COOPERATIVE RESEARCH AS A SOLUTION FOR TECHNOLOGICAL DEVELOPMENT

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INTEGRATION OF TECHNOLOGICAL AND BUSINESS STRATEGIES

To secure technology as a competitive advantage, PETROBRAS is treating its technological and business strategies together. The strategic projects PROCAP 2000 - Technological Innovation Program for Deep and Ultra-deep Water, PRAVAP - Strategic Program for Advanced Petroleum Recovery and PROTER - Program for the Development of Strategic Refining Technologies - are good examples of technological demands incorporated into PETROBRAS’ Strategic Plan.

To guarantee a perfect fit with its real business needs and facilitate the implantation of the technologies generated by research work, PETROBRAS provides the opportunity for all operational areas to vent their opinions during definition of the technological strategies.

COOPERATIVE FORMS OF RESEARCH

PETROBRAS has extended and consolidated a policy of technological cooperation with Universities, Research Institutes and manufacturers; this development not only reflects the need to share the burden for the development of embrionary technologies, but is also a measure of the awareness of the globalization of knowledge and of the objective to reduce the cost and risk associated with the R, D&E activity.
The partnership between CENPES and research institutes and the national and international scientific community bears a yearly price tag of around 10 million dollars, or 5% of the total yearly budget for research and technological development.

Among the several types of technological cooperation schemes embraced by CENPES, the permanent relationship with the national and international scientific and technological community and agreements of technological cooperation with operators and suppliers can be cited. These kinds of cooperation were generously used in the development of the successful Technological Capacitation Program for Exploitation in Deepwater (PROCAP).

a) Coherent Relationship with the National Technological Community

This sort of partnership seeks to strengthen the technological capacitation with the research community in areas associated with the petroleum industry; it takes different shapes like the joint development of projects, the organization of guided courses that lead to a Master in Science or a Philosophy Doctor’s degree, and periods of training at the research center for students and professors of Brazilian universities.

Besides the partnership with national institutes of technological development, CENPES participates in conventions and cooperative agreements with government agencies. The investment in this kind of partnership, mainly for the joint development of research projects and service rendering in areas of keen interest to the company, increased sharply of late years.

Total investment for the partnership with the national scientific and research community over the last 4 years summed 28.5 million dollars. During 1997 (up to March), 2.7 million dollars were already laid out for the joint development of R&D projects with 7 institutes and universities of the domestic S&T community.

At the domestic level, CENPES has also implemented cooperation with development agencies of the Brazilian government; in this case, fiscal incentives and special financing schemes are put to good use for technological development. The following examples can be cited:

- RECOPE - Cooperative research network, financed by MCT/FINEP. PETROBRAS is participating in three networks of priority topics: industrial automation, advanced processes of metal/mechanic transformation, and information application in engineering. Three
new networks for specific topics are being proposed: submarine engineering, catalysis and residue recycling. The three priority networks and the one for submarine engineering are now being structured. Each topic will be subdivided in four networks with a one million dollar budget for each network.

- OMEGA project, financed by MCT/FINEP. This program supports the development of projects of cooperative research headed by a university and having one more learning institute and at least two industries as other members. CENPES is participating in the project “Thermal Spray Coating”, a cooperation between CENPES, PUC, USIMINAS and Cascadura Industrial e Mercantil Ltda.

b) Coherent Relationship with the International Technological Community

The major challenges of the petroleum industry urged PETROBRAS to strengthen its knowledge base, which naturally led to contacts with international S&T institutes - such as universities, R&D centres and other companies of the same sector. This kind of cooperation, under the form of multiclients projects, is very much in use on a global scale; typically, one of the institutions - a university - coordinates the concerted effort and acts as a magnet for the attraction of other partners in potential. The total cost is fixed at the start of the project and paid in by each partner following a preestablished pro rata. At PETROBRAS, multiclient projects have been one of the most successful forms of acquisition of technology. For 1997, the revision of the Plurianual Plan of Activities for the period 1995-1999 fixed a 2.5 million dollars yearly outlay for this kind of projects.

c) Agreements of Technological Exchange

PETROBRAS, through its research center, has concluded agreements of technological exchange with petroleum industries like Shell, BP-Statoil, IFP and others; the object of these agreements is the exchange of experience and the insertion of technology as contribution in a joint venture. The table below lists several technologies being developed under such a system.
### Table 1 - Example of technologies being developed under agreements of technological exchange

