# CEHPAR – An UFPR/COPEL partnership

*Maurício Dziedzic e Marcos Tozzi*
*Centro de Hidráulica e Hidrologia Prof. Parigot de Souza – CEHPAR*
*Universidade Federal do Paraná – Centro Politécnico, C.P. 1309*
*Curitiba, PR – 80001-970, Brasil*
*Tel.: (041) 366-2020 x.6313, Fax: (041) 266-2935*
*e-mail: dziedzic@cch.copel.br, tozzi@cch.copel.br*

## *Abstract*

CEHPAR, a consulting and research centre in hydraulics and hydrology at Universidade Federal do Paraná (UFPR), was founded in 1959, becoming a joint venture between the university and the state's electrical utility company, COPEL, in 1976.

During its almost forty years of existence, CEHPAR has excelled in the development of hydraulic model studies, hydrological studies, and, more recently, environmental engineering studies. Being located at UFPR's engineering campus allows CEHPAR's staff to also become involved in the academic pursuits of undergraduate and graduate teaching and research. Its professors have historically been responsible for engineering undergraduate courses in fluid mechanics, hydraulics, and hydrology, and, since 1986, CEHPAR also promotes a graduate program which offers M.A.Sc. degrees in hydraulics, water resources, and, starting in 1998, environmental engineering, with the natural extension to a Ph.D. program in the workings for the turn of the century.

The close co-operation between UFPR and COPEL has enabled the university to maintain an outstanding and up-to-date infrastructure in its research and teaching laboratories, and computer facilities. Additionally, the engineering programs had theirs ranks strengthened by the continuous presence of CEHPAR's staff, which is financially supported by COPEL. On the other hand, COPEL has also gained from this partnership with the maintenance of a world-renowned research facility, and with the opportunity for its staff to enrol in the academic programs offered by CEHPAR.

CEHPAR also offers opportunities for both graduate and undergraduate students to acquire professional experience through participation in the many projects developed at the centre, either as trainees or as part of required thesis work.

Looking into the future, CEHPAR is currently involved in national and international research co-operation programs, which seek to further enhance its activities, offering new frontiers to UFPR and making new technologies available to COPEL. The centre is also seeking to increase its contributions to the community by teaming up with Curitiba City Hall for important environmental and water resources projects.

## Introduction

The "**CE**ntro de **H**idráulica e Hidrologia Professor **PAR**igot de Souza" (CEHPAR) is a partnership between the "**U**niversidade **F**ederal do **P**a**R**aná" (UFPR) - the state of Paraná's Federal University, and COPEL - Paraná's electrical utility company. Located in the city of Curitiba, in Southern Brazil, CEHPAR is a consulting and research institute in hydraulics, hydrology and environmental engineering.

## History

CEHPAR was founded in March of 1959 as CEPHH, "**C**entro de **E**studos e **P**esquisas de **H**idráulica e **H**idrologia", by hydraulics professors of UFPR's School of Engineering, under the supervision and guidance of Prof. Pedro Viriato Parigot de Souza. In July of 1973, the name was changed to CEHPAR, in honor of its founder, who passed on in the post of Governor of the state of Paraná.

One of the first tasks undertaken by the Centre was to develop a method for the prediction of maximum intensity of rainfall in Curitiba. The result is what is known today as Parigot's equation (Pinto et. al., 1976):

where i is the intensity of rainfall (mm/hour), $T_r$ is the return period (years), and t is the duration of the event (minutes).

Other projects included the development of design criteria for hydraulic structures, the organization and analysis of hydrological data for the state of Paraná, as well as the urging for the establishment of a state-wide monitoring network.

Among a long list of notables, three more names merit special citation in this brief historical sketch. Nelson Luiz de Sousa Pinto was at the head of CEHPAR for about a quarter of a century, one of his first assignments being the study of scour around bridge pillars (Pinto, 1961). Later, and with the collaboration of co-workers, he was involved in the development of design criteria for culverts, a job comissioned by the State's Highway Department (Pinto et. al., 1971). He then turned his attention to the problem of cavitation and aeration of high speed flows (Pinto, 1979), a subject to which his contribution is internationally recognized, and his methodology still adopted for the design of large hydraulic structures subject to flow velocities in excess of 30 m/s.

