Human and intellectual capital broadcast at the Scientific Technologic Parks.

Sebastiana Luiza Bragança Lana, Ana Cristina Alvarenga Lage
Instituto de Desenvolvimento Econômico e Social de Itabira. i.tec – Itabira Tecnology and Science. - Brazil

Abstract

The adoption and diffusion of technological innovation, has recently, reassembled the concept of global development and its economic arrangements. This process can be understood as a combination of productive forces of mainly two components: the first one is related with the original production factors - basic infrastructure to name just one feature - and technical factors (knowledge, for instance). The second component is related with the social aspect. Depending on the degree of the combination of these driving forces, one region can be more or less developed affecting the economic process. The majority of empirical research carried out in the field of innovation, technology and regional development confirm how complex these forces are. It is also clear that innovation and technological knowledge remains as key elements in the transformation of territorial and economic structures

Global development can also be defined considering the population's level of accessibility to the basic goods and services. It also can be evaluated based on the availability of work-trading and thus personal accomplishment. Technological development is tightly linked with economic and social evolution. The transformation of knowledge into products, process and services, which can be placed into market, is at any time, extremely important for the growth of the economy and society.

The conciliation of high-tech production involves the knowledge of several scientific and human areas, both aiming life quality. It is a long, costly and risky process, which largely depends on the innovative abilities of the members of the project to accelerate acquisition of new technologies, upgrade and transfer them over time. It includes systematically the expertise of sharing the results of research through industry and functional practices by using pertinent tools to collect pertinent information in technology, business intelligence, new products, politics, demographics, culture, and international relations. In other words: to learn, innovate and to transfer knowledge in a broad sense.

Technology is characterized by a human capability of planning and implementing different solutions in any area. Sharing the same notion, the process of innovation is thought to be a procedure of research and learning, resulting in a materialization of a completely new ability, which in turn, will be used to solve different problems.

Another very widely spread idea mentions the existence of some kind of organizational intelligence, which consists in an interactive capacity of firms and organizations that own this collective knowledge to solve complex problems.

In all these definitions, intellectual capital as "non tangible capital" is seen as a production factor and as an asset (like energy, land, only to name the most important) that organizations have to gather, in order to have success: in consequence, intellectual capital is a tremendous tool of wealth production and economic development

The technological innovation is understood here as a result of a process that involves a large group of professionals and different institutions and support mechanisms. The innovation can occur in different stages, from the conception of the idea until the diffusion of the final product throughout the society.

Innovation may be of different nature - a radical change, an improving characteristic of products, processes among others. In other words, it is important to state that innovation, in any case, means an idea that improves technology, whether it shows, at first a radically different nature or not.

Intellectual input, labeled here as "intellectual capital" sometimes means education and training, personal experiences, engagements or attitudes. In this first conception, intellectual capital is linked with the human capital. But, in a second and also very used conception, intellectual capital means property rights, patents, "star scientists", computers, research and development, innovation, and information technology.

Besides the technical dimension, an innovation process includes a great number of management aspects; meaning the capacity to recognize opportunities, strategically acting, therefore, demonstrating effortless abilities to mediate transactions.

Developed and less developed countries recognize that to improve their industry and ultimately to export their goods, there are methodologies carefully defined to upgrade science and technology activities. One of them should gather the active participation of the scientific community, through the research and learning at Universities and Technological Centers.

It is well known that the environment of the Technologic Parks encourages and supports the development of the pioneer ideas by providing physical infrastructure, technology-transfer initiatives and the intensive business support services knowledge. In some Tec Parks, and this is the case of i.tec Itabira High Tec Park – Minas Gerais – Brazil, these ideas are shaped in pre-incubation stage and incubation (the development of the innovation) - as well as in mature knowledge enterprises. Technological and Scientific Parks have a strong dependence on universities and research centers, focused on high-tech "up to date" science, mainly sponsored by governmental through specific programs and public initiative.

In a context where knowledge, efficiency and speed of innovation processes are recognized as the decisive elements for economic competitiveness, it is crucial that financial and human support remains active, so that development in a broad sense can attend to market demands.

The public and private sectors must carry out the financial support policy. They have responsibilities in technological promotion and innovation programs, which main implemented actions are the supply of a wide variety of business services related to technological schemes. However, the most important factor to initiate these innovation programs is, above all, the intellectual input.

All these aspects seam to be gathered in the Scientific Tec Parks area, where partnerships among Universities and firms are and will be the key to improve quality of life in a broad sense. Clusters of high tec qualified scientists into the surroundings of a Tec Park point out to the enlargement of the Universities frontiers.

