CHAPTER 6

PUBLIC POLICY INSTRUMENTS TO ENCOURAGE CONSTRUCTION INNOVATION: OVERVIEW OF THE BRAZILIAN CASE

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6.1 INTRODUCTION

This work aims mainly to present and to analyse the policies adopted by the Brazilian government to promote technological innovation in the construction sector. Knowing there is a great demand for building construction and specially for housing, the main investments oriented to innovation have preferably been accomplished in the latter and, for that reason, it will be the analysis and consideration focus in the present work.

The work is divided in three sections. In the first, the goal is to characterise the process of economic and technological development the Country has been going through in the last years, focusing on the innovation process in construction. In the second, there is a focus on the current and more significant Government policies that are oriented to technological innovation in construction, particularly in the construction of buildings, trying to show its impact on the whole productive sector. In this section of the work there is an attempt to answer the questions posed to all the countries participating in this work:

- What instruments and approaches are being used by Governments to promote innovation in this sector?
- What works and under what circumstances?

To look for answers to those questions, data were collected from academic works focusing on Government policies oriented to innovation and also to valuable information gathered directly from persons in charge of several projects in progress - to whom the authors would like to thank for the collaboration - and also the information supplied by several research and development supporting agencies in the Country.

Finally, in the third and last section, the conclusions of the work are presented along with answers to the questions posed by the participating countries:

**How to strengthen innovation in the construction industry?**

### 6.2 CONTEXT

#### 6.2.1 Technological and economic Brazilian development

This first section of the work shows the context in which technological innovation is happening in Brazilian Construction.

Brazil, after a period of great economy growth which happened from the beginning of the sixties to the end of the seventies, went through a period of great economic instability, high inflation, and literally no economic growth that lasted the whole 80s, extending into the early 90s.

That period was characterised by a series of financial difficulties, when the Government could not honour its commitments and not even refinance its debt; this also led to an increasing inflation, and to an expressive recession; as result, there was a series of economic plans that tried to stabilise the economy again.

Among the several plans proposed, in 1994, one was implemented that managed to keep the economy stability until now, at least from the inflationary point of view. However, the great foreign debt and the need of structural reforms in several productive sectors of the Country, and the Government itself, are still hindering factors that make it difficult to plan and forecast for medium and long terms. Completing this picture, the Government policies that have been establishing very high interest rates, is one more obstacle to be overcome for fully resuming growth.

In spite of all those difficulties, the 90s were also marked by internationalisation that caused the market to open to foreign companies and products, thus contributing to an expressive change in the national economy because, threatened by foreign competition, all the productive sectors were compelled to modify and to modernise their production relationships, aiming to increase their product competitiveness.

With that, a new phase is being consolidated of industrial growth oriented to production relationship modernisation. The construction industry, characterised by several authors for wastes of different natures, for high production costs, and for sustaining and keeping disqualified labour employed, due to the economic and social importance that it represents in the productive group, could not help participating in the process of the Country modernisation because, besides being responsible for the Country modernisation process, it is also responsible for high percentage of the gross domestic product (GDP), and intimately related with countless other activities, not just the ones concerning construction. It is within this modernisation process which the Construction Industry is going through that the next topic will be approached.
6.3 CONSTRUCTION AND TECHNOLOGICAL INNOVATION: RECENT EVOLUTION AND CURRENT PRACTICES

6.3.1 The years of growth and the crisis

Inserted in the economic context described above, construction has gone through different development phases and Government policies.

In the beginning of the 60s, according to the works of Farah (1988), from Fundação João Pinheiro (1992) and of Vargas (1994), structural changes happened in the whole Brazilian society, with significant repercussions in the Construction industry.

Infrastructure was implemented to make industrialisation possible, strengthening the heavy construction subsector, with great projects in the area of transports, energy, mining, and metallurgy; in addition, there was a strong urbanisation process that led to the development of the material and component construction subsectors particularly due to Government intervention, through the Welfare Institutes, of the People's House Foundation and, in 1964, through the creation of the National Bank of Housing (BNH), that aimed at mass production of housing units.

That period of economy investments and growth went on into the 70s, beginning to give signs of gradual fall starting in the late 70s, with an intensifying recession in the middle 80s. During that period great housing blocks were built, marking an important stage of the construction of buildings history in Brazil, mainly because it allowed the introduction of technological innovations leading to industrialisation. Between 1976 and 1982, for instance, the housing financial system financed annually, on average, the construction of nearly four hundred thousand new dwelling units. In the beginning of the seventies, motivated by the high demand provided by Government resources, the Building Construction sector was motivated mainly to increase productivity, so that it was possible to produce a great number of housing units in a short period of time.

The introduction of "innovative" constructive systems or "industrialised" systems, based mainly on the pre-fab components, mostly brought from other countries, was the answer given by the building companies to the demand.

According to Castro (1986), more than 50% of the technology used in those sites was imported and, for its adaptation to the national conditions, investments were required for technological research, carried out by the Government as well as by the manufacturers, and by construction firms. By the end of that period and the beginning of the eighties, the picture of resources supply begins to change, then marking the beginning of the crisis.

At that time, two factors began to substantially modify the construction scenario. On the one hand, there was a political opening in the Country, allowing the Government to enforce an action to allow for popular dwelling construction; on the other hand, there was an increasing economic crisis that hindered the liberation of financial resources, mainly because the financial system used until then was completely compromised.

The need to build more dwellings, given the existing deficit, and the shortage of resources led the search of a more intense construction cost
reduction. This last factor has consequently led to the need of adopting new constructive technologies; that is to say, of technological innovations.

So as to solve the housing problem, the State triggers an action oriented to new construction technologies and thus promoted several seminars and discussions that involved the whole productive chain. Farah (1988) reminds that at that time the experimental sites located in Naramdiba (Bahia state), in 1978, and in Jardim São Paulo (Sao Paulo state), in 1981, in which technological innovations were tested. The action aimed at achieving the modernisation of the sector so as to meet the objectives of the governmental action, of low-cost and of large-scale production, to cater for the low-income population.

The experimental sites were created to accomplish an evaluation of the proposed new technologies and, starting from there, to promote those that could be used.

For that occasion the outstanding role of Financiadora de Estudos e Projetos - FINEP (Financial Support of Studies and Projects), was stressed. FINEP is a public company belonging to the Ministry of Science and Technology - MCT, of the Federal Government, that aims to promote technological development and innovation in the Country, in compliance with the goals and priorities established by the State.

FINEP, that was acting in the housing area since 1976, in the research and technological development area, had a complementary action in connection with the National Bank of Housing - BNH, and with the National Council of Scientific and Technological Development - CNPq, an organism also belonging to the Ministry of the Science and Technology.

One of the actions of FINEP, in the late seventies, resulted in the definition of some research lines, with a priority to support the projects oriented to the low income population. A co-operation protocol was signed between FINEP and BNH for information exchange about researches in the area. Based on the activities developed in this period, in 1978 the Integrated Program of Habitation and Sanitation was approved, through which FINEP supported (together with BNH) several researches of the two areas chosen.

Through that action it was possible to set an important partnership gathering FINEP, BNH and IPT (Institute of Technological Researches of the State of Sao Paulo) for the development of an evaluation methodology for new constructive processes, that aimed at the establishment of evaluative parameters for the units produced in the experimental sites.

That partnership, in spite of undergoing ups and downs, has persisted until now, as it will be seen further on, because the evaluation of new constructive technologies is still an unsolved subject in the ambit of the Construction Industry in Brazil and new actions with that same objective are still under way.

Unfortunately that Governmental action did not last long because, although financial resources still existed for carrying out works with innovative processes and constructive components and of there being Government agents really engaged in the incentive process to the financing of those types of construction and of there still being actions as the partnership established with IPT, a more effective technological innovation policy never existed in the sense of involving all the actors in the same direction.
The Government itself was fragmented in relation to that subject, having groups that defended the maintenance of conventional construction and they only gave room to innovation when the lack of financing money forced the search for lower costs. Thus, the experience of technological innovations introduction ended up by characterising it as a punctual event, because as soon as the favourable conditions provided by the Government to the use of innovations ceased, there was a retraction in their use on the companies’ side and the whole process formerly described was abruptly interrupted with the worsening of the economic crisis which, added to the problems of construction financing fund management, caused the wreckage of the whole housing financial system operative until then.

According to Castro (1986) for the construction industry of material, component, and equipment, the investment in production amplification oriented to the housing demand was idle in the following years, mainly due to the countless pathological problems that appeared in the dwelling units, as a consequence of the absence of an adequate technological development.

With the lack of financing, the companies that had opted for development and the use of new technologies were forced to re-set their strategies. The flimsy innovation experiences ended up, and since 1986 the sector has been complaining about the lack of a financing structure for construction in the Country.

6.3.2 The current scenario

The current construction configuration begins with the crisis experienced since the late seventies, which has caused expressive changes in the sector.

A great competition resulted from the decrease in the number of works (in 1987 the number of licensed works was just 47% as compared to 1980). IBGE (1989) pointed out that companies had to work towards cost-reduction as the only possibility of maintaining their profitability and staying in the market.

