CI-BRASIL PROGRAM

Project for training personnel and support Design Houses in Brazil

1. Introduction

The supply chain of an integrated circuit essentially encompasses the following stages: project, manufacturing of chips (which makes use of more and more sophisticated physical and chemical projects), encapsulation and tests.

The investment on the implementation of manufactured units capable of producing chips typically ranges in the hundreds of millions of American dollars¹, or at least tens of millions when considering the plants needed for the encapsulation and testing stages. Nonetheless, it is possible to engage the integrated circuit business with relatively modest investments – of about hundreds of thousands of dollars per installation – beginning with the design activity in the country, at the same time contributing for the training of personnel that are indispensable for a further expansion of local supply activities in producing integrated circuits.

Based not only on the previously mentioned item, but – and mostly – based on the studies done since 2002 and the facts recollected in several workshops at the Discussion Forum for semiconductor industrial policy that took place along 2004, in which experts from the electricelectronic industry participated, as well as faculty and Brazilian and foreign scientists, the MCT (Ministry of Science and Technology) has considerations. The MCT considers that the several transformations through which the world semiconductor industry has been, specially in the last decade – have created a momentum for Brazil to effectively carry out a National Program for the Microelectronic sector beginning with a Design House(DH) project.

2. Conceptualizing Design Houses

A design house gathers human capital and specialized tools for computer hardware and software for the creation and enhancement of integrated circuits (IC) ranging from the very IC design and the reference design project associated to the IC up to the creation of IC simulators, operating systems and software development kits, as well as the firmware design the embedded software for the integrated circuits.

The action of design houses in the supply chain of ICs is shown below:

¹ In the case of components that use technologies considered state-of-the-art, such investments are worth over US\$ 1 billion.



DESIGN HOUSES – Personnel + Specialized Tools (HW and SW)

The main stages for developing an IC include: conceiving the system for requirement specifications for the IC, high-level modeling project, design check and validation, synthesis, layout; routing; tests and validation and final production. The investment needed for the creation and operation of a DH varies, depending on the complexity and stages in which it will act upon. Usually, DHs specialize in some end-product industry segments, such as the IC for the automobile industry or for the telecommunication sector, or information technology, excise goods etc. DHs also can specialize in developing tools for Electronic Design Automation – EDA and the IP-cores. It is highly important to keep the level of contact and relationship with the customers and in turn, with the product project to which the chip is being developed.

The DH's operation can be classified according to the way they are inserted into the engineering chain, as specified in document PNM-2002. In the study and in order to facilitate the opportunity analyses and the mechanisms for attracting and creating businesses in Brazil, design houses have been classified according to their destination and business model. We have identified three types of companies in this segment: DH1, DH2 and DH3, aside from software companies that provide indispensable work tools for the DHs. They are classified as:

Segment	Types of Businesses	Characteristics/ Market	Investments
	DH1 Dedicated/	Bound to a single	
	Vorticalized	semiconductor company (with or	Relatively small
	Verticalized	without owned manufacturing).	(from US\$ 1 to
Design	DH2 – independent	Grants or hires IP or DH3	US\$5 million),
Houses (DH)	integrators	services.	concentrated in
	DH3 – Independent	Providers of IP modules and	software, training
	Providers	embedded software according to	and workstations.
		DH1 or DH2 specifications.	

Design outsourcing companies are still small - with less than fifteen engineers – that do not advertise or develop any sort of publicity. They depend on long-term relationships with their customers and on the referrals they give to new customers.

We estimate there are thousands of design houses throughout the world providing design outsourcing services to OEMs and to semiconductor manufacturers and distributors.

Also, the design outsourcing market may have grown at an average annual rate of 12% between 2002 and 2005 having reached overall annual revenues of US\$ 2 billion.

At last, it is important to highlight that fixed investments required for the implementation of a design house are relatively modest, similar to the installation costs of computer software companies, what makes it very plausible to define a support strategy for this activity even in a context of severity with a commitment of reaching a tax balance part of the present moment in the country².

3. CI-Brasil Program Objectives

In order to develop the Brazilian microelectronic sector, the CI-Brasil Program will develop actions trying to establish a continuous cycle of development, capacity building and implementation of infrastructure in the area aimed at inserting Brazil in the world IC design market.

CI-Brasil program will follow two lines of actions in regards to the strengthening of the activity in IC projects in Brazil.

On the one hand, we wish to attract to Brazil a portion of the IC design activities developed abroad by Information and Communication Technology (ICT) companies, such as: Ericsson, NEC, Nokia, Bosch, Siemens, LG, SAMSUNG; semiconductor component manufacturers (Intel, AMD, ST Microelectronics, Atmel, National, Texas etc); or even independent international companies, specialized in design (such as MIPs or Rambus).