This paper will discuss the importance of the human and intellectual capital, acting as the center of the innovative process and the main driving force for broadcasting knowledge at STP.

(1) Executive Director of i. tec – Itabira Technology and Science – Minas Gerais –Brazil.

(2) Operational Director of i. tec – Itabira Technology and Science – Minas Gerais –Brazil.

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1. Developing the processes of knowledge.

Knowledge has become a key factor of competitiveness for national and regional economies, we are moving towards "knowledge economies". Knowledge intensive sectors in production and in services have a lead in this respect and to some extent they can be considered as role models for the future.

The main questions today are how to add value to knowledge? The main actors of this process are not only the universities and researches centres, but also the companies, which must have an improving research and development policy by itself or in partnership with other centres Vogt, 2004.

Knowledge is generated and accumulated by action. Doing something and judging the results is the general model. Owen (1994), Laestadius (1998), Asheim et.al. (2003), distinguish between analytical and synthetic knowledge bases.

Figure 1 shows the process as a cycle in which knowledge is used to create works, and works is created to build knowledge.

Knowledge using and knowledge building are not unstructured processes. They are controlled by the systems of conventions and rules under which all the scientific disciplines operate, aiming work done and judged. They may borrow from or emulate aspects of others scientific disciplines but, in the end, they are products of its evolution.

The general model of Figure 1 can be extended to a model that fits the dual nature of actions suggested by the analytic/synthetic dimension of the disciplines. On the left side of the diagram, the area of the theory, the model is a paradigm for inquiry. Existing knowledge under of theory is used to generate proposals. Proposals are tested with measures that verify or refute conclusions to build knowledge.

On the right side of the diagram, the realm of practice, the model forms a paradigm for application. Here knowledge is used through the application of principles to produce works. Works are judged for their worth as additions to the knowledge base using the criteria of the scientific and human areas.

Proposals and works also benefit from and contribute to ideas in other sciences interdisciplinary relationships.

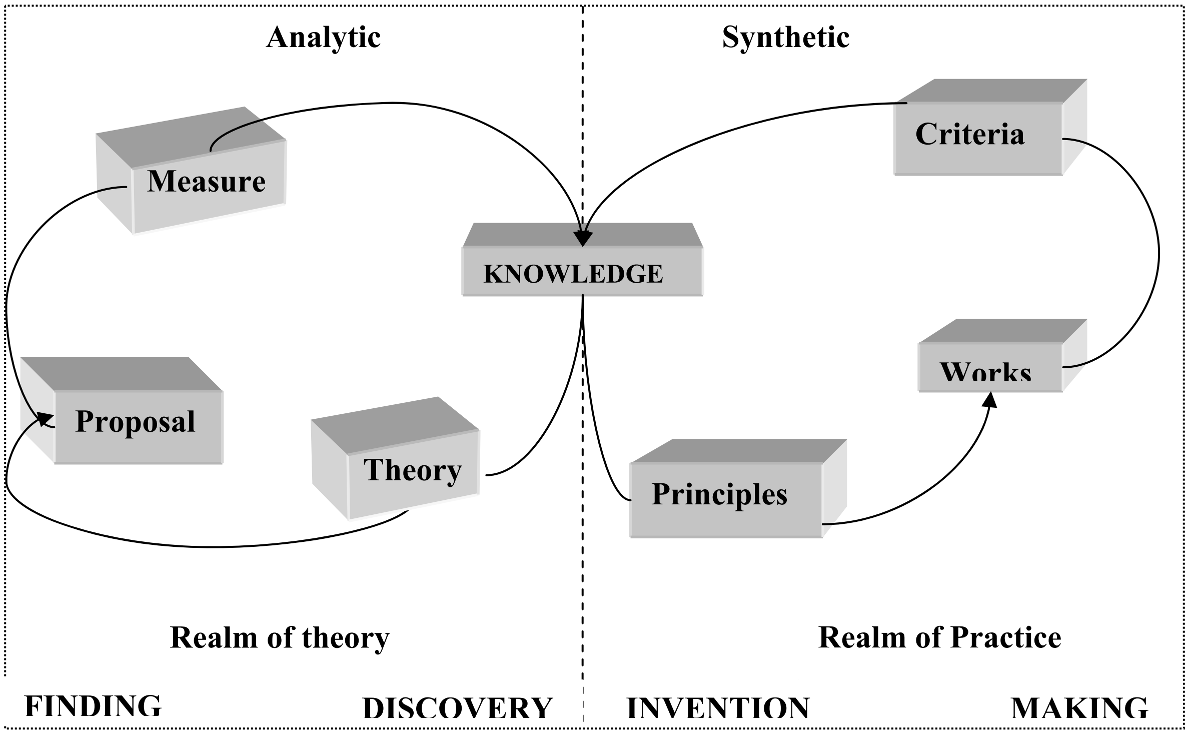


Figure 1- Building and using knowledge hand-in-hand across the realms of the theoretical and the practical.

