MANAGEMENT OF INNOVATION AND TECHNOLOGY TRANSFER PROCESS BETWEEN UNIVERSITY & INDUSTRY: THE MATERIALS RESEARCH CENTRE CASE IN UNIVERSIDAD DEL VALLE, COLOMBIA.

Juan Arturo Ortega, MSc [1] Alderson Neira Arce, MSc [2], Federico Sequeda, PhD[3], , Irina Gribenchenko, MBA [4]
[1] E.I.I.E.-Universidad del Valle, Cali - Colombia **juortega@pino.univalle.edu.co**
[2] IMST - North Carolina State University, Raleigh, North Carolina – USA **aneiraa@ncsu.edu**
[3]C.I.M. – Universidad del Valle, Cali - Colombia, **fsequeda@yahoo.com**
[4] GGT- Universidad del Valle, Cali - Colombia **igriben@hotmail.com**

Abstract:
In this work the innovation and technology transfer challenge in developing countries is addressed through the analysis of the mechanisms required to introduce science and technology concepts into a local society. This task is accomplished improving the knowledge and skills related with new technologies regarding new production process, products and markets. In this opportunity a University-Industry relationship case is presented taking in account the valuable participation of entities for science and technology promotion, research and development (I+D) centers, technology transfer center for productivity. Specifically the case of one of the largest public Universities in Colombia, Universidad del Valle and companies well recognized in the production of paper, metalworking and polymer production, considered sensitive for the economical future of the country. This project being sponsored by the national science for technical and technological development Institute - COLCIENCIAS as a part of an strategic plan, and the international cooperation agency of Japan – JICA, in charge of offering social, technical and sociological support for developing countries like Colombia. Finally three critical aspects, important for this process are identified as: a. Governmental policies related to science & technology transfer, b. Implementation of institutions like (R&D) research centers and national technical support centers, in charge of intermediation from foreign technologies to the national market and finally c. As a result of the management of intermediation organisms, is possible the technology transfer to the industrial network, improving aspects like productivity, quality and nationally and internationally competitiveness.

Keywords: *Technology and Innovation Management Process, Technology Transfer in Developing Countries, (R&D) Research and Development Centers.*

INTRODUCTION

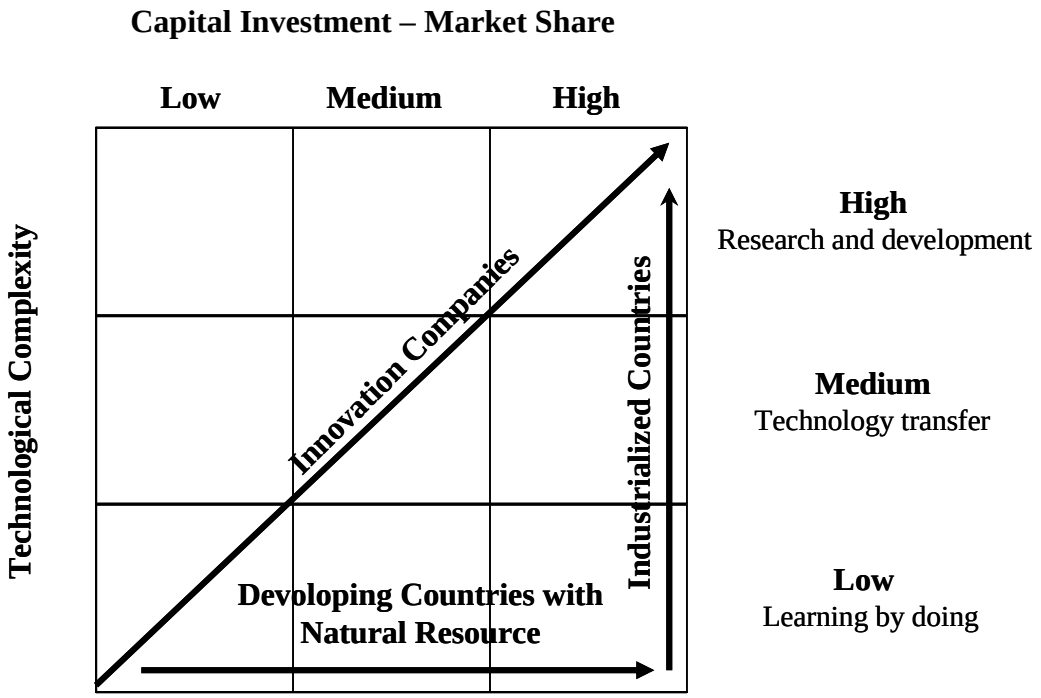
Diverse challenges regarding management of innovation and technology transfer process in developing countries and its relationship with national and international market is addressed in this work. This technology transfer process is only possible with the support and leadership of technical and technological research centers located in a specific zone of interest; created and leaded by university members interested in adapt, develop and apply *state-of-the-art* technologies to the national requirements within an emerging and flexible market.