On the other hand, and just as important because it contributes decisively for the accomplishment of the latter, there is the establishment of conditions that make it possible to set up Brazilian design houses as well as the stimulation to IC design activities in Brazilian ICT companies. The major action of the CI-Brasil Program will be:

 Attracting and creating a design house: the goal is to create at least eleven national houses in three years, be it as start-up companies or as groups connected to national companies or research centers; and the attraction of at

² Below there is a spreadsheet with the details of computer hardware and tools (support software for IC projects) with their respective costs, making up for the typical infrastructure of a Design House.

least four design houses DH1 connected to international semiconductor companies.

The purpose of the program is to promote the creation of a business critical mass in the area, aimed at positioning the segment consistently both abroad and domestically. This is part of a broad and important national microelectronic program, because in the short and medium runs it will guarantee the use of the personnel already trained thus avoiding the flee of skilled personnel (brain drain) to projects abroad.

4. Operation

In order to stimulate the creation and development of design houses in Brazil, there should be specific incentives and benefits, by using mechanisms and instruments that make it feasible to implement the infrastructure (physical facilities, hardware, software, communication and laboratories), the availability of human resources and access to markets.

So as to put the DH business forward, it must be implemented in places that follow these technical requirements:

- To have a technology incubator connected to Brazilian universities as a DH close partner;
- To keep a close exchange of information with personnel training centers with a clear competence in the design house area, to which there will be collaboration from the DH supported for training the personnel.
- To have a commitment in the support of local and national actions for attracting foreign design houses into Brazil.

Operation mechanisms, forecast physical and financial goals are the following:

Operation Mechanisms

a) Personnel:

The management of the CI-BRASIL Program will try to make available technological scholarships with different values. Those will be scholarships given to Brazilian professionals that will be part of the design house teams. The scholarships could be claimed by new businesses, including international company's dedicated/Verticalized DHs.

Physical Goals:

• Forecast of specialized personnel for the 5 centers/companies with CI-BRASIL:

New local Design Houses (*)	Total companies	Total Designers
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Year 1	Five (5)	5	50
Year 2	Two (2)	7	70
Year 3	Four (4)	11	110

(*) Average number of 10 designers

	Goal for new international companies (**)	Total companies	Total designers
Year 2	Two (2)	2	40
Year 3	Two (2)	4	80

(**)Average number of 20 designers

Financial Goals:

- Considering average values for scholarships: R\$ 3,500.00 a month for designers level 1 and R\$ 5,000.00 a month for designers level 2; in year 1 there would be 30 scholarships level 1 and 20 scholarships level 2, in a total of expenses R\$ 1.26 million + R\$ 1.20 million = R\$ 2.46 million/1st year and R\$ 2,90 million/2nd. year
- In year 3 there would be 80 scholarships level 1 and 30 scholarships level 2, in a total of expenses R\$ 3.36 million + R\$ 1.80 million = R\$ 5.16 million/3rd year.

b) Infrastructure

Workstations and servers, development and test kits, training and communication infrastructure will be made available by the Priority Program under the MCT – Programa Nacional de Microeletrônica – PNM-Design, as agreed by the commission 'Comitê da Área de Tecnologia da Informação (CATI)', responsible for the management of the information technology fund 'Fundo Setorial de Informática (CT Info)'.

- Hardware, software and design kits will be purchased by Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq - and transferred onto the project companies in the form of assignment.
- Design houses will be preferably implemented in foundations, incubators, technological parks or research institutes so that they make use of the existing infrastructure.
- Implementation of DHs in the cities of São Paulo, Porto Alegre, Campinas, Recife and Manaus according to the guidelines of the Priority Program PNM-Design and business plan what encompasses the interaction with the academic and the business sectors nationally and internationally, training personnel, number of projects accomplished, number of companies serviced and other science, technology and innovation indicators (S&T&I).

c) Forecast or resources needed for implementing 4 Project Centers (Resources of the IT Priority Program PNM-Design, Amazon Fund resources not accounted for)

Type of Expense (*)	Year 1	Year2	Year 3
4 DHs	(thousand R\$)	(thousand R\$)	(thousand R\$)
Imported Hardware (2 Servers, <i>backups</i> / DH, 4 DHs)	600	120	120
Workstations Linux x86 (8 per DH, 4 DHs)	256	50	50
Software **	3,360	3,360	3,360
Network Infrastructure	400	50	50
Consumption material	200	180	180
Permanent material	300	90	90
Training costs	80	80	80
Taxes, freight and import taxes ***	90	14	14
TOTAL	R\$ 5,286	R\$ 3,944	R\$ 3,944

(*) Considering the implementation of infrastructure in incubators, foundations or research centers

- (**) Cost strongly dependant on CAD licensing negotiations
- (***) Assuming tax exemption. Import by the 1990 act nº 8,010 from the National Council for Scientific and Technological Development (CNPq) or by an institution accredited by CNPq. For withholding taxes, add R\$1,200,000.00