By the process of doing and judging, questions are asked, answers obtained and decisions made. How these are formed are the key to using knowledge successfully to build new knowledge.

2. Building intellectual capital (IC).

Synthetic knowledge dominates in more traditional industries (like industrial machinery or engineering) and is characterized by the application or novel combination of existing knowledge, low levels of R&D and a strong orientation on solving specific problems articulated by customers.

Learning by doing and interacting, practical skills and tacit knowledge-from the Latin- (silent or secret) is highly important, leading to an incremental innovation pattern in industries with a synthetic knowledge base. In this case, intellectual capital (IC) sometimes means education and training (E&T), personal experiences, engagements or attitudes; in this first conception, IC is linked with the Human Capital (HC), Costumer Capital (CC) and is essentially based in people relationship. Thus most of the stock of the intellectual capital is tacit.

According to Stewart, A.T., 2001, the Intellectual Capital, IC, can be understood as the model show in Figure 2.

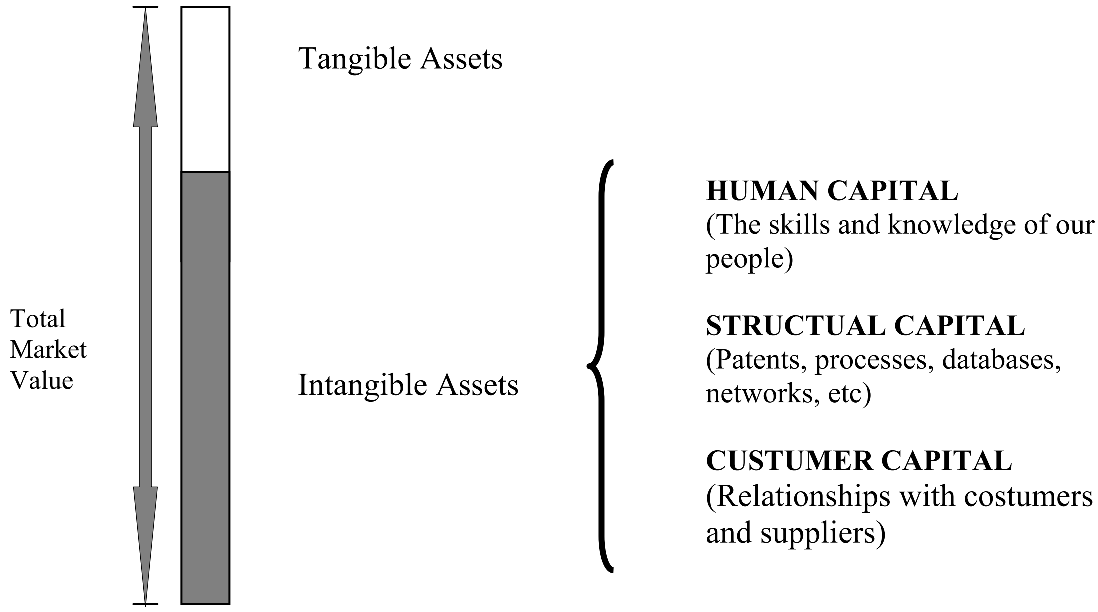


Figure 2 - The Intellectual Capital Model.

By the above model it has become standard to say that a company's intellectual capital is the sum of its human capital (talent), structural capital (property, methodologies, software, documents and other knowledge artefacts) and costumer capital.
In comparison, the innovation process in industries with an analytical knowledge, explicit knowledge –from the Latin (to unfold, to be open) base like biotechnology or information and communication technology is clearly different in nature.
There is a strong reliance on scientific inputs and codified (or codifiable) knowledge. It is in general far more important than in traditional sectors. Intellectual capital (IC) in a very used conception, belongs to the domain of structural capital defined as databases, property rights, patents, manuals, "star scientists", computers, research and development (R&D), innovation, formulae, recipes, procedures and information technology, although as said by Tiwana, A. 2000: " Technology helps collect, store, transfer, and distribute information. Information does not necessarily translate to knowledge, for much knowledge is to tacit and too obliviously ingrained in people's head to be codified – let alone transferred electronically.

