University Technology Transfer and National Innovation Policy: Success Stories from Brazil, Colombia and South Africa

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I. Knowledge, National Innovation Systems and Economic Development

> [It is] important to engage the UN system in the mainstreaming of Science and Technology in the broader developmental agenda. We call upon all the United Nations institutions responsible for Science and Technology, and the Bretton Woods Institutions … to continue to enhance capacity for countries to develop National Systems of Innovations policies aimed at providing an enabling environment for science to bear economic results of knowledge generation. These systems should produce centers of excellence, networks of knowledge generation and dissemination.[1]

Knowledge generation and technology innovation is essential to compete in the new global economy, and developing countries are poised to play an important role in this new economic paradigm. Providing sufficient support for publicly-funded scientific research that leads to the commercialization of technological outputs is critical to advancing the economies of developing countries. Innovations in agricultural production, biotechnology, alternative energy, water conservation and public health have already proved important in emerging economies. Prioritizing research and development, and formulating an appropriate innovation policy in developing countries will benefit regional economies where it is most needed.

Innovation requires highly-skilled scientists and engineers that will remain in the country. Most publicly-funded scientific innovation occurs in a university setting, and universities must provide the structure necessary to aid scientists in the commercialization of innovation. This structure is usually technology transfer offices that include policies guiding intellectual property ownership, licensing and revenue sharing with innovation producers.

This booklet provides examples of university technology transfer offices in developing countries. Each office must work within differing national innovation policies, funding mechanisms and overall systems of innovation. That said, each office endeavors to commercialize university-produced innovations to the benefit of local communities, regional economies and national economic development. By highlighting these successes in innovation, this guide illustrates how such public to private transfer of technology can have a positive effect on the local as well as national economy of developing countries.

Examples of Brazilian, Colombian and South African universities are presented, representing emerging economies that possess a minimum level of scientific and government infrastructure, appropriate laws and the desire to adjust their innovation strategy to best encourage economic growth through innovation. Each country possesses a system of research universities, intellectual property laws and a private industry capable of turning innovation into new and marketable products.

Admittedly, least-developed countries would not benefit significantly from formulating public policy that promotes scientific and technological innovation. The cost of creating such a system simply outweighs the potential benefits. These countries are better off focusing on providing clean water, fundamental health care and basic education.

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[1] Opening Statement by H.E. Mosibudi Mangena, Minister of Science and Technology, Republic of South Africa, addressing the Ministerial Meeting of the Group of 77 on Science and Technology, 3 September 2006.

a. Knowledge Generation, Economic Growth and a Culture of Science

The production and exchange of knowledge dominates the global economy. This new economic paradigm, known as the knowledge economy, is grounded in the need to generate well-educated highly-skilled human capital that produces technological innovation.

Universities play a critical role in the knowledge economy while producing highly-skilled scientists, they spur new technological innovations. This is not the entire story; for innovation to have an impact on economic development, it must be commercialized. Only when new technology is employed in an economically useful manner will technology have an impact on economic development and positive growth.

For emerging economies (including low- and medium-income countries), growth and international competitiveness largely depend on utilizing innovation, knowledge and technology, In 2005, the United Nations Millennium Project Task Force on Science, Technology, and Innovation supported this assessment with their publication *Innovation: applying knowledge in development*.[2] Convened to address how science, technology and innovation can help achieve the Millennium Development Goals,[3] the Task Force on Science, Technology, and Innovation concluded that economies, including emerging economies, rely on the generation and use of knowledge to drive economic systems.[4] Developing countries must enhance science, technology and innovation capacity to realize the following objectives:

1. Make progress on meeting the Millennium Development Goals, realize sustainable poverty reduction, and tackle regional health and nutrition problems;
2. Transform economies from those based on subsistence agriculture and low skilled manufacturing into ones based on the production of higher value, knowledge intensive, goods and services;
3. Raise productivity, wealth and standards of living; and
4. Develop appropriate R&D capacity to support technology-based economic growth to address country specific social, economic, and ecological problems.

Furthermore, scientific innovation has a culturally transformative effect. By shifting traditional social relationships and exposing greater number of people to technology, scientific innovation creates a "culture of science." Instilling a society with a culture of science involves valuing openness and the sharing of information, encouraging criticism and investigation, and broadening access to education for all people including women.

Converting the R&D system for many countries will entail numerous structural and organization reforms in the way R&D is performed. Modern science tends to function best when (i) research is linked to teaching, (ii) scientists and engineers from different disciplines collaborate in

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[2] Calestous Juma; Lee Yee-Cheong; United Nations Millennium Project Task Force on Science, Technology and Innovation. United Nations Development Programme 2005.
[3] Eight goals articulated at the United Nations Millennium Summit that guide UN development policy, September 2000.
[4] *Id at 44.*

problem-solving teams, rather than working alone, (iii) there are no distinctions made between basic and applied research; and (iv) there are close linkages between research scientists and business enterprises.

b. National Innovation Systems

What is innovation? Innovation is the creation, diffusion and use of new ideas and technological advances in an economy, and can take the form of new products, new production processes, new markets and new organizations. Because innovation is so important to progressing national economies, governments have created agencies and enacted laws designed to directly influence the level of domestic innovation. Such agencies, laws and policies are referred collectively as a "national innovation system" (NIS).[5]

Innovation systems set out to establish how resources are organized for the discovery, creation, development and economically productive application of new technologies. Components of an NIS include a countries' government policy-making infrastructure, university and government laboratory system, tax laws, and intellectual property laws, among others.[6] This framework creates an environment where innovation can thrive.

The level of innovation within a country is influenced by many factors thereby creating an extremely dynamic system. Countries have devised a plethora of strategies to encourage innovation, and no two systems are identical. Ultimately, the goal of an innovation system is to spur technological innovation and ensure that the innovation makes its way into economic production being adopted and used by private firms.

Innovation is the result of research and development (R&D), and investment in R&D must occur in both the public as well as private realms. Sound innovation systems strike a balance between encouraging public innovation and private R&D by not relying too heavily on one over the other. For the system to optimally function, both sides must be allowed the flexibility to structure licensing and research agreements, and to freely share technology and knowledge. Such public to private transfers of technology and knowledge are critical for taking an innovation or new technology and turning it into a marketable product.

Crucial for innovation is the interaction among various organizations and firms, often sharing knowledge, technology, facilities, and even researchers. Firms often cannot innovate alone; firms innovate in an interaction with customers, suppliers, other knowledge-oriented enterprises, universities, and sometimes even with competitors. This interaction between research organizations and private firms is important to the health of the overall “system” of innovation.

The NIS approach is based on finding research solutions to particular societal and market needs. These needs are better identified when there are stronger local connections between the

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[5] See, Richard R. Nelson, Editor, *National Innovation Systems: A Comparative Analysis,* Oxford University Press, 1993

[6] Björn Johnson and Bengt-Åke Lundvall, “National Systems of Innovation and Economic Development,” in Mammo Muchie, Perter Gammeltoft and Bengt-Åke Lundvall, *Putting Africa First, the Making of African Innovation Systems.* Aalborg University Press, Aalborg Denmark, 2003

innovating researchers and those who identify needs and stand to benefit in the market. Therefore, an essential and often overlooked component of the NIS is the local linkages between innovators and between innovators and industry. Whether these linkages are between private entities or are public-private interactions, such linkages must be rigorously encouraged to create a healthy and strong NIS. Of particular importance is activating public-private linkage, and transferring technological advances for commercialization.

c. Role of the Research Universities in the National Innovation System

For a country to successfully build a knowledge economy there must be a critical mass of human capital with advanced education and skills. Today, the majority of technological innovations are made by those with substantial education in science or technology. A framework to build capacity in science, technology and innovation should not overlook the necessity of investing in science and technology education. Furthermore, the reduction of inventions to commercial applications also requires skilled entrepreneurs. Developing countries need to devote resources to help young people receive this level of education.

Furthermore, universities are hotbeds of creative talent that can be tapped for entrepreneurial activities. Interactions with the surrounding community allow the university to gain direct knowledge regarding unmet social needs, some of which could be addressed through research and development activities. Universities also partner with industry to conduct collaborative R&D; create spin-off firms, participate in capital formation projects such as technology parks and business incubator facilities; introduce into their curricula entrepreneurial training and internships; and encourage students to take research from the university to firms.

Higher education is more important than ever for training and retaining talented and creative young people in developing countries. This change reflects today's international climate of access to education and a global economy that rewards technological expertise. Universities must shift their curricula and adjust their pedagogy to train and keep their best scientific talent, and provide this talent with opportunities to participate in collaborative research and engage in entrepreneurial endeavors. National development plans need to promote increasing links between universities, industry and the government. These adjustments then will impact the entire national innovation system, including private firms, R&D institutes, and government entities.

Encouraging public-private technology transfer is an important component of all innovation policies and can be especially crucial for developing countries. Universities do not often possess the expertise, resources or incentives to convert technological innovations to market-ready products. Private industry is best suited for this risky endeavor.

The greater involvement of the university in its external environment should be seen as an addition to its traditional task of knowledge and training high-level workers. Interacting with the external environment means that universities have begun to have a more entrepreneurial orientation, and connections with the external environment will drive research. Market-driven university research ensures that local needs are addressed through technology, thus having a greater impact on regional development.

Forming cooperative research agreements between universities and private industry will further ensure that research is relevant to the greater community. It is important to understand that industry and the university exist for different purposes – companies exist to make a profit, universities exist to generate and transfer knowledge and conduct research. However, a symbiotic growth of the two bodies can be complimentary – namely in conducting research. Such external interactions between university researchers and private industry are essential components of any national innovation system.

II. Technology Transfer and Intellectual Property Rights

> Technology transfer is the process of transferring scientific findings from one organization to another for the purpose of further development and commercialization…The process typically includes identifying new technologies, protecting technologies through patents and copyrights, forming development and commercialization strategies such as marketing and licensing to existing private sector companies or creating new start-up companies based on the technology.[7]

Technology Transfer is important for publicly-funded research institutions. Not only is the transfer of technology good for generating money by licensing inventions made by university scientists but also to demonstrate the relevance of the research projects to local and national development. Technology transfer helps to create new jobs through spin-off companies, contribute to the modernizing industries and facilitates cooperative projects.

In order to use emerging technologies as a tool for economic development, developing countries must provide strong legal protection for new innovations, and encourage the sharing of new technology for the purpose of commercialization. Strong intellectual property laws provide scientists and researchers with the incentive to engage in important developmental activities while ensuring the creativity that goes into innovation is not a wasted activity. Scientists and researchers can gain economic benefits by licensing their protected inventions and innovations or by developing and marketing their patented products on their own.

In short, the role of the technology transfer system is to facilitate cooperation between technology developers. This cooperation is mediated through formal business partnerships between government, non-profit, and private sector actors. Such partnerships greatly depend on clear and enforceable property rights. Technology transfer is an essential component of any national innovation strategy, but what defines an effective transfer system? The hallmarks of a successful technology transfer system are scientific cooperation, business partnerships, and unambiguous property rights.

a. Cooperation, Partnership and Intellectual Property Rights

Firm competition may be the dominant force behind market efficiency when dealing in mature commodities, but the highest-technology industries demand a different paradigm. In these

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[7] The Association of University Technology Managers (AUTM), definition of technology transfer at http://www.autm.net/aboutTT/index.cfm, last accessed 05 February 2007.

markets, overwhelming uncertainty and volatility associated with product development make it advantageous to spread out risk. In many cases, this means breaking up the technology development process into stages, where different actors develop discoveries at different steps along to way to commercialization according to their industry niche.

Before an innovation makes it to market, R&D must occur at several levels including illuminating the mechanism of action, scope, and safety of a technology. Firm specialization at different stages of product development is an effective way to spread out individual risk without diminishing the overall returns of investment. Thus, building strong horizontal linkages between developers is an integral part of constructing effective technology transfer infrastructure. The earliest stage of technology development is basic research, and at this stage it is usually unclear whether a discovery can become a viable commercial product or not. Further investment is required to answer that question.

To use the US system as an example, large public research institutions often perform basic research (the most risky stage of product development), then share technology with private companies who complete R&D associated with downstream development. The mechanism of sharing is usually through formally negotiated licensing agreements. In such a case, public research institutions and private industry are horizontally associated in product development as business partners in a sense. However, the exact configuration of the partnerships takes different forms; downstream developers can be large established firms or venture-financed start-ups.

These partnerships are founded on economic trust built on strong laws, and clearly defined property rights. Upstream innovators are comfortable releasing investments to multiple parties when they can be sure that the commercial benefit of their contribution will be accordingly appropriated. All partnerships benefit from the same intellectual property infrastructure for technology transfer as the archetypal university-private industry partnership, namely an effective and transparent intellectual property rights system. They can ensure this commercial benefit through the acquisition of intellectual property tools, particularly patents.

No firm can afford to pay the costs of performing research and development if the benefits of the research accrue as much in its competitors as to itself. Firms that have a proprietary position that enables them to recover the investment of R&D funds then can engage in more research. This proprietary position is generally achieved through the granting of a patent, a government granted limited monopoly on inventions that meet a legally defined set of parameters.

Developing countries aspiring to compete in the global marketplace must ensure adequate intellectual property protection for their scientists' creative output. Of concern is becoming fully compliant with the World Trade Organization's agreement on Trade Related Aspects of Intellectual Property (TRIPS) as early as possible to encourage inflows of investment from other countries. Many developing countries have become TRIPS compliant and have experienced economic benefits because of it. Between 1988 and 1995, nearly $425 billion worth of new factories, supplies, and equipment were invested in developing countries.[8] Intellectual property is a catalyst social, cultural, and techno-economic development.

[8] Imam, Ali M., *How Patent Protection Helps Developing Countries*, 33 American Intellectual Property Law Association Quarterly Journal 377 (2005).

Patents are the most powerful instruments of intellectual property with regard to technology transfer. Awarded in return for public disclosure, patents are temporary exclusivity rights granted to innovators. To qualify for a patent an invention must be novel, must make some claim of defined utility, and must involve an inventive step rendering the discovery "non-obvious". The patent instrument provides inventors with a means of exploiting their inventions for economic return for a period of 20 years.