Imported hardware: Servers: US\$ 50,000 per DH. Hardware: Linux x86 Workstations: R\$ 8,000 per station

Total cost for implementation and operation of 4 design houses (three-year period): R\$ 23.7 million.

c) Location

The proposal for implementing design houses is strongly linked to the feasibility of the effective participation of the DHs with the local, regional, national and international industries. Initially, we foresee the implementation of Project Centers in the following locations:

i) **Campinas** - Research Center Renato Archer (CENPRA): Cenpra hosts the first mask factory that is one of the essential inputs for manufacturing semiconductors for physical-chemical processing. Additionally, Cenpra has research lines in different areas of the microelectronic sector, both for component projects and for production process development, hence being of the major institutions for the policy underway.

ii) **São Paulo** - USP: Laboratório de Sistemas Integráveis Tecnológico (LSITEC). University of São Paulo is the Brazilian university with the largest number of researchers in the microelectronic sector, both for IC design projects and for production process development. Hence, it has a strategic role in the training of personnel that will support the national microelectronic policy.

iii) **Porto Alegre** - CEITEC: Porto Alegre will host the "Centro de Excelência em Eletrônica Avançada - Ceitec", the first unit to be implemented in Brazil for the full production of ICs with CMOS technology with prototypes. This will play a major role in promoting the training of personnel capable of acting in production processes with the CMOS technology leading (and yet for many years) the microelectronic industry.

iv) **Recife** – CESAR: Recife Center for Advanced Studies and Systems (Cesar). The University of Recife has one of the most active research groups in the country for the development of methods and microelectronic devices and coordinates the project Brazil-IP. This project has been implemented by a consortium with academic groups of ICs from eight universities: UNICAMP, USP, UFPE, UFCG, UFRGS, UFMG, UnB and PUC-RS – that develop IP modules, what has led to the development of methods, tools and training of personnel in IC activity projects which will be continued by the Center of Strategic Technologies of Northest - CETENE (Agency of MCT).

v) **Manaus** - CT-PIM: the Science, Technology and Innovation Center at the Duty Free Zone of Manaus will be a competence center in Microsystems and microelectronic device production technologies, what will make it a centralizing and replicating agent for the academic and business sectors for the basic technologies needed for adding value and innovating in the industry of electronic equipment installed at the Duty Free Zone of Manaus.

CENPRA and CEITEC will be 'anchor' units for implementing the DH Program to the extent they already have facilities implemented for the process stages of conceiving, designing, mask manufacturing, and ICs' manufacturing or tests.

However, training and capacity building activities must be decentralized in 05 regional centers, involving directly the facilities and installations at the Universities and incubators that are local partners (in the same city) of each DH implemented with the support of the Priority Program PNM-Design.

The focus each DH wishes to adopt will depend mostly on the local and regional demand. Nevertheless, we expect the proposed DHs develop ICs and innovative hardware in telecom, bank and industry automation, mechanic and electric industries in general; solutions in RFID, agribusiness solutions; development of circuits for the automobile, energy, wireless systems, chipset for Digital TV, Electronic Design Automation – EDA sectors, and IP-cores(Intellectual property modules) for developing IP libraries. With that, almost every need in the national industry is to be met.

5. Expert Training and Capacity-building

The success of this program is strongly dependent in the capability of training electronic engineers with expertise in integrated circuit projects and hardware systems. We propose the creation of 5 active training centers near each DH, and that at least one institution of this center hosts expert training activities.

CI-BRASIL Program will support the training activities with financial resources, following these requirements:

5.1 Specialization and on the job training in a DH

There will be a university program for training personnel in a specialization course (*lato sensu*) and national in scope, in the area of IC. This program will be technically managed and directly advised by the Brazilian Society of Microelectronics (SB Micro) to be responsible for the specification and quality control of the course together with the center-offering university.

The course will be given in 5 Brazilian universities with proper faculty and infrastructure, aiming at a broad regional distribution.

Capacity-building and On the job training Program Model

These are 540-hour courses for the specialization of professionals and future instructors in analogue, digital and mixed IC designs. Their application will always be done with the active participation of Brazilian university faculty members and business professionals with great experience. The professionals to be trained must have a major in electric engineering, computer science, physics or related areas. Activities will be distributed in three modules: upgrade, improvement and on the job training.

There will be a 180-hour on the job training module, which objective is to simulate real working conditions at a design house. Under the continuous supervision of experienced and active professionals, the student will develop a full project for real IC blocks from also actual specifications, in a professional state-of-the-art environment. During this period, there will also be activities dedicated for developing their entrepreneurial abilities.