As a conceptual reference, the technological development infrastructure also known as concept of National System of Innovation –Nelson (1993), will be analyzed; starting from the identification of the entities that play a role for promotion of science and technology together with the policies of such entities available for its support. In this case in a specific and very interesting region of the globe like Colombia (South America). For this analysis, a model-Ortega (2009) of national innovation system, and one more for management innovation process had been designed in the School of Industrial Engineering and Statistics (Universidad del Valle), and will be used for further analysis.

As a case study a key project has been chosen called *Hard and Superhard Coatings: Development and Industrial Applications* – Sequeda, Neira (2006), lead by the Materials Science Research Center, CIM-Univalle. In this specific case the technology transfer process and its further application to the industrial field (wood, paper, polymer production and metalworking manufacturing) will be analyzed.

THE SCIENCE-TECHNOLOGY-SOCIETY & INNOVATION SYSTEM

The scientific activity and its participation on the technological development are playing day by day an important role in a globalized economy. Thus direct technology contribution is getting more relevant due to the trend of scientific acceptance coming from industries and society parties giving as a result the most important an "intimate" relation between technological and economical development for establishing a new economic-technological world Map- Ortega (2007): G-7, G-20 working on R&D and high capital investment, and others developing countries learning by doing and transfer of technology . (See Fig. 1)



Source: Ortega, J.A.(2007)

Figure 1. The Economic – Technological World Map

By the other way, the relationship (technology and economy) and its application based on scientific knowledge, makes possible the creation of new technologies and furthermore an increase on the skills required to adapt those to the productive sector. As a consequence, new products will be created according to the local inquirities, facilitating the creation of new products and services. Finally affecting the economical and social development of a country, giving as a result the scheme called: SCIENCE-TECHNOLOGY-INDUSTRY-SOCIETY & INNOVATION also known as the concept CTS+I. (see Fig. 2).