Providing exclusivity rights to the inventor cures what economists call "the appropriation dilemma" of innovation—a market failure that results in underinvestment in technology development. Without strong intellectual property rights, investors lack private incentives to innovate since they cannot prevent market mimicry; once an idea is hatched, the marginal costs of diffusing the idea are extremely low and thus society benefits tremendously but the innovator cannot capture rewards. The profit incentive for investment is the *ex ante* (pre-invention) rationale for awarding IPR to innovators. Failing to provide this incentive results in an aggregate failure to reach the maximum efficiency or Pareto Optimum volume of investment, and society loses valuable innovative power.

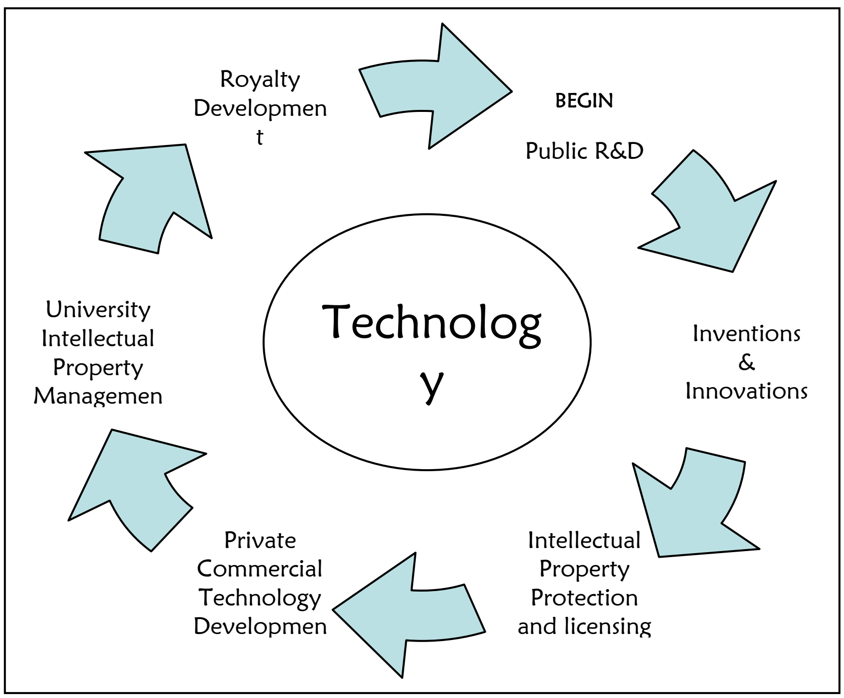

Figure 1 Technology Lifecycle –technology transfer and commercialization

Furthermore, lacking strong IPR introduces inefficiency in the *ex post* (post invention) stage as well. Well-established and defined property rights are necessary to reduce unnecessary transaction costs associated with litigation and enforcement uncertainty. These costs divert resources away from critical R&D activities, and reduce the value of patents. The more efficient the IPR regime in delineating grant and ownership rules, the lower the likelihood spurious litigation and piracy.

b. University Technology Transfer

Universities are institutions of learning and scientific progress. The main function of the University will always be education and primary research and inquiry; however, technology transfer and technology commercialization can support the university's mission. Technology transfer in universities is not a new concept; universities have always transferred technology through methods such as publications, student education and professor consulting. Technology transfer through intellectual property and know-how licensing adds a new dimension to student education and research opportunities for both professors and students.

Public research institutes, including government laboratories and public research universities, use technology transfer offices (TTO), to provide access to technology to outside entities. The role of a TTO is to facilitate university interrelation with the other two agents of the innovation systems: industries and government. Many countries undertake policy initiatives in an attempt to stimulate research partnerships between industry and publicly-funded research universities. Such initiatives intend to increase the rate of utilization and transfer of knowledge to the private sector. A number of mechanisms promote such partnerships including the creation of science parks, encouraging joint research and joint ventures, and new business incubators.

In order for publicly funded university research to be a formal part of the technology transfer system, universities must have the ability to acquire formal property rights on their discoveries from that research. In the US, the statute providing for university ownership of intellectual property is the Bayh-Dole Act of 1980 (discussed further infra).[9] Bayh-Dole fundamentally changed the relationship between public and private research, creating an environment where the two work together synergistically for the production of new technology.

The Bayh-Dole Act specified that universities retained ownership rights of the intellectual property rights (IPRs) on research results obtained using public funds. This Act of Congress is widely believed to have spurred a sharp rise in patenting activity in United States academic institutions. In an attempt to replicate this result, many countries, developed and developing, have begun to design innovation legislation that encourages more university-industry linkages.

Greater contact between public research and private industry is advantageous. Industries have an interest in gaining first – occasionally exclusive – access to new basic research, and also in sponsoring research on targeted issues and recruiting key scientific personnel. For universities, the main incentive is financial, with applied commercial research being a way to attract business research funding and, if successful, licensing income. However, for universities new organizational burdens came along with Bayh-Dole. The number of TTOs at US universities has increased considerably in the last 25 years, and the structures have changed significantly as well.

c. Promoting Stronger University – Industry Linkages

The association between university, industry and government constitutes one of the best ways to establish a link between technology and economic development. The system established by creating these public university/industry linkages exploits the complementarities between the agents: universities, as producers of the scientific and technological knowledge; industries, as promoters of the development and innovation of new technologies; and the government, acting as regulator and promoter of such relationships. Healthy complementary interaction creates a balance between these agents providing stability to the system.

The transfer of technology is fundamentally a matter of the flow of human knowledge from one person to another. At the legal level, this transfer is often accomplished through licenses dealing

[9] The Bayh-Dole Act is codified in United States Code: 35 U.S.C.

with the legal rights to use a particular technology in a particular context. However, at the human level, the expertise that went into the research is an essential element that is often overlooked or overly simplified. To best develop a technology, it is essential that the one who conducted the initial research be involved or available in the further development. Encouraging greater collaboration and greater linkages between the basic researchers and private industry contributes to competitiveness.

A starting point for enhancing the participation between university and industry is the TTO. TTOs were created with the objective to stimulate and to facilitate the interrelation with the two agents of the innovation systems: industries and government. Those universities that have a TTO generally assign them the duty of administrating all the services related to the management of intellectual property and licensing.

d. Innovation Policy Success: The Unites States Bayh-Dole Act of 1980

The United States, arguably the world leader in innovation, has a largely decentralized innovation system. There exists no explicit or overall innovation policy or a single bureaucracy charged with overseeing and managing the innovation system. Instead, there are several federal and state agencies possessing their own jurisdictions and agendas sponsoring their own innovation activities. The strength of the U.S. innovation system is widely regarded to be how quickly innovations are produced and then commercialized. This is due to the ability of the United States to publicly fund university and federal laboratory research; attract and train science and technology researchers; foster linkages between universities, federal laboratories and the private sector; grant intellectual property rights that provide incentives for the commercialization of innovations; and have a strong investment in research and development in the private sector.

Although no over-arching innovation policy exists for the United States, several pieces of legislation were passed that encourages innovative activity. One such piece of legislation is the Bay-Dole Act.[10] The Bayh-Dole Act of 1980 set the groundwork for public-private partnerships in science and technology by allowing universities and businesses operating with federal contracts to have exclusive control in most cases over the intellectual property that is developed. Since then other legislation has further encouraged such partnerships. For instance, the Technology Transfer Commercialization Act of 2000 improved the ability of federal agencies to license federally owned inventions to the private sector.[11]

The Bayh-Dole Act has proven to be the catalyst for a major transformation within the United States Innovation System. While it has long been realized that basic research in the United State universities and federal laboratories has supported technological innovation in the private sector by expanding our knowledge base, it was also eventually realized that their research could contribute more directly to economic growth. It was reasoned this could be done by making more effective use of the inventions universities and federal laboratories were producing. To do this, policy makers eventually passed the Bayh-Dole Act which gave public research organizations like universities the option to claim the intellectual property rights in the inventions their researchers came up with while conducting federally sponsored research.

[10] See note 9 supra
[11] The Stevenson-Wydler Technology Innovation Act, 15 U.S.C. 3710 (1980)

Since the 1950's, research conducted in United States universities and federal laboratories has been well funded by the government. Prior to 1980, intellectual property stemming from federally sponsored research remained the property of the United States federal government and was managed by the funding department or agency (i.e., Department of Energy, National Institute of Health, etc.). At the time, the federal government employed a liberal policy pertaining to the licensing of these inventions – that is, all patents owned by the federal government were considered a public resource and thus were freely available to any company who wanted to license the invention. This proved to have a dismal impact on the economic usefulness of these patents. As noted above, there is often a need to develop an invention to a point of commercial practicality – which requires time and money. And, also mentioned above, private companies are generally not willing to make such necessary investments if their competitors could easily free-ride on their efforts and license the same technology. Because of this policy, prior to 1980 less than 1% of all patents owned by the federal government were ever successfully licensed.

The Bayh-Dole Act effectively changed the rules pertaining to federally funded research. Under Bayh-Dole, universities and federal laboratories are given the option to seek patent protection and own the subsequent rights to the patent for any inventions made by university researchers, created in the course of federally funded research. There were only two major conditions imposed upon public research organizations for the right to claim patent ownership over such inventions: 1) they could not transfer ownership of the patents to other entities (but they could license use of the patents) and 2) in the event of successful commercialization of the new technology, researchers involved in creating the invention would have to be compensated.

The effect of Bayh-Dole was to transform universities into a much more economic productive part of the United States innovation system. As an indication of the success of Bayh-Dole in actually transferring new technologies into the private sector, we can look to licensing data. According to the yearly survey conducted by the Association of University Technology Managers (AUTM), the total number of cumulative active licenses between universities and private companies has risen from about 7,200 in 1992, to 27,322 in 2004.[12] During this period, the average number of licenses executed per university rose from 13.4 to 21.3 licenses.[13] Additionally, we can also look to start-up companies begun as a result of technology transfer of an academic discovery. In 1992, 156 start-up companies were formed, based around university technologies, in 2003 that number was 374; while in 2004, the number of new start-up companies based on an academic discover rose to 462. Further, university start-up companies enjoy a favorable success rate, as 70% of all university start-up companies formed since 1992 are still in existence today.[14]

Inventions developed at these public research organizations have greatly supported the emergence of biotechnologies and information & communications technologies, and are poised to support emerging technologies such as nanotechnology. The economic impact of the licensing

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[12] AUTM U.S. Licensing Survey: FY2004, available at http://www.autm.net/events/File/04AUTMSurveySum-USpublic.pdf. Last visited 26 March 2007.
[13] *Id*
[14] *Id.*

and commercialization of these university developed technologies, though difficult to measure, has been huge particularly for those regions with a concentration of public research organizations. Early attempts to estimate the economic impact of technology transfer placed the direct contribution of technology transfer at 428 billion in 1998.

The Bayh-Dole Act was clearly successful in increasing the economic usefulness of inventions developed in public research organizations by changing a specific characteristic of the United States' innovation system; The Act altered ownership of intellectual property rights in federally funded research. However, of even greater value to the innovation system were the indirect changes to the United States innovation system spurred by Bayh-Dole.

As a result of Bayh-Dole, entrepreneurialism has taken on a larger role in the public research community. Prior to Bayh-Dole, there was almost consensus among researchers and academics that the results of publicly funded research should be made freely available to the public and its application not hindered by intellectual property rights. Further, many researchers felt that any commercial application of their work would somehow "taint" their work and force academics to become beholden to the will of the private sector. In the post-Bayh-Dole world, this notion has steadily declined among researchers in public research organizations, and especially among university student researchers. This cultural change among researchers has opened the door to technology entrepreneurialism, evidenced by the increased numbers of technology start-up companies in the United States over the last 15-20 years. Further, many of today's leading research universities and business schools have incorporated courses and even degree programs on technology commercialization and entrepreneurialism.

Another important way Bayh-Dole encouraged far reaching change in the United States innovation system was by facilitating greater and fuller linkages between different segments of the innovation system, specifically between public research organizations and private firms. The process of technology transfer necessarily calls for greater ties between public research organizations and the private sector – sometimes these ties are initiated by technology transfer offices in the attempt to license technologies, and other times they are initiated by the private firm interested in licensing a new technology developed by a public research organization. In either case, when private firms do license technologies from universities, they often not only license a patent but they also contract for further development support of the technology from researchers involved with the invention. This has led to both stronger research partnerships and closer alignment of goals between the public and private sector.

Over the last several decades due to the perceived strength of the United States NIS model, national innovation policies of many countries are trending toward more decentralized structures. Developed countries are following the U.S. model and starting to focus on local and regional research and development interconnections; a trend being imitated by many developing nations. Generally, countries set up laws and policies designed to encourage scientific research and commercial development of innovations. Through a country's NIS, the government hopes to provide incentives that will spur socially- and economically-important innovations. One key component of any NIS is the encouragement of unencumbered technology transfer and licensing.

Major provisions of the Bayh – Dole Act (1980)

1. Non-profits, universities, and small businesses may retain title to innovations developed under federally-funded research programs.
2. Universities are encouraged to collaborate with commercial firms to promote the utilization of inventions arising from federal funding
3. Universities are expected to file patents on inventions they elect to own
4. Universities are expected to give licensing preference to small businesses
5. The government retains a non-exclusive license to practice the patent throughout the world
6. The government retains march-in rights.
7. The Bayh-Dole Act encourages universities to participate in technology transfer activities.

Box 1 United States Bayh-Dole Act

e. Model Technology Transfer Office

The technology transfer office (TTO) is an institutional mechanism created with the purpose of encouraging interaction between the university and private sector institutions, companies, and the government. The creation of a TTO derives from the necessity to improve the effectiveness of university performance in order to more efficiently commercialize innovations, promote local economic development, and possibly respond to socially significant needs such as battling local disease. Through research results, transfer and licensing of proprietary technologies and knowledge, universities in emerging economies can contribute significantly to the social well-being.