3. The innovation input.

In a classical industrial model the production logic was to multiply the same product for a number of growing consumers. It was easy to understand that in a knowledge society this pattern has an inverted signal: multiply more and more the product in a process of constant modification for the same market segment and a growing number of costumers. This explains, between other features, the importance of research and technological innovation.
It seems to be increasingly widely accepted that innovation greatly differs across sectors (see amongst others Pavitt 1984 and Malerba 2004). Innovative activities in knowledge-based companies are characterized by several specifics, making them different from those in more traditional sectors.
Knowledge inputs are often based on reviews of existing (codified) studies. Its generation is based on the application of widely shared and understood scientific principles and methods. Knowledge processes are more formally organized (e.g. in R&D departments) and outcomes tend to be documented in reports, electronic files or patent descriptions.

But what factor is the responsible for the innovation input?

The power to generate genial solutions lies within the formation of our mind, but a vast repertoire and a stimulant environment can also turbinate your creativity, said Artoni C., 2004. The history is full of examples of major creative icons like Plato, Da Vinci, Galileo, Shakespeare, and Mozart among many others in the scientific fields. However: what about our contemporaneous creative people? How this creative process happens and can be improved?

Although there is no absolute agreement, it is been accepted that creativity is the capacity to generate ideas linked to two components:

First is the originality (innovative idea). The second component is linked to the functionality, since creation must be useful in a broad sense. The reproduction of existing models cannot be considered as creative. Stuart, T.A. 2001 says that: "the guy who invented the first wheel was not as genius as the guy who invented the other three."

It is been discussed that an idea might be of two kinds; one converges to the only correct answer, while the other diverges into many alternative options. This second divergent idea has more chances to innovate, because it considers the fluid characteristic of science i.e., that science is not only evidences and techniques, but also intuition and creativity. So it is agreed that creativity cannot be measured, but its potential can be evaluated by the capacity to offer a great number of alternatives for a specific problem.

Many characteristics describe how the mind works; the capacity of association (recombination of ideas using uncommon paths), mental images (of known or opposed ideas), intuitive cognition (incubation of ideas), accidental discovery, past experiences, and intuition (unconscious thoughts affecting remote memory)

The mind map shown in Figure 3, roughly specifies that it have two hemispheres, left and right, divided into four regions; superior and inferior. The creative areas are situated mainly into the two inferior quarters, which defines the limbic system. This complex system deals with memory, the emotions and the sensorial answers in general. Intuition and reasoning however are located into the two superior quarters left and right, respectively. These four areas, however always interact with other in a continuous time and the process of creation which includes, interest, preparation, incubation, insight, test and application goes unequivocally through all four quadrants.

Figure 3. Mind map showing two hemispheres, left and right, divided into four regions superior and inferior.

Although the codification of knowledge plays a decisive role in sectors with an analytical knowledge base, tacit knowledge is of relevance, too. The argument put forward here is that there is a complex interplay between codified and tacit knowledge in the process of knowledge creation and innovation (Nonaka and Takeuchi 1995, Lundvall and Borrás 1999).

4. The diffusion of knowledge – the role of STP.

In sectors where an analytical explicit knowledge base prevails there is much more systematic basic and applied research than in traditional industries. The rate of product and process innovations, notably of a radical nature, is high. R&D efforts are typically strongly focused on generating radical innovations.

Academic spin-offs and new firm formation are important mechanisms when it comes to the application and economic exploitation of new analytical knowledge. In knowledge-based industries research is done to a considerable extent within companies. Nevertheless innovating companies are highly dependent on external knowledge sources. Universities, government labs and other research institutions are crucial agents in this respect, providing scientific research inputs for innovating firms.

Consequently, various forms of university-industry partnerships play a crucial role in the process of knowledge generation and innovation. It is often assumed, and there is also some evidence (Feldman and Audretsch 1999, Cooke 2002), that those knowledge-based firms and activities exhibit a strong tendency to cluster in a geographical space**.**

The industry - or cluster life cycle hypothesis (Swann 1998,) argue in this context that in particular in the early stages of industry development geographical proximity is vital whereas in latter stages, when the industry matures, economic activities become more geographically dispersed.

The importance of tacit knowledge in the innovation process, which is best transmitted via face-to-face contacts and through frequent interaction, is a key factor to explain spatial clustering in knowledge-based sectors, in particular in the early phases (Tödtling 1994). Malmberg and Maskell (2002) noted that co-located firms undertaking similar activities benefit from "observables and comparables advantages", i.e. they can monitor competitors directly and continuously, identify and imitate superior solutions and combine them with their own ideas. The value of knowledge assets can be multiplied many times, because they can be shared.

