michigan (or another equivalent institution),
2) found a small business which will choose, design and develop a viable product in knowledge engineering for the U.S. market, and
3) after two to three years, transfer the company to the Philippines for production and marketing of the product.

Note that such a venture will include both high tech and low tech components. The development of the computer software for the smart database will use artificial intelligence and computer science principles (which are high tech) while the encoding of medical and legal literature, or musical compact disks, will use low-cost professionals in the Philippines on a continuing basis. This venture would have the advantage of combining small business, higher education, and high technology. The principal ingredient for success of this venture would be the ability to

manage technology development, including the matching of the technical product to the market, and not just specific knowledge of the technology itself.

The small business environment is considered the most advantageous due to the direct application of a Filipino working group to the tasks of:

1) Product design and development
2) Planning
3) Financing cycle
4) Management of technology
5) Technology transfer

There would be little risk in this venture of technology actually being transferred. The amount of capital required for initiating this venture would be relatively small. The two largest risks would be 1) that the Filipino people involved with starting the company in the U.S. might not return to the Philippines and 2) that the product chosen might not be viable in the world market. In order to minimize these two risks, the following characteristics would be considered of utmost importance in selecting the Filipinos to initiate this venture:

1) Entrepreneurial spirit - assertive, risk-taking, able to meet a long-term vision with discipline,
2) Ability to work within a group - to be able to see the common interests between the individual and the group,
3) Absolute commitment to the Philippines - no question of commitment to return and uplift the Philippines with a new company which is viable and committed to long-term success on its own terms,
4) Ability to benefit from higher education -- post-graduate education will be a significant part of this venture, and should fit directly into the career path of each of the participants. This also speaks to an intellectual capacity which is both well-developed and flexible.
5) Specific skills related to artificial intelligence and/or business development -- there will be a certain complementarity of skills among the members in the Filipino group required for this venture to be successful. For example, some mix of research on artificial intelligence, systems analysis, project management, and product marketing will be needed.

With these criteria for selection (on the front-end), and the anticipation of a viable company moving back to the Philippines as a group, the risk of individuals not returning is minimized. In this way, the best opportunity available to each individual will exist in the Philippines.

In regard to the specific product-area, the field of knowledge engineering and information sciences applied to smart database is recommended. Specifically the smart database will provide a process of transforming information into a form that

facilitates intelligent, friendly, and automated retrieval, be it for medical (or legal) professionals or for compact disk consumers. This can be applied to providing a "query by meaning" of large archives of published information along with more traditional queries (by title, author, publication date, etc.).

Lower-level computer codes, e.g., ASCII (American Standard Code for Information Interchange) text, can be stored along with higher-level computer programs which link user requests with material contents. The computer program would have to be written by someone knowledgeable in both the specific field of the article (e.g., medicine or law) as well as computer programming. The two new technologies that the group would need to develop are (1) meaning extraction or condensation from text and (2) a "query-by-meaning" interface which would allow a user to translate his/her need for information directly to the article(s) which contain the meaning required.

Another smart database application to develop is pattern recognition of user preferences transformed into recommendations for future selection. For example, a large database of compact disks could be stored along with a number of characteristic parameters, which will be coded by trainded Filipino musicians. A user could indicate which disks were listened to and enjoyed, and then from that information, disks could be recommended which have similar characteristics. Still another application where this kind of pattern recognition is common is in computer dating. The technology required here is to take a general rating (1-10) and recognize, from a series of ratings, patterns of the underlying characteristics of previous dates, which can point to future possibilities.

The ideas outlined above were presented by the mission while in the Philippines, and were very well received. The distinction between technology-as-product and technology-as-process was understood and was also well received. With the excellent reception of this possibility, the next step would be to arrange for investment financing to support the group both in its U.S. phase and its return to the Philippines for production and marketing. This funding may come from multilateral, bilateral, national, and/or private sources, both in the industrialized countries and in the Philippines.

Conclusions and Recommendations

As indicated from the previous sections, there are definite and excellent opportunities for export-oriented industrial development in the Philippines in each of the three subareas of the electronics sector in the long run, and some of these opportunities are ready for aggressive Filipino firms and entrepreneurs in the private sector to pursue almost immediately. The UNIDO mission was designed in the outset to be action-oriented in the sense that we would make specific recommendations for actions to be considered by UNIDO, the Philippine government, as well as pirvate firms in both the Phiippines and the industrialized countries. The actions to be taken by the United Nations and the Philippine government are oriented toward the facilitation and stimulation of private-sector actions, which must be self-supportive in the long run. In other words, the public-sector actions are not to replace, but only to initiate and encourage, the private-sector activities in industrial development.