Sinildo Hermes Neidert, head of CEHPAR's hydraulics division for 22 years, is a scholar whose diligent work and excellence in fluid mechanics and hydraulic structures (Neidert, 1981) has contributed much to the attainment of the reputation of distinction enjoyed by CEHPAR. Presently, both Profs. Pinto and Neidert are members of CEHPAR's Consultive Council, which provides technical advice to the management, and analyses CEHPAR's directives and scope of action.

Finally, Francisco L. S. GOmide was head of the Hydrology Division from 1969 until 1982. Being a specialist in stochastic hydrology, he developed the theory of deficits for reservoir design and analysis (Gomide, 1975). After 1982 he took a leave of absence from CEHPAR to assume the position of director of COPEL, after which he became director of Itaipu Binacional. Nowadays he is the director of Ecelsa, the first electrical utility in Brazil to have been privatized. The innovative ideas presented in his research work in the area of energy planning and stochastic hydrology marked significantly his participation in CEHPAR's hydrology division, still greatly influencing today's work.

## Structure

Since its humble beginnings, in a 30 $m^2$ room in the basement of the downtown university building, CEHPAR has moved to UFPR's Politechnical Centre, which houses all engineering facilities. In this area, CEHPAR is now comprised of 7,000 $m^2$ of indoor, and 5,000 $m^2$ of outdoor laboratories with a storage capacity of 2,000 $m^3$ of water and a maximum flow rate of 1,600 l/s. A new office building, furnished with state-of-the-art computer equipment, of 1,700 $m^2$ has recently been inaugurated, which also houses a library with about 5,000 volumes and subscription to over 40 periodicals.

The centre maintains UFPR's undergraduate Fluid Mechanics teaching laboratories, while its main laboratories are available for graduate students for thesis work.

CEHPAR's staff is comprised of 25 engineers, including 5 Ph.D.'s, 12 M.A.Sc.'s (5 pursuing a Ph.D. degree), and one specialist. Additionally, there are 25 people employed as technicians and administrative personnel, and over 20 undergraduate students hired as interns. Most of the staff members are employees of COPEL, with the centre's consulting revenue accounting for over 60% of its expenses. A small percentage is taken from this revenue for direct investment in UFPR's infrastructure, such as library material, computer equipment and installations.

## Consulting

CEHPAR has established itself by the excellence of its hydraulic model studies and hydrological studies.

In the first category, the investigations carried out add up to more than 40,000 MW of installed hydroelectric power. Of special significance are the hydraulic models of Itaipu (12,600 MW), São Simão (2,700 MW), Salto Santiago (2,000 MW), Garabi (2,000 MW), Segredo (1,260 MW), and Salto Caxias (1,200 MW).

In the second category, much has been contributed to the understanding of the hydrology of the state of Paraná, a subject of utmost importance for the design of hydraulic structures. For instance, studies have been carried out for the climate of the state, the intensity of rainfall and design flow rates for small watersheds. A thorough understanding of the characteristics of the Iguaçu river, Paraná's most important body of water, has also been gained.

In addition to these studies, CEHPAR has also engaged in international consulting, such as the study of the Tigris-Euphrates Main Outfall Drain (Iraq), and hydraulic models for hydroelectric power plants in the Dominican Republic (Sabaneta and Monción) and in Malaysia (Bakun). Other national efforts include the modelling and instrumentation of experimental watersheds in the Amazon region. More recently, environmental engineering studies have been started in order to model water quality, and transportation and fate in the region of the Salto Caxias Hydroelectric Power Plant, presently COPEL's main project, which is expected to start operation in late 1998.

