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SHIFTING TO INNOVATION: PUTTING THE PHILIPPINE MICROELECTRONICS INDUSTRY AT THE FOREFRONT OF DEVELOPMENT

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Throughout the world, the electronics industry has become a key factor in development. In 1998 alone, revenues from the industry reached (US)$1,000 Billion[1] and the number continues to grow at a dizzying pace. The semiconductor industry is expected to grow at a rapid rate over the next five years. Because of this, many countries have expressed interest in strengthening the microelectronics base. This goal makes necessary the establishment and forging of a link among the industry, the government, and the academe which is the key contributor to research and future advancements.

Annual Semiconductors and Electronics Industry of the Philippines Inc. (SEIPI) reports[2] show a rapid increase in Philippine electronic equipment and component exports, starting from US $2.97B (28% of the total export figure) in 1992 to US $23.84B(67% of total Philippine Exports) in 1999. Export projections for the year 2004 amount to US $47.96B for the microelectronics industry, and the industry is expected to attract investments of US $500 million annually. At present, the country is primarily engaged in semi-finished to finished electronic assembly, printed circuit board assembly, burn-in testing and other labor-intensive manufacturing services. Truly, this is a far cry from the agricultural produce that the country was known for just over a decade ago --- a proof that the Philippines is capable of achieving every developing country's dream of becoming a key player in one of the largest and fastest-growing industries throughout the world.

However, for an industry that is expected to "propel the country's growth over the next decade"[3], more should be done to ensure that the Philippines forges ahead to the forefront of technological development. Whereas the country's manpower and funding is currently being poured into component manufacturing and testing, steps However, for an industry that is expected to "propel the country's growth over the next decade"[3], more should be done to ensure that the Philippines forges ahead to the forefront of technological development. Whereas the country's manpower and funding is currently being poured into component manufacturing and testing, steps need to be taken to involve the nation's resources in component and system design

The Microelectronics Industry: A Global Perspective

As the importance of microelectronics-related research and development is being felt, more and more countries are devoting time and effort to making the design and fabrication of microchips for various applications possible. In 1997, a study by a French organization Circuits Multi-Projets[4] (CMP) identified no fewer than 22 nations or regions with funded research and training programs to ensure that the field is infused with well-trained individuals capable of responding to

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the present needs and future demands of a growing industry. There are several desirable factors for competitiveness in this fast-paced industry and among them are:

1. Critical mass of people involved in innovation;
2. Well-equipped research institutions;
3. Educational institutions with strong foundations and updated curricula;
4. Strong entrepreneurial spirit of citizens; and
5. Availability of marketing and technical information.

The Canadian Microelectronics Corporation[5], in a study conducted recently, cites several notable programs implemented by other countries geared towards this purpose:

Europe

Europractice (formerly known as Eurochip) is one of the European Union's major government-funded programs designed to increase industrial strength in strategic areas. According to the organization's website[6], its goal is to improve the competitiveness of the European industry by the "adoption of advanced electronics technologies." Open to industrial companies, research institutes and academic users, it aims to provide complete service from idea to product, enabling it to deliver low-risk, low-cost and easy access to the latest competitive technologies. Europractice also offers support services from its partner organizations to assist users in achieving "fully packaged, tested and qualified devices and systems" ready for use and further development.

France

The government of France, which also participates in the Europractice program, also supports the University of Grenoble – based CMP organization established in 1981. It supplies its clients with "integrated circuit, micromachining, and multichip module fabrication for a number of semiconductor technologies for prototyping and low-volume production." According to its website, more than 2500 circuits for research, education and industrial customers have been fabricated for more than 240 universities, research laboratories and industrial companies in France and in 40 foreign countries.

United States of America

Even the firmly-grounded semiconductor industry of USA has found the need to establish organizations which "influence the strategic direction of pre-competitive research and long-range planning in microelectronics." Both the Semiconductor Research Corporation (SRC) and Semiconductor Manufacturing Technology (SEMATECH) are industry driven and government related projects, which are actively involved in funding university research programs.

Taiwan

In the ASEAN zone, Taiwan has its eyes set on becoming the leader in the microelectronics industry. Through the initiatives of its National Science Council, the government of Taiwan created a major industrial park in the city of Hsinchu near Taipei in 1980. Today, the country has become home to several well-known electronics products manufacturers including the largest foundry in the world, several research laboratories and universities, and the Industrial Research and Technology Institute which carries out many microelectronics-related projects as part of its mandate. These projects, which intertwine research, training and manufacturing, have made Taiwan a world power in microelectronics and electronics products, and the country is now touted to be the fourth-largest semiconductor manufacturer in the world.

