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# SENAI

## Institutional environment favorable to technological diffusion

### PRESENTATION

The present document is a summary of all trend and prospecting actions that SENAI National Department carried out in the past five years.

The first stage occurred with the development of methodologies that integrate SENAI's Prospecting Model, which counted on the participation of SENAI's Regional Departments and of the main research centers and universities of the country (UFRJ, USP, PUC RIO, FIPE), under the coordination of Unidade de Tendências e Prospecção do SENAI Nacional [National SENAI Prospecting and Trends Unit].

The results generated by the application of the SENAI Prospecting Model in, and until now, eight industrial sectors, enabled us to verify a vast field of applications which revealed unfoldings for the development of technological diffusion actions and modernization actions of SENAI itself. Those actions configure a second stage in SENAI's acting based on prospective studies.

We hope that this document would further contribute towards disseminating and consolidating a prospective vision in the institution.

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SENAI General Director

### I. INTRODUCTION

The prospective models -intensively used by large-size companies- and technology's life cycle curve, used mainly by dynamic sectors, are a reasonably recent instrument which application benefits has been reaped by larger size companies and by the public sector of more industrialized countries.

In the new paradigm of the current knowledge society one verifies the intensification of processes such as: (i) innovation and incorporation of new

technologies to productive processes; (ii) economic globalization; and (iii) formation of regional economic blocks; factors that contribute toward the increase of uncertainties involved in the investment decision processes on new technologies of the different economy agents (companies, workers, professional education institutions and government).

In companies, the uncertainties are entailed to the process and timing of adoption of new technologies, reinforced by their technological trajectories and based on learning which involves different professional classes that tend to strongly condition the incorporation patterns of new technologies. This process is even more critical for smaller size companies, for their investment decisions, given their scarce capital resources, will determine its market survival.

For the workers, the uncertainty manifests itself through the risk that the technical progress may promote significant alterations in the professional profile required by the industry and, consequently, in the personal decision regarding further capacity or re-qualification required to keep or improve his “employability” condition from the technical standpoint.

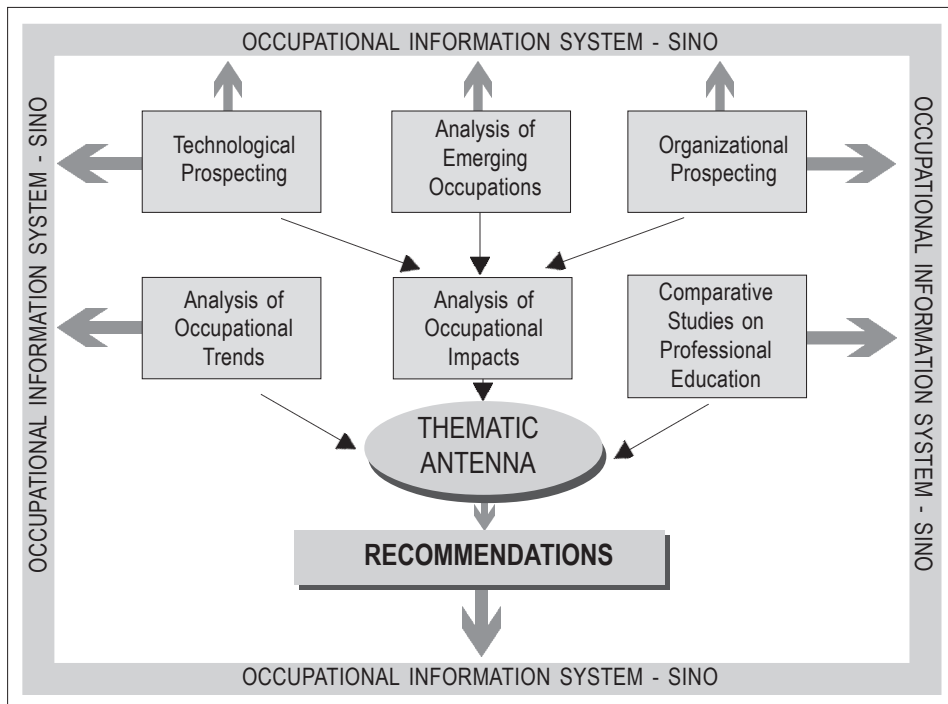
For vocational education institutions, to deal with uncertainty becomes a priority dimension. The risk involved in the investment decision on physical infrastructure and on human resources varies proportionally to how quick the technical progress is incorporated to the productive systems, as well as the adoption of new ways to organize production. In this particular sense, these institutions must be “one step ahead” to be able to respond in due time to company demands and worker demands, and failure as to this provisioning in due time may distance both the local companies’ competitiveness and the “employability” of workers.

For the government, uncertainty manifests itself through the risk of seeing full sectors lose their competitiveness with direct impact upon the local product levels, tax collection, income and jobs.

Thus, in the sense to generate mechanisms that facilitate the decisions of the economic agents, SENAI, conjointly with the main Universities of the Country, developed the SENAI Prospecting Model. The SENAI Prospecting Model enables one to estimate the behavior of the diffusion rates of emerging technologies and the configuration of the organizational formats in the near future, as well as engender estimations of job quantity that will be demanded at every five years. From those technological, organizational, occupational and educational estimations, subsidies are

generated for the development of proactive actions in the fields of professional education and of technical and technological services. The general layout of SENAI's Prospecting Model is revealed below, and then, each of its parts are described:

**Figure 1**  
**General Layout of SENAI's Prospecting Model**



- **Technological Prospecting:** Purposes to identify Specific Emerging Technologies (TEEs) -characterized by the SENAI Prospecting Model as innovations in development phase, pre-commercial or recently introduced in the market or those with low degree of diffusion despite being known to the market- which will have a diffusion degree of up to 70% of the user market in a time horizon of 5 to 10 years. Analysis of the Conditioning Factors to Technological Diffusion: The

objective of this activity is to identify, as representatives of the productive means and other specialists of the sector, factors that negatively impact the diffusion of the TEEs selected in the technological prospecting.