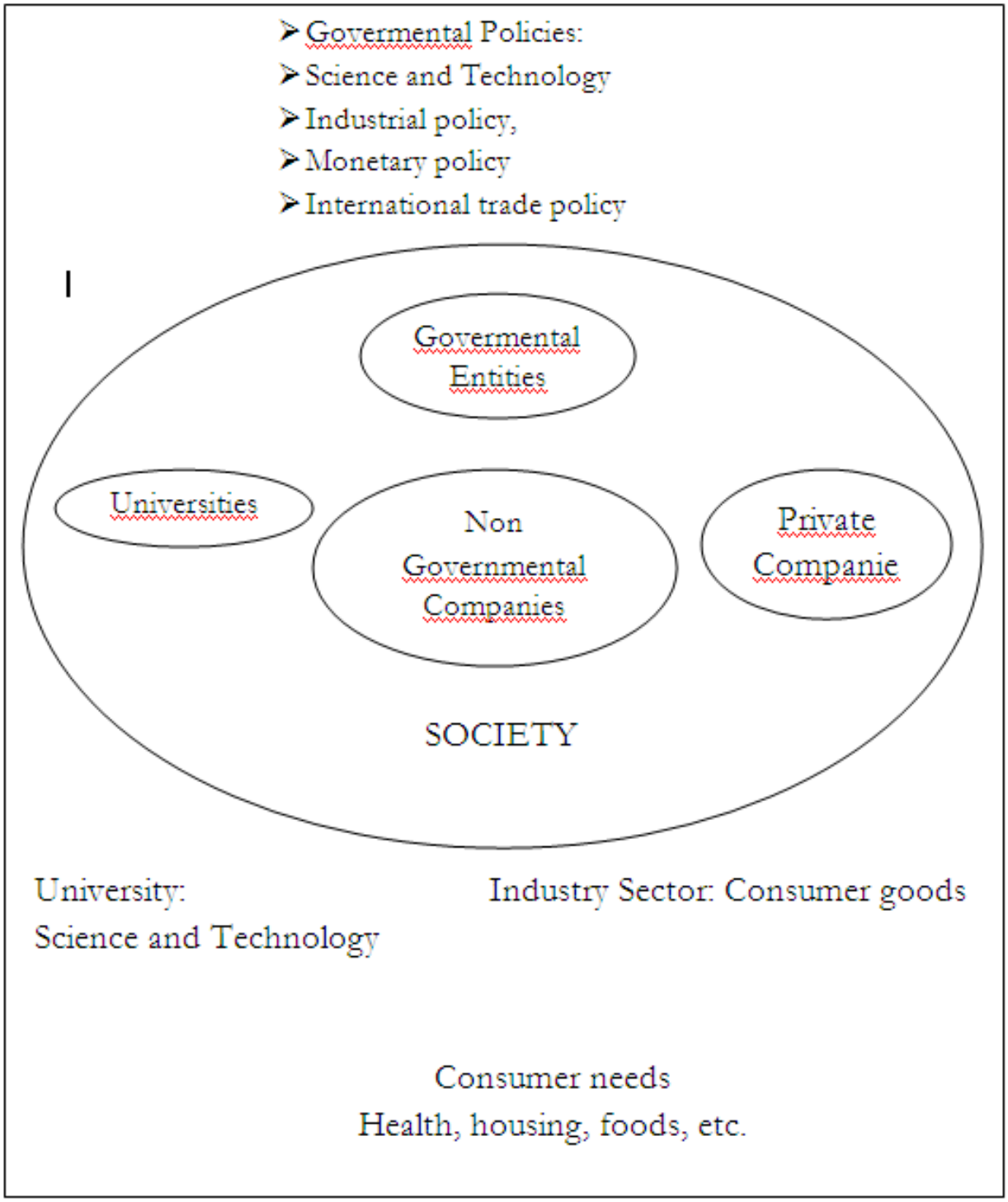


Figure 2. The Science-Technology-Society System

In modern society a model is required to work in conjunction with the main governmental agencies for economical development. In this case these entities are in charge of policies development, resources allocation for the support and promotion of science and technology and an adequate regulation system for industrial,

commercial, environmental and monetary issues. On the other hand universities and research groups as well as industries are leaders in the development process for the elaboration of technology development institutions, like sectorial centers for research and development, technology transfer centers, resource generation to finance innovation, and technology development. (see figure 3)