Enhanced knowledge creation is the result. Whilst not neglecting that geographical concentration can provide enormous opportunities for the transmission of non-articulated forms of knowledge between firms ("local buzz"), Bathelt et al. (2004) emphasize the importance of "global pipelines" through which access to codified external knowledge is secured. Indeed, combining these various types of knowledge can create new value.

In the cluster approaches, these concepts apply to the structure of a Scientific Technologic Parks, since they encourage and support the development of the pioneer ideas by providing physical infrastructure, technology-transfer initiatives and the intensive business support services knowledge. In some Tech Parks, these ideas are shaped in pre-incubation stage and incubation (the development of the innovation) - as well as in mature knowledge enterprises.

This will be the focus of the following sections, by introducing the case study of the **i.tec** – Itabira Technological and Scientific Park.

5. The Itabira Scientific and Technological Park – i.tec.

Itabira is located at approximately a 110 Km to the Belo Horizonte city, which is the capital of Minas Gerais State and also near to the Atlantic sea harbor. This is an advantage because the products can flow to be exported with lowest cost. This facility opens the opportunities for internal and external markets**.** Figure 4 shows the location where our analysis begins.

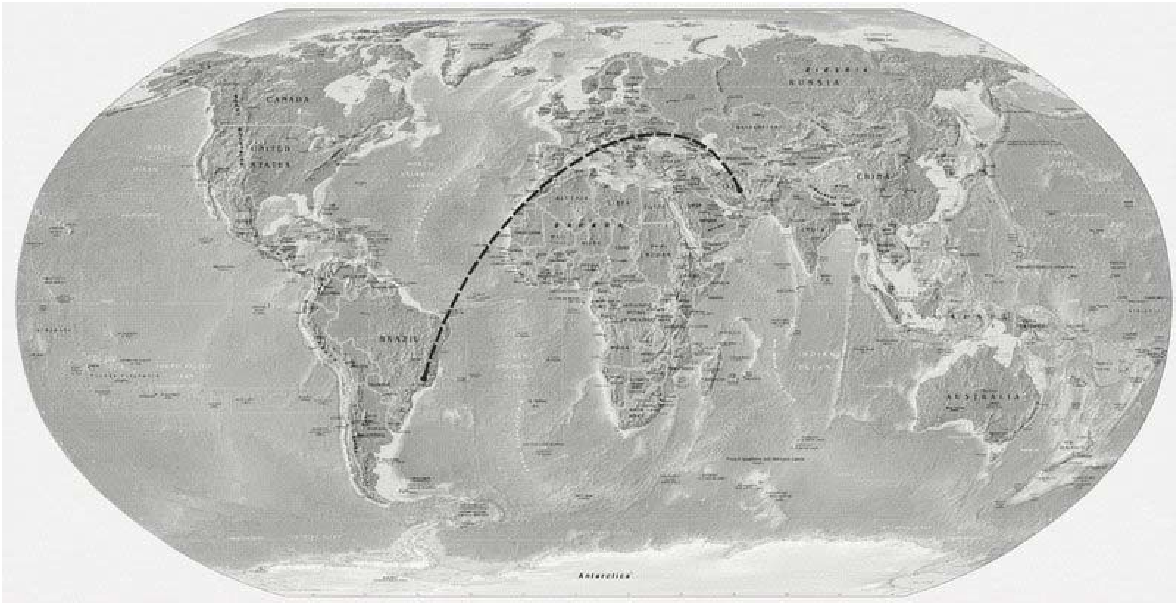
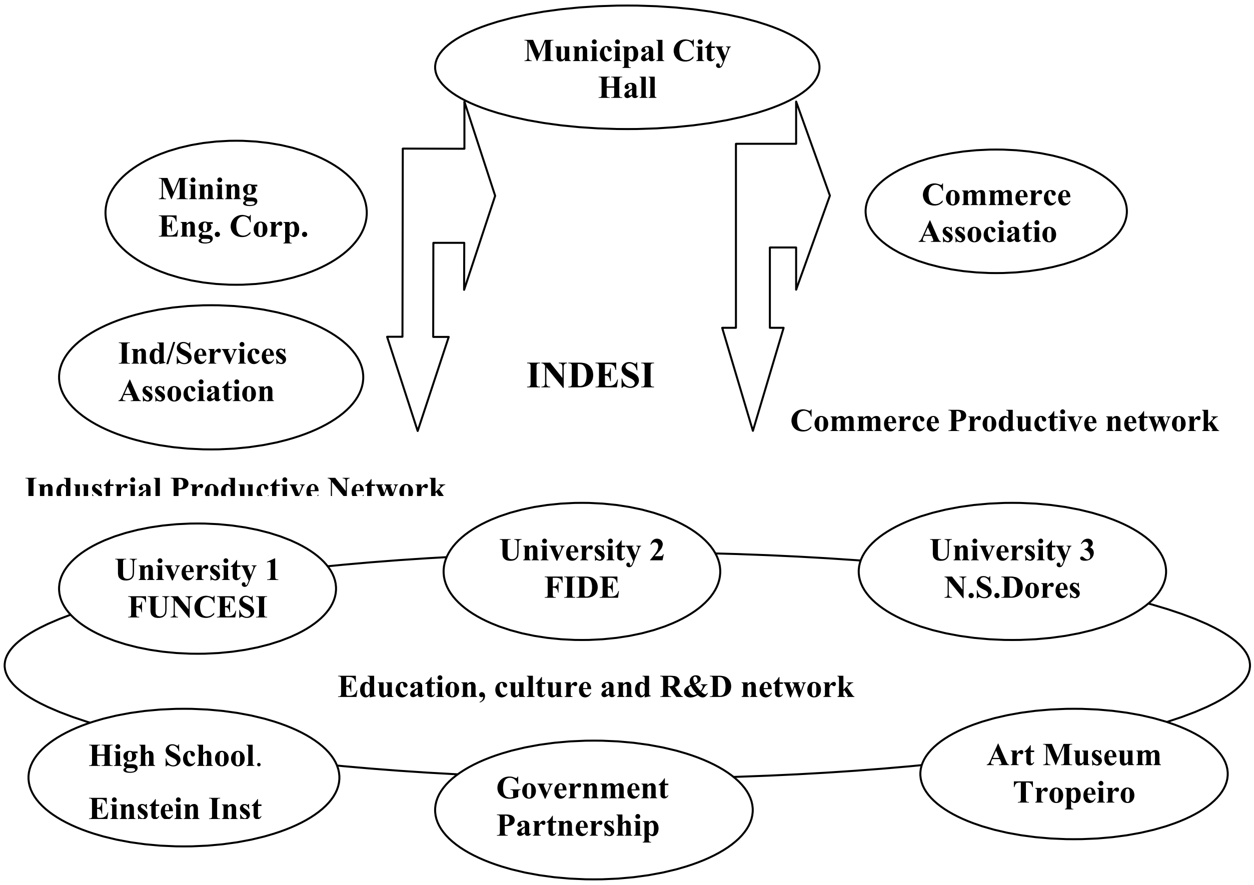