- **Organizational Prospecting:** Purposes to verify the possible occurrences of certain organizational trends; in the same time horizon defined in the technological prospecting.
- **Analysis of Emerging Occupations:** The study purposes to identify, in certain countries, occupational changes in the studied sectors, classifying them into emerging occupations, undergoing evolution and stable, according to definition of the Bureau of Labor Statistics (BLS) of the United States.
- **Analysis of Occupational Impacts:** The main objective of this activity is to discuss with companies and universities' representatives, the possible impacts of technological and organizational changes in occupations which were identified in the prospecting activities.
- **Analysis of Occupational Trends:** This methodology purposes to project the demand for labor of the national and state labor market, per sector and occupation. Such projection is done based on the building of macroeconomic and sector scenarios. The projections may serve as reference for the adjustment and formulation of professional formation programs by the professional education institutions.
- **Comparative Studies of Vocational Education:** The study aims (through comparative analytical research in countries that are reference in the education of the studied sector) at observing the main changes in the vocational education structure in these countries and check for the possibility of adaptation to the vocational training system offered by SENAI or by other vocational training institutions.
- **Thematic Antenna:** is the final and analytical stage of the SENAI Prospecting Model. In it are discussed all the results obtained in the previous stages. The analysis of those results will enable the generation of Recommendations for the decision-makers of the SENAI System, in regards to the actions of the Professional Education and Technical

and Technological Services, which will enable SENAI to act as a “induction” agent of technological diffusion through actions that would reduce the degree of uncertainty of decision-makers at the TEEs acquisition stage. Monitoring: This activity enables retro-feeding of SENAI’s Prospecting Model. In this phase, it is sought to accompany the occurrence of the results obtained by the prospective studies and occupational trends. These results enable SENAI to develop new actions aiming at providing support to technological diffusion and to modernization of its operational units.

The main results of the SENAI Prospecting Model reside on the technological, organizational, occupation and educational trends analyses related to the economic activity sector where it is applied.

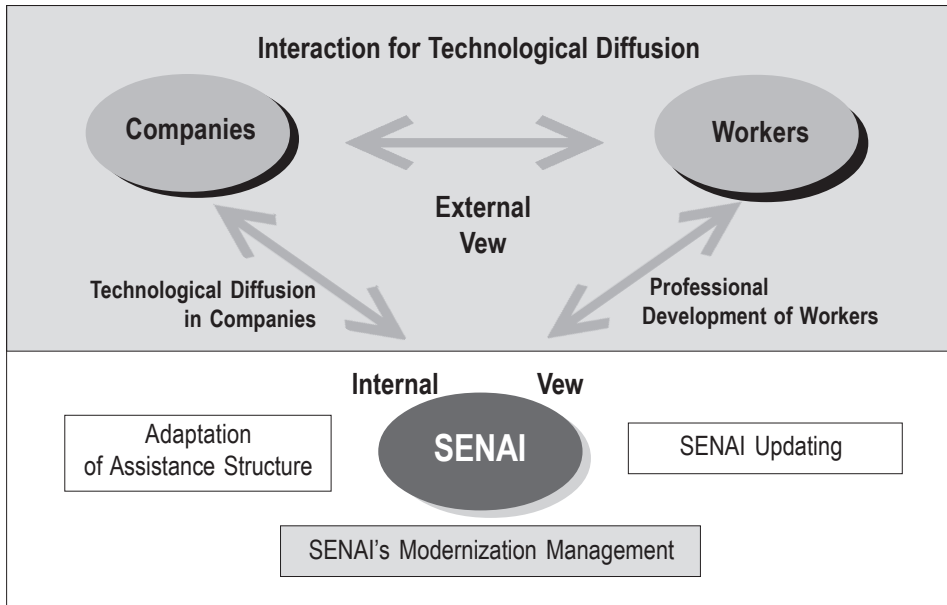
This is the first step in order to reduce the uncertainties of the main economic agents involved in the decision-making processes linked to new technologies. In these decision-making processes there is a strong interdependence in the risks involved amongst those agents, centered in two common difficulties: (a) incomplete information and casual about new technologies (its impacts, use conditions and relative advantages and disadvantages), amongst other characteristics; and (b) absence of an institutional environment that favors the investment decisions through the reduction of risks involved.

Thus, from the main results obtained through the SENAI Prospecting Model actions are developed aiming at forming institutional environment favorable to technological diffusion, in which the professional formation institutions play a central role, according to what is shown below by Figure 2:

From the superior part of Figure 2 above (Interaction for technological diffusion) one comprehends the products developed by SENAI destined to companies and workers and the inferior part (SENAI Modernization Management) and comprehends the products destined to the institution itself (human resources capacity and technological updating).

A brief description of the main results of each one of those topics will be presented in the following section. In item II, a summary of the main results of the SENAI Prospecting Model is presented; the item III deals with Interaction for Technological Diffusion; item IV related to SENAI Modernization Management; and item V will touch on the publications generated by those activities.

**Figure 2**  
**Institutional Environment Favorable to Technological Diffusion**



## II. SENAI PROSPECTING MODEL: RESULTS SYNTHESIS

The new paradigm of the knowledge society and the intense technological innovation process bring an accelerated incorporation of new technologies and organizational formats to productive processes. These factors create an ever more complex operation context to professional formation institutions and technical and technological services provision companies, in which dealing with uncertainty becomes a strategic dimension.

This more complex context derives from a greater mobility of productive capita, of varied and interdependent networks formation of companies located in different regions of the country and even abroad (information technologies and communication technologies facilitate that production decentralization process) and of quick changes in the professional profile of workers. For professional formation institutions those issues render the need to anticipate to technological, organizational and occupational changes im-

perative, so they can better manage their educational and technological processes.

The SENAI Prospecting Model was developed to reach those main objectives and comprises various methodologies, according to what was explained in the previous item. Up until now, the Model was applied in eight (8) industrial sectors, and a ninth sector is in current progress. The sectors are as follows:

- a) Petrochemical;
- b) Textile;
- c) Telecommunications;
- d) Machines and Equipment;
- e) Civil Construction;
- f) Foods (Meats);
- g) Foundry;
- h) Forging;
- i) Shipbuilding and floating structures (in progress).

