A Technological Intelligence System for a Sectorial Institution

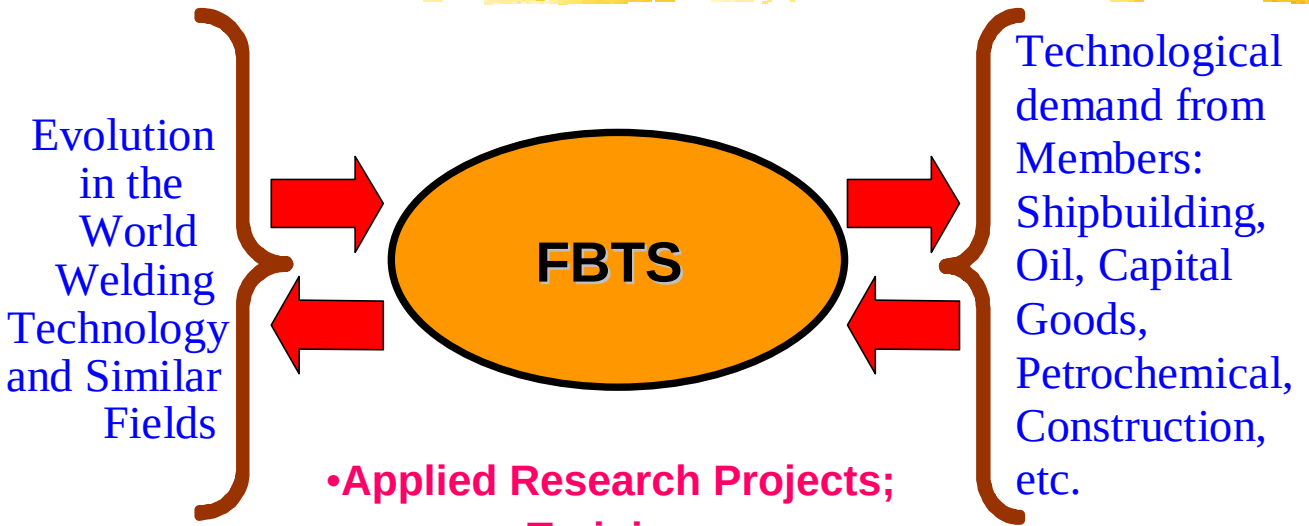
(Brazilian Foundation of Welding Technology - FBTS)

By Marcelo Maciel Pereira

Advisors: Henri Dou

Fátima Stollenwerk

Brazilian Foundation of Welding Technology - FBTS



- **Applied Research Projects;**
- **Training;**
- **Personnel and Product Certification;**
- **Technical Consultation and**
- **Technological Information.**

INTRODUCTION

- How to identify the main welding technological trends in developed countries and what is the Brazilian situation for applying these technologies in the segments under study?

- What is the importance of Technological Intelligence to assure the competitiveness of technological basis companies or of those which face great changes in their social and productive environment, in general, and of FBTS and its clients in particular?

- How to systematize Technological Intelligence in FBTS performance fields, offering to its clients certification, training and R&D on surveyed subjects that can be translated into future business opportunities and sources of competitive advantages to companies?

Techonological Intelligence and its Importance to R&D Institutions

World Transformations (Thurow, 1997):

- ✔The end of communism;
- ✔The demographic change;
- ✔The absence of a dominant power, either economic, military or social;
- ✔The global economy and
- ✔The technological change, emphasizing the power of knowledge.

Techonological Intelligence and its Importance to R&D Institutions

The Globalization:

- ✔ Any thing can be made anywhere and sold in another place;
- ✔ The set up of great economic and trade blocks: European Economic Communit, Asian Block, NAFTA and MERCOSUL;
- ✔ Change in the technical and economic paradigm.

Cycles	*First*	*Second*	*Third*	*Fourth*	*Fifth*
Beginning ***End***	1770/80 1830/40	1830 1880	1880 1930	1930 1980	1980 ?
Description	Mechanization	Stean power and railroad	Eletric power and heavy engineering	Mass production, “fordism”	Information technology
Key factor	Cotton and cast iron	Coal and transportation	Steel	Oil and derivatives	Micro-eletrônics and digital technology
Infrastructure	Canais, roads	Railroads, World Navigation	Offer and distribution of electric power	Highways, Airports and Aerial paths	Infoways, Networks and dedicated software systems

Lastres, 1997

Techonological Intelligence and its Importance to R&D Institutions

The Power of Knowledge and Innovation

The Innovation Process (Escosteguy,1996):

- ✔ **demand or market - pull and**
- ✔ **science or technology - push**

Four categories (Freeman et al, 1988)

- ✔ **incremental innovations;**
- ✔ **radical innovations;**
- ✔ **technological paradigm; and**
- ✔ **technical-economic paradigm.**