That cost-reduction was sought mainly through production rationalisation. According to IPT (1987) and (1988), the companies try to obtain productivity gains and to minimise costs as well as time through production rationalisation, without disrupting the productive base that characterises the sector. To reduce the waste of time and of material, some of the main conventional construction bottlenecks are fought, such as: lack of articulation among the several design types and between office and site; absence of quality control; bad work conditions as a factor for low productivity; site disorganisation, etc.

Although the building companies were concerned with their costs and with identification of new actions so that they could keep their competitiveness in the market, on the Government side, only FINEP, besides other fostering organisms for essentially academic research, through scholarships, such as CNPq, FAPESP - Foundation for Supporting Research of the State of Sao Paulo (Fundação de Amparo à Pesquisa do Estado de São Paulo) and CAPES – Foundation Co-ordination for Personnel of University
Level Improvement, maintained some action aiming at the development of the construction industry.

In the mid 80s, FINEP programs were elaborated in the field of social development. For the housing area four researches lines were established with emphasis on the formation of human resources, as described below:

- Production process of the urban space (land use legislation; studies on urban land profit, and on the real estate market)
- habitation production process (the construction industry and the construction material industry; technological researches seeking low-cost construction)
- the Government, policies for investments in housing; equipment of collective use
- dissemination (exchange promotion in researches; creation of informative bulletins; surveying the "state of the art" in the sector).

The Program of Housing, Sanitation, and Urban Development was also elaborated, with the priority of choosing, in each of the following subsectors:

- Researches aiming at subsidising the responsible agents performance for policies planning and implementation
- case studies and pilot-experience aiming at the solution of local problems, with special concern to the low income population
- projects aiming at simplified technologies diffusion for users.

In 1987, a new Program, PROURB - Urban Development Program - was approved by FINEP; it concerned the areas of Housing and Urban Development. Its research lines were defined from a comprehensive debate with the scientific and technological communities, and with other financing agencies such as: CNPq; Ministry of Housing, Urbanisation and Environment; and Federal Savings and Loans (CEF - Caixa Econômica Federal). It should be remarked that after BNH was closed in 1986, CEF was appointed to co-ordinate all activities concerning the research related to that bank.

The implementation of those programs were made both in terms of public policies oriented to the housing area, and in the new material and constructive systems development.

In the area of new materials, studies concerning the use of vegetable fiber (sisal and coconut) were financed and the use of lightweight aggregate in construction, developed by the Centre for Researches and Development of Bahia - CEPED - and for the use of fine grained concrete in construction, accomplished by the School of Engineering of Sao Carlos - EESC/USP.

Concerning constructive systems, it is worth mentioning the outstanding research accomplished by several organisms, among them the following stand out PCC-USP (Departamento de Engenharia de Construção Civil da Universidade de São Paulo), with the development of new constructive and dissemination methods and processes for the technical environment; FAU-USP (Faculdade de Arquitetura e Urbanismo da Universidade de São Paulo) with the elaboration of a catalogue of constructive
Public Policy Instruments to Encourage Construction Innovation: 
Overview of the Brazilian Case

...typologies potentially usable in low-cost housing in several areas of the State of Sao Paulo; IPT (Institute of Technological Researches of the State of Sao Paulo), establishing minimum performance criteria for the production of housing to low-income strata; CETEC (Foundation Technological Centre of Minas Gerais), with the elaboration of a catalogue of constructive typologies potentially usable in low-cost housing in several areas of the State of Minas Gerais.

In spite of the efforts accomplished by several researchers in the area (notedly between the end of 1989 and the beginning of 1993), sponsored by FINEP, countless difficulties existed to establish a true policy orientated to the Technological Innovation of the sector.

Even so, two researches were supported: the first, developed by the Foundation for Technology of the State of Acre - FUNTAC, addressing the search for alternatives of low-cost housing for the Amazon Region; and, the second, accomplished by the Latin American Institute - ILAM, of Sao Paulo, the latter aiming at designing and building prototypes adapted to the conditions of certain urban areas of the Brazil.

A more systemic approach from the Government happens through the Ministry of Social Action within which the National Program of Housing Technology - PRONATH (BRASIL, 1991) was created, linked to the Brazilian Quality and Productivity Habitat Program PBQP-Habitat (Programa Brasileiro da Qualidade e Produtividade do Habitat), having as a guideline the technological and managerial modernisation of housing production. In this program, it is clear that actions aiming at the sector "technological innovation" are indispensable, and the following should be stressed:

- To strengthen the productive structure of the sector concerning its technological and managerial capability
- to implement policies of labour training that enhances the introduction of technological innovations
- to motivate the use of new technologies for housing production
- to strengthen laboratory and research infrastructure for technological development and services rendering
- to foster the creation of new laboratory units and research groups, advisory and technological consultancy
- to develop courses on technological innovation
- to develop mechanisms of technology transfer.

Regarding the Technological Innovation Program - PRONATH (Brasil, 1991) it shows the following central objective: “to improve the knowledge range and available technologies in the Country, in the design, material manufacturing, and component areas, as well as in construction, operation, and maintenance of housing construction”.

Aiming at that, a proposition was made to minimise the current “technological bottlenecks” in the subsector to reach the following goals:

- Developing technological innovations in the design, material, component, and constructive systems areas
training all the national productive sector for the use of design, production, construction, operation and maintenance new technologies.

- promotion and large-scale application of new technologies in housing construction.

In 1992, now in the competence of the Ministry of Social Welfare, the Program was reformulated concerning the actions planned for the biennium 93/94, becoming less comprehensive and more adapted to the financial constraints of the Country. The objectives of "final cost reduction of low-income housing" and of "housing quality improvement" started to prevail over others and the actions to be developed aim at technological innovation, the use of appropriate technologies of local conditions, and the fight against construction waste.

From this new definition, several initiatives were adopted in the ambit of the Program, for example, the accomplishment of a show room in Brasília, gathering alternative constructive systems; and also, a Co-operation Agreement with the Italian Government, in the year of 1989. Within this agreement, a "National System of Technological Development Applied to Housing" project was elaborated and approved in 1991, whose objective was the financing of equipment for construction materials and component tests, aiming at creating conditions, in national laboratories, to improve the quality and productivity of housing production, especially the one of social interest. The project intended to establish ten evaluation centres counting on equipment and technical personnel, besides the assemblage of a reference system of technologies at national level.

Besides, there was also the popularisation of the Ministry of Welfare Normative Instruction no. 4, that established general guidelines for systems and constructive components approval in programs administered by the National Secretary of Housing and by the Ministry itself. This document, of great relevance for the sector, was approved by actors such as the Private Insurance and Capitalisation National Federation Companies - FENASEG; Brazilian Association of the Companies of Real Estate Loans and Savings - ABECIP, and Federal Savings and Loans - CEF and, although it was not actually implemented, it generated a lot of discussion and debates in the construction sector, strengthening the need of such guidelines as well.

For a presidential decree of July 1993 a new program of Government action was also created, aiming at technological innovation, called Program of Technology Diffusion for Low-Cost Housing - PROTECH, linked to the General Secretary of the Republic Presidency and supported by eight Ministries, among them the Social Welfare and the Science and Technology Ministries (MCT), getting resources from of the Federal functional properties alienation (Decree no. 1,036 of 04.01.94).

PROTECH aimed at the diffusion of new construction technologies for low-income housing by means of financing the construction of some pilot units, and the establishment of a diffusion centre from those units. That group was named Technological Village. Eight of those villages took part in this program, but only five were concluded at an average of a hundred dwelling units each; ten technologies were selected for each village. A valued aspect of this program was the community participation and of representative society
sectors for choosing the technologies to be adopted. Many Technological Villages were built in several Brazilian States, such as Parana, Minas Gerais, Bahia, Sao Paulo, among others.

Parallel to these initiatives, a wide debate was promoted by MCT, in April 1993, through the Brazilian Academy of Sciences - ABC, about housing research in the Country. From this debate, some issues emerged: normatisation and certification areas as priority subjects, assembling and memory recovering of the experiences accomplished, quality and productivity management in construction, new materials and technologies development, and sector trade formation and training. As a conclusion, the need to promote sector re-articulation due to the action of multiple institutions also emerged (FINEP, s/d).

Facing this scenario, it was necessary to implement a Housing Technology Program - HABITARE, by FINEP, to plan and to carry out the strategy in this area, especially concerning the contribution to the public policies formulation, implementation, administration, and evaluation in the field of science and technology. More information will be provided in the second part of this work; however, one action to be remarked in this program (for its relevance in the innovation technological process) is a research initially conducted by IPT and now by COBRACON (Brazilian Committee for Construction, from ABNT - Brazilian Association of Technical Norms) that will allow for minimal norms for innovative construction system performance evaluation. For that, the Ministry of Science and Technology has allotted resources from the National Program for Privatisation to FINEP within the "Low-Cost Housing Technology."