The Organization of Economic Co-operation and Development (OECD) expresses the concept of a TTO:

> Technology transfer or technology licensing offices are those organizations or parts of an organization which help the staff at public research organizations to identify and manage the organization's intellectual assets, including protecting intellectual property and transferring or licensing rights to other parties to enhance prospects for further development. A public research organization may have a single centralized TTO, it may have several TTOs associated with it (e.g. for different school or departments), or it may outsource to an external TTO which has several clients organizations"[15]

Most TTOs are young, having an average of 12 years in the United States, and less than 10 in European countries.[16] The OECD definition of a TTO points out that the main activity of the

[15] OECD, *Turning Science into Business: Patenting and Licensing at Public Research Organizations*, OECD Publishing 29 May 2003.
[16] *Id.*

TTO is intellectual property and activities related to its disclosure, protection and licensing. This definition however, could be more focused and defined. TTOs deal with every stage of technology transfer from invention disclosure to patent licensing, and then take on business decisions. It can take several years, after a technology is legally protected, until the university receives royalties (income obtained by the sale of products) originated by the licensed technology, if ever (revenue is never guaranteed).

There are a number of purposes that university TTOs serve, and no two offices are identical. Considering technology transfer as a process, Friedman and Silberman (2003), define it as a "process whereby invention or intellectual property from academic research is licensed or conveyed through use rights to a for-profit entity and eventually commercialized."[17] Seigel argues, "the primary motive of the TTO is to protect and market the university's intellectual property. Secondary motives include promoting technological diffusion and securing additional research funding for the university, via royalties, licensing fees, and sponsored research agreements."[18] This is probably the most common prioritization of goals, but by no means monolithic. Some TTOs have explicit missions of income generation while others focus on economic development. In all cases, the setting up of a TTO requires a close plan examining the needs of the university, the needs of the community, and what resources are available.

TTOs range in form with some being internal to a university or department, while others have been set-up as external separate agencies working on behalf of the university. In either way, it is wise to remember that it is rare for a TTO to be self-funded through royalties. As was mentioned above, the technology commercialization process can take years, and a license may never generate substantial royalties. However, the potential benefits from a few successes can have an enormous impact on local and national economies, and therefore university technology transfer infrastructure must be set. Without a TTO to promote and actively pursue licensing opportunities, important and potentially valuable innovations will languish on the shelf.

Regardless of the structure chosen for the TTO, several essential things must be considered. One of the first things to consider is how large of an office is needed and what mix of professionals will be needed. Taking into account various skills and expertise required, there should be a mixture of business and researcher related knowledge on hand. This could take the form of having university researchers participate as TTO board members or in some capacity as committee members, while bringing in full-time business managers for administration.

A second consideration is hiring General Counsel—will it be in-house or contracted through a local firm specializing in intellectual property matters? There should at least be one person with experience in intellectual property, licensing and contracts that can ensure the university complies with all national and local laws and regulations. In-house General Counsel is not absolutely necessary, but having counsel in-house allows this person to have greater access and knowledge of the overall TTO strategy, opportunities and goals.

[17] Friedman, J., Silberman, J., 2003. University Technology Transfer: Do Incentives, Management and Location Matter? Journal of Technology Transfer, 28, 17-30.
[18] Siegel, Donald et al., 2003. Assessing the Impact of Organizational Practices on the Relative Productivity of University Technology Trasnfer Offices: an Exploratory Study. Research Policy, Volume 32, Issue 1, 27-48.

A third consideration is how to measure success. As is mentioned above, TTOs rarely become self-sufficient. With planning, reasonable and manageable expectations can be formulated, and appropriate benchmarks and metrics can be implemented. When first implementing a TTO, the budget and success metrics are considered and how to measure success is discussed. Knowing the TTO strategy is essential, and measuring success at the very beginning is different than measuring success later once the TTO has been established for some time.

III. Brazil

> Innovation is our lifeblood, and Brazil's decision to pass an Innovation Law that incentivizes and facilitates scientific and technological research and partnerships sent an important message to companies like mine who already invest in Brazil and see enormous potential. Brazil can and should capitalize on the law, both by encouraging the sorts of partnerships and technology transfers that the law envisions, while simultaneously strengthening the basic enabling conditions for innovation: rule of law, respect for intellectual property rights, free and open markets, and efficient and effective regulatory systems.[19]

Brazil is developing its innovation system to become Latin America's leading research center for new technology and innovation. By subtly shifting its NIS from a centrally controlled hierarchical structure to an increasingly decentralized system, Brazil is encouraging local connections to be made for research, but there is still a ways to go to design a system as interconnected as are more developed systems. Brazilian reforms of recent years are creating an innovation system modeled on the American paradigm: subsidize research; provide intellectual property incentives; encourage public-private cooperation toward technology commercialization.

Historically, direct federal government support to certain industries was how major innovation was funded. Direct support issued through "sectoral funds," were directed to specific internationally competitive industries such as aviation. Because of these funds, the private sector R&D efforts relied predominantly on large firms within a handful of industry sectors. This paradigm is currently shifting, but it will take time.

Brazil's NIS is complex and split between federal, state and municipal players. Funding for public research comes from both Federal and State sources. More coordination between the federal and state science and technology agencies is being fostered, but states are largely able to determine their own funding strategies for state public universities. Greater resources and control over research funding decisions are being devolved to the state or regional governments rather than being controlled centrally.

One of the most important factors affecting an innovation system is the level of funding invested in the system itself. In Brazil, overall research funding has only risen from 0.7% of GDP to a disappointingly 1.0% in 2005.[20] Furthermore, nearly 60% of R&D activity is carried out and financed by the government, with nearly 70% of that going to universities and research institutions.[21] Brazil should make an effort to encourage more private R&D; however, with such a share of research funding going to universities, fostering public-private technology transfer is imperative.

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[19] Grey Warner, Senior Vice President for Latin America at Merck & Co., Inc. Quoted in press release for Movimento Brasil Competitivo, Mechanisms of Innovation and Competitiveness, 6 July 2006. Located at http://www.compete.org/gi/pdf/MBCPressRelease.pdf [last accessed 20 February 2007].
[20] Organization for Economic Cooperation and Development Economic Survey Brazil, 2006. OECD 2006.
[21] *Id.*

More private industry investment in R&D must be encouraged in order for Brazil to strike a balance between private and public investment in R&D. While there are a growing number of technologically savvy small and medium sized businesses in Brazil, many do not invest heavily in innovation and few export their goods to the global market. Overall, industry investments represent around 30% of the total Brazilian R&D investment.[22] While Brazil is a leader in South America in R&D investment, nearly all of the scientific innovations occur in the public sector. Furthermore, Brazil's public innovation funding is concentrated geographically. São Paulo, probably the most innovative region in Brazil, receives a significant share of the public funding where large research universities are based.

There are a number of government organizations that directly promote and fund research and development, such as the National Council for Scientific and Technological Development (CNPq)[23] and the Financing Agency for Studies and Projects (FINEP).[24] Both CNPq and FINEP are part of the Ministry of Science and Technology (MCT). The objectives of the CNPq include the stimulation of science and technology and innovation, and in contributing to the formulation of national science and technology policy. CNPq has the objective of doubling the funding for R&D to 2% of GDP in the next few years.[25]

The mission of FINEP is to encourage scientific and technological research in public and private institutions. Though, in theory, FINEP is a good program, the level of funding provided by FINEP is closely associated with the country's economic performance. In the economic downturns of the early 2000s, the level of funding provided by FINEP decreased, making long-term innovation resource planning extremely difficult for firms and universities that rely on the program.

Funding in Brazil does not entirely come from the federal government as states also play a critical role in funding R&D. Nearly all states have founded their own agencies for support of R&D, following the pioneering and highly successful example of São Paulo state. São Paulo has its own innovation institutions and funding system, such as the Fundação de Apoio à Pesquisa do Estado de São Paulo (FAPESP).[26] State-run universities had a distinct advantage over the federal universities because state-funding for scientific research did not carry as many restrictions regarding licensing as federal funding did. Therefore, state universities such as the University of Campinas in the state of São Paulo were able to create an environment were innovation has thrived.

Until recently, Brazil was economically fairly closed, relying on import substitution with little international competition in many industry sectors. Domestic competition between firms was contained to local competition and therefore did not face pressure to innovate. Both of the situations described above contributed to a poor environment for encouraging innovation. But what had been most devastating to the promotion of innovation were the restrictions imposed on technology transfer on research conducted under federal grants and the limited enforcement of

[22] *Id.*
[23] http://www.cnpq.br/
[24] http://www.finep.gov.br/
[25] CITATION
[26] http://www.fapesp.br/

intellectual property rights. The restrictions on technology transfer included licensing to the government, which helped some industries like aerospace, but which have been harmful like the domestic information technology and computer industry which developed under import substitution and now faces heavy international competition from global competitors. Without an environment that promoted greater flexibility in licensing and technology transfer, the computer industry innovated at a much slower pace than global competitors.

Beginning in the latter half of the 1990s, Brazil began to implement schemes designed to foster greater public innovation and public-private technology transfer. However, universities and their scientists typically considered the university to be mainly a teaching institution shunning the greater contacts with private industry the government was trying to foster. This perception is changing, but is changing slowly. In July 2004, the Brazilian House of Congress passed the Innovation Law designed to reduce many of the barriers encountered regarding technology transfer and issues of IPR ownership.[27] Implementing legislation was recently enacted and it is too early to assess the law's impact.

a. Public Policy for Innovation – Brazil's Innovation Law

A recent development for the Brazilian innovation system is the passage of the Innovation Law. The aim of the Innovation Law is to create the legal framework needed to improve Brazil's capacity to generate and commercialize technology. The objective of the law was to address some of the issues that had led to poor commercialization of the R&D generated by Brazil's public institutions and universities. The Innovation Law has provisions regarding incentives for innovation and scientific research, and encourages public-private R&D cooperation by stating explicitly the following:

- Public researchers are allowed to take temporary leave from their public position in order to work for a private enterprise;
- Public research institutes may agree to share their laboratory facilities with private-sector enterprises;
- Public and private partners may specify by contract intellectual property rights ownership;
- The public research institute and its employees are obligated to protect trade secrets associated with their research;
- The public research institute is allowed to license a technology to a private enterprise;
- Public research institutes and private sector enterprises may enter into capital relationships for the purpose of R&D partnerships;
- Individual researchers are allowed to share in the economic returns associated with successful commercialization;
- Development agencies are strongly encouraged provide financial and human resource assistance in support of private sector R&D.

[27] Brazilian Law No. 10,973

This new law confronts some of the major institutional problems that have weakened technology commercialization in Brazil. Prior to this law, public research institutions, including public universities, had to undertake a public bidding process for technology licensing. Now they only need to public a "request for licensees" in order to transfer or license their technologies.[28] This will accelerate the process of licensing by these institutions and should improve the commercialization of innovations.

For Brazilian researchers employed by public institutions, the new Innovation Law strengthens the innovative environment by providing incentives to establish research and development partnerships. Researchers will have the option to work in other institutions for the time necessary to conclude joint-projects while continuing to receive their regular salaries. Furthermore, researchers will be allowed to request special leave without pay if they decide to become involved with a "start-up" company in order to develop and commercialize their new technologies. Benefits from the commercialization of intellectual property are expected to be shared among researchers, the public institutions and private firms. This is expected to stimulate collaboration between academic institutions and industry.

The Innovation Law also requires universities to create "Offices of Technology Innovation" designed to handle the management of the technology generated by researchers particularly with regard to decisions about intellectual property licensing.[29]

b. Intellectual Property Laws

Like many aspects of its NIS and innovation policy, Brazil's intellectual property rights regime is above average as compared to Latin America and far behind the industrial countries. The Brazilian IPR institutions are slow to process patent applications and even slower to enforce IP laws. Additionally, for international corporations possessing foreign patents, importers were required to pay a licensing fee if there is no local production involved with the product. This has encouraged of increased foreign direct investment in local production facilities, but has limited foreign patent holders.

Brazil has made several key moves in bringing their intellectual property laws up to international standards. As part of this overhaul, Brazil implemented a grace period for inventors to file patents; the inventor has a 12-month period to file for patent protection after the invention was made, during which time the inventor may seek financial partners to pursue commercialization of the technology.

Further, Brazil has adopted a number of measures clarifying the rights and obligations attached to intellectual property developed by university researchers in the courts of research.[30] As a general principle, researchers are treated as employees of universities and their research products as property of the universities. Researchers are entitled to a bonus for inventions that are

[28] *Id.*
[29] *Id.*
[30] Claudia Ines Chamas, *Management of Intangible assets at Brazilian University*, presented at the DRUID Summer Conference on Industrial Dynamics of the New and Old Economy – Who is Embracing Who?, Copenhagen, Sweden (June 6-8, 2002).

successfully commercialized but which does not exceed one-third of the total value of the commercialized product. The Ministry of Science and Technology (MCT) has published a number of guidelines for universities and other bodies concerning distribution of funds arising from commercialization, patenting expenses, confidentiality clauses, and other topics. Further, the MCT provides research funding to universities that is contingent on the adoption of the institutional rules that follow the MCT guidelines.

Despite these efforts, IP policies at public-universities are not well defined, and the MCT has not enforced its funding conditions in universities. Out of nearly 150 universities, only a handful provides any kind of support to researchers interested in patenting their inventions. From 1990-1999, Brazil's universities submitted only 307 patent applications to the National Institute of Industrial Property, with over 60% of these coming from just two universities. Universities are plagued with a lack of financial resources to patent and engage in licensing, a lack of qualified personnel to facilitate technology transfer, and a lack of technical knowledge, both in licensing strategies and international patenting.