This is an exclusive dedication course and participants will be selected based on a public invitation process and supported by monthly R\$ 2,500 scholarships during the whole training, in a way as to guarantee total attention and dedication to the learning process. There will be a practice lab for the on the job modules at the DH supported by the Priority Program PNM-Design.

Type of Expense (*)	Year 1	Year 2	Year 3	
	(thousand R\$)	(thousand R\$)	(thousand R\$)	
Faculty wages (R\$ 200.00 / hour _gross)	350	350	350	
Scholarships (R\$ 2,500.00 / month)	3000	3000	3000	
Costs/ transportation / Management	250	250	250	
TOTAL	R\$ 3,600	R\$ 3,600	R\$ 3,600	

(*) Considering the course will be offered in 3 institutions for a total of 100 students/year

Total cost of the specialization program (three-year period): R\$ 10,800,000.00

5.2 Program for Qualification and Certification of Professionals for the IP-cores Project (Strategic Program in IP-cores). Action in Brazil-IP.

CI-Brasil Program will support the activities for competencies and experts (undergraduates and graduates) in the area of project certification of an Intellectual Property module.

The actions associated to this program are connected to the university network Brazil-IP that has been producing quite promising results. The project has now 8 universities that have trained over 50 students in the project area IP-cores following international quality standards.

The objective of this action is to train and certify professionals that will act on the IP-cores project. The IP-core market has grown 30% a year and the embedded electronic industry (automobile, telecommunications etc) is one of the industries that fosters this market the most. But, in order to act in this segment we should train personnel with competence in Intellectual Property modules. The training should be guided by the following topics:

- 1. Scope (all project phases must be considered);
- 2. Completion (projects of major IP-cores must be considered);
- 3. Quality (IP-cores must be projected according to world quality standards);
- 4. Efficiency (actions must be directed to train personnel and set up technology in a way as to not only add IP-cores providers, but also IP-cores industry users).

In sum, these are the goals to be achieved:

- IP-cores training goal: about 84 professionals with industry quality standards

- Physical goal: development of 14 to 21 IP-cores with industrial quality in three years.

Year	Capital/year	Cost/year	Scholarships/year	Total/year
1	70	152	257	479
2	70	332	432	834
3	50	512	525	1,087
Total Cost	190	996	1,214	2,400

Table – Total cost of training program (in R\$1,000.00)

5.3 Action follow-up and evaluation for the FRH

All decentralized and supported Capacity-building/Training actions in the CI-BRASIL Project will be evaluated periodically, and depending on the evaluation results, new stages will be launched. It is basic that all government investment be followed by a strict evaluation so that objectives can be complied with. In order to guarantee the evaluation and certification of participating groups, we would have to create a validation and certification center that would follow international quality standards.

6. Ordering a prospective market study

Setting up a prospective market study is aimed at identifying niches in which the DHs must act upon in order to fulfill the national market and guarantee a successful outcome. That is, we wish the study can identify the engineering services for the electronic project in the country. Thus, we propose to allocate as soon as possible the sum of **R\$ 500,000.00**

7. Conclusion

The CI-Brasil Program will be an important instrument for making it possible to:

- Develop final product engineering development in Brazil focused in the Electronic Complex systems;
- Develop computer tools for supporting IC projects by companies and/or software development centers located in Brazil;
- Stimulate synergies and externalities drawn from the strengthening of technological parks focused in various segments of the electronic complex with the creation of IC advanced design centers with advanced infrastructure for telecom, cutting-edge Electronic Design Automation - EDA tools (specialized software), high performance workstations and shared-use libraries;
- Increase competition in the different national economic sectors, through the supply of innovative products and services both differentiated and value-added with the use of ICs developed in Brazil;

- Broaden personnel training and capacity-building supporting projects cooperated among education institutions and research centers and companies, with the major purpose to meet the real needs of the production sector; promote the exchange with internationally renowned companies so as to train designers and faculty members in state-of-the-art techniques, methods and tools;
- the strengthening of the national electronic industry by means of the spread of concepts related to the manufacturing of semiconductor devices and techniques and computer tools used in the IC project with Brazilian electronic engineers; and
- technology-based entrepreneurship focused on ICs and software development to support this activity ("Electronic Design Automation EDA").

Finally, these are the resources needed for the implementation, continuity of the Design House Program and personnel training for a three-year period:

Type of Expense (*)	Year 1	Year 2	Year 3
Expert personnel: DTIs for DHs	2,46	2,90	5,16
Infrastructure DHs	5,29	3,95	3,95
Brazil IP- Program	0,80	0,80	8,80
Program Training (capacity building and on the job training)	3,60	3,60	3,60
Scholarships CNPq-PAETI	to define	to define	to define
TOTAL	R\$ 12,15	R\$ 11,25	R\$ 13,51

Summary table of needed resources for implementation, operation and maintenance of DHs during three years (in **million reais**).