We recognize that any action to implement our recommendations will require funding. It will not be appropriate for us to suggest any specific financing arrangements. However, in offering the following recommendations, we have taken into account our understanding of both the availability and the constraints of financing realities. In particular, we have considered financing possibilities from both the Philippine government and the Philippine private sector, as well as the exploration of financing sources external to the Philippines through UNIDO's assistance.

Investment Climate

The investment climate in the Philippines is much more favorable than what the news media have projected overseas. The Philippine government, with the assistance of the private companies in the Philippines, both foreign and indigenous, should mount a deliberate and systematic effort to publicize internationally about the economic and political conditions in the Philippines. Such international publicity should emphasize not only what the new national policies are to encourage foreign investment in the country, but also what the multinational companies have actually done recently to accelerate investment in the Philippines.

While it may be obvious to some government officials, we wish to stress the urgent need to reduce the bureaucracies involved in day-to-day business and in governmental approval procedures for the investment and operations of the foreign firms in the Philippines, including the further improvements of the Filipino Customs Department. Frequent surveys and communications with foreign firms in the Philippines should be conducted to detect potential emergence of new problems and to help keep the whole process efficient.

Electronics and Semiconductor Manufacturing

Every effort should be expended to attract more "high labor content" export oriented work to the Philippines. These activities are not all "low tech" and are a necessary (but not sufficient) first step to upgrading Filipino electronic technology. Services to be performed include the assembly and/or testing of semiconductors, read/write heads, board stuffing, sheet metal fabrication, floppy drives, electronic "boxes" of all kinds, electric motors, hard disk drives, etc.

Attracting these activities will require a focused, effective government/industry/academe team whose task will be to promote the Philippines to multinationals, and to smooth the interfaces between the various government bureaucracies. Hopefully, the success of the venture will be such that prioritizing foreign investments in the various electronics manufacturing activities will soon become one of the team's tasks.

The team's funding should permit the establishment of promotional offices, initially for two years, in the U.S. and Japan staffed by high level personnel capable of interfacing with businessmen in the host countries. We recommend that the Philippine government and UNIDO jointly explore the possibility of funding the startup costs for the first two years of operations of these promotional offices, which should become self-sufficient after two years.

Although we do not recommend for the Philippines to embark upon the most intellectually advanced and the most capital intensive electronic technologies in the immediate future, we do recommend that a realistic long-term national plan be developed for the Philippines to become a center of manufacturing excellence, and that the strategic technologies developed should be aimed at this objective. We recommend that an appropriate Filipino team of government, university, and industry people, with the assistance of foreign experts, be commissioned to develop this plan over a two-year period. The planning effort should be centered around the Philippine experts who should travel overseas to learn and gather necessary information through seminars, courses, conferences, interviews, and plant tours. Part of the plan should include the development of an effective curriculum for high-technology electronics and semiconductor manufacturing, including wafer fabrication processes. Such a curriculum should be supported by low-cost equipment acquired from (or perhaps donated by) multinational companies that have an over-capacity in wafer fabrication using current technology. Funding for the development and initial implementation of this national plan should come from the Philippine national government, with some matching fund from other sources to be determined through UNIDO's assistance, and with the contribution of multinational companies which may be induced to donate certain equipment as indicated above.

Computer Software

Mainframe computer software services -- initially program maintenance, documentation, and conversion, and eventually program development -- are the best export opportunities for the Philippines in this subarea. The associated problems, that there are a relatively small number of mainframe computers available in the Philippines, and consequently the limited experinece and capability of Filipino programmers to utilize these machines, must be solved in order to exploit these opportunties.

We recommend that a marketing office be set up by the Philippine government in Japan and in the United States with the purpose of attracting to the Philippines the investment by large foreign corporations which would transfer their software maintenance facilities to the Philippines. The Philippine government could encourage this alternative by offering significant tax and investment advantages to the companies which are far-sighted enough to accept this offer. The marketing offices should be staffed mainly by Filipinos with computer and marketing experience, but should also include local marketing experts in Japan and in the United States, respectively, who know the local markets well. The initial funding for the first year of the marketing offices should come from the Philippine government, augmented by additional funds to be explored with UNIDO's assistance. After the first year, the funding may phase out in one to two years, after which the offices would be either self-supporting or no longer needed.