Despite some of the weaknesses in the system outlined above, there are a number of successes in university technology transfer where offices are forging industry connections. One such success is at the University of Campinas in the State of Sao Paulo, and its technology transfer office known as INOVA.

c. Technology Transfer at the University of Campinas – INOVA

> To fortify the partnerships with companies, government agencies and other organizations of the society, creating opportunities so that activities of teaching and research can benefit from these interactions, contributing for the economic and social development of the Country[31]

Established in July 2003, the Innovation Agency of the State University of Campinas (INOVA) controls the technology transfer and technology development activities of the University of Campinas. Since its 2003 inception, INOVA has signed 9 license agreements with private companies. The agreements provide for the commercialization of 22 technologies for a period between 10 and 15 years. By the fifth year of existence, UNICAMP projects to be managing 100 license agreements. In addition to these licenses, in 2005 alone, INNOVA submitted 66 patent requests to the National Institute of Industrial Property (INPI – Instituto Nacional da Propriedade Industrial).[32]

Source: Inova website

[31] Mission Statement of INOVA
[32] All information from interviews and http://www.inova.unicamp.br/site/06/index.php

INDICATOR	2004	2005
Contracts / Agreements Negotiated	N/A	56
Contracts / Agreements Signed	46	41
Total Revenue from Contracts / Agreements Negotiated	N/D	R$11,396,830 US$5,180,377
Total Value of Contracts / Agreements Signed	R$6,616,289 US$3,007,404	R$9,009,284 US$4,095,129
Patents Filed	50	66
Software Protection Filed	12	9
Technology Start-ups Incubated	10	12
Technology Start-ups Successfully Graduated from Incubation Period	0	8
Partnership Workshops with Industry / Business Corporations	24	12
Staff of Inova Unicamp	33	49
Total Value of Inova Unicamp New Projects Financed	N/A	R$3,900,000 US$1,772,727

Table 1 – Selected Performance Indicators for INOVA

Such a performance by UNICAMP, in its short existence, emphasizes the importance of having such institutions. INOVA was created specifically to strengthen links between the university and the market, and has exceeded expectations. Now other universities in Brazil and elsewhere are looking to UNICAMP as a model. Furthermore, there is an initiative studying the possibility of creating an infrastructure at UNICAMP to support other universities as well as small and medium-sized companies, in areas relating to the management of intellectual property.

The office structure of INOVA includes 30 employees, including a director, part-time technology transfer agents, and students responsible for patent analysis and marketing analysis. INOVA does not have a lawyer dealing exclusively with IP issues, but the lawyer is mainly used in partnership development and at the incubator and technology park.

An illustrative list of the companies to which licenses have been granted include:

- **Cristália** – pharmaceutical industry. The 2 licensed patent applications cover anesthetics with controlled liberation.
- **Scitech** – surgery instruments industry. The 6 licensed patent applications present new formulations for stent coating for heart patients.
- **Usina São Francisco** – agribusiness industry. The licensed patent application describes a method for sugar cane processing and extraction of its sub products.
- **Diagnósticos Laboratoriais Especializados** – genetic analysis. The licensed patent application describes a method for genetic death detection.

- **Feldmann** – kits production. 1 licensed patent application was about kit formulation for genetic analysis.
- **TechFilter** – environmental treatment industry. The 8 patent applications licensed are concerned with environmental treatment.
- **Steviafarma** – food and drug industry. The licensed patent application describes a process for soy isoflavones extraction.

Negotiating a licensing agreement is a complex task. The model used by UNICAMP includes the development of the patented invention into a marketable product and the license to use the invention within the same agreement. Such terms are important to negotiate at the very beginning as it is difficult to negotiate these terms once a product with a commercial market and revenue expectations has been developed. UNICAMP generally negotiates royalties that vary between 2% and 7% based on the gross income or the net income. Each case and technology is unique. All contracts include royalty auditing in order to confirm if the sale results presented by the licensee are reflected accurately. Additionally, one-third of the royalties received by UNICAMP are distributed among the inventors, in order to promote new inventions and innovations.

In the short existence of INOVA, there have been several successful and potentially lucrative licenses. One such license is for an innovation in paint technology using nano-technology to improve white pigment (see box 2). Additionally, INOVA oversaw the licensing of a process for the extraction of isoflavones aglycones from soybeans – a chemical used for hormone replacement therapy and has indicated use for the treatment or prevention of osteoporosis, menopause symptoms, hypertension and blood clots associated with high cholesterol. A plan to enter the market with a product produced from the isoflavones is planned for March 2007.

INOVA Success Story: BIPHOR™ white pigment for paint

BIPHOR™ is a white pigment constituted of aluminum phosphate nano-particles. The patented product and process, jointly developed by Unicamp and Bunge , a multi-billion-dollar global company has the potential to substitute for the highly toxic Titanium Dioxide (TIO^2) presently the only white pigment used by water paints manufactures worldwide. The licensed patents were the result of a research group led by Unicamp's Prof. Fernando Galenbeck of the Chemistry Institute. The new pigment involves three Unicamp's patents and one patent shared by Bunge and Unicamp.

BIPHOR™ shows several advantages as compared to TIO^2 : it is whiter, less costly, and is considered a green chemical that can be discarded with no harm to the environment , at the same time gives more quality and endurance to the paint coating.

Bunge estimates a total world market of US$ 5 billion yearly for the white pigment. The company invested US$ 1 million the 9 years in the joint product development with Unicamp and is the exclusive fully licensed user of the patents for 10 years. Bunge expects to conquer a market share of 10% in the next 5 years. Unicamp estimates its income from the 1.5% participation in the net sales of the product at US$ 4,5 million/year. This income will be shared equally by Unicamp's central administration, its Chemistry Institute and the researchers/inventors.

Presently Bunge is producing samples in pilot plants of 1,000 tons/year, aiming to the commercial development of the new product. The company plan to build a new plant in Brazil that will rech a production between 100.000 and 200.000 tons/year.

Box 2 – INOVA Success

IV. Colombia

a. National Innovation System and Policies

The government agency responsible for scientific funding was created in 1968; the Instituto Colombiano para el Desarrollo de la Ciencia y la Tecnología (Colombian Institute for Scientific and Technological Development - COLCIENCIAS)[33] finances projects in basic and applied research.

Congress enacted Law 29 (1990) creating the National Science and Technology System and The National Science and Technology Council (SNCT). SNCT is the government agency responsible for establishing policies and coordinating science and technology activities. Law 29 also provided guidelines to promote scientific and technological knowledge and specified the entities and persons dedicated to these activities. Furthermore, Law 29 conditions the granting of the exemptions, tax deductions and other tax benefits to the technological and scientific activities that are recognized by law, with previous approval from COLCIENCIAS. In 1995, as a result of SNCT activities, the government created the "Sistema Nacional de Innovacion" (National Innovation System), to integrate institutions, formulate and implement R&D as well of science and technology policies.

Under this institutional scheme, SNCT is responsible for coordinating and preparing policies and programs in scientific and technological development. SNCT seeks to modernize the economy, increase private sector investment in S&T and facilitate interaction among Colombia's research institutes, universities and companies. SNCT is composed of twelve programs or areas of work. Each program for its sector coordinates S&T planning, formulates policy, promotes funding and integrates the views of various advisory committees. Programs include areas such as agriculture, electronics, telecommunications and computer science, energy and mining, aquaculture, biotechnology and social sciences.

In addition, eleven Science and Technology Regional Commissions were created (now twenty-eight), classified by productive sector or area of science, serving as the pipeline for an increasing percentage of public funding for research. In the changes introduced since 1990, COLCIENCIAS was attached to the National Planning Department, *Departamento Nacional de Planeación]* (DNP)[34] and became the technical secretariat of the National Science and Technology Council.

Further policy changes occurred in 2000 when Congress enacted law 633 creating tax incentives for scientific and technological development. In 2001, Law 643 created the National Research Fund on Health and in 2003 COLCIENCIAS becomes part of CONPES Consejo de Política Económica y Social (Economic and Social Policy Council) which leads to the CONPES 3038, a national policy framework involving among others the following areas: (i) development and strengthening of the national capacity in science and technology; (ii) innovation, competitiveness and technological development; (iii) enhancement of the capacity to improve social services and

[33] www.colciencias.gov.co
[34] http://www.dnp.gov.co/paginas_detalle.aspx?idp=708

generate information about the situation of the country; (iv) generation of knowledge for sustainable development; and (v) economic integration.

Investment in Colombia's scientific and technological development, the size of the scientific community and its technological infrastructure are clearly inadequate for a country of its size and level of relative development. Public investment in this field is currently around 0.64% of GDP[35], an increase compare to 2001 which was 0.2% of GDP.[36] Colombia GDP in 2005 was 122.3 Billion USD[37]. This is quite low when compared with the investment figures in industrialized countries (where investment levels range between 2% and 3.6% of GDP); it is even low in comparison with investment in some Latin American countries such as Chile (0.7% of GDP) where it approaches 1% of GDP. Spurred by the prospect of Free Trade Agreement with the United States and the strategic public policy named "Colombia 2019" (commemorating independence from Spain); political will is building to elevate investment up to 1.5 % of GDP. COLCIENCIAS investment budget in 2005 was approximately 37.4 million USD which was 16% higher compared to 2004.[38]

While in Latin America and the Caribbean, the share of R&D performed by higher education institutions declined (1995 and 2003) Colombia was an exception.[39] Among the reasons behind this are an increase of the number of universities performing R&D from 15 in 1992 to 50 in 2006, increase on the number of research groups in universities from 400 to 2,000, and an increase on the number of individuals dedicate to R&D from 4,000 to more than 20,000 all in the same period of time. However, in the same period of time, the participation of the business sector in R&D actually fell by half.[40]

In addition, despite significant improvement during the period of 1995 – 2003, the proportion of researchers in the total labour force of Colombia (0.2%) is significantly lower compared to the rest of Latin America and the Caribbean (0.6%).[41] Above Colombia we found Argentina (1.6%), Chile (1.2%) and Uruguay (1.0%). The US and Finland, the proportion of researchers in the total labour force was 0.8% and 1.6% respectively per 1000 in 2003 (In Finland were 16 per 1000). Furthermore, in contrast to the regional pattern, the share of researchers employed in the business sector, which increased in countries such as Mexico and Brazil, in Colombia fell by almost 50 percent in Colombia.[42]

Finally, Colombia High-technology exports, meaning products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery, were only 6% of total exports compared to 7% in 2001 and 2003.[43]

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[35] COLCIENCIAS
[36] UNESCO – Country profile http://www.uis.unesco.org/profiles/EN/GEN/countryProfile_en.aspx?code=1700
[37] World Development Indicators, April 2006, World Bank
[38] In average 1USD equal to 2,331 pesos in 2005
[39] Education, science and technology in Latin America and the Caribbean: a statistical compendium of indicators, Inter American Development Bank, 2006
[40] *Id.*
[41] *Id.*
[42] *Id.*
[43] World Bank

b. Colombia Intellectual Property Laws

Colombia protects IPR by a combination of international conventions, Andean Community (Ancom) decisions and national laws. The next are some the international and regional conventions:

- WIPO Convention, since May 1980
- Berne Convention (Literary and Artistic Works), since March 1988
- PCT (Patents), since February 2001
- Rome Convention (Performers, Producers of Phonograms and Broadcasting Organisations), since September 1976
- Geneva Convention (Unauthorized Duplication of Phonograms), since May 1994
- WCT (WIPO Copyright Treaty), since March 2002
- WPPT (WIPO Performances and Phonograms Treaty), since May 2
- TRIPS Agreement, since April 1995
- Andean Community since January 1993
- G-3 since January 1995
- UCC since March 1976
- UPOV since September 1996[44]
- Inter-American Convention on Trademark and Commercial Protection, 1929
- International Convention for the Protection of New Plant Varieties, 1978
- Paris Convention on Protection of Industrial Property, 1995
- Pan-American Convention (Buenos Aires), 1910
- Inter-American Convention on the Rights of Authors, 1946
- International Treaty on the Registry of Audio-visual Works, 1989

Colombia, as a member State of the Andean Community[45] shares a common industrial property system with specific regulations on IP as well as institutions, for example the Andean Court of Justice.[46] The legal regime governing industrial property is contained in Andean Community Decision 486, regulated in Colombia by Decree 2591, of December 13, 2000 and the Single Circular Letter dated July 19, 2001 issued by the Superintendencey of Industry and Trade (SIC).[47] Decision 486 maintains the previous term for patents at 20 years, with no extensions permitted. Anyone may apply for a compulsory licence if a patent is not worked within four years of application or three years after granting (whichever is later); if working is suspended for a year or does not satisfy local demands as to quality, quantity or price; or if the patentee is unwilling to enter into a licensing agreement on reasonable terms. The government may use

[44] WIPO
[45] Four-country free trade areas formerly know as the Andean Group; originally formed in 1969. http://www.comunidadandina.org/
[46] This is the judicial body of the Andean Community, which is comprised of four Judges, each representing one of the Member Countries (Colombia, Ecuador, Bolivia and Peru), and has territorial jurisdiction in the four countries. The Court ensures the legality of Community provisions through nullity actions, interprets Andean Community laws to ensure that they are applied uniformly in the territories of the Member Countries, and settles disputes
[47] http://www.sic.gov.co/propiedad/propiedad.php

compulsory licensing in matters relating to public health, economic development or national security. Compulsory licences are never exclusive.

Industrial designs are now registered for ten years instead of eight, and identical terms are provided for utility models and integrated circuits. Trademarks are registered for ten years, with an indefinite number of ten-year renewals available if the trademark remains in use and maintains its distinctiveness. Trademarks must be registered with the Distinctive Signs division of the SIC. By registering a trademark or a slogan, the Superintendency grants the trademark or slogan holder the right to use it on an exclusive basis. Registration is subject to cancellation if not used within three years. Marks ineligible for protection include those confusingly similar to previously registered marks or involving generic indications and commonly used words. Decision 486 allows the holder of a well-known trademark to go directly to the SIC to request that the registration of a similar trademark in Colombia be cancelled without going through the courts, which expedites decisions.

In addition to invention patents, Decision 486 also addresses aspects of industrial designs, trademarks, appellations of origin, and unfair competition connected with industrial property. Other industrial property regulations are the Industrial Property Act of 1925, amended 1931; Commercial Code, 1972; Decree Law 1234, 1972; Law 170, 1994; Andean Community Decision 345 of 1993 and Andean Community Decision 391 of 1996. The SIC in January 2001 extended protection for industrial secrets and patents to ten years. On other matters, persons in the Andean Sub-region who have created or obtained a new variety of plant by applying scientific knowledge enjoy the exclusive right to produce and market that plant for a period of from fifteen to twenty-five years.[48]

The protection of copyrights is regulated by Law 23 of 1982, Law 44 of 1993 and Decision 351 of the Cartagena Agreement and its regulatory decrees. Decision 351 establishes adequate and effective protection for authors and other holders of rights to works of intelligence in the literary, artistic, or scientific fields, whatever their type or form of expression and irrespective of their literary or artistic merit or purpose. Other Copyright laws are the Civil Code (Article 671), Law 23 of 1982 and Law 44 of 1993. Finally, Colombian and Andean Community legislation protects business secrets, with stringent penalties for violations

The Civil Courts are competent in litigation concerning intellectual property rights. The Council of State is in charge of the legal control of administrative acts concerning issues related to intellectual property, such as grants, refusals and cancellations.