Figure 4 – Location of Itabira/MG/Brazil.

The i.tec –Itabira Technological and Scientific Park is a productive arrangement structured in:

- A "Condominium Park" of 63.806m^2, vertically fit in five floors, occupying a projection area of 14.872m^2, about 35 % of the available land. It is expected in 2012 112 technological middle-sized companies that will absorb 2.167 work posts.
- An Entrepreneurial Park to conceal individual, mature enterprising business, middle size, occupying independent spaces, in an area of 205.209m^2 (54% of ground occupation), located around the Centre of Studies and Environmental Technology Development in a preserved area of 217.100m^2. There will be 50 companies, an institutional platform and 3 504 permanent openings.

A Metropolitan High Speed Net guarantees the connection among them and the entities, and the intern and extern nets. The total investment amount is R$153 millions from which total R$6.9 millions were already invested (urbanization done).
Scheduled to be built in ten years, in five stages, each one with a two year duration, the project of the "Condominium Park" includes nine modular blocks, multi-function, that will be insert to attend the technological bases of market companies.
The Marketing program includes new business attraction one by one. All the 162 companies of technological support located at the "Condominium and Entrepreneurial Parks", should produce on the 10th year an additional amount of R$994 million, in which will be added R$209 millions in salary work posts. The entrepreneur management is under the responsibility of INDESI – "Instituto de Desenvolvimento Sócio Econômico de Itabira".
The INDESI – "Instituto de Desenvolvimento Sócio Econômico de Itabira" is funded by the associated members of the local community and represents the regional public interests. Among them are the presence of three universities, Commerce Association, Industry & Services Association and the Municipal City Hall, this last as the main sponsor of this project.