Finally, we attention should be drawn to the last Government policies concerning the State of Sao Paulo’s Low-Income Housing Quality Program, the so-called QUALIHB (started in 1996); the Programa Brasileiro da Qualidade e Produtividade do Habitat – PBQP-H (Brazilian Quality and Productivity Habitat Program), of the Secretaria Especial de Desenvolvimento Urbano - SEDU (the State Secretariat of Urban Development, directly related to the President of Brazil) (1998); and the Competitiveness Forum of the Civil Construction Industry, co-ordinated by the Development, Industry, and Foreign Trade Ministry (Ministério do Desenvolvimento, Indústria e Comércio Exterior – MDIC) (2000).

In the second part of this work, more information about these and other Government actions in progress that aim directly or indirectly at construction modernisation will be discussed and answers will be provided to the following questions:

- What instruments and approaches are being used by Governments to promote innovation in this sector?
- What works and under what circumstances?
6.4 PUBLIC INTERVENTIONS

This second section discusses the major public interventions which are now contributing to technological innovation in the Brazilian Construction sector, as shown in Table 6.1:

- Programs to support R&D: FAPESP, CAPES and CNPq actions
- Programs to support advanced practices and experimentation: the HABITARE Program
- Programs to support performance and quality improvement: the QUALIHAB Program, the PBQP-Habitat Program and the Competitiveness Forum of the Civil Construction Industry
- Programs to support the adoption of systems and procedures: COBRACON / ABNT Actions.

6.4.1 FAPESP

6.4.1.1 Objectives

The Fundação de Amparo à Pesquisa do Estado de São Paulo – FAPESP (Foundation for Support to Research of the State of Sao Paulo) is one of the greatest Brazilian technological and scientific financing organisms. Its major objective is to provide grants and other activities related to technological and scientific research, local and international interchange, and information in the State of Sao Paulo. It is an autonomous organism.

6.4.1.2 Annual resources

FAPESP annual budget is one hundred and sixty thousand million dollars (FAPESP, 1998), and it finances not only actions concerning the construction industry, but also academic research programs. The Health sector is the first one, with 21% of the funds, followed by Biology, with 16%, Engineering – 16% (all fields together, among which Construction), Social and Human Sciences – 12%, and Physics – 9%.

Its resources come from the VAT - value-added tax, once 1% of this tax of the State of Sao Paulo is destined to technological and scientific research.

The construction industry projects are granted about 1% of the total amount of funds, or something like one and a half million dollars per year (FAPESP, 1998).

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1 In reality FAPESP is largest state financial backer in Brazil where similar institutions exist such as in states of Alagoas, Bahia, Ceará, Goiás, Maranhão, Mato Grosso do Sul, Minas Gerais, Para, Paraíba, Paraná, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Norte, Rio Grande do Sul, Santa Catarina e Distrito Federal. From its importance is given the focus.
6.4.1.3 Means

The FAPESP actions concerning construction industry projects include the sponsoring of about one hundred and eighty projects, from which two thirds are grants (for young scientists and for Master of Science, Doctoral and Post-doctoral studies). The other third is related to research funds for specific projects, laboratory equipment, library acquisitions, congress organisation, participation in congresses, invitation to foreign researchers, book and journal publications, for example.

The construction projects are related to almost all types of studies, focused on building and the habitat problems, which goes from building economics and architecture, to very technical issues; from studies carried out in laboratories to those conducted by means of field or library investigations; from individual to integrated projects, involving different groups from different universities or research centres.

Even if FAPESP has normally financed universities or research centres, from the mid nineties onwards, it has also attempted to finance industry projects where innovation appears as a central subject, mainly for small and medium firms, by means of PITE - Inovação Tecnológica em Parceria (Technological Innovation by Partnerships), and PIPE - Inovação Tecnológica em Pequenas Empresas (Technological Innovation in Small Firms) Projects; the former is based on the partnership between the innovative firm and a research centre, and the latter is the same, but specifically oriented to small firms.

6.4.1.4 Contribution to innovation

It is very difficult to objectively estimate FAPESP actions for contributions to innovation in the sector.

The grants allotted to young scientists (fifty per year) are investments for the future; the results of those allotted to master of science (thirty per year), doctoral (thirty-five), and post-doctoral (five) students are more obvious, even if we do not have indicators to measure their impact. Nevertheless, one can say that the FAPESP system is one of the most effective and efficient of the Country, and that it is very selective, with a very strict control.

Some reflections may arise about the investments directly related to technological projects and also to the promotion of innovation.

Thus, on the one hand, if we regard the amount of specific projects, normally those with more resources, related to construction, it can be easily seen that their relative participation in all the money allotted is less important in other Engineering fields. In fact, this kind of project responds to 37% of the financial investments of the Foundation, percentage that decreases to 10% if we regard Engineering, and to only less than 7% in the construction case.

On the other hand, the number of industry financed project based on innovation (PITE and PIPE) is almost zero (according to FAPESP, 1999, only one of PITE Projects are related to construction subjects). Two may be the reasons for that: either the idea is not very attractive to “construction” firms, or the technical board of the Foundation prefers to finance more “advanced”
areas, like electronic, chemistry or new material. We suppose that the first is the real reason, even if “Construction” is not one of the major research strategic themes defined by the technological and scientific policy of the Country.

The conclusion: construction has to look for other financing sources, and not only for grants. If it reaches the same average figures of Engineering, or 10% of the total funds, this can represent the increase of three hundred and eighty thousand dollars per year, or more 26%. In the same way, if construction firms, in partnership with the academic sector, get 1% of the total amount of funds allotted to innovation, this will represent something like one hundred and thirty six thousand dollars a year, or additional 9%.

It means that the construction industry could get from FAPESP something like two million dollars per year, or 36% more than it is granted nowadays. It can also be supposed that the contribution to innovation of the total investment would grow in the same proportion.

6.4.2 CAPES’s actions

6.4.2.1 Objectives

Foundation Co-ordination for University-Level Personnel Improvement - CAPES is a public organism linked to the Ministry of the Education - MEC. Its main objective is in helping MEC in master degree policies, co-ordinating, and stimulating - by means of scholarships, aids and other mechanisms - the formation of highly qualified human resources for teaching at universities, research, and the attainment of public and private sectors professional demand. CAPES also manages a specific program that is of interest to this work called PADCT (Scientific and Technological Development Support Program) whose goal is to widen, improve, and consolidate the Nation's scientific and technological competence in the university environment, research centres, and private enterprise; this is done through integrated projects that impact scientific and technological development. This program results from World Bank funding to the Brazilian Government through the Ministry of Science and Technology, MCT. FINEP and CNPq also act as PADCT administrators, and their aims are wider than the ones mentioned above.

6.4.2.2 Annual resources

As the data for the scholarships specifically granted to the construction area could not be accessed, they can be estimated by adopting the same percentile of incidence of that area in relation to the total amount allotted by FAPESP, which is 1%.

In fact, it seems that no significant mistake will be committed, once the relative percentile of Construction Engineering in relation to the total are similar in the two cases: 16.0% on average in FAPESP (1998) and 16.6%, 15.9% and 18.9% in CAPES, respectively for master, doctorate and post-doctorate grants (1999 and 2000 - until June - data).
If the value of 1% is adopted, it will provide the following numbers (1999 and 2000 average): annual number of master scholarships: 88; annual number of doctorate: 69; annual number of post-doctorate abroad: 3; total annual scholarships: 160.

Those values correspond to a monthly average expenditure of US$76,000 or a little more than nine hundred thousand dollars a year (1999 and 2000).

Besides scholarship awarding, *CAPES* also finances part of the Graduate Programs infrastructure (*PROAP* and *PROF*) and it also has fostering programs. According to the same previous reasoning, the average annual values granted to construction would be of six hundred and seventy thousand dollars.

On the whole, *CAPES* direct annual support to construction is estimated to be almost a million, six hundred thousand dollars.

The amount of *PADCT* resources oriented to construction could not be calculated, either. In all, the Loan Contract between the Brazilian Government and the World Bank foresees, for the first stage of *PADCT*, the amount of US$ 310 million, which must get US$ 50 million as a private sector counterpart, leading to a grand total of US$ 360 million.

### 6.4.2.3 Means

The essential means for innovation contribution for *CAPES* is through scholarships besides financial support for specific research projects, laboratory equipment, library acquisitions, congress organisation, participation in congresses, invitations to foreign researchers, book and review publications, etc.

Besides that, as manager of programs such as *PADCT*, *CAPES* could also act indirectly in the financing of companies and specific projects in science and technology.

However, it must be remarked that among the *PADCT* components, just one of them, the so called *CDT* - Component of Technological Development, which aims to promote technological development of companies and to increase investments from the private sector in R&D, through fostering the partnerships between the academic and the productive sector aiming at the improvement of the global performance of the Brazilian innovation system and the diffusion of technology, favouring the construction sector.

The *PADCT* funds managed by *CAPES* are limited to the following: allotments for human resource training and development project formation; scholarships in the Country and abroad; aids for events and trips both in the Country and abroad; resources for equipment and permanent material to

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3 The other two components are: 1) *CCT* or Science and Technology Component that aims at promoting and financing Research and Development/R&D and human resources in areas of national development relevance (Chemistry, Chemical Engineering as *QEIQ*; Geo-Sciences and Mineral Technologies as *GTM*; Science and Material Engineering as *CEMAT*; Environmental Sciences as *CIAMB*; Biotechnology as *SBIO*; Applied Physics as *SFA*; 2) *CSC* or Sectorial Component that consists in promoting and financing activities oriented of services rendering such as supporting to Brazilian sector of R&D reform and improvement process.
laboratories; acquisition for science and research schools and centres; air ticket provision.