Below, a summary of the main results reached in each sector is presented, given the proper highlight to: 2006-2010 Economic Scenario; States with the largest employment growth in the Sector - 2006-1020; Participation in the Industrial GDP in 2004; Main Technological Trends; Main Organizational Trends; Main Occupations Trends; Main Educational Trends.

## **II.a Sector: Petrochemical**

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Participation of the Sector in the Transformation Industry GDP in 2004:  
1%

States with largest employment growth in the Sector - 2006-2010: Rio de Janeiro and Bahia

### **2006-2010 Economic Scenario**

The tax policy will likely not affect Petrobras' investment capacity. Furthermore, the inflation targets will most likely allow an alignment between the internal prices and international prices of oil derivatives during the entire 2006-2010 period. Petrobras will probably implement its pluriannual plan of investments and expand the oil refinement capacity throughout the period, with highlight to the refinement capacity of crude oil. However, in the

short-run, the performance of resins and elastomers production will likely negatively pressure the sector.

### **Main Technological Trends**

- Increase in the importance of management technologies.
- Growth in the use of automation technologies and process controls.
- Growth in the use of technologies that reduce the emission of pollutants -gas and liquid.
- Offer increase of new products based on new polymeric combinations.

### **Main Organizational Trends**

- Approximation between companies from 2nd and 3rd generations.
- Increase of the importance of the Research, Development and Innovation stage of the products.
- The direction of investments is still guided towards the increase of production volume.
- The outsourcing process will tend to grow.

### **Main Occupation Trends**

- Growth of the importance of engineers and environmental technicians.
- Growth of professional specialized in polymers.
- The workers directly involved in the operation of plants will operate full-time as regards detection, diagnosis, actions and accompaniment of action.

### **Main Educational Trends**

- The on the job capacity/enabling will be intensified in companies of the sector and will likely encompass all areas, including R&D.
- Introduction of knowledge related to environmental management and training of technicians.
- Incorporation of related knowledge to management technologies and risk analysis in the training of engineers and technicians.
- Intensification of the knowledge related to polymers materials.

## **II.b Sector: Textile**

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Participation of the Sector in the Transformation Industry GDP in 2004: 2%  
States with largest employment growth in the Sector - 2006-2010: São Paulo, Santa Catarina, Minas Gerais, Mato Grosso, Bahia, Ceará and Paraíba.

### **2006-2010 Economic Scenario**

Even though the elevation of real income may assure a greater demand for the sector in the period, on the other hand, the keeping of the currency Real valued will tend to reduce its competitiveness. Furthermore, the end of the textile and clothing (ATV) agreement will likely increase the competitiveness of importations, keeping the growth of the sector highly conditioned to the penetration of Chinese products in Brazil.

### **Main Technological Trends**

- Development of new products through new textile fibres.
- Productivity increase through the automation of the spinning and weaving processes.
- Participation increase of “cleaner technologies” in the textile processing segment.
- Use of computer tools in the creation and development stages of confectioned garments.

### **Main Organizational Trends**

- Greater concern with the needs of end clients.
- Offering of greater variety of textile articles.
- Growth of retail companies’ power
- Greater integration among the agents that comprise the productive chain, generating several production and distribution networks.

### **Main Occupational Trends**

- Arising of the Textile Fibres Engineer.
- Growth of Textile Designers importance.
- Reduction of the importance of operational occupations due to the automation process.

### **Main Educational Trends**

- Incorporation of knowledge related to informatics and electronics in the technical and operational education training.

- Increase importance of professionals with holistic vision of the production chain.
- Incorporation of knowledge related to the management and commercialization in the formation of engineers and textile technicians.
- Incorporation of behaviors skills – teamwork and creativity – in the education formation of textile technicians and engineers.

## **II.c Sector: Machines and Equipment**

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Participation of the Sector in the Transformation Industry GDP in 2004: 3%  
States with largest employment growth in the Sector - 2006-2010: São Paulo, Rio Grande do Sul, Santa Catarina, Paraná and Amazonas

### **2006-2010 Economic Scenario**

The sector will probably continue to present growth in face of the consolidation expectation of economic growth (in case of investment goods), and of the expansion of credit to individuals (in case of durable goods). The reduction possibility of iron and steel commodities prices may benefit producers and machinery and tractor consumers in the coming years.

### **Main Technological Trends**

- Use of information technology in the viability of virtual manufacturing – remotely teleoperating or teleprocessing a certain equipment.
- Increase of product development, using modularization and standardization concepts.
- Increase use of near net shape technologies in which a ever larger number of operations is combined in a single machine.
- Increase use of technologies with high speed cutting concept.
- Increase use of conception technologies and quick prototyping

### **Main Organizational Trends**

- Arising of subsystem assembler companies.
- Dislocation of production process stages (plant manufacturing) to small manufacturers.
- Aggregation by level one companies (manufacturers) of post-sales services.
- Narrowing of relations among the productive chain links and greater integration amongst the various activities of the company.
- Offer increase of services by manufacturing companies.

### **Main Occupational Trends**

- The operational occupations will be more multifunctional with the involvement of these professionals in support functions.
- Arising of Materials Engineer.
- Arising of Automation and Robotics Technician.

### **Main Educational Trends**

- Incorporation of knowledge related to the management of processes in technician training.
- Incorporation of knowledge related to process control technologies in operator training.
- Incorporation of knowledge related to the standards and processes of standardization in the training of engineers and technicians.
- Incorporation of knowledge related to environmental management in the training of engineers, technicians and operators.

### **II.d. Sector: Telecommunication**

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Participation of the Sector in the Transformation Industry GDP in 2004:  
1%

States with largest employment growth in the Sector - 2006-2010: São Paulo, Rio de Janeiro and Minas Gerais.

### **2006-2010 Economic Scenario**

The improvement of the economic activity will likely bring new perspectives for the demand for data communication. In case of the so-called conventional communication, the perspectives are also favorable, considering the income recovery scenario. It must be observed intensification in the migration process of fixed telephony traffic to mobile in the coming years. Before the increase of competition amongst two services, the use rates are likely to retreat, which may generate an additional stimulus for the demand for conventional calls.