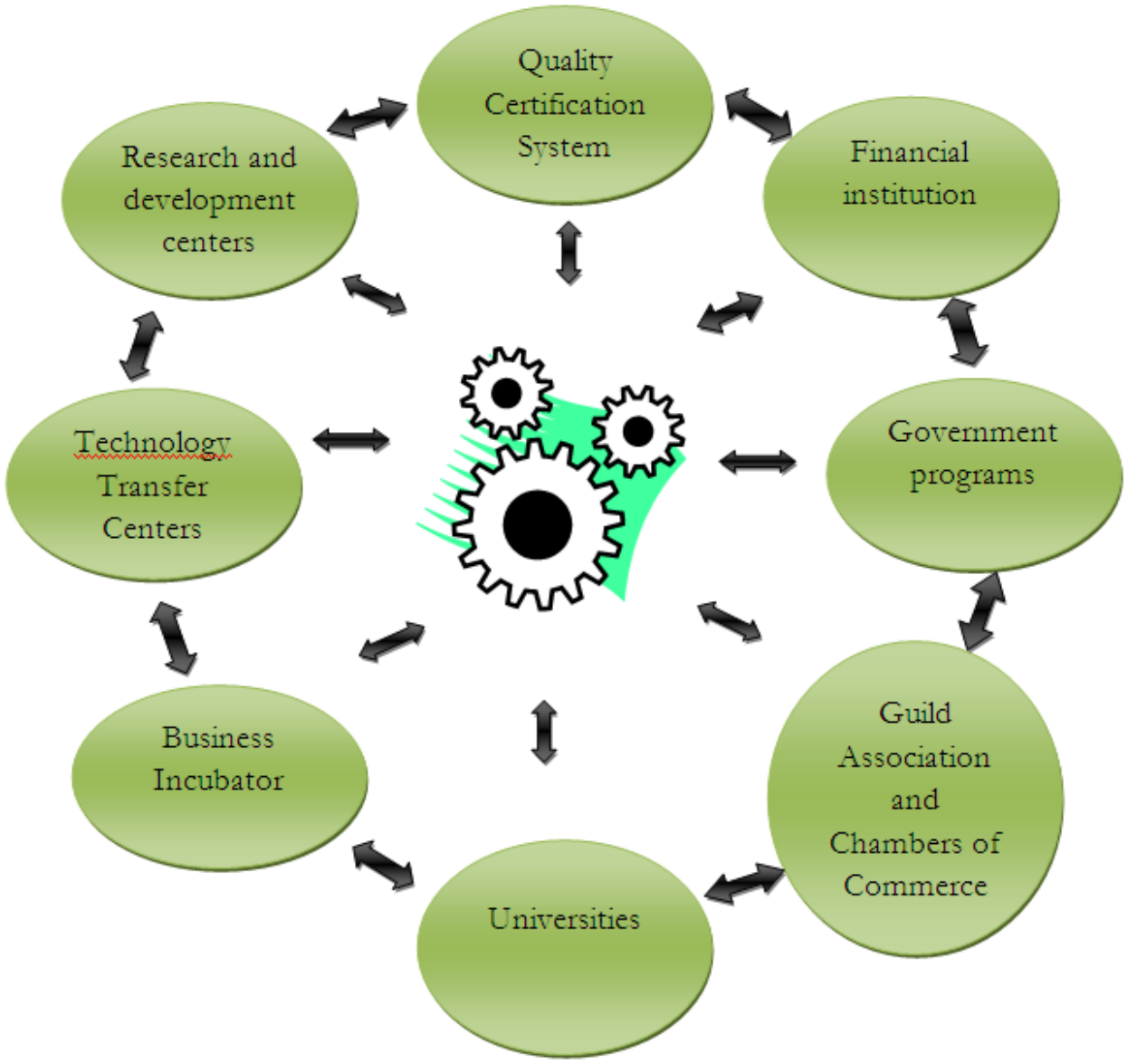


Figure 3. National Innovation System

Is also important to point out that the capacity for strategic R&D project management from the companies and universities shows its leadership and capacity for innovation.

THE MATERIALS RESEARCH CENTER - CIM

The Materials Research Center – CIM, belongs to the School of Engineering Materials in Universidad del Valle which promotes State-University-Industry strategic alliances making possible the development of new materials for the Colombian market.

Its origins date from 1998 when a project called Hard and Super hard Coatings is initiated trough the financial support of the national council for science and technology COLCIENCIAS and co-financed by the most important companies related with the metalworking, mechanical, wood and paper sector in the country, a

government institution SENA, in charge of technical training and support for middle sized companies, for a total project cost of 2.1 million dollars.

The Model for Management and Technology Innovation: A proposal from the Research & Technology Management Group from Universidad del Valle - Colombia

In figure 4 the schematics of the process used to evaluate potential ideas for future innovation projects is shown. From the analysis of existing products and processes compared to the changing and challenging market tendencies and a detail review about new technologies able to satisfy these new requirements.