6.4.2.4 Contribution to innovation

As in the case of FAPESP actions, it is very difficult to objectively estimate the contributions to innovation of the CAPES actions, including the ones originated by PADCT resources.

6.4.3 The CNPq actions

6.4.3.1 Objectives

CNPq, National Council for Scientific and Technological Development, is a Foundation linked to MCT - Ministry of the Science and Technology - to foster research. Its mission is to promote scientific and technological development and to support researches, necessary to the social, economic and cultural progress of the Country.

To carry out its mission, CNPq accomplishes three basic activities: fostering, research support and science and technology information and diffusion. Among them, the first two are of special interest.

CNPq also manages a specific program on this line, the Training of Human resources for Strategic Activities Program - RHAE, whose goal is to improve competitive conditions in Brazil for the international scenario, by improving the technological capacity in themes selected according to their strategic relevance, according to MCT guidelines; their clients are public or private companies, producing goods and rendering service.

6.4.3.2 Annual resources

In all its programs, CNPq granted in 1998 a total of 933 scholarships for Civil Engineering, that represented 2.2% of the overall. Once again, adopting the same percentile of incidence in the construction area in relation to the total adopted by FAPESP, which is 1%, the total number of scholarships reached 424, and almost two thirds of them are either for master or doctorate programs.

In terms of values, the estimated total invested in construction, in 1998, was three million dollars.

6.4.3.3 Means

As mentioned before, two of the three basic activities of CNPq are of interest here: fostering and supporting research.

Thus, fostering is the main action developed by CNPq, for promoting scientific and technological development in the Country, aimed essentially at preparing human resources and for supporting the accomplishment of researches, through the granting of scholarships. The
direct support to research seeks to promote and to stimulate the production of the necessary knowledge for the economic and social development of the Country, to the confirmation of the cultural identity, besides the rational and non-predatory use of its natural resources.

The fostering action is organised in Basic and Special Programs. Basic Programs are those oriented to the planned use of the fostering instruments, according to the traditional areas of knowledge, among which Civil Engineering in general, and Construction in particular. The Special Programs are those that correspond to strategic areas and multidisciplinary fields, as well as those of regional features, whose action concerns any area of knowledge. They are characterised by the perspective of medium range, focusing on induction mechanisms, for interinstitutional articulation and for the relevance criteria incorporation, in compliance with Government orientations contained in sectorial and regional policies that require strategic contributions from science and technology.

Besides that, in the area of the RHAE Program, CNPq manages a specific budget destined to grant scholarship to several modalities (3 to 24 months long): in-Country and abroad internship; to welcome specialist visitors; for industrial technological development; for in-country training and abroad.

The 1998 percentile shows, however, that the supporting modalities, at least in the case of Civil Engineering, took place mainly through the fostering actions through scholarships (66% of the total value) or of "productivity in research scholarships", granted to renowned researchers (25%), than those that support research, directly, or indirectly, through support coming from external researchers (total of 9%).

6.4.3.4 Contribution to innovation

It is once again very difficult to objectively estimate the contributions to innovation from CNPq actions.

6.4.4 The HABITARE Program

6.4.4.1 Objectives

To contribute, through support to researches in the area of science and Technology, to the solution of the Brazilian housing problem and for the modernisation of the construction sector, always having in mind integration with environmental concerns (FINEP, s/d).

To achieve the general objective the following action lines were defined:

- Setting of co-operative research networks
- dissemination and evaluation of the available knowledge
- development of new technologies
- integration with the productive chain
• stimulation and consolidation of research institutions’ partnerships with companies of the sector
• management of quality and productivity
• development of normatisation
• decrease in construction environmental impact
• proposition of urbanisation criteria and infrastructural aspects
• innovative procedures of housing management
• evaluation of public policies
• post-occupancy evaluation.

6.4.4.2 Annual resources

There is a variation of resources from one year to the other. In average it totals something close to US $816,000.00. In the last years the total resources invested were: 1996 – US $530,000.00; 1997 – US $1,055,000.00; 1998 – US $786,000.00; 1999 – US $896,000.00. For 2000, the forecasted value is R$2 million or US $1,111,000.00 (not reimbursable). The resources of the non reimbursable financing come from FNDCT - National Fund for Scientific and Technological Development. FNDCT is managed by the Special Presidential Secretariat.

It is a Fund established so as to provide financial support to priority programs and projects for Brazilian scientific and technological development.

6.4.4.3 Means

HABITARE is a FINEP (Financial Support of Studies and Projects) program which is a public company belonging to the Ministry of Science and Technology - MCT, responsible for financing projects concerned with the technological development of the Country.

In this program, based on the action lines previously presented, two basic types of projects exist: the non-reimbursable, from which financial return is not expected, and the ones of applied research, in which it is mandatory to involve the company that will use the technology to be developed or improved, and financial return is expected.

The projects of applied research are of on-line application, that is, they may apply at any time. The required information must make possible for FINEP not only to confirm the adherence of the proposals to the operational policies and action lines, but also the financial conditions of the proposing company, the warranties offered, the internal coherence of the proposal in terms of objectives, budget, methodology, deadlines, etc.

The interest rates, paying off periods and amortisation are defined case-to-case, within the possible institution limits (usually more favorable than market values).

There is no previous definition of the type of technology to be financed, but it is necessary to contextualize its importance for the sector or for the productive chain of the financed action. It is possible to finance projects of
quality management and of managerial administration, as well as basic education on general contents to workers, so as to complement a technological development project.

The non-reimbursable projects are launched by means of public submission - each them contemplating specific themes - and they are open to the participation of: Research Institutions, non-profit Associations and Technical-Scientific Societies - both public and private. Companies of the sector can participate under the research institutions co-ordination, and offer financial counterpart (that can be financed).

In compliance with the proposed themes in the submission phase, the institutions elaborate projects that, besides the usual presentation of a project of R&D itself, they should inform the monitoring and evaluation processes of the projects and - which should be emphasized - the strategies through which the research results are passed to the productive sector.

The criteria for judgement and choice of the projects to be selected may vary according to the submission, but they are basically:

- Performance qualification - approach related to the researcher’s capacity or the group’s, research methodology and institutional infrastructure
- intrinsic merit of the project - likelihood that the researches will lead to new discoveries or progress inside science and technology or that will cause impact in the area or in areas of science and technology
- usefulness or relevance of the research - it considers the likelihood that the research can contribute to the technological development and solution of social problems
- impact on the infrastructure of science and technology - potential that the researches contribute to better understanding or improvement of the quality, distribution or efficiency of the scientific and technological research, education and human resources
- budget - the consistency of the proposed budget in relation to the submission objectives, to the institutional and the researchers’ team capacity
- financial participation - financial participation of the productive sector in the project
- resulting projects for researches supported by HABITARE.

6.4.4 Contribution to innovation

There is no numeric data about the impact of those actions on the productive sector, and much less of the specific impact over the technological innovation. However, it is possible to verify that the Program has indeed contributed to the technological improvement in the sector constituting not only one of the small financial sources for the study and development of innovations, but also a great opportunity of effort concentration of the Government’ organisms, research institutions, non-governmental organisations, class union, and private enterprise around that subject.
Unfortunately, the reimbursable projects of applied research have not received great acceptance from the sector. Nonetheless, its contributions have been more punctual in helping to develop some products and specific processes.

It is expected, in the next years, with the search of better quality and productivity for the companies, that there will be a larger demand for projects in that modality. On the other hand, the non-reimbursable projects have had a good adhesion of the research institutions, and, among their contributions to innovation, the following stand out:

- Clustering of several organisms and innovation-oriented institutions in joint projects;
  the program has been working under the consultancy of a co-ordinating group, composed by main agents that act in the area, and in that way it has allowed those institutions wider possibilities for the development of the sector.
  In that sense, one of the projects financed by the program resorted to a very interesting research strategy for the first time in a continental dimension country, and several scattered research centres, like Brazil: the concentration of several research centres and universities around a single project, optimising the resources and enlarging the research scope and its results in the productive sector. This is the research "Alternatives for reducing material at construction sites", involving researchers from more than sixteen Brazilian universities, whose main goals were to collect rates for material and components loss at the sites, to identify the causes and, based on the results obtained, to propose alternatives to reduce these wastes (see: http://www.pcc.usp.br/Pesquisa/perdas/)

- establishment of dissemination/information networks on innovation processes and products in the sector;
  the concern of the program with its knowledge transfer to the productive sector has lead to the creation of informal networks of knowledge diffusion among the research centres and the productive sector. Besides that, an information network was created for the sector, formed by several linked nucleus, and centred in an Internet site

- technological innovations financial proposals;
  several projects were financed aiming at both new products development and of the improvement of existing processes and products, some of them with the collaboration of several companies of the sector, and, consequently, with the immediate diffusion of the researches results.