Furthermore, as part of the IP chapter negotiated in the Free Trade Agreement with the United States (FTA), which is signed but yet to be ratify by each national Congress, Colombia shall ratify or accede to the following agreements by the date of entry into force of the FTA:

- The Convention Relating to the Distribution of Programme-Carrying Signals Transmitted by Satellite (1974);
- The Budapest Treaty on the International Recognition of the Deposit of Micro organisms for the Purposes of Patent Procedure (1977), as amended in 1980)
- The Trademark Law Treaty (1994);

[48] http://www.comunidadandina.org/

Finally, the Report of the Industry Trade Advisory Committee on Intellectual Property Rights (ITAC-15)[49] infers the FTA will encourage adopting tougher enforcement strategies and expanding IPR best practices protection. Among the best practices include the following provisions: provides for the restoration of patent terms to compensate for delays in granting the original patent; applies principle of "first-in-time, first-in-right" to trademarks and geographical indications, so that the first person who acquires a right to a trademark or geographical indication is the person who has the right to use it; provides rules for the liability of Internet Service Providers (ISPs) for copyright infringement, reflecting the balance struck in the U.S. Millennium Copyright Act between legitimate ISP activity and the infringement of copyrights.[50]

c. Key Figures

	INVENTION PATENTED IN COLOMBIA							
	FILE				**GRANTED**			
	Residents	**Non Residents**	**PCT**	**Total**	**Residents**	**Non Residents**	**PCT**	**Total**
2004	71	132	1238	**1441**	11	283	0	**295**
2005	91	169	1501	**1761**	7	249	0	**256**
2006	141	133	1729	**2003**	10	206	7	**223**
	572	**2878**	**5811**	**9261**	**79**	**2308**	**7**	**2395**

	UTILITY MODEL					
	FILED			**GRANTED**		
	Residents	**Non Residents**	**Total**	**Residents**	**Non Residents**	**Total**
2004	144	9	**153**	40	7	**53**
2005	136	25	**161**	27	6	**33**
2006	220	11	**231**	35	19	**54**
	1090	**101**	**1191**	**195**	**51**	**339**

	INDUSTRIAL DESIGN					
	FILED			**GRANTED**		
	Residents	**Non Residents**	**Total**	**Residents**	**Non Residents**	**Total**
2004	157	210	**367**	57	129	**186**
2005	131	243	**374**	98	183	**281**
2006	137	319	**456**	65	177	**242**
	761	**1530**	**2291**	**401**	**1541**	**1942**

Source: Colombia Patent Office (Superintendencia de Industria y Comercio)

[49] http://www.ustr.gov/assets/Trade_Agreements/Bilateral/Colombia_FTA/Reports/asset_upload_file605_9835.pdf
[50] Ibidem

d. Universidad de Antioquia – Leader on Innovation

Different organizations in Colombia have made great efforts and investments on research and development accomplishing good results. As was previously mentioned, in Colombia an increase of the number of universities performing R%D from 15 in 1992 to 50 in 2006, offers an interesting niche to study. Among them, Universidad de Antioquia (AU) has been identified as a leading organization because it has developed original policies and strategies to bring together Academia, Industry and the Government.

i. Brief History

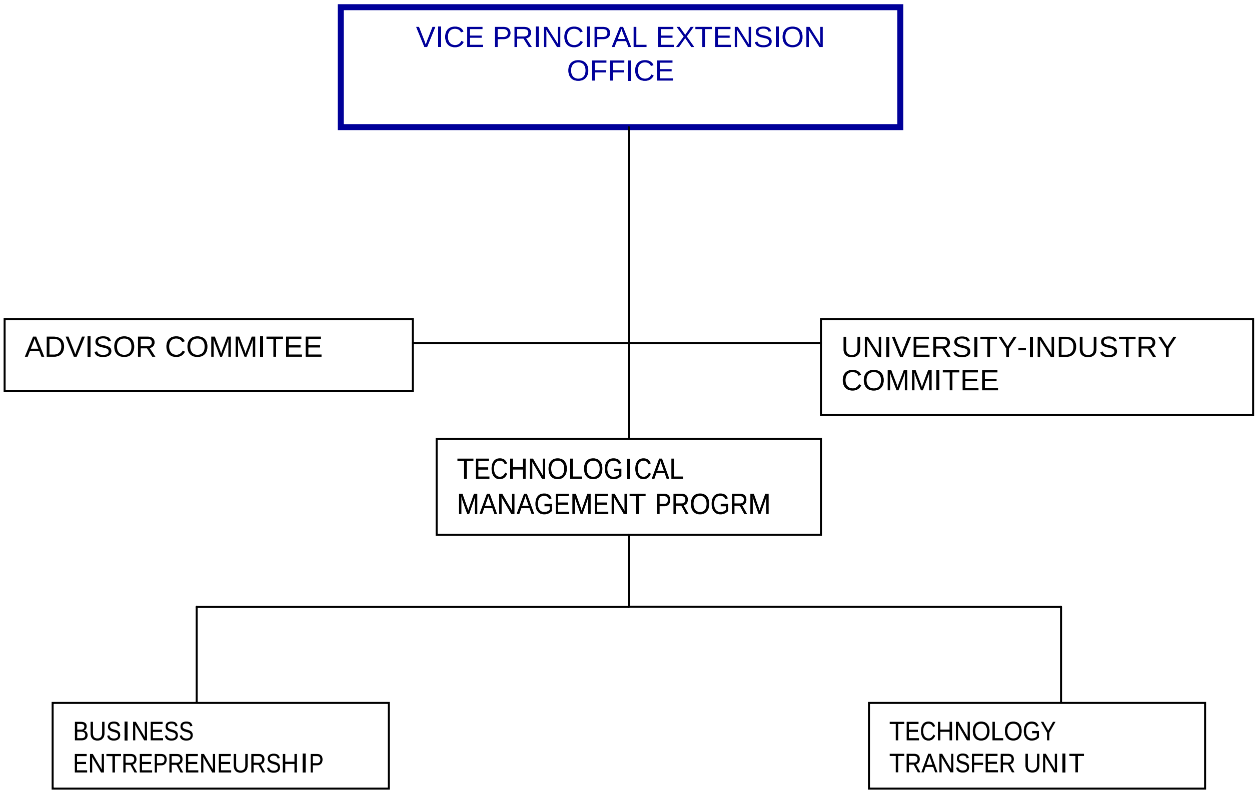
AU is the largest public university in the Department of Antioquia, Colombia. Funded in 1803, AU has 33,100 students, 68 undergraduate programs and 148 graduate programs. The University has 1,674 permanent professors and 3,172 visiting and adjunct professors. With its 164 research centers, all recognize by COLCIENCIAS, AU it's the number one university with "Category A" (93) research centers in Colombia.[51]

In 2000, AU realized the need of appointing a person solely in charge of supervising all R&D activities. By April of 2002, AU decided to create the "Programa de Gestion Tecnologica" or PGT (Technological Management Program assigned to the Virrectoria de Extension (Vice Principal Extension Office – see the flowchart below), with the responsibility of developing guidelines and managing policies on R&D activities. One of the PGT crucial functions is to act as a link between the University, Industry and Government in the region in order to identify and develop business partnerships. In other words, a new organization and strategy was created to change the traditional prevention between the public and private sector on R&D.

UNIVERSIDAD DE ANTIOQUIA
1803

Sede de Investigaciones Universitarias – SIU (University R&D Headquarters)

[51] COLCIENCIAS has classified three types of research centers. Category A, B, C. Category A is the highest ranked for research centers

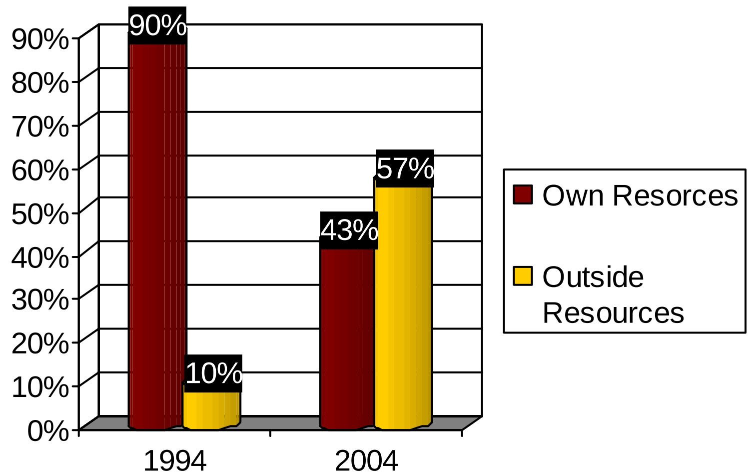


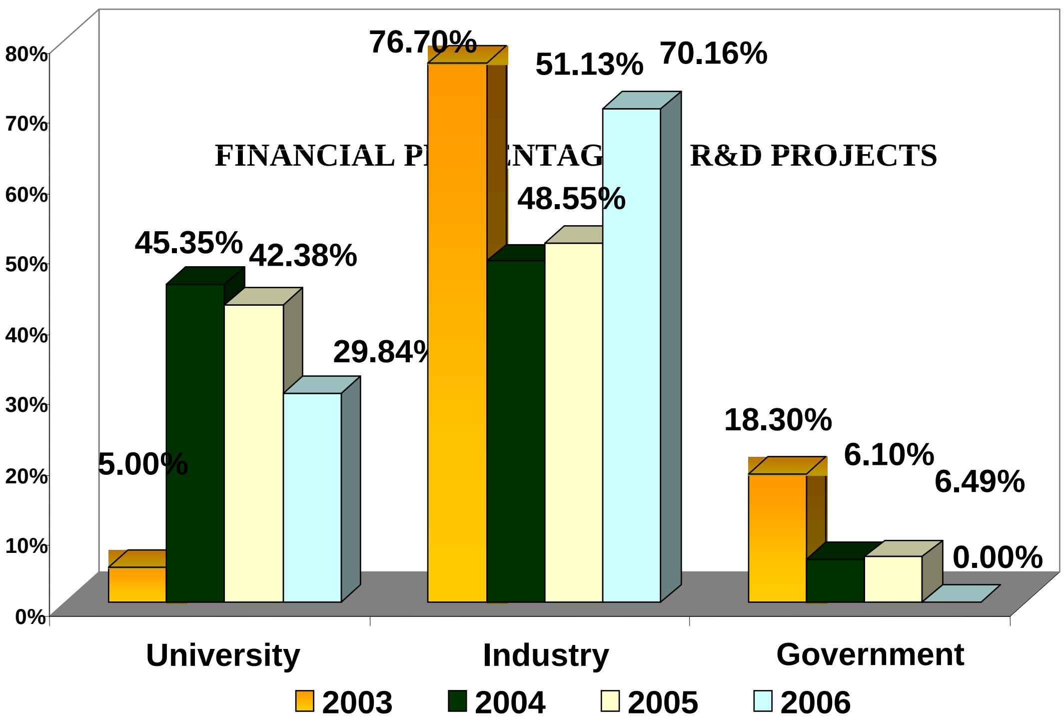
Parallel to this, AU created two working units with specific missions: (1) the Unidad de Emprendimiento Empresarial (Business Entrepreneurship Unit and Unidad de Transferencia Tecnologica (2) the Technology Transfer Unit. By 2004 AU had formulated a strategic policy to strengthen the Technological Management Program. Evidence of the difference made by the program comes from the Technical Cooperation Agreements between AU and some of the largest companies' based in the region for a 5 year period.[52] Through these agreements, Antioquia University works with companies together with the center of technology development to apply research and development to innovate production and services. In addition, the financial percentage on R&D projects (see graphic below) shows a dramatic improvement of Industry support in 2004 and 2005.

In 1994, AU financed 90% of its R&D with its own resources and only 10% came from outside the university. In 2004, in part thanks to the law 633 mentioned before and to the PGT, AU started to implement a different approach to reach out to sponsors and develop strategic alliance between the university, industry and the government. By 2004, the balance had risen to 57% of the projects being financed by outside sponsors (for example COLCIENCIAS or the private sector). AU's own resources totaled 12.5 million USD, while outside resources totaled 16.6 million USD.[53]

[52] Among them, Grupo Empresarial Antioqueño (one of the largest Business Group in Colombia), Metro Medellin (Subway Metro System), Orbitel S.A (telecommunications company) , Tecnoquimicas (Pharmaceutical Company),
[53] In 2004 USD average equal to 2,613 Colombian pesos.

ii. Financing of Research and Development (R & D) projects[54]





Source: Adapted from presentation made by Universidad Antioquia,

[54] Source: Adapt from presentation made by Universidad Antioquia, "Universidad de Antioquia en Dialogo con el Sector Productivo" Third International Congress LES CAN "Winning in Licensing: Value through Technology, Cartagena, Colombia, September 15, 2005

iii. Pragmatic Strategies

One of the key factors in obtaining an increase in outside resources has been the strong channels of communication build between the University, Government and the Industry. For this purpose PGT created five specific strategies:

- Effective linkage of the University with the entities and organizations of the National System of Innovation
- Culture in Technological Management
- Sharing Information on Research Results
- Productive and competitiveness of firms
- Industrial and Business Entrepreneurship

In 2001, AU launched the "Encuentro Universidad-Empresa-Estado" or *Encounter of University-Industry-Government,* as a national annual event to evaluate and discuss innovation, science and technology policies and their impact on economic development. Thanks to strategic partnerships with other public universities, the private sector and the government the Fifth Encounter[55] held November of 2006 offered the opportunity to exchange international initiatives and best practices and compare them with national and local efforts in Colombia.[56]

In 2003, AU moved forward by developing a permanent and stronger linkage among the actors in innovation. AU launched what is called "Comite Universidad – Empresa para el apoyo a la Investigacion Aplicada y la Gestion Tecnologica" or "University and Industry Committee on Research and Technology". The original Committee was composed of University board members and successful private business of the region. The positive reaction and interest by the private sector to the idea led to the creation on new and different committees focusing on specific economic sectors, today know as "Comite de Empresarios" (Industrial committee). At the end of 2003, AU invited six other universities (today 10), public and private and based in the region, to enrich the capacity on R&D and share opportunities on new projects.