### **Main Technological Trends.**

- Increase of technologies based on convergence of voice, data and multi-media (video) services and the interoperability amongst equipment, networks and software applications.
- Dislocation of the market focus to the flexibility of the passing bandwidth offered, besides the assurance of the service provided quality.

- Growth of xDSL technologies and fiber optics technologies until end users.
- Growth of technologies related to communication safety through the opening of platforms and offering of multi-services in the Telecommunication Networks.

### **Main Organizational Trends**

- Increase of the importance of the specification activities of technical traits and of the service management.
- Increase importance of receptive Call-Centers.
- Increase importance in the development of application software.
- Increase importance of the prototyping, test, validation and homologation activities of system/solution.

### **Main Occupational Trends**

- Arising of the Mobile Telecommunication Systems Engineer.
- Arising of the Mobile Telecommunication Systems Technician.
- Arising of the Microwave Transmissions Technician.
- Increase importance of professionals who harness the systemic view of the productive flow.

### **Main Educational Trends**

- Incorporation of knowledge related to quality control and production management in the formation of operators and technicians.
- Incorporation of knowledge related to the consumer market in the formation of engineers.

## **II.e. Sector: Civil Construction**

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Participation of the Sector in the Transformation Industry GDP in 2004:  
17%

States with largest employment growth in the Sector - 2006-2010: Many states, but the largest growth is seen in São Paulo

### **2006-2010 Economic Scenario**

In the mid term, the civil construction sector presents favorable expectation, considering the maintenance of the current release of real estate financing. The infrastructure sector only starts to gain weight from 2007 on, after the presidential elections. The functioning of the Private and Public Sectors

Partnerships (PPPs) will only provide relief to the sector after 2010, given the legal obstacles intrinsic to the process.

### **Main Technological Trends**

- Growth of the use of technologies based on subtle industrialization concept.
- Use of Web technologies for project planning stages, managing the execution of the construction work and commercialization of the undertaking.
- Growth in the use of integrated subsystems (bathrooms and ready-doors).
- Growth in the use of technologies for the optimization of the construction stages.

### **Main Organizational Trends**

- Elevated increasing importance of the environmental protection, consumer rights and legislation referring to soil use and occupation.
- Greater approximation and articulation among the links, generating a valued productive chain specific for a certain market niche or type of undertaking.
- Increase importance of the life cycle of the environment built.
- Strong tendency towards outsourcing processes, making service suppliers earn greater importance.
- Growing importance of consultation projects & engineering companies.

### **Main Occupational Trends**

- Increase importance of managerial activities for professionals of the technical area.
- Arising of the job position referent to Productivity Controller in the Constructions Works.
- Arising of the job position referent to Engineering Analyst.
- Arising of the job position referent to Processes Prospecting Engineer.
- Arising of the job position referent to Information Management.

### **Main Educational Trends**

- Incorporation of knowledge related to the management of production in the training of technicians and engineers.
- Incorporation of knowledge related to information technologies in the training of technicians and engineers.
- Incorporation of behavioral skills in the training of operators.

- Incorporation of knowledge about metrology, modulation, rationalized processes and constructive systems in the training of workers, technicians and remaining professionals of the Civil Construction sector.

## **II.f. Sector: Foods**

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Participation of the Sector in the Transformation Industry GDP in 2004:  
10%

States with largest employment growth in the Sector - 2006-2010: Ceará, Minas Gerais, Rio Grande do Sul, Paraná, Pernambuco, Bahia, Rio Grande do Norte, Santa Catarina, Bahia, Pernambuco and Rio Grande do Norte.

### **2006-2010 Economic Scenario**

This sector will likely be mainly influenced by three factors: a) heating up of the domestic demand; b) maintenance of the competitiveness of the national gross product in the foreign market; and c) world economic growth. It is worth highlighting that the exportations of the sector have been gaining room in a way to represent approximately 40% of the total national production.

### **Main Technological Trends**

- Increase in the development of innovations in the genetics, nutrition and animal health areas.
- Increase use of technologies that enable a strict monitoring of the sanitary requisites and of food safety.
- Increase use of technologies that aid in the increasing expiration date of commercialized products.
- Growth of technologies based on new materials and packaging methods.

### **Main Organizational Trends**

- Increase importance of environmental legislations and inspections in importer countries.
- Diffusion of the certification systems.
- Increase importance of policies related to the control and regulation of genetically modified products.
- Increase importance of traceability systems.

### **Main Occupational Trends**

- Operation of transversal occupations to the sector, such as Biotechnologists, Biotechnology Laboratory Technicians and Logistics Analysts.
- Increase importance of professionals who have knowledge about clean technologies and group vision.
- Increase importance of professionals who study the consumers, their expectations and demands.
- Arising of new related activities to the genetically modified organisms (GMO).

### **Main Educational Trends**

- Incorporation of environmental and social dimensions in the training of all professionals who work in this sector.
- Incorporation of knowledge related to the characteristics of the end consumer in the training of food engineers.
- Incorporation of knowledge related to the certification processes in the technicians' training.
- Incorporation of knowledge related to hygiene, health and safety in the training of operational professionals.

### **II.g. Sector: Footwear**

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Participation of the Sector in the Transformation Industry GDP in 2004: 1%  
States with largest employment growth in the Sector - 2006-2010: São Paulo, Ceará, Minas Gerais, Bahia and Goiás.

### **2006-2010 Economic Scenario**

Despite of the elevation of real income having assured a larger demand for the sector in the period, the maintenance of the appreciated currency exchange, which reduced the competitiveness in the sector, and also, the negotiations of the Brazilian Government with China and Argentina, may result in a reduction of growth potential.

### **Main Technological Trends**

- Increase of offering of new products incorporated to new materials.
- Increase use of "cleaner technologies" in the gluing and finishing stages.
- Increase use of information technologies in the development, distribution and commercialization stages.
- Increase use of management technologies in production management.

### **Main Organizational Trends**

- Increase importance of labor legislations and inspections in importer countries.
- Increase importance of environmental control Governmental programs.
- More intense use of standardization and certification systems through seals related to quality, respecting the environment and social responsibility actions.
- Larger adoption of lean manufacturing systems by the manufacturers.