The Philippine Situation

The nation's workforce, among other things, has been attracting foreign investments. In recent years, large multinational companies have been setting up factories in the Philippines' technological parks, and to date, there are over 50 chip assemblers and computer component makers who have invested in the country.

At present, the academe is also trying to catch up with its foreign counterparts through research and intensive study of current advancements. In the Electrical and Electronics Engineering Department of the University of the Philippines (UP EEE), undergraduate theses are conducted semi-annually, focusing on various technologies. For the first half of the year 1999 alone, the Intel-funded Microprocessors and Microelectronics Laboratory has produced several research projects as listed below.

Starlite ATM Switch

Asynchronous Transfer Mode (ATM) is a high bit rate, relatively low-cost technology capable of handling voice, data, image, video, high-quality sound and multimedia in an integrated way. The implementation of this technology eliminates the need for separate lines and transmission media for different kinds of communication traffic.

One of the major aspects in designing an ATM network is the switch implementation. For the undergraduate study[7], a group of students focused on the simulation of an 8x8 Starlite ATM switch. In the future, it is hoped that the academe, in cooperation with the industry, would be able to design an asynchronous transfer mode network, which is low-cost and highly adaptable to the Philippine setting.

HPIB Centronix Converter

In the industry and academe, there is a need to interface a printing device with the oscilloscope, which, for the most part, shows the operation of the device under test. Although of great importance in circuit development, this device is not easily obtainable because of its high cost.

The undergraduate thesis[8] aimed to produce a low-cost alternative to this device.

PCI Prototyping Board

Peripheral Component Interconnect or PCI is a high-speed bus technology and is considered to be superior to other buses in terms of design and performance. PCI also supports automatic device configuration, thus, it eliminates the need for hardware jumpers and software configuration utilities.

The objective of the project[9] is to design and fabricate a 5V PCI Prototyping Platform card capable of the following features: PCI compliant 32-bit, 33 MHz Interface (Target only) and supports plug and play architecture. The PCI card must also support the following target functions: type zero configuration space header, parity generation and parity error detection, I/O read and write commands, and configuration read and write commands.

It is recommended that other PCI capabilities and features be explored and implemented in hardware. This includes burst transfer, data stepping, fast back-to-back transactions, etc. Also, the PCI 64-bit implementation appears to be a very interesting endeavor.

Reconfigurable FPGAs

Reconfigurability is one of the main advantages of Field Programmable Gate Arrays. Because of this feature, the hardware needed to implement several functions is minimized, since a system could act as different devices on demand.

The undergraduate study[10] focused on this aspect, and implemented a system, which could be an encoder or, a decoder or, a multiplier on demand. This system is easily expandable, and can be used for several industrial applications.

32-bit Pipelined RISC Microprocessor

The improvement of an existing implementation has always been a part of the development of technology. Specifically, for a microprocessor, this improvement is achieved through the design of its architecture. For a RISC microprocessor, a suitable improvement can be the integration of pipelining in its design.

Pipelining is the overlapping of the execution of instructions. Its realization had its advent in the late 1950's. The goal is to improve the throughput by making the instructions execute in a parallel manner. The theoretical "speed-up" of the processor would be the number of pipeline stages.

The project[11] incorporated a 32-bit five-stage integer pipeline in an existing implementation of a 16-bit non-pipelined RISC microprocessor by Engr. Gemini Abad and Engr. Leonard Jarillas. The improvement hopes to serve a lot of purposes. Some features of this microprocessor include operand forwarding, 2-bit branch prediction scheme, and vectored interrupts.

Viterbi Convolutional Error-Correcting Coder-Decoder

In communications systems, accuracy in the transmission of data is very important. However, when information passes through a channel, distortion or errors occur. Thus the need for error correcting codes.

The undergraduate thesis[12] aimed to design a coder-decoder using (3,2,3) convolutional encoding and hard-decision Viterbi decoding. At present, the said project will be used to test the bit error rate (BER) of a wireless communication system.

Challenges of Philippine Science & Technology

Most industry watchers and technical consultants see the Philippines as the "hottest site[13]", but sadly this goes only for chip assembly and other low-end, less technical stages of product conceptualization, design and production. Although the Philippine microelectronics industry has experienced a boom despite the economic crisis, it has yet to become one of the world's market leaders. This is partly because of several factors of the Philippine Science & Technology scenario which might make it difficult for the country to maintain its position, much less improve its status, in the highly-competitive global microelectronics industry.