Source: Universidad Nacional

[55] For complete information and agenda of the event please visit www.unal.edu.co/extension_nal/vencuentro.html and http://www.unal.edu.co/extension_nal/vencuentro_prog.html

Source: Universidad Antioquia, a committee meeting of research and development specialists

The goal behind these committees is to build trust between the business world and academia to increase productivity and competitiveness in the region, apply research on what the private sector needs and engage the government with its public polices on science and technology. The regional government of Antioquia is represented by the Productivity and Competitiveness Secretary and the local government of Medellin by the City Planning Office.

Each committee is led by a CEO of a successful private company. The committees meets the first Friday of every month at SIU (University R&D Headquarters) representing 18 strategically chosen economic sectors in the region, among them: food, financial services, car manufacturer, energy, textiles, chemistry, health, wood, and agricultural.

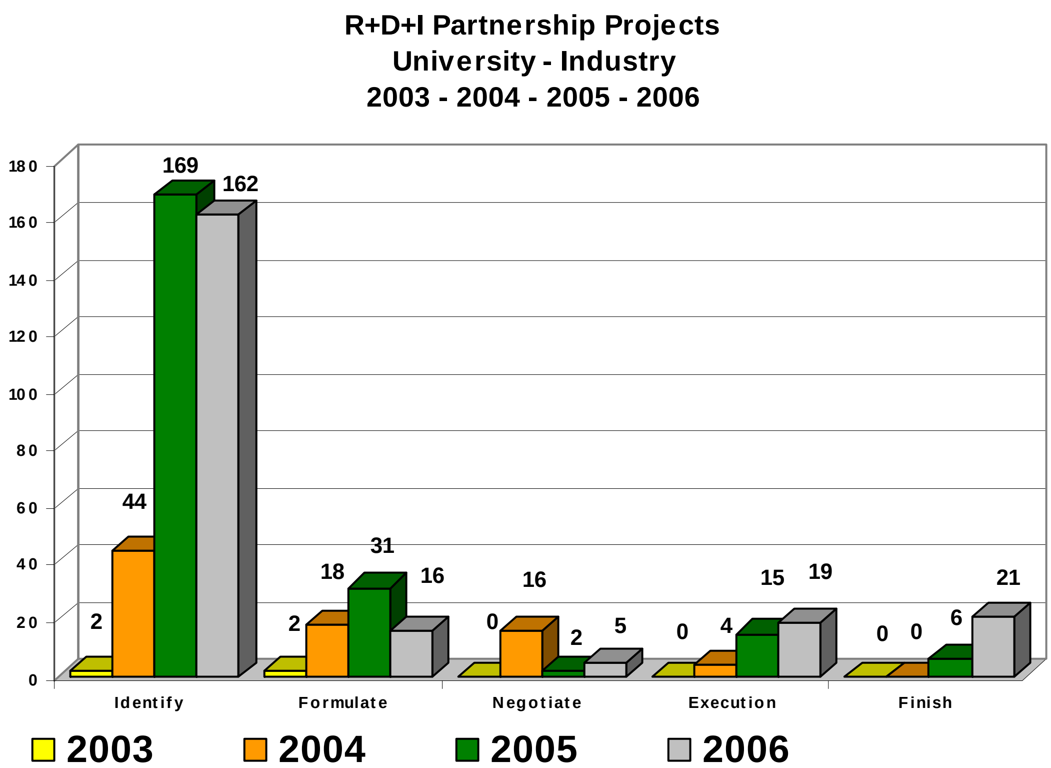
The committees have seven strategic objectives:

1. Advocacy and Awareness of the relation University-Industry-Government
2. Identification of R&D needs of the private sector
3. Identification of R&D capacities of Universities
4. Interaction between and integrate university and industrial research groups
5. Strength technological advocacy and TTO within universities and industries)
6. Promotion of a risk capital fund for R&D projects and new enterprises
7. Promotion and information the private sector on incentives to invest on R&D

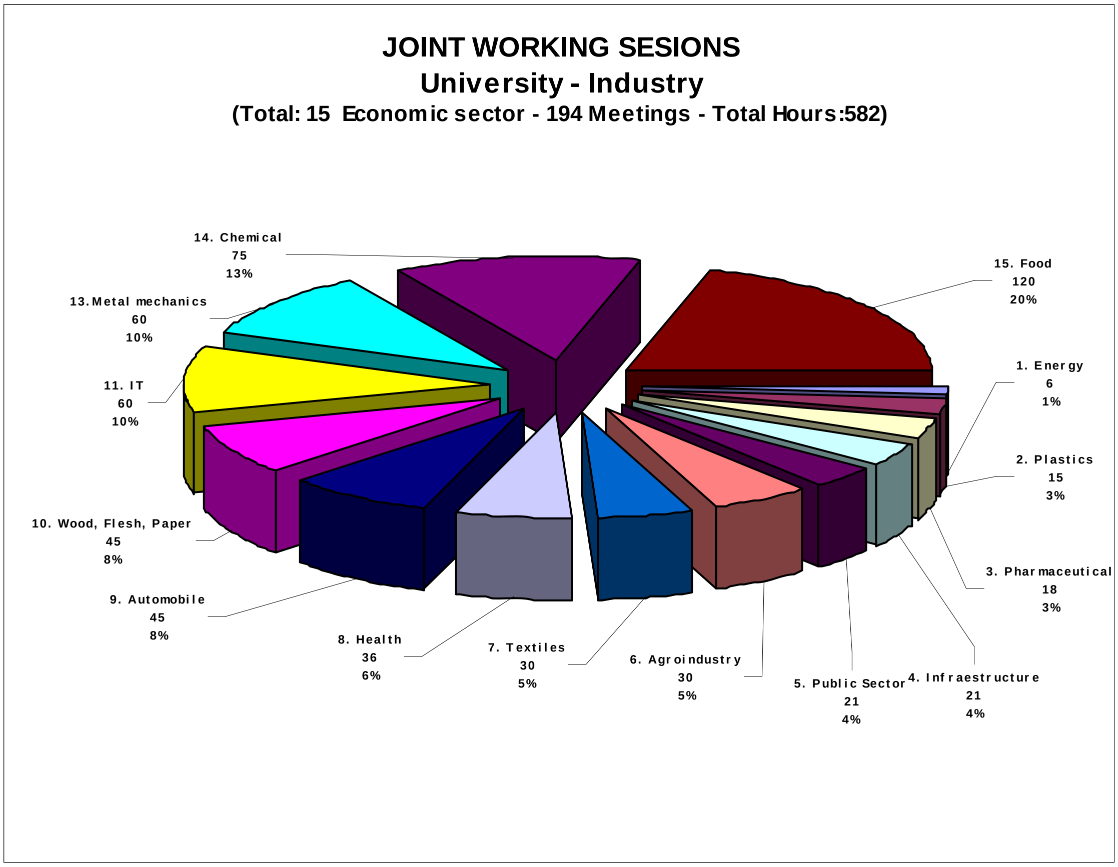
Centers of Technology Development

1. CIAL	Centro de Desarrollo Tecnológico de la Industria Alimentaría
2. CORPO ECO	Centro de Desarrollo Tecnológico de la Industria Eco - Eficiente
3. CIDET	Centro de Investigaciones y Desarrollo del sector Eléctrico
4. CNPML	Centro Nacional de Producción Más Limpia
5. CTA	Centro de Ciencia y Tecnología de Antioquia
6. CECIF	Centro de Investigaciones de la Industria Farmacéutica
7. CIDICO	Centro de Investigación y Desarrollo para la Industria de la Construcción

Source: Adapted from a presentation made by Universidad Antioquia, "Universidad de Antioquia en Dialogo con el Sector Productivo" Third International Congress LES CAN "Winning in Licensing: Value through Technology, Cartagena, Colombia, September 15, 2005.



Source: Adapted from presentation made by Universidad Antioquia, Medellin. 2007.



Source: Adapted from presentation made by Universidad Antioquia, Medellin. 2007.

Of the new projects in the pipeline, the private sector gives 70% of the financial support, 15% comes from AU and another 15% from the government.

iv. Success Stories:

1. Technology to innovate car manufacture

In 2004, RENAULT, decide to develop a new economy car to increase its sales in the emerging markets. To achieve this, RENAULT requested its three assembly partners in Latin America (Colombia, Mexico and Brazil) for business and technical proposals to produce and assemble the new LOGAN. SOFASA, the Colombian manufacture was chosen to produce the car to be sold in Venezuela, Ecuador and Colombia thanks to the mechanical design made by the School of Engineering of AU.

Among its international standards RENAULT requires that all vehicles have six year anticorrosive paint. The foreign technology available for this cost between US$8 and 10 million and requires 18 months to implement. Clearly, this demanded cost and time beyond the original budget and period of production for SOFASA. The Chairman of the Project at SOFASA contacted the Comite de Empresarios" or (industrial committees) and presented the problem. Ricardo Moreno, researcher at Universidad de Antioquia with two recent graduates took the challenge and offered a local solution at half of the cost and in only six months.

- The solution the professor and the mechanical engineers came up was the design of Surface Treatment Tunnel by which the outer casing of the car is submerged in a tunnel where anticorrosive paint is spread over every part of the car structure. The innovative Colombian engineering design was approved by RENAULT, and the investment was approximately 3.9 million Euros. The mechanical design is so effective and economic that it is now being used by SOFASA in the production and assembly of other brands, for example TOYOTA in Colombia. The total investments was $3.8 million USD, of which $300,000 USD were tax exempt through the support of COLCIENCIAS, AU received approximately $200,000 USD and around 13 local small companies benefited by $3.4 million USD.

SOFASA S.A.

Source: Adapted from presentation made by Universidad Antioquia, Medellin. 2007.

2. United States Patent # 7,041,647 - Inonophore and Antimicrobial Activity of Peptide Derived from a Natural Protein

Inventors:	**Lemeshko; Viktor** (Medellin, **CO**)**, Guzman; Fanny** (Bogotá, **CO**)**, Patarroyo; Manuel E.** (Bogotá, **CO**)**, Segura; Cesar** (Medellin, **CO**)**, Orduz; Sergio** (Medellin, **CO**)
Assignee:	**Corporacion Para Investigaciones Biológicas** (Medellín, **CO**) **Universidad de Antioquia** (Medellín, **CO**) **Fundación Instituto de Inmunológica de Colombia** (Bogota, **CO**) **Universidad Nacional de Colombia** (Bogota, **CO**)
Appl. No.:	**10/751,984**
Filed:	**January 7, 2004**

AU in partnership with two health research centers, Fundacion Instituto de Inmunologia de Colombia and Corporacion Para Investigaciones Biologicas, and with the largest public University of Colombia, Univerisidad Nacional, filed and obtained the above US patent (2006).

The invention is related to the field of antimicrobial and ionophoric peptides, a synthetic peptide, which inhibits microbial growth. This peptide also shows ionophoric activity in rat liver mitochondria. Furthermore, pharmaceutical compositions and compositions for agricultural use containing the peptide of the invention are also foreseen.[57]

3. Further AU patents include disclosures for the telecommunication, agriculture industry and food industries:

- Gasifying Combustión - System for gassifying coal for brick making
- Humus Fortifier - Restorer of low organic material soils.
- Remote maintenance and verification of telephone plants
- Microencapulation Technology
- Process applicable in the food sector a for your pocket

V. South Africa

[57] Abstract - USPTO

The South African economy is generally regarded as strong when compared with the Southern African region. In an effort to maintain this relative strength, South Africa is another example of a country adjusting its system of innovation to allow greater flexibility for publicly-funded research institutions to transfer technological innovations to the private sector. South Africa has an extensive higher education system possessing a strong research orientation. Because of this research orientation, South Africa means to create greater university-industry linkages in a measured attempt to spur innovation and boost the economy.

a. Research Funding: The Innovation Fund and THRIPS

The success of a country's NIS is directly related to the amount of funding provided for research activities. South Africa, for being one of the most developed countries in Africa, must invest more in R&D. Numbers for 2006 indicate that South Africa spent about R12 billion, or 0.87% of GDP. This is a decline from numbers posted in 1990 that showed R&D spending at 1.1% of GDP. Compared to countries that South Africa competes with, this percentage is far too low. A decent indication of the strength of a country's economy is what percentage of GDP is spent on R&D, with most developed nations spending around 2.7% on R&D. The 2006 OECD average is 2.15% and Finland, with an economy about the same size as South Africa, spends 3.5%.[58]

Despite needing more funding support for research and development, some universities have anticipated the importance of technology licensing and invested in technology transfer offices and intellectual property policies. These universities are increasing industry linkages in an attempt to commercialize a greater total of university innovative output.

Many universities, however, have had to convince researchers that commercialization of research outputs were in their best interest and in the best of interest of the local and national economy. According to an article by Glenda Kruss, South African university researchers see partnerships with industry as contrary to their traditional role of generating new, widely available knowledge.[59] Government policy must fund university-industry partnerships as to promote innovation, enhance global competitiveness and improve South Africans' quality of life.[60] Universities promoting industry connections can harness the innovation potential of their researchers while still maintaining academic integrity. Balance and strategy is vital to healthy university – industry partnerships. Once these connections are in place, universities can help meet industrial needs for technological progress and contribute to national development.

Universities in South Africa are poised to play an important and vital role in the battle against poverty, HIV/AIDS and neglected diseases, and other important issues that are of regional significance to Southern Africa. To create the partnerships that will lead to beneficial breakthroughs in medicine, telecommunications and other innovations that will help battle

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[58] David Walwyn, Editor, National Advisory Council on Innovation, *The South African National System of Innovation: Background report to the OECD Country Review of South Africa's National System of Innovation*, 21 July 2006

[59] Glenda Kruss, SciDev.Net, *University-Industry links: lessons from South Africa*, http://www.scidev.net/Opinions/index.cfm?fuseaction=readOpinions&itemid=542&language=1 (29 November 2006).