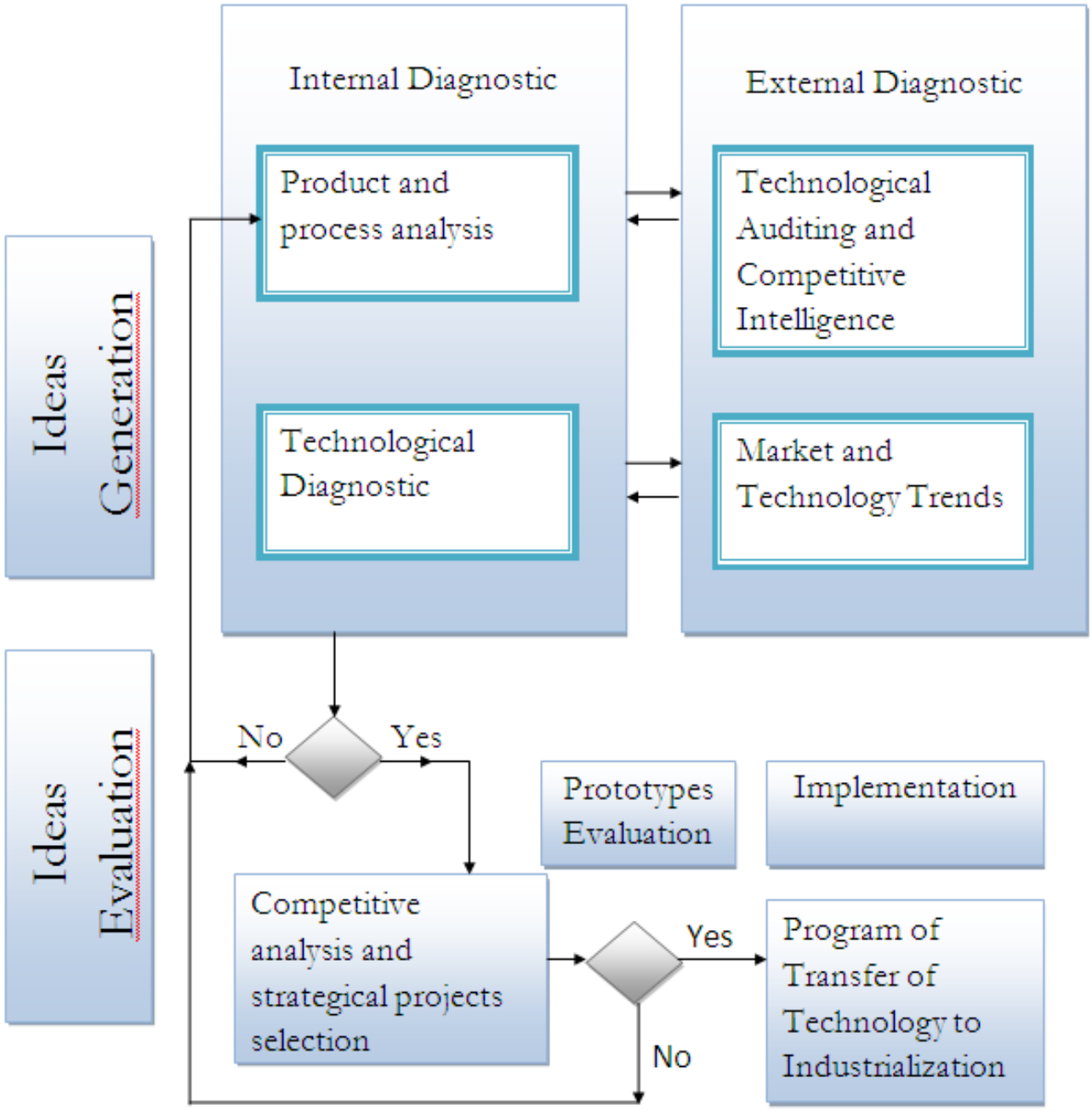


Figure 4. The Management Innovation Process Model – Ortega J.A.(2009)

The work strategy involves first a diagnostic phase consisting in generation of ideas, then these ideas are evaluated by a multi-criterion method: institution-strategy related with actual capacity for technology and

economic resources. Then after this analysis the ideas with higher score are chosen. Then a prototype is design for further test and finally the stage of technology transfer is initiated. As an example a project design by the materials research center is explain as follows.

The Material Research Center and its Project Hard and Superhard Coatings

Cutting tools lifetime and cutting quality represent a large impact in the whole production practice- Neira, Sequeda (2001). Knives, extrusion dies, drill, punches etc. are subjected to a large amount of wear caused by corrosion, abrasion and high temperatures due to its operation. This wear is defined as the detachment of material particles as a result of its interaction with the product being cut or the interaction with a counter part during service. As a result the tool is no longer useful due to lack of properties required to accomplish its duty. To improve that, a surface treatment to increase the hardness is used trough a coating that at the same time reduces the corrosion process and increase the lifetime of the tool and decrease the down time during production.

Technology Transfer Impact of Hard and Superhard Coatings Process

The participation in technology transfer process is part of a huge effort from the Colombian country to improve products quality, increasing productivity and employment opportunity trough an increased participation in a global market.

This takes place during the 70's and 80's when a national program send teachers to US and Europe to pursue doctoral studies in chemical, physics and materials science.

Furthermore, this new professionals arrive to the country and participate in a technology transfer program to improve the quality and productivity of the national industries using foreign standards. With that purpose, the new incoming professionals start R&D groups within universities as a first step in the technology transfer process in which new students were trained in those technologies and preliminary tests were conducted as well (all these activities were included in the undergrad and postgraduate program). The research topics chosen were the treatment of new materials as polymers, super alloys, ceramic and composite materials among others.