- financing for new technologies evaluation;
  evaluation of some advanced experiences of introduction of new constructive systems, which is fundamental for future decision making about the use of those systems, and, consequently, for their dissemination.
Finally, it should be noted that the limit of those results is also found in the development of broader Government projects and policies, where PBQP-Habitat is an example of the productive sector itself (see below).

6.4.5 The QUALIHAB Program

6.4.5.1 Objectives

The State of Sao Paulo’s Low-Income Housing Quality Program, the so called QUALIHAB⁴, is a Program to support performance and quality improvement, that is being implemented in the State of Sao Paulo to the local supply chain of the building sector. The Program is based on the purchasing power of a common client of these actors, the low-income housing office of the State, CDHU (Companhia de Desenvolvimento Habitacional e Urbano – State of Sao Paulo’s Housing and Urban Development Company. Through the QUALIHAB Program, CDHU aims at optimising the quality of housing with regard to products and services that have been used in their conception and implementation, from partnerships with the main actors of the sector through agreements. These agreements ponder: the implementation of specific quality program, the maximisation of the rate profit x cost (direct costs and costs of exploitation) and the satisfaction of the customers.

Although this Program is not meant to encourage innovation itself, it has had a very important effect, as will be seen below.

6.4.5.2 Annual resources

The CDHU contracts, on average, forty thousand housing units per year, on three hundred financial operations. Its resources come from the State of Sao Paulo’s budget and, especially, from VAT -value-added tax (up to 95%), once 1% of this tax is destined to the so-called social interest housing. CDHU’s annual budget is about three hundred million dollars.

Despite those values, the resources of the QUALIHAB Program are not so important, as they represent only seven hundred thousand dollars per year, or less than 0.3% of the total budget. It must not be forgotten that it is not a program oriented to support R&D, not even to support advanced practices and experiments. In fact, the firms have done the most important investments, and it is difficult to correctly estimate the counterpart amount of money they have actually spent. Small firms, that normally adhere to the Program, usually claim that their external investments to comply with all the QUALIHAB requirements are of about thirty thousand dollars, without taking into consideration the internal costs (the salaries and upgrading skills of the employees that work in the reorganisation process of the firm, besides machinery, such as computer soft- and hardware, for instance). If the number of firms involved in the Program up to now is estimated, nearly three hundred can be figured out, which means that these firms have invested something like

⁴ QUALI is a contraction of quality, and HAB, of housing.
nine million dollars to support performance and quality improvement, or three million dollars per year, since 1998.

6.4.5.3 Means

The QUALIHAB Program is based on "deals", even if it has a local scope (the State of Sao Paulo represents almost 40% of the Brazilian GDP). A particular characteristic of these agreements is that they have been negotiated by the CDHU with the different unions acting. For instance, after a negotiation period, the general contractors' union, which is the most affected agent up to now, set up an agreement with CDHU in order to create a quality assurance system that has been included in CDHU's procurement processes since July 1998. This system is based on the ISO 9000 Standards and it includes the "level of qualification" concept.

It is easy to understand the CDHU power as a client that is able to improve quality and innovation in all the supply chain of the local housing providers sector. It should be noted that Brazil has undergone a very particular moment, with low inflation and important economic growth; from this context, paradigms have been changed, and the barriers that regulate competitiveness in many sectors, including the building construction have been gradually removed.

Some of these new features can be remarked concerning the economic and commercial measures through: the new requirements from customers, both public and private, that express themselves further in terms of quality, delay decrease, and demand of services, among them innovation; the tendency of decreasing prices of the housing units; the opening of markets to international competition.

The lack of financial resources and the deep crisis in the housing financing system, that have affected the private market as well, are also new important constraints, now connected to the financial dimension of the environmental concerns.

It is said that intervening changes in the Brazilian real estate market caused an unprecedented growth in the competition among firms. Indeed, two thirds of the State of Sao Paulo general contractors building sector considered "competition" as their most prominent problem in 1997, preceding others as interest rates, being equivalent to problems linked to manpower or suppliers.

It is within this context that it is necessary to understand CDHU actions: the financial power of the State, that collects funds thanks to a specific legislation, combined with a strong competitive environment, that has driven all actors of the sector to react and to accept a new logic of efficiency, ruled by quality management and assurance principles, and by the search for innovation.

In spite of its comfortable position in this process, the CDHU did not want to impose rules. Instead, and this is one of the most prominent features of the QUALIHAB Program, it has made the decision to conceive and to put into practice a program based on "deals". What were they concerned about? In short, they consist of commitments negotiated with the employers' different actor unions, which have established two main points:
Public Policy Instruments to Encourage Construction Innovation: Overview of the Brazilian Case

1) a set of “technical referential” requirements, adapted to each case, based on concepts and tools of quality management and assurance principles which CDHU progressively requires in the procurement phase of its contracts, and deadlines to answer them, in a short period of time (in the particular case of the general contractor’s agreement, it took from January 1998 to January 2000 to be accomplished).

Indeed, the CDHU well understood that the only way to get some concrete and positive results is to efficiently contract the distinct actors of the sector, represented by their unions. To recover the delay in relation to the technical capacity, organisational ability, and bound to management, the partnership public housing “buyers” x private actors has imposed itself.

What were and still are interests for industries, engineering firms and contractors in this setting? Very simple: in a context of strong competition it means to achieve advantages in the procurement phase of the CDHU operations. Besides, even though the rule of the "least price" remains valid, all those that have been “certified” by the Program economising. For example, general contractors no longer need to proceed to quality controls while using products certified by QUALIHAB, provided that they are already qualified.

The State purchasing power connected to private sector partners' expertise, weaknesses, and needs has led to a common goal: housing quality; this quality is perceived in its multiple features: architectural, constructive, environmental, performing, innovative, etc.

Going deeply into the details of the Program organisation, it could be said that the QUALIHAB Program's negotiations with different unions began in 1994. In all the cases it has conducted to progressive processes, with gradual deadlines, that foresee a period of two and a half or three years for their complete implementations. The Program is organised in two committees: "Material, Components and Systems" and "CAE – Construction, Architecture & Engineering." The unions that take part in the first one are those that represent producers of steel for reinforced concrete, cement, lime, prefabricated products, ceramic products, tubes and plastic components, industrialised sealers, electric components, for instance. The "CAE" committee is more heterogeneous, and it has included, among others, unions that represent general contractors, architects, engineers, construction managers, laboratories, topographic services, and foundation subcontractors firms.

So far, almost twenty different agreements have been signed in both committees, and all of them are based on the principles shown above. So, every actor's technological and financial limits have been respected.

For instance, in the "materials, components, and systems" agreements, the technical clauses were based on the objectives and principles of product certification. Before requiring that only certified products should be employed in CDHU projects, the Program foresaw some intermediate levels, based on the idea of progressive quality control of production lines. It also foresaw the implementation of new standards and codes, adapted to the Brazilian scenario.

In their turn, most of the agreements of the "CAE" committee are based on the objectives and principles of the ISO 9000:1994 Standards, as is the QUALIHAB Qualification System for General Contractors (QUALIHAB-
Going deeper into the presentation of this System, it can be said that, in an agreement signed in November 1996 between CDHU and the two general contractors’ unions, the QUALIHAB-GC as a gradual process (with its series of partial deadlines) had a period of three years foreseen for its complete implementation. The System reached its first upper level “A” in January 2000.

The QUALIHAB-GC System has four levels of achievement and, according to them, the quality management system of the firms is evaluated and ranked in a progressive and continuous way. It has also another particular point: the qualifications are made only by third-parties audits carried out by accredited external independent auditing service organisations. It is consisted of eleven requirements that are related to some of the twenty chapters from paragraph 4 of the ISO 9001:1994 Standards. It can be considered as a preparatory model to the ISO 9002:1994 certification.

The most important principles of the QUALIHAB-GC are (Cardoso (1997) and Cardoso et al. (2000)):

- The step-by-step progression, that allows general contractors to adjust themselves to the accorded requirements, offering them the necessary time for self-development, while creating the educational conditions that induce them to progress in the improvement of their quality management system
- the proactive characteristic, that aims to create an environment that leads firms to a certain degree of qualification
- the fact that the assignment of a qualification is a privilege of the Assignment Commission of an accredited organisation which is composed of representatives of the general contractors and of the customers (CDHU and civil society)
- the guarantee of anonymity of the firm until the end of the evaluation process and the use of the transparency principles, the independence of those who agree to the qualifications and the collective decision process adopted in this case.

It can be said that a French successful experience in adapting the ISO 9000 Quality Management Systems requirements to the Building scenario inspired the Brazilian system: the QUALIBAT System (Sycodés 1996/97; Archambault, 1995).

In conclusion, as from January 2000, to participate in the CDHU submissions, general contractors should have the qualification level “A”, the highest. In mid 2000, there were almost two hundred and fifty firms qualified by QUALIHAB-GC, among which more then one hundred level “A”.

Figure 6.1 illustrates the major ideas related to the agreements celebrated between CDHU and the actors’ unions, taking the General Contractor’s as an example.
6.4.5.4 Contribution to innovation

Since 1998, the QUALIHAB Qualification System for General Contractors has been adopted by almost two hundred and fifty general contractors, and is deeply changing their relationship with their suppliers, with a very important forward linkage effect in the supply chain; the backward linkage effect, affecting the relationships between general contractors and their clients in a positive way, is also an unanswerable fact.