<table>
<thead>
<tr>
<th>Technology</th>
<th>Agreement</th>
</tr>
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<tbody>
<tr>
<td>Deep water drilling</td>
<td>PETROBRAS-BP / Statoil</td>
</tr>
<tr>
<td>Multiphase pumping</td>
<td>PETROBRAS - Shell</td>
</tr>
<tr>
<td></td>
<td>PETROBRAS-BP / Statoil</td>
</tr>
<tr>
<td>Submarine completion</td>
<td>PETROBRAS - Shell</td>
</tr>
<tr>
<td>Floating production systems</td>
<td>PETROBRAS - Shell</td>
</tr>
<tr>
<td></td>
<td>PETROBRAS-BP / Statoil</td>
</tr>
<tr>
<td>Tension leg platforms</td>
<td>PETROBRAS - Shell</td>
</tr>
<tr>
<td>Hydrates and paraffines</td>
<td>PETROBRAS - Shell</td>
</tr>
<tr>
<td></td>
<td>PETROBRAS-BP / Statoil</td>
</tr>
<tr>
<td>Catalysers</td>
<td>PETROBRAS - IFP</td>
</tr>
</tbody>
</table>

d) Partnerships

Petroleum production in deep waters can only be achieved through adaptation of conventional production systems. PETROBRAS, through its research center, has for this sake established agreements of technological cooperation with equipment suppliers. Table 2 gives examples of this kind of cooperation.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Supplier</th>
</tr>
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<tbody>
<tr>
<td>Submerged centrifugal pumping - BCSS</td>
<td>Pirelli, Tronic, Trust Reda/Lasalle and Trust Sade-Vigesa/Cooper-Camerom</td>
</tr>
<tr>
<td>Multiphase pumping</td>
<td>Westinghouse/Leistritz</td>
</tr>
<tr>
<td>Horizontal wet Christmas tree</td>
<td>Cameron</td>
</tr>
<tr>
<td>Multiphase meter</td>
<td>Fluenta</td>
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</tbody>
</table>

Table 2 - Examples of Equipment Developed in Cooperation with Suppliers
The submerged centrifugal pumping technology (BCSS) is the result of an agreement of exchange between PETROBRAS and six suppliers, notably, Pirelli (electrical cables), Tronic (electrical connectors), the Reda/Lasalle trust (pump, motor and protector), and the Sade-Vigesa/Cooper-Cameron trust (adaptation of the wet christmas tree to receive the electrical connectors). In this case, PETROBRAS is holder of the wet christmas tree technology.

The system, a substitute for the gas lift elevation method, is installed at the 4-RJS-221 well (Carapeba oil field) and is operating since October 1994 without servicing. This project made PETROBRAS the worldwide pioneer in the development of this technology. A new installation at the 4-RJS-477A well (Albacora East) is planned in 1109m water depth.

e) Cooperative/Participative Agreements

In Mercosur, the CODICID - Comité de Dirigentes de Centros de Investigación y Desarrollo Tecnológico - is working to define effective forms of technological cooperation between Latin-American State-Owned Oil Companies, such as CENPES/PETROBRAS, IMP/Pemex, ICP/Ecopetrol and INTEVEP/Pdvsa. Eight topics of common interest were identified, discussed in seminars and unfolded in projects. The projects are to be implemented under a cooperative structure - one of the R&D centres does the coordination while all other members contribute human and financial resources - or under a participative structure - one of the R&D centres heads the effort and the others work at specific phases or stages of development. The elected topics contemplate the upstream and downstream segments of the petroleum industry, such as:

- formation damage and deposition of solids;
- well stability;
- biotechnology applied to the oil industry;
- artificial lift;
- homologation of analytic techniques and evaluation of catalysts, fillers and products;
- FCC process and fuel reformulation;
- heavy charge conversion: hydrocracking, coking and others;
- molecular modeling applied to catalysis.
The return on investment in R,D&E at PETROBRAS is expressed by one of the indicators of the Performance Indicator System maintained at CENPES; the indicator takes only the benefits of the P,D&E projects into account, excluding eventual benefits of technical services, environmental projects, methodology development and capacitation. In 1996, the ratio between the benefits obtained from projects concluded during the last five years and the respective costs was 4.2. Figure 1 shows the evolution of the indicator for the last 5 years.

![Graph](image1.png)

**Figure 1 - Evolution of the Benefit/Cost Indicator at CENPES**

The cooperative research model adopted at the PETROBRAS Research Center shows excellent business results; it not only makes state-of-the art technology available to the Company, but also allows research at reduced cost and, as such, makes room for the conduction of an adequate amount of scientific research of longer maturation in cooperation with universities and other national and international scientific institutions.