## Academic Pursuits

Being a university institution, CEHPAR has always allowed academic interests to permeate its consulting work. Most of the engineers in the centre's staff are also professors at UFPR, both at the undergraduate and graduate level. As technical work is developed, the staff is constantly seeking to either improve existing techniques or develop new ones. Therefore, peer-reviewed publications in scientific journals and conferences have resulted from most of the jobs undertaken.

Each engineer at CEHPAR is responsible for the guidance of at least one undergraduate engineering student, which is hired as an intern and participates actively in the projects tackled by the centre. This practice has proven extremely valuable, since most of the centre's current technical staff was, at some point, an intern at CEHPAR.

In a more concentrated effort, since 1986 CEHPAR promotes a graduate program which offers M.A.Sc. degrees in hydraulics, water resources, and, starting in 1998, environmental engineering, with the natural extension to a Ph.D. program in the workings for the turn of the century. At the time of writing, 20 theses have been successfully defended, 15 are under preparation, and another 25 are expected to be started in the near future. Some of the students enrolled in the program are CEHPAR's professionals, which, despite being open to criticism for the unavoidable in-breeding promoted, has allowed these people to obtain a master's degree with no need for additional financial support.

## Current Trends and Future Work

While maintaining its historical range of activities, CEHPAR is actively seeking to broaden its scope by embracing and developing new technologies. One such instance, well under way, is the development of in-house expertise in the modelling of water quality which started in 1996 with the preliminary environmental assessment of the Barigüi river watershed, one of the main areas in the metropolitan region of Curitiba, and came into full speed with the contract to model water quality in the rivers and reservoir in the immediacy of the Salto Caxias Hydroelectric power plant. Among the fruits from this work, three M.A.Sc. theses are expected, with the first one to be defended in mid 1998. The preliminary assessment of the Barigüi river watershed has resulted in a grant from FINEP, a Brazilian funding agency, to further investigate the matter, and in a formal cooperation agreement between CEHPAR and Curitiba City Hall, which may result in CEHPAR being hired to develop similar studies for other areas of the metropolitan region.

Another subject currently under pursuit at CEHPAR is the use of GIS technology in water resources modelling. The first steps have been taken to develop expertise by applying GIS tools to an experimental watershed, and to provide guidance in the development of a city-wide storm monitoring network, which aims to make available on-line flood risk maps.

Despite a continued demand for CEHPAR's physical models, the centre also plans to develop Computational Fluid Dynamics (CFD) expertise in the design of hydraulic structures.

Finally, CEHPAR is seeking ISO 9000 certification for its laboratories, and plans to seek ISO 14000 certification for the entire centre in the near future, using these opportunities to train personnel and eventually offer consulting advice for ISO 14000 certification.

CEHPAR is currently involved in national and international research co-operation programs, which seek to further enhance its activities, offering new frontiers to UFPR through student and staff exchange programs, and making new technologies available to COPEL.

## Conclusion

The present paper seeks to illustrate how a university-industry joint program can be successfully carried out by describing the experience shared by UFPR and COPEL in the development and maintenance of a world-class engineering and education facility. During its thirty-nine years of existence, CEHPAR has excelled in the areas of hydraulic model studies and hydrological modelling. More recently, the centre has undertaken studies in environmental engineering, performing water quality modelling of water bodies in the vicinity of hydroelectric power plant sites.

Research carried out at CEHPAR has enabled the establishment of design criteria of hydraulic structures, modelling techniques in hydrology, as well as promoted a large number of scientific publications. Furthermore, the practice of hiring undergraduate students not only contributes to their education but also provides the centre with a better pool of professionals for eventual hirings.

The maintenance of a graduate program has enabled CEHPAR to maintain its high level of contribution to academic activities at UFPR, as well as to carry out scientific research in parallel with its consulting work.

CEHPAR currently seeks to broaden its scope of activities by developing expertise in environmental engineering, GIS integrated hydrologic modelling, CFD modelling of hydraulic structures, and ISO's 9000 and 14000 certification.

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