### **Main Occupational Trends**

- Increase importance of Fashion Designer.
- Increase importance of professionals with managerial and sales view of the sector.
- Arising of the materials technician function.
- Arising of the materials engineer function.

### **Main Educational Trends**

- Incorporation of knowledge related to supply chain management in the technicians training.
- Incorporation of knowledge related to computer tools for developing and modeling in the training of technicians and fashion designers.
- Incorporation of knowledge related to biomechanics in the training of technicians.
- Incorporation of knowledge related to environmental management including topics about legislation, treatment of wastes, recycling and environmental responsibility in the training of technicians.

## **II.h. Sector: Foundry**

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Participation of the Sector in the Transformation Industry GDP in 2004: 1%  
States with largest employment growth in the Sector - 2006-2010: Minas Gerais, São Paulo, Pará, Bahia and Maranhão.

### **2006-2010 Economic Scenario**

The possible increase of the real income of workers may provoke an elevation in the consumption of durable and non-durable goods, which, in turn, mainly use copper and aluminum as inputs. The international prices may decline from 2006 on, in face of a possible elevation of the North-American interest rate and of the increase supply of the main producers of non-

ferrous metals. In Brazil, investments for the increase of copper and aluminum production of Companhia Vale do Rio Doce and the investments of Grupo Votorantin (aluminum) will likely assure an expansion scenario towards the production of the sector in the forecasted horizon.

### **Main Technological Trends**

- Increase use of new materials in forged pieces.
- Increase use of cleaner technologies in the molding process.
- Increase use of management technologies related to the certification systems and managerial tools.
- Increase use of technologies for the reuse of foondry rejects.
- Increase use of management and process simulation software.

### **Main Organizational Trends**

- Increase of the importance of environmental legislations and inspection in importer countries.
- Increase importance of the safe-guarding actions of importer countries.
- Growth of Commercialization of products through electronic transactions (Internet, B2C, amongst others).
- Adoption, by forging companies, of production systems based on cells.
- Establishments of environmental seals by the manufacturers of end products.

### **Main Occupational Trends**

- Increase of employment opportunities in the sector for occupations in the environmental area.
- Increase importance of Research and Development Professionals.
- Increase importance of professionals involved with costs management.
- Increase importance of professionals involved with certification and quality systems.

### **Main Educational Trends**

- Incorporation of knowledge related to Brazilian Regulating Standards (NRs) and environmental and quality certifications in the training of technicians and engineers.
- Incorporation of knowledge related to quality and environmental management tools in the training of operators.
- Incorporation of knowledge related to the management of technological innovation in the training of managerial level professionals.

### **III. INTERACTION FOR TECHNOLOGICAL DIFFUSION**

SENAI's actions to assist the creation of a favorable environment for the diffusion process of new technologies are established considering two different levels. One external, in which SENAI acts together with companies and workers through dissemination of technological information, curriculum reformulation and occupational information (Interaction for technological diffusion), and one internal, where SENAI creates a permanent process of modernization management in a way to supply the current demand and prepare itself for that demand that is being stimulated through its diffusion actions (SENAI's Modernization Management).

The operation alongside companies and workers is based on the premise that the diffusion process of new technologies begins with the dissemination of technical and market information, which contributes to reduce the degree of uncertainty in the decision-making process for the purchasing of those technologies. For such, SENAI's National Department created the SENAI Technological Diffusion Project, which organizes a series of activities and elaborates specific documents to operate in technological diffusion processes conjointly with companies and SENAI professors and technicians. In the following lines, we present the diffusion actions for companies, given that the actions for professors and technicians will be presented subsequently, in a specific item.

#### **III.1. Technological Diffusion in Companies**

SENAI's Technological Diffusion Project seeks to disseminate to businessmen of specific industrial sectors (and also to professors of SENAI itself, as we will see in the next item) information about Specific Emerging Technologies, prospected by SENAI's Prospecting Model, which will provide greater probability of diffusion in the next 10 years. For the dissemination of that information five supplementary tools were selected: SENAI's Technical Diffusion Workshop; Guided Visit to Technological Fairs; "IN TIME Technological Diffusion"; Technological Diffusion Bulletin; Technical Study about Specific Emerging Technologies. Those tools are detailed below.

### **III.1.a. SENAI's Technological Diffusion Workshop**

It purposes to present the SENAI's Prospecting Model results to the considered sectors and, in a more detailed fashion, supply information about a set of Emerging Technologies prospected by SENAI's Prospecting Model. That information is presented by technicians through panels. Businessmen have their participation guaranteed in those events. During that time, the participating businessmen fill out questionnaires that seek to map their knowledge about Specific Emerging Technologies and identify the technologies that have greater diffusion potential.

### **III.1.b. Guided Visit to Technology Fairs**

Proceeding with the technical information dissemination process, a visit is planned to the main suppliers of the Specific Emerging Technologies. For such, the participants will have to fulfill a script that was established in the end of SENAI's Technological Diffusion Workshop. Furthermore, the visit to the Technological Fairs is one of the tools used by the technological diffusion monitoring methodology used by SENAI. As a supplement of this activity, the participants fill out another questionnaire that -based on the premise that the Technological Fairs may be considered indicators of innovation for industrial sectors- seeks to identify, according to the perception of the participants, new technological trends for the sector considered.

### **III.1.c. "In Time Technological Diffusion"**

This publication is the result, prepared in journalistic language, of workshops and visits to Fairs. It is elaborated by a journalism professional that bears as his/her function, synthesize the information generated during the workshop, and interview the participants seeking their impressions and perceptions about the events. The "In Time Technological Diffusion" is distributed through the Technological Information Nucleuses of Regional Departments to the Operational Units and companies of the sectors considered.

### **III.1.d. Technological Diffusion Bulletin**

The Technological Diffusion Bulletin seeks to increase the dissemination scope of the information about the Specific Emerging Technologies. The Bulletins are released every quarter and its distribution is done through electronic means or in printed form. This letter is sent to a group of interest companies of each Regional Department, as well as to sector professors and

institutions through the Nucleus of Technological Information or SENAI Schools.