The companies operating in the scientific and technological parks benefit from the following incentives:

- Favourable location conditions, infrastructure and communication use, by payment on instalment basis, ensured or facilitated by the administrator for a determined functioning period,
- Tariff reduction of charge services offered by the administrator,
- Tax reduction and other incentives are granted by the local authorities for the fixed assets and land given to the park for its use.

Itabira Tech Park is linked to universities and therefore attractive to organizations, which are interested to use this environment to favour their research and development projects.

The funds provided by the Science and Technology Ministry were of the order of 9.650 Millions, of which a sum of 5.650 Millions in 2006/2007 will be directed towards to sponsor capital expenses, technological scholarships formalized by the CNPq, which is also a source of the MCT fund.

This resources support projects destined to develop operational services to incubators installed inside a technological park, to enable pre-incubator people to their projects and to study the economical viability of technological products.

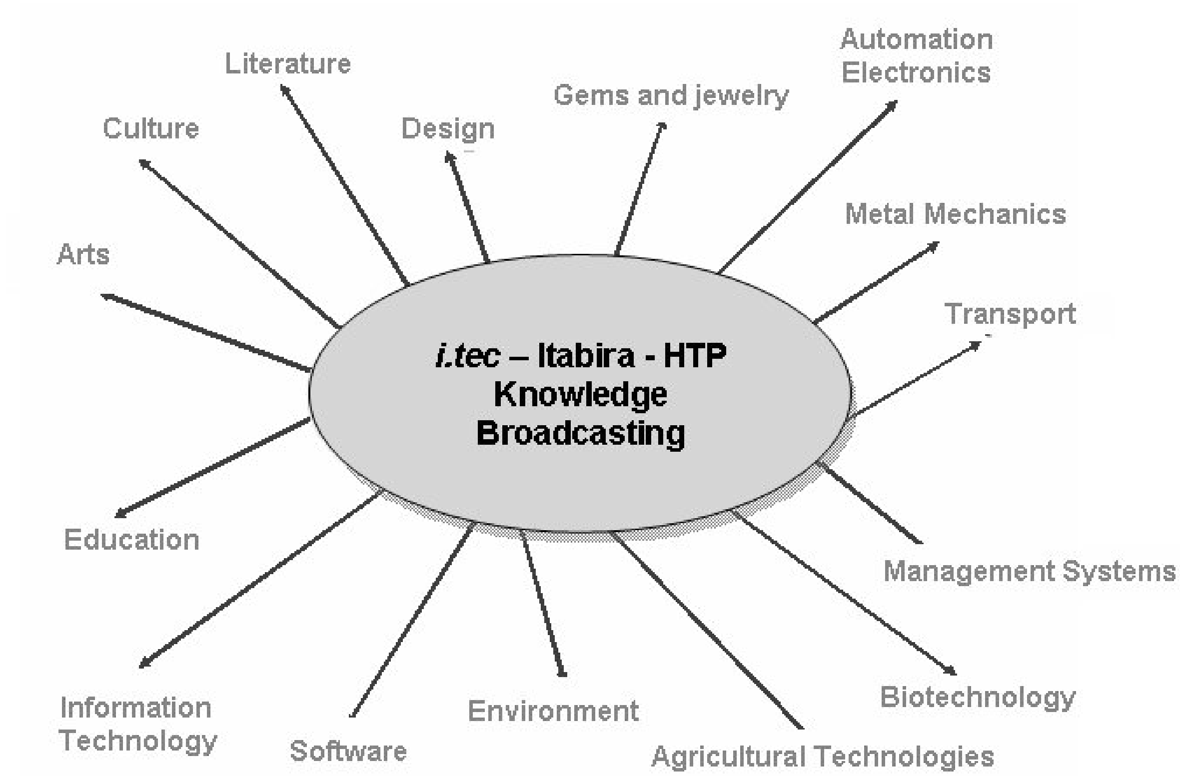
Next year the total sum will be of approximately 10Millions and this sources allied to the City Hall counterparts and other partnerships like BNDES, SEBRAE and State Governments, will consolidate the already existing Technological Parks and will give support the ones in development, which are displaying economical and technical viability.

The economy of Itabira is based on industry (58% to 61%) and services (42% to 39%), data from the last decade. Mineral extraction is the activity, which is responsible for more than 80% of the region economy.

Considering the regional local history and the companies that configure the productive local arrangement, it was possible to identify the technological domains of importance to the regional economic development. This is possible by observing factors such as their competence viability, value enhancement to the production by innovation applied to the technology of products and processes, in association with education systems.

Beginning its activities in 2005 i.tec was linked at first, with the main regional abilities and using the human and raw material potential available in the region, it was developed the following research and technological domains shown in Figure 6, strategically seeking development and innovation.