As a second alternative, we recommend that all the minicomputer and microcomputer software vendors be invited to form a consortium of suppliers. The initial objective of the consortium will be to do offshore mainframe computer program maintenance, conversion, and documentation. The consortium should have both marketing offices in Japan and in the United States, which would be funded as described in the above paragraph. In addition, the consortium will need a mainframe computer facility in the Philippines. We recommend that the funding for this facility, which is to be shared by the current minicomputer and microcomputer software vendors, be sought through the cooperative efforts between the Philippine government and UNIDO.

Finally, the Philippine government should provide incentives for large Philippine companies with existing mainframe computers and staffs to expand their activities to include offshore services. Although we do not expect many Philippine companies to take on these new activities, we believe that there are a few which already have marginal interests and can be spurred by government incentives to take on these activities. To the extent that they do get into such activities, the social benefits of additional employment, contribution to foreign exchange earnings, and training skilled computer manpower could well justify the government incentives.

High-Technology Development

High technology promises potential high payoffs but also involves high risks, which would be unjustified for many Philippine firms to take. In addition, high technology can best be developed in the kind of processes which are found only in the venue of selected geographical areas in the world, such as the Silicon Valley in California and in Ann Arbor, Michigan. If the Philippines is to participate meaningfully in high-tech development in the long run, it behooves her to learn about that process.

We recommend that the Philippine government make a commitment to the transfer of the high-tech development process to the Philippines, as well as to assist Filipino firms to participate in the development of high-technology products.

We recommend that the Philippines seriously consider sending a group of 3 to 5 people to go to a high-tech breeding ground (such as Ann Arbor in the United States) to develop a new enterprise jointly with a counterpart group which has a track record of forming successful high-tech new-start firms. A strong candidate for the technology to be developed would be smart database that could suggest new consumer products (e.g., compact disks) to purchase and/or new professional documents (e.g., legal and medical articles) to read, based on the principles of artificial intelligence. An important criterion for choosing the candidate technology would be the need for low-cost professional manpower in the Philippines to make the system(s) work in the long run.

In order to manage the high risks associated with the high technology, we recommend that the Philippine government organize a team consisting of a technical entrepreneur, a potential private investor, an imaginative government official, and a UNIDO official to visit potential high-tech partners in the United States to explore the feasibility of the suggested venture. Financial support to get the new high-tech enterprise into a self-supporting going concern should be considered jointly by this team and the potential partners, with the prior understanding that the funding may eventually come from a combination of sources, including the Philippine government, the Philippine private sector, the foreign (e.g., U.S.) venture capital, and other funding sources to be determined with UNIDO's assistance. To get the process started, we recommend joint funding by UNIDO and the Philippine government for the above-described visit by a Philippine team.

Acknowledgments

The mission members wish to thank the support they have received from UNIDO and from the Philippine Government. We very much appreciate the capable and tireless efforts made by Ms. Jiji D. Julian and Mr. Rene A. Briones of the Philippine Center for International Trade Expositions & Missions, Inc. (CITEM) in making the arrangements for the mission to visit many organizations and individuals, both according to the preset schedule and extemporaneously. We are particularly grateful to Mr. Eduardo Santayana of the Philippine Metals Industry Research and Development Center (MIRDC) for his imaginative assitance in developing the mission in the first place, and in skillfully facilitating the positive interactions between the mission members and the many diverse interests and personalities in the Philippines.

The mission members also wish to acknowlege the special contributions, in the form of original ideas and timely advice, made by Dr. Stanley M. Sternberg, who has served as a resource person for the high-technology subarea of the mission.

Appendix A: Backgrounds of Mission Members and Resource Person

Eugene A. Blanchette is Director of Operations, Raytheon Semiconductor Devision, in Mountain View, California, USA. He is also President of Eugene A. Blanchette & Associates, Inc. in Palo Alto, California. Mr. Blanchette has worked in the semiconductor industry since almost the beginning of that industry, and has held executive positions in many well-known companies in the field, including Fairchild and Motorola. In addition, Mr. Blanchette has extensive international experience in a wide range of countries, including the Philippines, Mexico, India, Ireland, Singapore, Japan, and Korea.

Kan Chen is Professor of Electrical Engineering and Computer Science, University of Michigan in Ann Arbor, Michigan, USA. He is also President of Kan Chen, Inc. in Ann Arbor. Professor Chen's teaching and research responsibilities have been in the fields of systems engineering, technology planning and assessment, and social decision making. Dr. Chen has had international consulting and lecturing experience in a number of countries, including China, Japan, India, Mexico, African and European countries. He has published 7 books and over 100 technical papers.