Most of the cutting-edge devices in the market today contain chips which have passed through the country in one or more stages of production, but the Philippines still lags behind the microelectronics giants of the world. At present, the country is still unable to design its own systems and components. While other countries have ventured into the more profitable and innovative areas of design and technology conceptualization, the country has limited itself unjustly

to taking on the burden of performing routine tasks for other technologically advanced countries. Thus, there is a need for a reorganization of the industry, and from other countries' experiences, it is necessary for the government, industry and academe to consolidate their efforts and ensure that the collective research undertakings both contribute to and benefit from the funds and resources.

A study[14] conducted recently by R. Guevara, et al. cites several problems of the Philippines' Science and Technology programs:

1. Very weak link among academe, industry and government research and development institutes (RDIs);
2. Low research and development (R&D) activity; and
3. Shortage of R&D-capable engineers, scientists and facilities.

From these perceived weaknesses, it is evident that the country's various sectors have to make a concerted and well-organized long-term effort to realize a highly competitive microelectronics industry.

Strategies for Improving the Science & Technology Situation

The study also proposes several strategies to improve the state of Philippine Science & Technology. Among these are the establishments of:

1. S&T parks
2. Innovation centers
3. Research and Development Institutes

However, these strategies share some disadvantages, listed below as cited in the study:

1. Costly front-end investments;
2. Uncertain return on investments;
3. Single rather than multi-faceted view of technology development; and
4. Concentration of ownership of these initiatives in one stakeholder.

Thus, there is a need to formulate a dynamic strategy, which adapts to the Philippine situation and addresses the problems of the current microelectronics industry.

VCTI: An Alternative Strategy

The Comprehensive Program to Enhance Technology Enterprises (COMPETE) is a Department of Science and Technology (DOST) project aimed at encouraging collaborative research and development work among government research institutes, the academe, and private sector. Program COMPETE shall be implemented through the establishment of a Virtual Center for Technological Innovations (VCTI).

The VCTI is presented as an alternative strategy for improving the S&T situation. It is a network of individual members or associations of members from academe, government and industry, which aims to marshal their resources and efforts to achieve a common goal: that of elevating the Philippines in microelectronics design. To achieve this, VCTI aims to shift the local electronics industry from offering contract services to original design manufacturing, producing products, which are globally competitive.

The VCTI, whose pilot project is in Electronics, has the following salient features:

Little or no infrastructure and manpower requirements. The essence of the VCTI is networking based on electronic networks and multimedia technology. Its members make

facilities and human resources accessible. Hence, members act as host to certain equipment or facilities, being responsible for maintenance, proper utilization and accessibility.

Integrated comprehensive, complementary and customized services. The VCTI provides a comprehensive range of services in education, training, consultancy, information and R&D which is varied but directed along the direction of VCTI, related by a common goal and tailored to the requirements of beneficiaries.

Market-driven, client-oriented activities. All activities of the VCTI, whether for its own sustainability or in the service of its members and clients, shall be guided by trends in the market, innovation and needs.

Shared leadership and management. All the bodies comprising the organizational structure of the VCTI consists of representatives from all stakeholders. No single member has a monopoly of activities and their control. The VCTI organizational structure is similar to that of a foundation to ensure sharing of responsibilities, obligations and ownership of the VCTI.

Equitable sharing of costs and benefits. Stakeholders share equitably in the start-up and maintenance costs of the VCTI. They also have equitable shares in its profits.

VCTIs overcome the problems of the aforementioned strategies for improving Philippine S&T. This is due to the following reasons:

Relatively low investments. The VCTI avoids high front-end investments because, by definition, it requires minimal physical infrastructure (other than networking) and new personnel. Its physical and human resources are based on its members.

Comprehensive coverage of technology development. It focuses on all aspects of technology development, from inception of an idea to its commercialization as a product or technology.

Sharing of ownership. Ownership is not concentrated in one stakeholder; stakeholders shall share the responsibility of management and financing of the VCTI.

The VCTI Roadmap

The goal of VCTI is to create a culture of research and development among the nation's industry. To realize this goal, VCTI has defined a five-year plan summarized in the following figures:

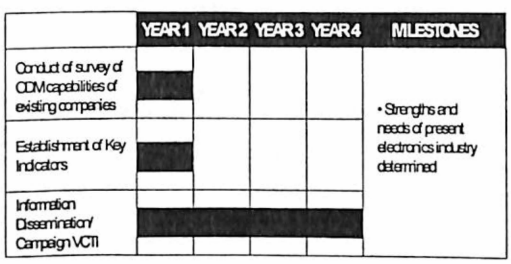

Figure 1 : Roadmap for gathering and dissemination of information

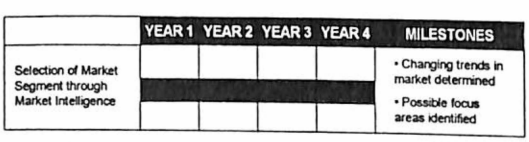

Figure 2 : Roadmap for market scanning

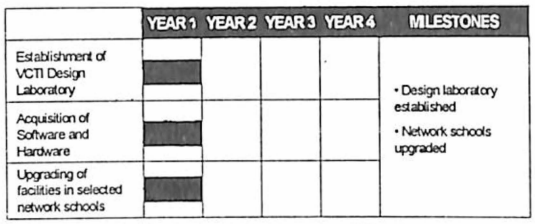

Figure 3 : Roadmap for enhancement of facilities

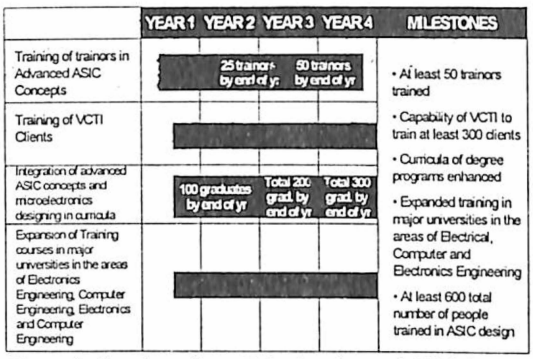

Figure 4 : Roadmap for training in advanced ASIC design

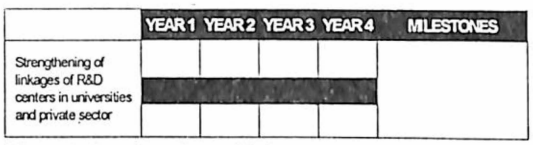

Figure 5 : Roadmap for establishment of network linkages

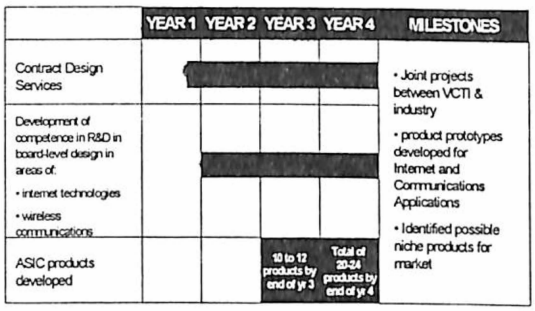

Figure 6 : Roadmap for research and development

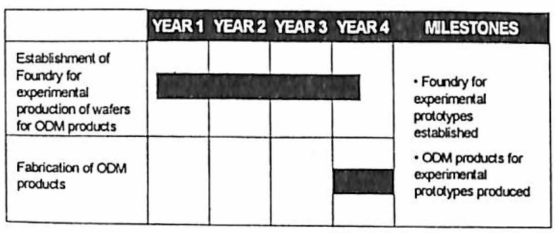

Figure 7 : Roadmap for fabrication

With these objectives, the country will surely be brought closer to its goal of becoming one of the world leaders in microelectronics design. However, the realization of this goal is quite a formidable task, and as the experience of other countries prove, it will not be possible without the intensive collaboration of the government, the academe and the industry.

The VCTI initiative is only one of the forces, which could drive the Philippines closer to its long-term visions. With this, it is hoped that other initiatives will follow these first steps toward technological independence and innovation.

[1] Status 1999: A Report on the Integrated Circuit Industry (Integrated Circuit Engineering Corporation, 1999).
[2] SEIPI Webpage. *http://www.seipi.org/*
[3] Tiglao, Roberto. "Stealth Technology", Far Eastern Economic Review, July 15, 1999.
[4] *http://cmp.imag.fr/*
[5] Information primarily from the "Canadian Microelectronics Corporation: National and Regional Initiatives". *http://www.cmc.ca/*
[6] *http://www.europractice.com/*
[7] W. Descallar, M. Tabangcura, J. Tan Chin. *An 8x8 Starlite Asynchronous Transfer Mode Switch Simulation.* UP EEE 1999.
[8] H. Alvarez. *HPIB Centronix Parallel Port Converter.* UP EEE 1999.
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[10] G. Antonio, L. Raquepo. *Implementaion of a Reconfigurable System Using FPGAs.* UP EEE 1999.
[11] L. Lee, C. Sangil. *32-bit Pipelined RISC Microprocessor.* UP EEE 1999.
[12] A. Chio. *Viterbi Convolutional Error-Correcting Coder-Decoder.* UP EEE 1999.
[13] Tiglao, Roberto. *op cit.*
[14] R. Guevara, et. al. *Study on the Feasibility and the Operation of the Virtual Centers for Technological Innovation (VCTI) Concept in the Philippine Context (Focus on Electronics and Advanced Materials).*