- Metal - Mechanics Technology,
- Environment Technology and Engineering: solid residues management, biomass, recycled materials, disposables, furniture industry, extracts and resins, paintings, echo tourism.
- Biotechnology: clinical exams, reagents and systems, equipments, pharmacy, phytotherapy, degenerative diseases medicine, transgenics, agricultural technologies, irrigation, milk derivatives, genetics developments.
- Information Technologies: software, automatic industrial processes, computer industrial production (mechanics, paper, ceramics), management systems and environmental monitoring and instrumentation.
- Sociological Technologies: Education, industrial design, cultural products, and hand made products, gems and jewellery.



5.1. i.tec Physical Structure:

i.tec's domains are oriented for production, creation and development of knowledge of not only innovative processes and products, but also are guided for the production, generation and multiplication of the arts and culture, contributing with the social elements in its structures, spaces of convenience for the population and the ones who work there. Therefore, ***i.tec*** spaces presents:

- Advanced posts and specialized units of superior education;
- Development centres of technological, artistic and cultural research;

- Industries and companies of services of technological base, centres and platforms of long-distance services;
- Centre of events - conferences, workshops and expositions and business-oriented units of development;
- Gym and art areas;
- Companies specialized in "funding", risk capital, legal assistance, certification institute (conformity, quality and metrology), net supplier, technology commercialisation companies, including e-commerce.
- Technological-productive integration centre: intermediating the relations between i.tec and the external productive market system;
- Social services - sports, leisure and entertainment, day-care centre, restaurant, parking, reception, etc;
- The INDESI administration for i.tec operation and maintenance;
- Support services, including intranets (voice, image, data, multimedia, long-distance services) with connection to the REMAV Itabira, and heliports;
- Green areas, water mirrors, gardens, footpaths and areas for resting and studying.

These articulated elements must observe an internal and external balance that minimizes or eliminates negative impacts and stimulates the synergies and exchanges, exercising a paradigm of life quality.

5.2. Knowledge diffusion at Itabira Scientific High Tech Park – itec.

Knowledge sharing doesn't happen without help. At **Itabira STP – *i.tec*,** the newcomers are introduced to the most important element of knowledge sharing: a network of the entrepreneurs, particularly the one of the same interest area, to improve a network of future friends, regarding of course, that our efforts are directed to balance openness and privacy.

The communication between the people at i.tec - Itabira HTP is addressed by the same rules applied to the big companies, i.e., providing leadership, culture, and infrastructure and building social capital, trust and confidence.

We believe that the speed of economic evaluation at any organization is a function of the number and quality of interconnections between individuals and the ideas that they hold. As the level of connection rises, the ability to combine ideas grows. It is on these interactions of ideas that we reach breakthroughs.

We keep in mind that this sort of communication is not effective only by using the e-mail system, but through human contact and proximity by promoting short training courses, workshops, coffee breaks and cultural festivities.

We also agree with the computer-based metaphor: "facts might be considered digital while skills might be analog". Therefore we encourage our entrepreneurs for the possibilities of learning how to transfer knowledge by using their whole bodies during simulation games, through human resources, short courses and workshops.

6. Conclusions.

At these beginning of activities **Itabira Scientific High Tech Park – *i.tec*** knows that:

- There is no uniform methodology and no single way to analyse the diffusion of knowledge at STPs; it depends on the perspective from which we look at them.
- STPs have different dimensions; beyond material linkages, immaterial forms of knowledge exchange must exist which, via interviews and surveys, can be made visible.
- This exchange assumes different forms; technological spill-overs, formalised ways of getting knowledge trough regular contacts to the knowledge infrastructure or informal ways.
- Firms within different areas behave differently; in their ways of gaining access to and sharing their knowledge.

- Yet these forms of knowledge sharing are influenced by the clusters of the same area themselves; they influence the behaviour and they act as institutions to promote the knowledge exchange.

In our context, this means that knowledge creation and technology management is not an automatic outcome of individual rational behaviours. The institutional perspective serves to identify additional factors influencing economic behaviour, leading to cooperation. Human behaviour has to be understood as social and cultural phenomena, which is therefore influenced by institutions that shape this behaviour.
STPs can also be considered as ‘social technologies’, because human action in the form of ‘economic activity’, sometimes function inside the economic units, or between them.
Social technologies involving ‘standard human interaction’ are considered institutions as soon as they are regarded by the relevant social group as a role model, becoming an attractive way to get things accomplished.

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