### **III.1.e. Technical Studies about the Specific Emerging Technologies**

These studies –developed by universities– purpose to generate more detailed theoretical and empiric information about the purchasing and use of emerging technologies. For such, secondary sources and case studies are used that present real data about the importance of the technologies for the companies which hold them. The study contemplates the following topics:

- **Technical Description**

In this topic, each TEE of each technological segment will have its technical description presented, taking into account: composition or structure of the technology; principle of functioning and functioning; functions and functionality (in case of product technologies); possible new products generated by technology; relative advantages (cost x benefit) in face of the replaced technology (in case there is replacement); list of suppliers, their main characteristics and their national or regional distribution; financing lines for acquisition of TEES.

- **Case Study**

In this topic, it will be presented case studies of companies that use the studies TEES. In this study, the possible real productivity and market gains of the company after the acquisition, use or development must be presented; new products generated from the technology (if any); relative advantages in face of the replaced technology according to the users' perception; the technology transference process and the possible cares observed during the process.

### **III.1.f. Summary of technological diffusion actions in companies**

In 2007, four workshops were set up and five guided visits were made to technological fairs, involving 42 people and 25 lecturers. A summary of the technological diffusion actions in companies, carried out in 2007, is laid out on Table 1.

**Table 1. Technological diffusion actions: workshops and fairs (2007)**

Events	2007		
	Number of events	Participants	
		Businessmen	Lecturers
SENAI's Technological Diffusion Workshop	4	42	25
Technological fairs	5	42	-

We can have an approximate idea of the effectiveness of those actions processing the evaluation questionnaires that the employees filled out in the end of those events. Considering that questionnaire of related items the “importance to the sector of the approached themes”, “applicability of the themes in their activities” and “adding of new knowledge”, 93% of the businessmen evaluated those activities as excellent or good. That is, those events, in the view of the businessmen, helped the comprehension of the new technologies.

Another questionnaire applied during those activities contributes to the monitoring of the prospected emerging technologies diffusion rates. Considering all the businessmen who filled out that questionnaire, we identified a current diffusion rate of emerging technologies in their companies around 33%. When we asked about the diffusion in the next 5 years, the diffusion rate reached 79%. That trend is precisely the expected rate for the technology diffusion curve, once that the expectation is that those technologies present a lower diffusion rate in the present and more elevated in the future.

Considering the technological diffusion actions, in the prism of the publications that contain more detailed information about the emerging technologies, we reached 23 distinct headings with number of copy published of 11,800, according what is shown on Table 2.

**Table 2. Technological Diffusion Actions: publications (2007)**

Publications	2007		
	Number of Publications	Copies per Publication	Total
Technological Diffusion Bulletin	13	600	7,800
“In Time” Technological Diffusion	5	600	3,000
Technical Studies	5	200	1,000 *
Total			11,800

\* Forecast for 2008.

## **III.2. Professional Development of Workers**

The actions derived from SENAI Prospecting Model directed towards the Professional Development of Workers may be grouped in Curriculum Updating and SENAI's Occupational Information System (SINO)

### **III.2.a. Curriculum Updating**

The actions guided toward the Curriculum Updating are inserted in the assistance of designing new occupational profiles, which occurs under the ambit of the Sector Technical Committees, coordinated by National SENAI's Professional Education Unit. Those committees are consultation forums installed in order to debate about subjects related to education and employment. They comprise professionals from various internal and external segments to SENAI, which practical and theoretical know-how and vision of the future contribute to guide the decision-making process in what regards the professional education actions. The main functions of the committees are:

- Define professional profiles based on competencies, contemplating parameters that enable performance appraisal.
- Permanent updating of professional profiles.
- Supply subsidies for the elaboration of standards for professional certification.

The information generated by the application of the SENAI Prospecting Model to the occupational industrial sector considered, contextualizes a future scenario in which the occupations in question will probably act. That information is fundamental for the fulfillment of a determined stage of the professionals' profile definition methodology based on competencies, which seeks "to identify and diagnosis trends related to the sector, upon the type of necessary academic formation and future perspectives". So, the profiles generated by the committees will be apt to assist not only to the current needs of the industrial demand, but also to those future needs conditioned by the diffusion of new technologies and organizational changes.

That information has already been taken to the Sector Technical Committees, given that eight in the civil construction sector and one in the textile confection sector (Table 3). The occupations which establishment of profiles had the insertion of SENAI's Prospecting Model information were as follows:

**Table 3. Sector Technical Committees with the insertion of information of SENAI's Prospecting Model**

Sector	Occupations
Civil Construction	Undertaker
	Shapes Carpenter
	Low Voltage Building Installer Electrician
	Building Gas Plumber
	Foreman
	Bricklayer
	Industrial Installer
	Civil Construction Painter
Clothing Confection	Technician in Clothing Confection

The effectiveness of that insertion in the sector technical committees may be verified by the analysis of new performance<sup>1</sup> patterns and competency elements<sup>2</sup> established for the occupations in focus, according to what is described below.

### III.2.b. Curriculum Updating Results

Once the information generated by the SENAI Prospecting Model is related to the possibility of change of activities (tasks) of certain occupations, one may establish as indicator the modifications identified in the performance standards and competency elements that are related to the information generated by SENAI's Prospecting Model. Below, some examples of information use generated by SENAI's Prospecting Model in selected occupations of the civil construction sector are presented.

Occupation: Bricklayer

- Competency element: Carry out structural masonry
- Information generated by SENAI's Prospecting Model: Structure masonry was a Specific Emerging Technology that will have major diffusion probability.

1 Performance standards, according to the established methodology, are actions that together enable the professional to reach a competency element.

2 Competency elements - Are groups of activities that together enable the professional to execute a certain task.

Occupation: Foreman

- Competency Element: Manage work teams; participate in the construction work executive planning
- Information generated by SENAI's Prospecting Model: Increase use trend of management tools in the construction work site; approximation trend amongst the technical and operational levels.