More than this, other actors in the supply chain are also concerned with this movement. For instance, architects and engineering firms have just followed in the same way, proposing a progressive system, similar to the general contractors’. Construction managers and foundation subcontractors firms already have their progressive systems, which have qualified almost thirty-five firms of both types (mainly foundation ones).

Industrialists are also implementing quality principles and tools in their production lines; new standards and codes have been developed; the technical capacity of the laboratories have been stimulated as well, among other actions.

Not only the CDHU projects, but also many others all over the Country, including the private sector, have been affected in a positive way by all these actions. More than that, customer’s needs are now more respected than they used to be.

Nevertheless, its is not easy to estimate the contributions of the QUALIHAB Program to innovation. It is undeniable that it has changed at the same time the way companies understand “quality”, such as CDHU and the most important actors of the building sector. The firms’ internal and external
processes, and their relationships are changing, since new procedures have been established, new technologies can now be tested in a much more “controlled” environment due to the right of anonymity, and so on.

In conclusion: the QUALIHAB Program is a very important driving force to all the actors, acting as a motor of innovation, that now begins to spread all over the Country, by means of the national Program PBQP-Habitat, as will be seen below.

6.4.6 The PBQP-HABITAT Program

6.4.6.1 Objectives

Like the QUALIHAB Program, the Programa Brasileiro da Qualidade e Produtividade do Habitat – PBQP-Habitat (Brazilian Quality and Productivity Habitat Program) aims to improve quality and innovation of the social housing sector. The major differences between QUALIHAB and PBQP-Habitat are:

1) **PBQP-Habitat** is a national program, dealing with national projects, looking for national solutions for the commons problems found in the supply chain, all over the Country.

2) it understands housing in a broad way, meaning habitat, and deals with the implementation of services other than housing units themselves, as streets and roads, utility networks (for water, electricity, etc.).

3) it has the search for innovation as one of its central points. Most of the major actors of the sector are concerned with the optimisation of the quality of housing and its environment concerning products and services applied in their conception and execution.

It was created in 1998, as an evolution of de “building” subjects related to the Programa Brasileiro da Qualidade e Produtividade – PBQP (established in 1992), and is nowadays one of the Programs of the Secretaria Especial de Desenvolvimento Urbano - SEDU (the State Secretariat of Urban Development, directly related to the President of Brazil), that is in charge of its co-ordination.

The underlying principles of the purchasing power of the State and of the partnerships with the main actors of the sector have also been adopted here. Nevertheless, now there is not a single client like CDHU, but a set of them, in the three levels of the Brazilian Government field of action: municipal, regional (each of the 27 Brazilians States) and federal ones. The most important is Caixa Econômica Federal - CEF, a Federal Bank of Savings and Loans, with an annual budget of more than 2.2 billion dollars, which financed two hundred and eighty thousand new houses in 1999.

The PBQP-Habitat Program was created in December 1998, and its major objective is to “give support to the Brazilian effort toward modernisation of the housing construction sector, trying to increase the competitiveness of its products and services, stimulating projects that could increase quality and productivity in the sector”. (www.pbqp-h.gov.br)

It has some additional objectives:
Public Policy Instruments to Encourage Construction Innovation:  
Overview of the Brazilian Case

- To stimulate the relationship among the actors of the supply chain  
  - to promote international relationship among South American  
    countries  
  - to collect and to make available information about de Program itself  
  - to stimulate the quality assurance of material, components, and  
    systems  
  - to stimulate the quality assurance of construction, architectural and  
    engineering services  
  - to promote actions to increase the level of qualification of the  
    manpower, from the traders to the directors of the firms  
  - to promote the establishment and the diffusion of standards and  
    codes  
  - to fight disrespect to the Codes  
  - to support innovation  
  - to promote managerial capacity of the public organisms that are in  
    charge of the social housing sector, in all the Government levels  
    (municipal, regional and federal).

6.4.6.2  Annual resources

The SEDU does not construct housing itself; as was seen above, CEF has an  
annual budget of 2.2 billion dollars. One can consider that part of this amount  
is invested in innovation, by means of some “experimental” operations, where  
innovation is carried out through controlled monitoring.

In their turn, the resources of the PBQP-Habitat Program are of  
about five hundred thousand dollars per year. As it belongs to the QUALIHAB  
Program, SEDU is not oriented to support R&D, nor to support advanced  
practices and experiments. In fact, the firms are induced to do the most  
important investments and, in spite of the similarity of both programs, as the  
PBQP-Habitat Program has just begun, we can not forecast its effects yet, as  
with QUALIHAB.

6.4.6.3  Means

The PBQP-Habitat Program is also based on “deals”, negotiated by the public  
“buyer” in each city or region with the different local actor’s unions, respecting  
of the local characteristics of the supply chain, level of technical and  
economical development, for example.

In fact, the Program is based on the action of each “regional co-  
ordination”, all of them co-ordinated by the central structure, in Brasilia, the  
capital of the Country. Sixteen of the twenty-seven Brazilian’s states are  
already members of the PBQP-Habitat (on May 2000). Even having their  
“local” focus, the local agreements should respect some national rules defined  
by the national union of the actors concerned, in a process co-ordinated by the  
PBQP-Habitat Program staff.
Here the same technical, social, and economical aspects used to explain the “success” of the QUALIHAB Program can be used. It is to justify the intended effect to be caused by the PBQP-Habitat Program on the supply chain, which is being progressively spread throughout the Country, in a negotiated and co-ordinated process. The particular moment of the economy should be noted, in which many factors could be explained, such as: the new constraints that influence the competitive stakes of the building sector; the new requirement demonstration on behalf of customers, mainly public ones; the lack of financial resources; the growth of competition among firms.

Once again, in spite of their comfortable position in this process, SEDU, CEF and the local public “buyers” involved in housing projects did not want to impose rules. On the contrary, and taking advantage of CDHU good experience, they are once again making the decision to conceive a program based on agreements and to put it into practice. There are already at least three States where the local “buyers” are very involved with the Program, and where many local “agreements” have already been signed: Rio de Janeiro, Bahia and Pará (in the south-eastern, north-eastern and north regions, respectively).

The main difference of the PBQP-Habitat agreements signed between the local public and private “buyers” of Low Income Housing sector, in the PBQP-Habitat ambit, and those signed in the QUALIHAB ambit, is that in the PBQP-Habitat case the local goals and delays are defined depending on the local conditions (a diagnostic phase will demonstrate this), even if the “requirements” are the same all over the Country.

The interests for industries, engineering firms, and contractors that are reacting in a positive way to the ideas of the Program are exactly the same as they are in the QUALIHAB case: to take advantage in the procurement phase, but now in another scale, as all the Country is concerned. It means that a general contractor qualified level “B” in Rio de Janeiro is eligible to participate of the procurement phases at level “B” in the State of Pará, and vice-versa.

The organisation of the PBQP-Habitat Program has some similarities with the QUALIHAB Program. Besides being based on the “local” structure and adopting the same dual structure of the QUALIHAB Program, based on both committees, “Materials, Components and Systems” and “CAE – Construction, Architecture & Engineering”. Due to its federal scope, the National Forum of the Industry of Materials and Distributors is managing the first committee and the National Federation of General Contractors the second one.

The PBQP-Habitat Program comprises twelve Projects. Each of the twelve Projects is trusted to a manager, and has particular objectives and goals to achieve. Among them, seven can be highlighted: the “PBQP-Habitat Qualification System for General Contractors”; the Project “Regional Program”; the “Co-operation Project with France”; the Project “Support to the Use of Alternative Materials and Systems”; the Project “National System of Technical Approval”; the Project “National Goal of the Housing Sector”; and the Project “Improvement of the Technical Normatisation”.

The “PBQP-Habitat Qualification System for General Contractors – SiQ-GC” is very similar to the QUALIHAB Qualification System for General Contractors – QUALIHAB-GC. It is closer to ISO 9002:1994 standards and keeps the central idea of four progressive levels of qualification.
The Project “Regional Program” is promoting an international relationship between Brazil and the southern countries of South-America (Argentina, Chile, Paraguay and Uruguay), working with themes related to quality and productivity (habitat), where innovation appears as one of the central subjects. In March 2000, a Regional Forum was created in the fifth meeting of the group, in Buenos Aires. The major objectives of the Forum are: integration of qualification process in all levels; stimulation of the development in the supply chain; development of common norms and codes; development of common mechanisms for technical approval; stimulation of forms of co-operation with other economic blocs, like ALCA or EU. Consequently, the innovation is directly related to the Forum’s concerns.

In its turn, the co-operation Project with France, supported by the Inter-American Development Bank, is one of the most important concerning innovation. The French partner is CSTB – Centre Scientifique et Technique du Bâtiment, the most important French building research institution. Thanks to this Project, Brazil had five technical missions in 1999 dealing with subjects such as quality management, innovation in construction, and site organisation. In 2000, five exchange programs in France of members of the PBQP-Habitat staff took place (with twenty participants so far).