[60] *Id.*

poverty; the institutions must understand the competitive dynamics of their target industry, and what individual firms in their region could use. To accomplish this objective, a new channel of communication must be opened between universities and private industries must be encouraged and fostered.

Unlocking the knowledge and innovation potential of South African universities and public research institutions is vital. South Africa understands the potential of university innovation and promotes greater university-industry linkages though support and funding for research and training cooperation between firms and universities primarily through the Technology and Human Resource for Industry Program (THRIP) and the Innovation Fund.[61] Both avenues support South Africa's Research & Development and innovation strategy by encouraging greater collaboration and technology transfer from between public and private institutions.

The Innovation Fund is one of the main agencies responsible for the implementation of South Africa's R&D and innovation strategy. Initially set up as a funding agency, today the Innovation Fund has taken a more proactive role in assisting eligible South African institutions and its researchers in their technology transfer activities.

The Innovation Fund is structured to house the Intellectual Property Management Office (IPMO) and the Innovation Fund Commercialization Office (IFCO) which specifically provides support to funded projects for intellectual property management and technology commercialization.[62] Both offices provide technical assistance and capacity building for the exploitation of intellectual property. The IFCO offers assistance with deal structuring, devising a path to market, and performing due diligence, thereby accelerating the commercialization of technologies developed with Innovation Fund support. Two funding mechanisms make up the IPMO designed to finance and secure intellectual property rights resulting from publicly financed research and development - the Patent Support Fund and the Patent Incentive Fund. The Patent Support Fund provides financial support for patent portfolios of inventions from publicly funded research institutions. The Patent Incentive Fund provides incentives for researchers and post graduate students at publicly funded research institutions to get patents granted for their inventions at the South African Patent Office.

THRIP is another avenue for funding South African university research and aid commercialization. THRIP, managed by the National Research Foundation on behalf of the Department of Trade and Industry, partners companies with universities and challenges companies to match government funding. THRIP promotes scientific research, technology development and technology diffusion by sharing the cost with industry, and by removing the risk of developing commercial technology from the research institution.

Firms and THRIP invest jointly in research projects lead by South African universities in science, engineering and technological institutions to train researchers and students and promote technology innovation by allowing researchers to be mobile. Researchers are allowed to move

[61] http://www.nrf.ac.za/thrip/ and http://www.dacst.gov.za/science_technology/innovation/innov_home.htm
[62] Department of Science & Technology, Intellectual Property Rights (IPRs) From Publicly Financed Research Framework. August 2004. Available, http://www.naci.org.za/OECD/IPR_from_PRF_Policy_Framework.pdf

between the university labs into private industry for a limited duration, along the following schemes:

- The exchange of researchers and technology managers between South African Higher Education Institutions (HEIs), Science, Engineering and Technology Institutions (SETIs) and industry.
- The placement of SET graduates in firms, while they are working towards a higher degree on a joint research project.
- The placement of SET graduates in small, medium and micro enterprises (SMMEs).
- The placement of SET skilled company employees within HEIs or SETIs.[63]

THRIP's website explains how funding takes place [see Box 3]:

THRIP aims:
1. To provide South African industry with the means to obtain specific responses to its technology needs.
2. To produce a flow of highly-skilled researchers and technology managers who understand research, technology development and the diffusion of technology from the viewpoints of both industry and academia.
3. To provide a new and enhanced educational experience within the context of technology development and/or diffusion, through participation by students in collaborative projects

THRIP objectives:
1. To increase the number and quality of people with appropriate skills in the development and management of technology for industry.
2. To promote increased interaction among researchers and technology managers in industry, higher education and SETIs, with the aim of developing skills for the commercial exploitation of science and technology.
3. This should involve, in particular, promoting the mobility of trained people among these sectors.
4. To stimulate industry and government to increase their investment in research and technology development, technology diffusion and the promotion of innovation.

THRIP priorities:
The dti's financial support for a project may be doubled, if it supports any of the following THRIP priorities:

1. To support an increase in the number of black and female students who intend to pursue technological and engineering careers;
2. To promote technological know-how within the Small, Medium and Micro Enterprise (SMME) sector, through the deployment of skills vested in HEIs and SETIs;
3. To facilitate and support multi-firm projects in which firms (including at least one BEE) collaborate and share in the project outcomes;
4. To facilitate and support the enhancement of the competitiveness of black owned enterprises through technology and human resource development.

Box 3 – Overview of THRIPS Funding, from http://www.nrf.ac.za/thrip/about.html last visited 08 March 2007.

[63] http://www.nrf.ac.za/thrip/

b. Technology Transfer and Innovation Policy in South Africa

Science and technology policy makers in South Africa are aware of the economic potential possessed by their university system and are attempting to strengthen their technology transfer system. In 1996, the Department of Science and Technology (DST) embarked on a study of South Africa's innovation system culminating in a White Paper on Science and Technology. This White Paper called for changes in South Africa's science and technology policy and announced a number of new initiatives to aid national science and technology efforts. Among the more important of these initiatives were the creation of the National Science Foundation (NSF) to manage funded grants for science and technology research; the Innovation Fund to help sustain long-term research projects; and the National Advisory Council on Innovation (NACI) to inform further science and technology policy.[64]

The DST followed the White Paper by outlining a national strategy to boost innovation and research and development. According to the 2002 government document *South Africa's National Research and Development Strategy*, a new R&D strategy was introduced consisting of three "pillars:" 1) Innovation, 2) Science, engineering and technology (SET) human resources and transformation, and 3) Creating an effective government S&T system.[65] With regards to the innovation pillar, a range of technology missions would be established and funded including a focus on biotechnology, information technology, natural resource utilization, and "technology for poverty reduction."

The R&D strategy set out clear policy goals regarding where South Africa wanted research and development to be in the future and how to address "key weaknesses" in its overall NIS. Articulated among the weaknesses were 1) inadequate funding of the national system of innovation, 2) the declining research and development in the private sector, and 3) challenges faced by intellectual property in new and emerging technologies. By addressing these weaknesses in the national system of innovation, South Africa hopes to meet national goals of economic development and improvement of quality of life for all citizens.

Though progress has been made since 2002, more work is required to modernize South Africa's innovation system. In an address announcing the launch of The Cooperative Framework on Innovation Systems between Finland and South Africa on 28 September 2006, Mr. Mosibudi Mangena, Minister of Science and Technology, stated that

> There is substantial scope for further improvement of our national system of innovation, and a number of key challenges still need to be addressed. These include, in particular, 1) ensuring the provision of appropriate science and technology human capital; 2) improving the coordination of the governance framework within the National System of

[64] Department of Arts, Culture, Science and Technology, *White Paper on Science and Technology,* 1996
[65] Department of Science and Technology, *South Afirica's National Research and Development Strategy,* August 2002.

> Innovation; and 3) bridging the innovation chasm or translating our research outputs into effective new products and services.[66]

Since the release of the R&D Strategy, various other initiatives have emerged, including the National Biotechnology Strategy (2001)[67] and a Nanotechnology Strategy (2006)[68], designed to build on existing strengths in these critical sectors, at the same time as developing human resources and generating research outputs. The objectives of these strategies were to help South Africa to become more globally competitive and address some of the socioeconomic problems faced by the country. The issue of technology transfer was brought to the fore by a proposal contained in the R&D Strategy to introduce measures to encourage better protection and exploitation of intellectual property arising out of publicly funded research projects. This has recently been expanded upon with the release in 2006 of a Framework for Intellectual Property Rights from Publicly Financed Research.[69]

This Framework was created in an attempt to bridge the "innovation chasm", a concept used to describe the gap which exists between knowledge generators (universities and research institutions) and the market. By bridging this gap, local innovations are more likely to impact economic growth. The Framework calls for the introduction of a consistent approach for the protection of intellectual property developed with public financing, based on good practices globally, while remaining responsive to the local context. Institutions will be required to put in place IP policies consistent with the legislation, thereby ensuring a level of harmonization across institutions, something that has always been lacking in South Africa. These policies would obligate employees and students to disclose all intellectual property they develop.

The Framework is modeled on the United States Bayh-Dole Act, and proposes the adoption of similar provisions:

- Conferring on institutions the responsibility to seek protection for their intellectual property in exchange for the right to own and exploit it;
- A reporting duty to a designated government agency on intellectual property management activity;
- The obligation to share revenue earned from intellectual property exploitation with the individual inventors or creators of the intellectual property concerned;
- A right for government to a "free license" to intellectual property should this be in the national interest; and
- A preference for licensing to local companies and small business.

Technology transfer in South Africa is still evolving, but things seem to be on the right track. A handful of technology transfer offices have now been operating for several years and have

[66] Address by the Minister of Science and Technology, of the Republic of South Africa, Mr. Mosibudi Mangena, at the Launch of the Cooperation Framework on Innovation Systems Between Finland and South Africa (Cofisa) in Pretoria on 28 September 2006. Last accessed 1/11/2007 at http://www.dst.gov.za/media/speeches.php?id=220
[67] Department of Science and Technology, *A National Biotechnology Strategy for South Africa*, 2001
[68] Department of Science and Technology, *The National Nanotechnology Strategy,* (2006)
[69] Department of Science and Technology, *Framework for Intellectual Property Rights from Publicly Financed Research.* (2006)

become fairly established entities. These offices are gradually building up a track record of licensing deals and spin-off companies. Of great importance is that a core of professional, experienced technology transfer practitioners is in place. And of greater importance, university technology transfer is supported by the government.

c. South African Intellectual Property Laws

By international standards, intellectual property protection is fairly robust. South Africa is a member of the Paris Convention, the Patent Co-operation Treaty and the World Trade Organization's Agreement on Trade Related Aspects of Intellectual Property (TRIPs). South African inventors with priority registration in the South African Patent Office secure around 100 United States patents per year, representing nearly 2.5 patents per million of population. Compared to the rest of the developed world, this is low. Since patents are one of the strongest forms of intangible value, this is evidence of a major weakness in South Africa's ability to become a knowledge economy.

Patents and preliminary patents, the most important IP for technology transfer, are issued by the Registrar of Patents in Pretoria and are granted in terms of Section 25 of the Patent Act for new and non-obvious inventions that can be applied in trade, industry, or agriculture. An invention may be a new product, process, appliance or composition, or an improvement to any existing product, process, application or composition. A patent provides ownership rights for a period of 20 years from the date of submission of the patent application. A shorter term of 12 months is provided for preliminary patents.

Of much importance to South Africa is conforming to TRIPs. In addition, the Convention on Biodiversity (CBD), linking indigenous knowledge and benefit sharing to the notion of intellectual property, is also of great significance. Policy debates surrounding intellectual property have taken on a new importance due to the desire to balance IP with requirements under the CBD and TRIPS while at the same time formulate a solid policy framework that encourages greater publicly-funded research and use of the IP system.

South Africa is keenly aware of the importance of the Bayh-Dole Act in the United States and has clearly indicated that it wants similar changes in the way publicly financed research is utilized by institutions to create economic value and to stimulate high-tech business development. At present, South Africa does not have a formal policy framework for intellectual property protection of publicly financed research; however, as mentioned above, a framework has been created. One of the consequences of this is considerable uncertainty (among institutions and individuals) about intellectual property rights and their management, particularly when the research is publicly financed. Benefit sharing, the cost of patenting, the sale of intellectual property rights outside of South Africa, the quality of licensing agreements, and the professional management of intellectual property protection in universities and research councils are important issues.

Since there is no overarching national framework for ownership of publicly-financed intellectual property, universities have been left to formulate their own policies. However, not all universities have explicit intellectual property policies and, where policies exist, these are not uniform across institutions.

There is growing appreciation for the value of intellectual property as an instrument of wealth creation in South Africa. A number of firms have good intellectual property offices but universities and Science Councils have not created a strong intellectual property ownership framework outside of a handful of institutions. The rights of government, financing institutions, performing institutions and their staff are not defined legally. There is a need for the creation of a proper framework and enabling legislation for the management of intellectual property arising from publicly funded research. This being said there are several universities that are striving to change the system and provide frameworks for the management of their intellectual property. The University of Stellenbosch is one such university that has established a technology commercialization framework, and the North-West University has developed a framework for commercialization including explicit intellectual property policies, though NWU's office is small. Both institutions are outlined below.

d. Technology Transfer at North-West University, Potchesfstroom

> [To] produce high-quality, relevant and focused research, basic as well as applied, supplying innovative solutions to challenges faced by the scholarly community, the country, the continent and the world. Implement research results and expertise, both commercially and community directed, for the benefit of the country, the continent and the World.[70]

The mission statement above represents the role North-West University envisions for itself in the wider community. The sentiment articulated above is echoed in the introductory section of their formal policy regarding the commercialization of intellectual property rights which reads, "North-West University has the avowed intention of applying its expertise for purposes of service delivery and development in the interests of the broad South African community, and wishes, apart from doing basic research, also to do applied research and research in application of high quality."[71] Overall, North-West University has set out to create a framework in which university innovation is protected, licensed and commercialized while providing incentives for researchers to create innovations.