Arnold R. Kent is President of Worldwide Information Services, Ltd. in Los Angeles, California, USA, which has an operation in the Philippines and has provided services to clients in the U.S., Europe and the Pacific. Mr. Kent has over twenty years of experience in the data processing industry and has been involved in the area of management consulting in the public accounting profession. He has held positions with a number of large companies, including RCA, Lockheed, Coopers & Lybrand, and Deloitte Haskins & sells.

Damian J. Kiska is owner of KDS Enterprises, a private consulting firm in Ann Arbor, Michigan, USA, and represents Machine Vision International Corp. in the mission. Mr. Kiska has extensive experience in database management for industrial, medical, financial, and small business. He has led projects and developed software for electronic circuit board inspection, using high-level computer languages. Mr. Kiska's educational background includes international affairs, specialized in a multidisciplinary approach to the North-South question.

Stanley R. Sternberg is President and co-founder of Machine Vision International Corp. (MVI) in Ann Arbor, Michigan, USA. MVI is a research and development company whose products are sophisticated video processors with the ability to perform complex visual discriminations, such as determining whether a complex machine is properly asembled or guding a robot to perform an assembly operation. Dr. Sternberg is both an inventor and an entrepreneur. He has launched several high-tech companies, holds 15 patents, and has published over 50 scientific articles in the image processing area.

Appendix B: Schedule of Mission Activities in the Philippines

August 25, 1988 (Thursday)

Briefing on the Phillipines Electronic Industry (CITEM)

Hosted luncheon by the Philippine Computer Society (PCS)

Presentation (Mr. Kiska) followed by discussion and consultation with mission members and representatives of industry and government.

Dinner hosted by the Philippine Software Association (PSA)

August 26, 1988 (Friday)

Courtesy call: Undersecretary Tomas Alcantara (Bureau of Investment)

Courtesy call: Dr. Christian Newman (UNIDO)

Plant visit: Integrated Microelectronics

Plant visit: Complex Electronics

Dinner at regular meeting of PCS

August 27, 1988 (Saturday)

Plant visit: Fil-Am life (c/o Ms. Teodora & Mr. Mirasol) (Messrs. Kent, Kiska, Dr. Chen)

Site visit: De La Salle University (c/o Ms. Teodora) (Messrs. Kent, Kiska, Dr. Chen)

Site visit: Anteneo University (c/o Dr. Tong) (Messrs. Kiska, Dr. Chen)

August 28, 1988 (Sunday)

Leave for Baguio (Dr. Chen, Messrs. Blanchette, Kiska)

August 29, 1988 (Monday)

Plant visit: Texas Instruments

Plant visit: Moog Inc.

Return to Manila

August 30, 1988 (Tuesday)

Plant visit: Intel-Philippines (Mr. Blanchette)

One-on-One consultation with members of the Philippine Computer Society (Mr. Kent, Dr. Chen, Mr. Kiska)

One-on-One consultation with faculty of De La Salle University (Mr. Kiska)

Augsut 31, 1988

Plant visit: Philips Components, Inc. (Mr. Blanchette)

Site visit and consultation: National Development Corporation (NDC) (Dr. Chen and Mr. Kiska)

Site visit: University of Philippines (Dr. Chen)

Site visit: SGV (Messrs. Kent and Kiska)

Site visit: SEIFI (Mr. Blanchette)

September 1, 1988 (Thursday)

Site visit: Computer Engineering Corporation (Messrs. Kent, Kiska, Dr. Chen)

Debreifing session: at Bureau of Investment with courtesy call on Undersecretary Raul A. Boncan

September 2, 1988 (Friday)

Courtesy call: Dr. Antonio V. Arizabal, Secretary of Science and Technology

Report Writing

September 3, 1988 (Saturday)

Departure

Appendix C: Contacts

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Department of Trade & Industry

Gnina Gabor President
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Jiji D. Julian
CITEM (Cntr for Intl. Trade Expo. & Missions)

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Department of Trade & Industry

Jorge L. Reyes
Program Officer
United Nations Development Programme (Phil.)

Melito S. Salazar
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Board of Investments

Eduardo Santayana
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MIRDC (Metals Industry Research & Dev. Cntr)

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Board of Investments

Jose Mari Trenas
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Systems Standards, Inc.

Mac Macaraeg
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Advanced Industry, Inc.

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Emma V. Teodoro
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