The Project “Support to the Use of Alternative Materials and Systems” was developed between 1998 and 1999, to offer housing “buyers” and in particular CEF a technical way to evaluate the performance of innovation solutions proposed by the actors of the sector in operations financed by this bank. To understand the importance of this Project, it can be said that there are inadequacies in the Brazilian standards, and the consequences are not only the difficulties in evaluating ordinary solutions, but also mainly innovative ones. The Project created a direction that aims to evaluate these innovation solutions, reducing the risks involved. It is a “prototype” of a Technical Approval System.

The Project “National System of Technical Approval”, that is not yet in progress, will allow the development of an “integral” Technical Approval System, in accordance with international rules, mainly with those of the South-American countries. It will be a very important tool for innovation.

The last two projects - “National Mobilisation Goal of the Housing Sector” and “Improvement of the Technical Normatisation” – are very closely related. In fact, the National Mobilisation Goal of the Housing Sector, the rate of conformity with the national standards of the major products that are used in housing construction, is expected to grow to 90%, from 1998 to 2002. It seems to be a simple task or even obvious for those from a developed country; however it is a great challenge that should be overcome by the less developed and poorly structured ones, like Brazil. In fact, Brazil does not even have all the necessary standards, many industry products do not follow the existing ones and the required justice system is not so effective to enforce customers’ rights, for example. Attaining the fixed goal, and, at the same time, developing the standards is one of the most important aspects of the PBQP-Habitat

5 The amount of money accorded by the Inter-American Development Bank to the CSTB – Centre Scientifique et Technique du Bâtiment has not been considered in this document (Annual Resources).
Program, and many actions have been carried out in this way, since 1998. The engaged actors from the supply chain expect to meet the deadline.

6.4.6.4 Contribution to innovation

Since 1998, the PBQP-Habitat Program has tried to organise the actions that are carried out all over the Country concerning quality, productivity and innovation in housing construction. Many things have already been done, but many others still lag.

As PBQP-Habitat is trying to make use of the successful experiences conducted all over the Country, where QUALIHAB seems to be the most important, and if the actions already implemented are considered, it can be said that its impact on innovation will be very important.

For instance, we estimate that, from January to June 2001, up to one hundred general contractors’ firms will be certified by the PBQP-Habitat’s SiQ-GC. This will deeply change their relationships with their suppliers, with a very important forward linkage nation-wide effect in the sector.

Industrialists are already progressing in the search of standardisation and compliance with the accorded codes. The Project “National Mobilisation Goal of the Housing Sector” is working very well, with a reasonable reduction of codes non-compliance.

Laboratories capabilities seem to be one of the major problems in this process, as they cannot for the moment respond to the whole need of experiments, and tests that have to be conducted. Important investments should be made by the sector to overcome this weakness in the production chain.

It can also be expected that architecture and engineering firms will join this movement in the coming months.

The international experiences were been important, concerning Brazil neighbours and France, thanks to the Regional Program and to the technical co-operation Project.

Its is not easy to estimate the future contributions of the PBQP-Habitat Program to innovation. Nevertheless, as in the QUALIHAB Program, it is undeniable that it has already begun to change the way the major actors of the building sector think “quality”. The internal process of the firms and the external ones, concerning to the relationship between them and the way they take customers’ necessities into consideration, are beginning to change; new procedures have already been created, new technologies can now be tested in a much more “controlled” environment, and so on.

In conclusion the PBQP-Habitat Program is also a very important driving force to all the actors the innovation of products and processes. Its major characteristic, which means the great passport for its success, is the partnership between the public and the private forces involved in housing construction (namely habitat).
6.4.7 The Competitiveness Forum of the Civil Construction Industry

6.4.7.1 Objectives

The Competitiveness Forum of the Civil Construction Industry is another federal project that is related to the improvement of the supply chain of the sector. As its name suggests, it is a forum, where the major actors of the sector, co-ordinated by the Development, Industry, and Foreign Trade Ministry (Ministério do Desenvolvimento, Indústria e Comércio Exterior – MDIC), are put together to identify problems related to their relationships and also internal ones, so as to solve them, to expand the competitive capacity of the sector (MDIC 2000a), (2000b) and (2000c)).

The Forum has also other objectives, related to generation and income of employment, to regional development, to innovation promotion and to foreign trade promotion.

The Construction Industry is one of the twelve forums organised, and it was started in May 2000.

6.4.7.2 Annual resources

In this case, nothing can be said about investments, as the Forum has just been established.

6.4.7.3 Means

After a first phase, when a diagnostic has been done and the strategic plan of actions established, it can be supposed that, from the moment all the actors of the supply chain are trying to improve their competitive capacity, promoting innovation will be one of the ways to do this.

Nevertheless, so far, it is not clear through which actions this innovations will happen, but we can suppose that organisms like FINEP, the financial supporting organism will finance them.

6.4.7.4 Contribution to innovation

There has been no direct contribution so far. The only product is a diagnostic of the sector, and a strategic plan of actions, with objectives and goals, defined according to the problems identified.

6.4.8 The COBRACON / ABNT actions: technical norms for evaluation of innovative constructive systems for habitations

6.4.8.1 Objectives

The objective is the elaboration of norms for performance evaluation of new material, components and housing construction systems.
Addressing all the stages of the productive process - from the initial research - allowing a larger flexibility and a better adaptation to its development - going through process and product improvement up to easy acceptance and adoption of new technologies.

6.4.8.2 Annual resources

The total cost of the project, expected to be developed in 18 months, from January of 2000 to June 2001, involves resources around US$ 80,000.00, that would lead to an annual average of US$ 53,000.00.

6.4.8.3 Means

The project is being developed by the Brazilian Association of Technical Norms (ABNT) – a non-profit civil entity. ABNT is, in Brazil, the association oriented to Technical Norms elaboration in several areas whenever necessary. The association works by means of committees that are established in connection with each productive sector. In the case of construction, the committee in charge is COBRACON - Brazilian Committee of Construction - that elaborates the norms for the sector.

For that specific work, COBRACON is receiving financial support from Federal Savings and Loans (CEF) together with FINEP.

6.4.8.4 Contribution to innovation

One of the problematic aspects for the use of new technologies is the absence of norms for approving new ones in the Country. The financial agents, and even the Government institutions, and NGOs feel insecure about financing constructions with innovations due to doubts concerning their performance.

When ready, it is intended that those norms are a safe tool on which the Government's financial supporters, NGOs, or private entrepreneurs could base their work, bringing a positive impact to the productive chain in the sense of facilitating the adoption of technological innovations in the sector.

6.5 EFFECTIVENESS OF PUBLIC INTERVENTIONS

In the second part of this work, the current and more significant Government policies oriented to technological innovation in construction were presented, particularly in the building constructions, that are synthesised in Table 1, in order to show their contributions to the sector. It was in this part of the work that we tried to answer to the questions:

- What instruments and approaches are being used by Governments to promote innovation in this sector?
- What works and under what circumstances?
Data from that table show an annual investment from the Government of US$ 8.15 million, mainly being invested in human resources formation (75%), that is not meant as an investment in technological innovation.

On the other hand, in this third and last section, the conclusions of the work are presented through which we will try to answer the last question posed by the participating countries:

- How to strengthen innovation in the construction industry?

Before proceeding to the answers, it is appropriate to say that, Government programs, although timid, have been providing conditions for technological evolution of the sector; there are also the initiatives from the private sector. Many authors that have been studying the productive chain behaviour involved with the construction of buildings, among them, Picchi (1993), Cardoso (1993 and 1996) and Barros (1996) have identified a series of other factors, belonging to the market, favourable to the technological development and the innovation implementation in the construction sector such as:

- Increasing demand from consumers that derive from: Country democratisation, establishment of PROCOn's (public institutions for the consumer's defence, CONsumer PROtection), and the new code for consumer's defence, which prioritises consumers’ rights from the market point of view
- influence of the sectors of heavy construction manufacturing industry - to face the crisis, some heavy construction companies decided to operate in the building sector carrying influences and procedures from a part of the industry that always had better organisational and technological procedures
- more demanding labour - with the widespread democratisation of the Country, and the increase of labour rights from the 1988 Constitution, labour became more demanding by itself, concerning safety and construction procedures.

It is worth mentioning that the sector of construction material and components that has been presenting a growth not only qualitative, but also quantitative since the sixties, and has been modernising in a very consistent way ever since.

During the last decades it was possible to find a great increase in the number of manufactured products on-site. The basic materials such as sand, cement and lime, for example, are giving way to industrialised mortar. The mortar coatings themselves are being replaced by polymeric products, of faster application and better performance.

Even though the Brazilian construction productivity remains low (McKinsey, 1998) and if material losses in works are still significant (Agopyan et al. 1998), evolutions have happened in that sense. The movement towards quality management systems implementation in companies, especially in construction firms is a reality.
From a general point of view, the numbers from the sector continue thoroughly favourable towards its modernisation. The housing deficit of the Country remains high (5.5 million dwellings to be built and 8.5 million dwellings demanding urgent improvements). The participation of the construction industry in the GDP has kept an average of 6% of the total, constituting one of the highest as a single economy sector. Besides, if all the construction macro-complex (comprising material and components) are considered, that participation jumps to almost 15% of GDP (FIESP, 1999).