We also asked the technicians responsible for the conception and conduction of the works of the Sector Technical Committees to make an evaluation of the insertion of the prospecting data in the meetings of the Civil Construction Committees. One of the responsible parties informed us that:

*"The information supplied constituted a rich source of data that subsidized and provided scientific basis to the developed work with the various National Sector Technical Committees for the elaboration / validation of the following professional profiles: Undertaker, Shapes Carpenter, Low Voltage Building Installer Electrician, Building Gas Plummer, Foreman, Bricklayer, Industrial Installer and Civil Construction Painter. The Committee was constituted by several specialists from the technological area being studied, their components brought forth to the realization of the elaboration / validation work of the professional profiles their technical know-how and their experiences in the job market, which combined and crisscrossed with the research data grant greater scientific validity to the information gathered, for it enabled in certain periods to check the information when doubts arose and in another time, confirm the gathered information."* (Responsible 1, Sector Technical Committee).

The other responsible, of whom the evaluation was solicited from, declared:

*"The results of the prospecting of the Civil Construction area presented to the Committees in a synthetic form, with the aid of power point slides, soon after the opening of the efforts were part of one of the important stages preconized in SENAI's methodology for the establishment of professional profiles based on competencies, that is, the Input for the profile definition. It was constituted without any doubt, through relevant documented source, drawing the interest and questioning of the participants, beside other sources as the Brazilian Classification of Occupations (CB) and national Classification of Economic Activities (CNAE).*

*Considering that, it is desirable that the prospecting studies related to professional profiles to be defined by the Sector Technical Committees – national or regional – if any, would be presented to the Committee members, given that*

*those subsidize the establishment of the Professional Profiles, both as to the Professional Competencies itself and the Qualification Work Context.” (Responsible 2, Sector Technical Committee).*

### **III.2.c. SENAI Occupational Information System**

Occupational information system work as an important referential for the elaboration of strategies and actions plans for companies, workers, students, professional formation institutions and governmental bodies be able to face the challenges of an ever more competitive job market. Moreover, the more information is generated in a context that incorporates signs of future job market behavior, the more valuable that information is.

For those reasons, SENAI developed an occupational information system, which services as an efficient indicator of job market trends. It is elaborated through a detailed data survey, made from the Industry Occupational Families, identified in the Brazilian Classification of Occupations from RAIS (Annual Social Information Registration of the Labor and Employment Department) from PNAD (Annual Sampling Survey per Domiciles) and from the occupational trends analyses.

SENAI’s Occupation Information System comprises three Websites, with the following names: *Almanaque de Profissões* [Professions Almanac], *Profissões Industriais* [Industrial Professions] and *Sentinela Ocupacional* [Occupational Sentinel].

The Professions Almanac is destined to the youth. In times of intense job market competition, those who possess greater knowledge about the profession and who present the necessary competencies required by companies have a head start. The choosing of a profession and the first job opportunity are dilemmas faced by our youth. To know more about a given profession and invest on professional formation may be excellent steps for those who want to grow professionally.

SENAI, pondering about aiding young adults through the clarification process about professional careers of the industrial sector, elaborated the Professions Almanac. In it, the young candidate obtains information about the activities performed in the daily routine of the job, what companies expect of a certain type of professional, where the young person may prepare him/herself to exert the professional and what disciplines will be emphasized through the formation program.

The Industrial Professions website contains occupational information for human resource managers of companies, while the Occupational Sentinel website is destined to the professional who is employed or unemployed and suggests some occupational mobility possibilities. The Occupational Sentinel Website is under development.

#### **IV. SENAI MODERNIZATION MANAGEMENT**

SENAI's Modernization Management represents SENAI's most effective way to operate towards an Institutional Environment Favorable to Technological Diffusion. It means that SENAI not only induces technological diffusion in companies, but also seeks to adapt itself to that diffusion process.

Thus, SENAI's Modernization Management objective is to render flexible, adapt and permanently update the professional education actions and the technical and technological services actions of SENAI units.

In order to reach that objective it was developed a methodology that considers a set of indicators that take into account the current and future dynamics of the productive system in the inclusiveness area of each SENAI unit. Some types of modernization are defined due to the needs of the Regional Departments and associated to the behavior of those indicators (nine types of modernization were defined). Thus, a unit may not be eligible for any one of the modernization types, at the same time that it may be eligible to more than one. For each type of modernization a technological module is defined and a human resources capacity module is defined as well.

SENAI's Modernization Management methodology is used in SENAI System's Modernization Program for Industrial Competitiveness, which focuses an industrial sector in which SENAI operates. The first stage of that process is substantiated in the elaboration of Regional Updating Plans and of a National Plan.

In order for the Modernization Management methodology to be efficiently applied, a System was deemed necessary.

## **IV.1. Permanent Modernization Management System**

The Permanent Modernization Management System renders viable the application of the modernization management methodology and was organized considering some dimension:

- a) establishment of rules for the elaboration of updating plans, defined by the technical and executive instances and divulged to all the Regional Departments;
- b) definition of indicators and criteria (showing the current and future behavior of demand and supply of each Unit) to be applied to all units, in a way that an alteration in any indicator or criteria may be valid for the group of units;
- c) elaboration of an operational procedure manual containing the procedures for the filling out of questionnaires, as well as the explanations for all the indicators and eligibility criteria of the Units.

A portion of the indicators used in SENAI's Modernization Management is linked to the future behavior of employment in the area which encompasses each unit, obtained through the Analysis of Occupational Trends. The main purpose of the Occupational Trends Analysis is to estimate the qualified labor demand, in a way to anticipate the formation of professional education actions, and technical and technological services actions.

The analysis of the occupational trends uses the input-product method that, in general, consists in calculating the impacts upon the national and state employment per sector, from variations projected of the aggregate demand for various sectors of the Brazilian economy, based on technical coefficients of the input-product matrix. Thus, the projection of jobs for the inclusiveness area of each unit has the methodological support of the input-product matrix of the Brazilian economy.

Another part of the indicators is associated to the effective rate of diffusion of certain technologies, which will be dealt with on item IV.3 (Technological Updating).

The operationalization of the System occurs through a set of tools that assure the choosing of units to be modernized in each type of modernization.

The tools are the following:

- Database: a relational database was structured in which themes are dealt such as Projections of New Jobs, Technological Diffusion, data

about SENAI's Assistance, Competition etc. It also services as reference for the Business Intelligence (BI) platform;

- The Business Intelligence (BI) Tool: a tool supplied by Hyperion is used, which is considered the global leader in Business Performance Management software;
- WEB consultation mechanisms: WEB consultation mechanisms were developed to the DR (validation of inclusiveness areas and choosing of the Units for Modernization), interconnected to databases and to BI tools.