Those groups were sponsored by the national council for science and technology COLCIENCIAS trough a new program for technology innovation that took place on late 80's and early 90's in which the appropriate research facilities where acquired to be installed on the universities and some technical support centers working in conjunction with the universities as well.

This helps to a technological and scientific maturing process making possible the second stage for the process consisting on the creation of a hard coatings pilot line and the training of professionals to run it. At the same time is created the academic program for materials science and engineering around the country with the purpose to start gathering information from industries about challenges they were facing in terms of materials wear and corrosion to be solved by the coating technology. Some samples then were taken and subjected to the coating treatment using first the research facilities and when the required results were attained by the test those were scaled up to the pilot line for large area samples. These samples being most of them extrusion dies, punches, cutting knifes and materials for ostheosynthesis.

Thanks to the big impact of these preliminary tests, the third stage was initiated by establishing a technological center in charge of link basic research groups and coupled them with the industrial requirements. In 1997 is created then the Materials Research Center – CIM, adjoined to the Universidad del Valle, composed by materials scientist from undergraduate and graduate programs. Also sponsored by the Colombian government trough COLCIENCIAS. Trough this center people from industry is trained about the benefits of new materials technologies from academic personnel and the requirements from the industry are interchanged in the same manner.

Five companies make part of this pilot program, mainly related to metal mechanic, wood, paper and aluminum production. (Those areas were chosen for being neural points for the economy at that time).

The fourth stage consists in establish technical and technological agreements between University-Centers for Technological Development-Industry, trough joint projects, strategic alliances and long term technical support programs.

At the same time network programs are initiated trough South America with universities working with new materials development and companies acquiring new process and technologies and the process involved for such transfer to be used as a benchmark for the national experience. Parallel to that the program start the process to get support from international cooperation agencies from Japan (Japanese International Cooperation Agency - JICA) and Germany (Servicio Nacional de Aprendizaje - SENA ASTIN), obtaining economical resources and at the same time a link to updates to the technology discussed in terms of new developments and implementation.

Technology Transfer Process Impact:

a. Over the National Research and Development System

Due to the interaction with these international cooperation agencies is possible to start a Pan-American training program in coating technology for scholars, technicians and entrepreneurship personnel, in order to show all the capabilities of this technology and in some cases the feasibility for business opportunities.

This cooperation take place during 10 years from 1998 to 2008 in which 24 research groups and laboratories from countries like Peru, México, Brazil, Chile, Paraguay, Venezuela, Cuba and México from which the most representative are:

- Laboratorio de Metalurgia Física, Universidad de Río Grande do Sul (UFRGS), BRAZIL
- Departamento de Física , Universidad de Chile, CHILE
- Facultad de Física – IMRE, Universidad de la Habana, CUBA
- Instituto de Investigaciones en Materiales, Universidad Nacional Autónoma de México, Universidad Nacional Autónoma de México, MEXICO
- Instituto de Investigación en Comunicación Óptica, Universidad Autónoma de San Luis Potosí, MEXICO
- Facultad de Ingeniería Geológica y Minería Metalúrgica, Universidad Nacional de Ingeniería, PERU
- Facultad de Ciencias Físicas y Matemáticas, Universidad Nacional de Trujillo, PERU
- Instituto de Ingeniería Química, Facultad de Ingeniería, Universidad de la Republica, URUGUAY
- Escuela de Ingeniería Metalúrgica y Ciencia de los Materiales, Universidad Central de Venezuela, VENEZUELA
- Centro de Ciencia e Ingeniería de Nuevos Materiales y Corrosión (CEMANCOR), VENEZUELA

The cooperation brings also contact with worldwide experts in coating technologies (characterization, production and improvement) and international joint projects with industries trough national universities are set.

b. On the University and Research Centers and Laboratories

Thanks to this program (international technical cooperation), is been possible for students to pursue graduate studies in the area of new materials and state-of-the-art production technologies with the lead of the materials research center well as:

1. Faculty and research access in the areas of study located in South America, North America, Europe and Asia.

2. Opens the possibility for Master and Doctorate Students to have international advisors trough the cooperation net established by the technology transfer process.