More than 60% of the national gross investment is done in construction while machinery and equipment come to 25%; the remainder is stock. Linkage Index sets Construction Sector ranking as fourth in the Brazilian Economy. Backward linkage index is the main effect for this performance; it provides US$ 27 billion; for the forward linkage index this number is USD 2.8 billion. The private sector has the first place in the backward linkage index; that is why the construction sector is called the “economy locomotive” (de Oliveira & Cardoso, 1999).

Also remarkable are the direct and indirect employment participation in numbers. In 1989 the industry employed 3.9 million people, representing 6.9% of the occupied labour in the Country and 26.3% of the employment in industrial activities, according to data from the Brazilian Institute of Geography and Statistics (IBGE, 1989). For each direct employment in the sector, the generation of 2.68 indirect employments is considered, and therefore, involves more than ten million people.

It is important to remark that Brazilian construction is one of the sectors less dependent on imports, which means, according to the Government's effort in search of credit in the trade balance, a thoroughly favourable aspect to its development.

However there are factors that have been hindering the innovation process, among them the following:

- Difficulty in forecasting the future market behaviour
- great number of taxes and other social contributions for each registered worker, that has been motivating workers' precarious and informal hiring and to the growth in the subcontractors number, not only for increasing productivity and quality of the work process, but as a form of cheating labour laws, and of cost-reduction
- great trade rotation that hinders training
- backward vision by some managers in the sector, who do not see innovation introduction as an investment, but as cost-increase, and who do not perceive technological innovation as a strategy for profit increase
- little capitalisation of the sector with the existence of a great number of companies with small capital, and therefore, with difficulties in making investments.

We do not have all data to estimate the level of innovation and the R&D investments in the sector. On the other hand, although the sector has many problems to solve and the level of these investments is lower than desirable, the environment is favourable to innovation.
Table 6.1 Main public Brazilian intervention synopsis of technological innovation support in the field of construction in progress in July 2000, described in section two of this work.

<table>
<thead>
<tr>
<th>Innovation Stage</th>
<th>Name</th>
<th>Resources to Construction</th>
<th>Objectives</th>
<th>Means</th>
<th>Contribution to Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programs to support R&amp;D</td>
<td>FAPESP</td>
<td>One and a half million dollars per year.</td>
<td>To finance grants and other activities related to technological and scientific research, local and international exchange and information in the State of Sao Paulo.</td>
<td>The sponsoring of about one hundred and eighty projects, which two thirds are grants. The other third concerns research funds for specific projects, laboratory equipment, book acquisitions, congress’ organisation, congress’ participation foreign researchers, book and review publications, etc.</td>
<td>It is very difficult to objectively estimate the contribution to innovation due to FAPESP actions. The grants accorded in 1998 were: to young scientists – fifty; to master of science studies - thirty; to doctoral studies - thirty-five; to post-doctoral studies – five. The FAPESP system is one of the most efficient and effective of the Country, and it is very selective, with a very rigorous control. 60 other research projects (1998) for specifics projects, laboratory equipment, book acquisition, congress’ organisation, congress’ participation, foreign researchers, book and review publications, etc.</td>
</tr>
<tr>
<td></td>
<td>CAPES</td>
<td>One million, six hundred thousand dollars a year (estimation excluding special programs such as PADCT).</td>
<td>Highly qualified human resources formation for the teaching at universities, research and the attainment of the professional demand of both public and private sectors.</td>
<td>Grant of scholarships and graduate programs infrastructural support.</td>
<td>It is very difficult to objectively estimate the contributions to innovation due to CAPES actions.</td>
</tr>
</tbody>
</table>
Table 6.1  (Continued) Main public Brazilian intervention synopsis of technological innovation support in the field of construction in progress in July 2000, described in section two of this work.

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</thead>
<tbody>
<tr>
<td>Programs to support advanced practices and experimentation</td>
<td>CNPq</td>
<td>Three million dollars a year (estimated).</td>
<td>To promote the scientific and technological development and to support researches, necessary to the social, economic and cultural progress of the Country.</td>
<td>Development of three basic activities: fostering (grant of scholarships; 91% of the budget), research support and science and technology information and diffusion.</td>
<td>It is very difficult to objectively estimate the contributions to innovation due to CNPq actions.</td>
</tr>
</tbody>
</table>
| The QUALIHAB Program | HABITARE            | Eight hundred thousand dollars | To contribute, through support ingresearches it in the area of science and technology, to the solution of the Brazilian housing problem and to construction modernisation, always having in mind the connection with environmental concerns. | Financial support for companies' proposals for technological development. | • Clustering of several organisations innovation-oriented institutions in joint projects.  
  • Creation of diffusion /information networks on innovation in the sector.  
  • Financing proposals for technological innovations.  
  • Financing for new technologies evaluation. |
Table 6.1 (Continued) Main public Brazilian intervention synopsis of technological innovation support in the field of construction in progress in July 2000, described in section two of this work.

<table>
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<tbody>
<tr>
<td>Programs to support performance and quality improvement</td>
<td>The PQIP-Habitat Program</td>
<td>Five hundred thousand dollars per year</td>
<td>To support the Brazilian effort of modernisation for the housing construction sector, trying to increase the competitiveness of its products and services, stimulating projects that could increase quality and productivity in the sector.</td>
<td>Based on “agreements”.</td>
<td>Three States with agreements already signed. Integration with countries of Southern South-America. The SiQ-C System. The Project “National Mobilisation Goal of the Housing Sector”. The technical co-operation Project with France.</td>
</tr>
<tr>
<td></td>
<td>The Competitiveness Forum of the Civil Construction Industry</td>
<td>Nothing up to now.</td>
<td>To improve the sector supply chain and also the generate employment and incomes, regional development, to promote innovation and foreign trade.</td>
<td>Based on an initial and a strategic plan of actions, with objectives and goals, defined according to the problems identified.</td>
<td>Diagnostic, plan of action, objectives and goals.</td>
</tr>
<tr>
<td>Programs to support implementation of systems and procedures</td>
<td>COBRACON/ ABNT</td>
<td>Fifty thousand dollars</td>
<td>To elaborate norms for evaluating housing new materials, components and construction systems.</td>
<td>Multidisciplinary research team co-ordinated by COBRACON with financial support from CEF and FINAP.</td>
<td>To facilitate the adoption of new technologies as soon as guidelines are offered for its safe use.</td>
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</table>
Therefore, to motivate innovation in Brazilian construction, and thinking of the actions that should be kept by the State, or its support or articulation, these actions would be oriented to:

- Incentive new products and processes research and development, allotting an amount of resources in R&D to the sector in compliance with its economic and social importance
- Human resources formation in all education levels
- Increase Government and its institutions’ induction action as buyer (purchasing power)
- Incentive technological competence development, and local and regional producers, with environmental protection
- Incentive better integration of the productive chain with co-ordinated modernisation actions in progress
- Nation-wide incentive to technological co-operation actions between research institutions and companies by means of co-operative networks, as well as abroad, mainly with Southern South America
- Companies refinement aiming at competitiveness and innovating capability increase, including financial support for R&D investments
- Better capability and valorisation for research institutions and universities, both working together with the private sector
- Improve laboratory capability in the Country, with help from the public sector, linked to the research institutes and universities, or from the private sector
- Refine technical normatization, with emphasis on norms oriented to performance, still incipient in Brazil
- Incentive the certification of traditional products and processes
- Develop new products and processes technical approval mechanisms
- Make public the tested and approved innovations, that can reach the less privileged layers of the population, which by themselves build three-fourths of the housing production of the Country, through self-help-construction
- Valorise consumers’ protection mechanisms and increase their understanding in relation to their rights
- The warranty of an efficient and effective law functioning system.

As shown in the work, the Brazilian Government has been promoting important actions in that sense, but there is still a lot to be done. One percent of its investments in a sector that responds for, at least, 6% of GDP is too little.

On the other hand, it is not the Government task to promote construction industry innovation by itself and not even to be the main agent of the process. The roles and responsibilities have to be shared:

- Private enterprises (makers, manufacturers, designers, managers, dealers, etc.), by themselves have been promoting concrete and integrated action; they should improve their understanding about the

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6 This production is estimated around 800,000 new dwellings a year.
meaning of innovation, of its strategic role, and of the benefits it provides, by investing more on its development; although there is no data, the percentage of the sector gross revenue invested in R&D is, certainly, very low; could there be a distinction between manufacturers and others? Do they reasonably invest in R&D?

• should the financial agents and the insurance companies more and more motivate the use of innovative solutions that accrue technical and economic benefits, with performance warranty; why constitute a performance insurance system that does incentive and does value the innovations of assured performance?

• research institutes and universities should more and more look for innovation as a clear and tangible goal, by integrating with the productive sector, without losing sight of consumer’s interest and society’s in general

• society and consumers should enforce the Government, its institutions and the companies, claiming their rights and valorising innovative initiatives that bring them benefits.

In spite of all these difficulties, the Brazilian scenario is quite promising, above all for the development sense that it presents, more than for the absolute numbers themselves, as they are still low, and very far from desirable.