In addition to the above mission statement, the Department of Research Support also lists objectives and goals to be achieved in the years 2006 to 2008. Among the objectives are the worthy aim to "maximize the number of publications … and the registration of patents, …, optimize the number and quality of licensing fees," and to "market the expertise of the University in a pro-active way, so as to ensure more research contracts and work from the private and public sectors."[72] Further, one specific goal listed by the Department is to "co-operate with

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[70] Research and Innovation Mission Statement, North-West University, Strategic Plan for Research and Innovation 2006 – 2008. Available at http://www.nwu.ac.za/opencms/export/NWU/html/research/StrategicPlanforResearchandInnovation21April2006.doc, last accessed 16 January 2007.
[71] Noth-West University, *Modus Operandi of the Section Legal Services North-West University: Policy about commercialization of intellectual property rights,* accessible at [last accessed
[72] *Id.*

the Marketing and Communication department in order to create and implement a strategy for the *marketing* of the University's research."[73]

Additionally, the Innovation Office also sets out a list of general goals. The Innovation Office (IO) is the focal point through which innovation at the university is stimulated and offers a specialized function to advance innovative research, leading to patents, innovative products and processes which culminate in an Intellectual Property portfolio, which it manages to obtain optimal returns. The innovation office explicitly describes their purpose by stating, "the return on innovation activities include financial benefits, the creation of spin-off companies, networks with industry and new research opportunities."[74] The IO further lists how the office enhances innovation on the campus:

- Support researchers with the negotiation process
- Negotiate licenses and other agreements
- Manage existing innovation and commercialization agreements
- Develop performance benchmarks for the university
- Identify new innovation and commercialization opportunities
- Protection of Intellectual Property
- Market new technologies and research output
- Develop human resources in the field of innovation and commercialization
- Develop and maintain external networks and relationships
- Develop relevant policies and guidelines for innovation and commercialization
- Establish and develop spin-off companies (incubation)

North-West University in South Africa is pioneering university research and industry linkages. Recently announced partnerships include an agreement worth R15 million between North-West University and BioPAD for setting up a unique metabolic platform. Two-thirds of the money will be used by the School of Biochemistry to install the technology in laboratories, while the rest will be used to operate these laboratories over a period of three years.

As well as the Innovation Office of NWU, there are other formal structures within the university designed to promote technology transfer and spin-offs. One of these is the Incubation Fund. The Incubation Fund, under the control of the Innovation Office, provides funding for the furthering of innovation, commercialization and the creation of small businesses.

i. NWU Intellectual Property Commercialization Policy

Technology transfer offices must clearly articulate policies regarding ownership of intellectual property and North-West University has clearly established IP policies freely available on the Internet. These policies explicitly state how researchers are to progress in developing and disclosing their inventions, how revenue from licensing activities will be split, and how licenses should be constructed and improved.

[73] *Id.* [emphasis original]
[74] *Id.*

Though the technology transfer office at NWU is quite small with an equally small staff, the fact that clear intellectual property policies have been put into place demonstrates the dedication the university feels for technology transfer and commercialization. For example, the *policy for the division of funds from commercialization of intellectual property* sets out and defines the procedure of how licensing funds from patents, software and model registrations are to be divided: Twenty-five percent of funds go to the inventors as incentives; 20% to the focus area or school to which the project is linked (pro rata if more than one focus area is involved); 15% to the faculty concerned; 20% to the Incubation Fund of the University; and 20% to the strategic fund of the NWU (contribution to the University). Furthermore, over and above the 25% incentive to the researcher, an additional incentive may be paid at the discretion of the Institutional Director according to a disclosed formula. Therefore, the researcher, as incentive, could receive up to 35% of Net Income resulting from the invention within a designated time frame.

North-West University also provides their researchers with explicit step-by-step instructions in the *Guidelines for the Patenting and Commercialization of Research Outputs*. Once a university-derived innovation is ready to be commercialized, several expectations are leveled on the inventor/s. These steps include, among other things, requiring that one or more models based on the research outputs be built and the patent claims be quantified; a provisional business plan of at least three pages should be compiled and submitted prior to seeking a patent; and, once market analysis is undertaken, the legal advisors, Department of Research Development, and the Vice-Rector of Academic should be in on the process.

Rounding out NWU's policy regarding commercialization of research outputs, the university provides a *Guide for the External Cooperation in the Field of Research and the Commercialization of Research Outputs*. As the name implies, this extensive document covers the case where cooperative research is undertaken with entities outside of NWU. This policy covers everything from drafting formal cooperation agreements, intellectual property rights, and overall management of the research project. Understanding the importance of cooperative research, NWU actively pursues such partnerships which can lead to useful inventions and important innovation. However, along with these partnerships comes the risk of misappropriation, and premature disclosure thereby jeopardizing patentability. Part of the overall commercialization strategy of NWU is to reward staff by allowing personnel to benefit where commercialization of intellectual property rights arise during the course of official university activities. Therefore, it is recommended that universities construct an explicit policy regarding these kinds of collaborative research.

2006 NWU Innovation Performance	
Domestic Patents	6 provisional patents, 2 patents
Foreign Patents	5 PCT, 2 other
Licenses Overseen	12 active licenses

e. Technology Transfer at Stellenbosch University - InnovUS

Where North-West University represents the small technology transfer office, Stellenbosch University is the example of the large well-developed technology transfer office. Stellenbosch University regards the commercialization of its knowledge base and technology transfer as part of its responsibility in the area of community interaction. This is in contrast to some universities that regard technology commercialization efforts to be a stream of revenue for the university. The institution has developed administrative structures to support its commercialization and technology transfer activities and has also created an enabling environment for researchers in terms of intellectual property rights. The success of the institution in the area of innovation and technology transfer is confirmed by its performance in THRIP as well as in the fact that in May 2005, SU won the Department of Science and Technology award as the Most Technologically Innovative Higher Education Institution in South Africa.

The University of Stellenbosch has a well-established technology commercialization procedure and office that operates within Stellenbosch University called InnovUS. InnovUS is responsible for technology transfer and new business development of university derived innovation and inventions. InnovUS is comprised of, as one would expect, an Executive Director of Innovation and Commercialization; a Director of Intellectual Property and a Managing Director among other partners within and outside Stellenbosch University. Furthermore, the university has established a wholly-owned private company called Unistel Group Holding Ltd. that functions along with InnovUS in commercialization activities by creating start-up companies.

i. SU Intellectual Property Commercialization Policy

As iterated above, successful university technology transfer offices must have clear policies regarding the protection and exploitation of intellectual property developed by staff, students and other parties. Stellenbosch University has always been a pioneer in university technology transfer and indeed has in place a detailed policy regarding the exploitation of intellectual property that was last updated in 2005. The policy includes in a single document available for download detailed steps regarding the allocation of income derived from the licensing of intellectual property; IP ownership issues including staff, students, visiting lecturers, outside organizations, and funders; how IP should be licensed; and how the university forms spin-off companies.

Stellenbosch University has been a pioneer in South Africa in terms of intellectual property protection and exploitation. Continuing in this tradition, SU has even formulated university policy regarding the protection of biodiversity and indigenous knowledge which has become increasingly pertinent in the world of intellectual property. Whenever university intellectual property is deemed to have an impact on South African biodiversity, SU negotiates in consideration of the preservation of South Africa's indigenous biodiversity.

The division of income derived from the commercialization of intellectual property is different than seen at NWU. The formula followed by InnovUS provides for 12% of the gross income to be allocated to the University and for all direct costs incurred by the parties in terms of the registration and commercialization process to be recovered from the gross income before any allocation of the balance of the income can take place. The balance constitutes the net income, of which 50% is allocated to the inventor/creator in their personal capacity, 25% is allocated to the environment where the inventor/creator resides (to be applied in the interest of research), and 25% is allocated to the central account of the University.

Stellenbosch University has achieved great success in spinning-off companies. Where the University decides, usually in consultation with the inventor or entrepreneur, to exploit intellectual property through a spin-off company, a separate enterprise is established that is normally a subsidiary or associate company of Unistel Group Holdings Ltd. The University, inventor/entrepreneur and other possible partners own shares or other interests in accordance to an agreement made beforehand. Depending on the activities of the spin-off company, and where the University's public image will be involved, the University reserves the right to insist on a 26% special vote as a shareholder or member. Wholly owned subsidiary enterprises may be established where the University for strategic reasons owns full control and shareholding through Unistel Group Holdings Ltd. Currently, Unistel Group Holding Ltd. manages six companies representing a range of innovative technologies including a company specializing in space satellites and another in feeds for aquamarine environment.

The following page has a flow-diagram for the commercialization process of inventions at Stellenbosch University.

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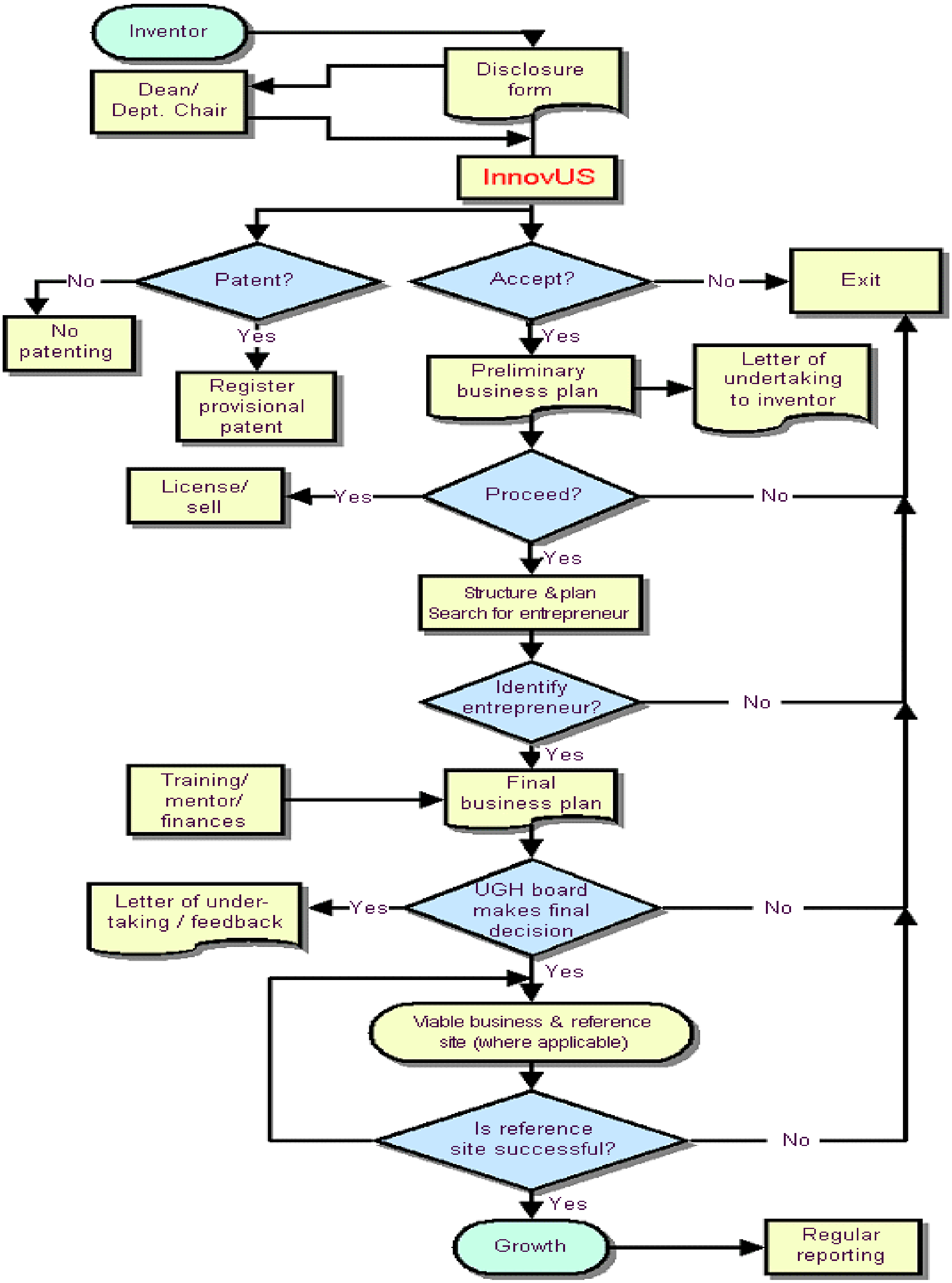

Inventor
Disclosure form
Dean/ Dept. Chair
InnovUS
Patent?
No
No patenting
Yes
Register provisional patent
Accept?
No
Exit
Yes
Preliminary business plan
Letter of undertaking to inventor
License/ sell
Yes
Proceed?
No
Yes
Structure & plan Search for entrepreneur
Identify entrepreneur?
No
Yes
Training/ mentor/ finances
Final business plan
Letter of under-taking / feedback
Yes
UGH board makes final decision
No
Yes
Viable business & reference site (where applicable)
Is reference site successful?
No
Yes
Growth
Regular reporting

1. The Stellenbosch University Satellite - SUNSAT

An example of strategic industry-university partnership exists at Stellenbosch University. Spun out of research conducted by graduate students at Stellenbosch University and funded by the government of South Africa for 26Million Rand, Sun Space and Information Systems (Pty) Ltd. (SunSpace for short) produces technology for use in micro-satellites that can supply affordable high-resolution imagery to African governments. The **S**tellenbosch **UN**iversity **SAT**ellite (Sunsat) is a miniaturized satellite designed and manufactured in Africa for the purposes of providing images that can help monitor, regulate and manage resources, for example, water distribution, crop management and settlement infrastructure.

SunSpace was formed to expand and commercialize the Sunsat technology. Through close links with Stellenbosch University and Unistel, SunSpace occupies office and lab space inside the general building of the Faculty of Engineering. Recently, a technology transfer and satellite contract was recently signed and started with an overseas client.[75]

VI. Conclusion

Transfer of technological innovations along with the transfer of specialty knowledge contained in skilled human capital is essential for commercialization of technological outputs. Adequate funding for research and development activities along with appropriate IP laws, tax incentives and innovation policies will lead to economic development through technological innovation. Prioritizing research and development, and formulating an appropriate innovation policy in developing countries will benefit regional economies where it is most needed.

Producing innovation requires highly-skilled scientists and engineers that will remain in the country. Most publicly-funded scientific innovation occurs in a university setting, and universities must provide the structure necessary to aid scientists in the commercialization of innovation. This structure is usually technology transfer offices that include policies guiding intellectual property ownership, licensing and revenue sharing with innovation producers.

We presented examples of university technology transfer offices in developing countries, each office working within varied national innovation policies, funding mechanisms and overall systems of innovation. That said, each office endeavors to commercialize university-produced innovations to the benefit of local communities, regional economies and national economic development. Hopefully, through the highlighting of successes in innovation, we illustrated how such public to private transfer of technology can have a positive effect on the local as well as national economy of developing countries.

Emerging economies possessing minimum level of scientific and government infrastructure, appropriate laws and the desire to adjust their innovation strategy to best encourage economic growth through innovation are poised to reap the benefit of technology innovation. Having the appropriate national and institutional innovation framework greatly contributes to the success of technology transfer.

[75] http://www.sunspace.co.za/