## **IV.2. Human Resources Capacity**

An important contribution by SENAI's Prospecting Model to the capacity of human resources of SENAI is linked to SENAI's Modernization Management. Given that there are other equally important contributions, it was decided to organize a specific item to deal with that team (Item V).

## **IV.3. Technological Updating**

SENAI's Modernization Management encompasses a permanent process of technological updating, characterized by dynamic productive system in the inclusiveness area of each unit.

Until now, the technological updating occurs for the basic and technical professional education action levels and for the technical and technological services actions. According to the need and to the dynamism of the productive system, the modernization may enable expansion, supplementation, replacement and improvement of equipment and facilities. For each type of modernization, technological modules were defined, comprising mature and emerging technologies.

As SENAI's Modernization Management preconizes low investment risk, the demand indicators are very important for the decision of choosing each type of modernization in each unit. One of those indicators refers to the effective rate of diffusion of technologies that comprise each technological module.

In order to calculate the effective rate of diffusion of technologies that comprise each technological module a survey was developed, in a statistically representative sample of companies of the machines and equipment

sector, based on interviews with closed questionnaires. The technological diffusion survey for the Machines and Equipment sector had national inclusiveness with the participation of all SENAI Regional Departments.

#### **IV.4. "IN TIME Modernization"**

Seeking to announce all the modernization actions, it was granted a divulging instrument named "*IN TIME Modernization*". Written in journalistic language, that instrument summarizes the actions developed in each stage of the modernization process and links interviews with participants of the process and institution directors. In 2007, three of those publications were elaborated totaling 1,800 copies.

### **V. HUMAN RESOURCES CAPACITY**

Human Resources Capacity linked to Institutional Environment Favorable to Diffusion may be dismantled into four dimensions: SENAI's Modernization Program; SENAI's Technological Diffusion Project; Contribution to the National Capacity Program of Professors; Publications.

#### **V.1.SENAI's Modernization Programme**

Under SENAI's Modernization Programme ambit the capacity given to human resources is guided towards the use of technical basis that the referred Program will modernize in each participating unit. In this case, the capacity provides, for each technology, a module that may be dismantled into the following dimensions: leveling; suppliers and technical delivery. According to the technology, the number of hours varies for each component, given that for some technologies the leveling capacity program will not be needed.

#### **V.2. SENAI's Technological Diffusion Project**

Under SENAI's Technological Diffusion Project ambit, SENAI's Technological Diffusion Workshop ambit and the ambit of the Guided Visit to Technological Fairs also count on the participation of SENAI technicians and

professors, which represents a very efficient mechanism characterized by updating and dissemination of information about emerging technologies.

In that opportunity some questionnaires are applied, given that one of them purposes to perform a mapping of the know-how of professors about Emerging Technologies and of suggestions about possible updating and capacity strategies. In 2007, the participation of SENAI's professors and technicians in the diffusion activities reached 62 participants, according to what is presented on Table 4 below.

**Table 4. Participation of SENAI's professors and technicians in technological diffusion activities**

Events	2007	
	Number of Events	Participating Professors
SENAI's Technological Diffusion Workshop	5	62
Technological Fairs 5	62	

### V.3. Contribution to the National Programme of Professor Capacity

SENAI National Department's Professional Education Unit develops a National Program of Professor Capacity. The information derived from SENAI's Prospecting Model has also been incorporated to that Program, such as the case of the Program guided towards civil construction professors.

### V.4. Access to Publications

All the publications generated by SENAI's Prospecting Model, particularly the Recommendations deriving from the Thematic Antenna (see item 6) are distributed to SENAI's professors and technicians.

In the same manner, the publications generated in SENAI's Technological Diffusion Project are also sent to SENAI's professors and technicians: "*In Time Technological Diffusion*", based on SENAI's Technological Diffusion Workshop, where discussion panels are set up about new technologies and in the Guided Visits to Technological Fairs; *Technological Diffusion Bulletin* and the *Technical Studies about Specific Emerging Technologies*. Furthermore, those publications are available on the UNITEP's website.

## VI. PUBLICATIONS

SENAI's Prospecting Model comprises a set of methodologies for prospecting and trend analysis and generates structured and contextualized information to aid the institutional decision-making process. In order to direct and map future trends, studies are carried out according to those methodologies, which give birth to numerous publications.

The studies and main results referent to the SENAI Prospecting Model originate the publications category named Série [Series]. They are:

- Thematic Antenna;
- Technological and Organizational Diffusion;
- Sector Studies;
- Emerging Occupations;
- Technological and Organizational Studies;
- Occupational Studies;
- Occupational Papers;
- Educational Studies;
- Methodological Documents;
- Modernization

The publications that divulge the results of the SENAI Prospecting Model with a defined periodicity are grouped in the category named Periódico [Periodical]: They are:

- Occupational Bulletin;
- Technological Diffusion Bulletin;
- Formal Employment Projections;
- Publications Catalog;

Besides the Series and Periodical categories, the studies that deal with themes that may widen their importance in the future are organized in the Em Tempo [In Time] category, divided up into three parts:

- IN TIME;
- IN TIME Technological Diffusion;
- IN TIME Modernization.

Finally, there is a line of publication editing with other institutions that present affinity with the thematic encompassed in SENAI's Prospecting Model. The publications Em Parceria [In Partnership] are the following:

- SENAI's Prospecting Model - Methodological Document (SENAI/OIT/Cinterfor);
- Brazilian Life Industrial Professions (SENAI/UnB);
- Research and Development at SENAI: Impacts upon Industry and Professional Education (SENAI/OIT/Cinterfor).

In the period between 2003 and 2007, 103 distinct editions have been published, totaling approximately 60 thousand copies. Fifty thousand folders have been published, besides the elaboration of CDs and DVDs about SENAI's Prospecting Model and other themes. That material was first distributed to the Regional Departments and their Units, besides other institutions of the Industry System. Unions, Associations and university specialists directly involved in the prospecting activities also received those publications.