3. Access to international data bases not available beforehand

4. Offer the students the possibility of work in areas of global interest trough the support of multidisciplinary research and development groups giving them the opportunity to explore possible applications in the national market.

c. On the Materials Research Center CIM

Due to its main purpose to establish a connection between academy and industry, the materials research center has been able to:

1. Elaborate strategies analysis for innovation including resources, capacities and actual knowledge from the best practices applied by the industry.

2. Gain knowledge in aspects like the national system for innovation and development, technology transfer, its non-technological aspects for innovation. For the first time using local science and technology indicators to establish the impact of new technologies in the national market.

3. Analyze the development in territories caused by organization for production, innovation diffusion, knowledge sharing, urban development and its interrelationship with national agencies and new development policies.

4. Know the patterns and factors influencing the creation of new technology-based companies, considering pre-existing developed models used on foreign countries collaborating with the technology transfer process.

5. Master the mechanisms for technology transfer in the private and public sector as well as the academy. And improve the adaptation skills managing aspects like the permanent changing global markets.

d. To the companies participating in the process

The main advantage for the participating companies is the access to new technologies additional to the technical and scientific support non-existing before. Additional advantages are:

1. Technical and technological feedback about new technologies and the national policies required to be able to use them.

2. Appropriation and development of the coating technology thanks to the effort of the national government and the universities. Offering those, new products with better quality and lower cost and in most cases focused but not limited to increasing productivity.

3. Feasibility studies, for new technologies different from hard coatings, initiating then a new technology transfer process.

General Impact of the Technology Transfer Program

- Improvement of the research pertinence and its promotion in foreign countries.
- Contribution with the creation and consolidation of research groups and centers for technology development, involving the training of young research students.
- Promote interdisciplinary projects to be developed in the region of interest.

As shown before the important impact given by the project was possible through the multidisciplinary cooperation of governmental agencies, industry and university. Making possible this technology adaptation and further appropriation, showing not only its technical and economical relevance but also as an example of the importance of this academy-industry cooperation allowing the industry to achieve higher product standards and for the academy a more pertinent use of resources focused on solving actual national problems, using state of the art technologies.

CONCLUSIONS

- Science and technology policies – COLCIENCIAS (2008) constitute and effective resource to promote the sponsorship of R&D centers and supports the technology transfer process in developing countries.

- The R&D centers should have their own model for management and innovation to make them more versatile evaluating technical and commercial possibilities for new process or new services.

REFERENCES

1. COLCIENCIAS (2008) "COLOMBIA Construye y Siembra Futuro – Política Nacional de Fomento a la Investigación y la Innovación.

2. Neira A., Sequeda, F. (2001) "Hard and Superhard Coatings – Industrial Applications"- (Recubrimientos Duros y Superduros: Desarrollo y Aplicaciones Industriales)**,** "IV Curso Internacional de Procesamiento de Materiales por Plasma", Comisión Nacional de Energía Atómica - Centro Atómico Constituyentes, Agencia de Cooperación Internacional del Japón - JICA – Buenos Aires - Argentina CAC. Agosto 4 al 30, 2001.

3. Nelson, R. (1993), The National Innovation System, University of Columbia.

4. Ortega J.A. (2007) "Management of Sectorial Technology Chains and Integral Evaluation of Potential Projects on Innovation Technology, PICMET, 2007.

5. Ortega J.A. (2009) "El Proceso de Gestión de la Innovación en Organizaciones con Responsabilidad Social: El caso de MAC S.A.", ASCOLFA, 2009.

6. Sequeda, F. Neira, A. (2006) Informe Final de Gestión del Proyecto "Recubrimientos Duros y Superduros: Desarrollo y Aplicaciones Industriales" Universidad del Valle, Centro de Investigación en Materiales C.I.M., Junio 2006.

7. Sequeda, F., Neira, A. (2005) Use of Duplex Process to Enhance the Mechanical and Tribological Performance of Hard Coatings, Society of Vacuum Coaters Annual Meeting Proceedings, Denver, Colorado, USA Abril 2005.

8. Sequeda, F. Neira A. (2001) "Hard Coatings Applied to the Paper Process Industry" – (Recubrimientos Duros Aplicados a la Industria Papelera), I Congreso Internacional de Materiales y II Encuentro Nacional de Ciencia y Tecnología de Materiales, November 5 – 10, 2001.