Techonological Intelligence and its Importance to R&D Institutions

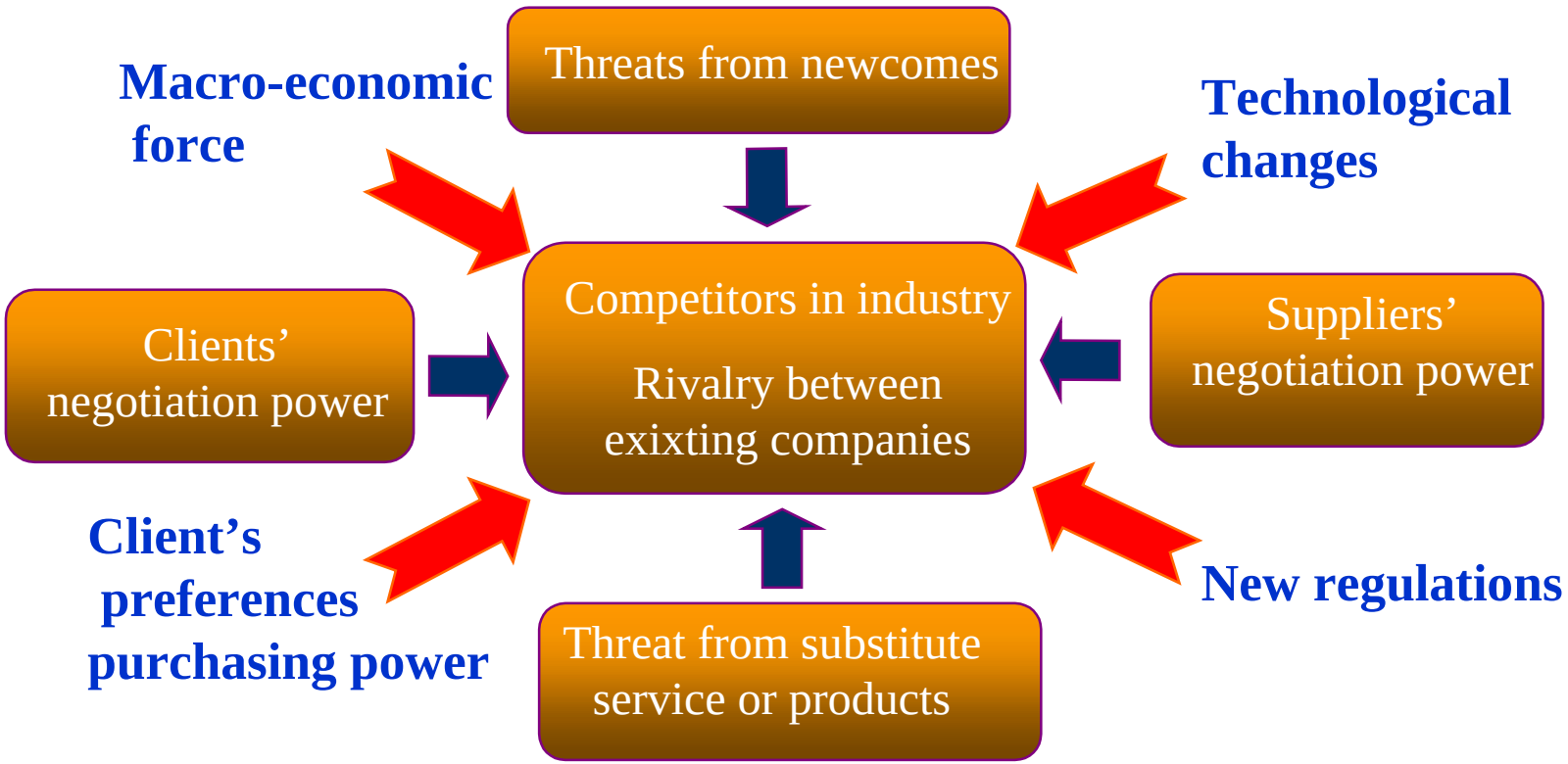
- The number of scientists duplicate every 13 years;
- 300 thousand magazines are published/ year;
- Twenty thousand publications/ day (chemical area);
- Tthere are 600 thousand publications/ year;
- Every ten minutes a new network goes into the air
- In the next 15 year, there will be more periodicals than in the last 2.500 years. Coelho, 1997

→ **Hyperinformation**

- A fiercer competition;
- Smaller period of time between reseach and application;
- Fast technological changes;
- New and unexpected competitors;
- New regulations and incentives;
- Wide world markets, and
- Major world competitors. Dou, 1997

→ **Hypercompetition**

Techonological Intelligence and its Importance to R&D Institutions



Adapted from Porter, 1989

The Traditional View Competitive Advantage

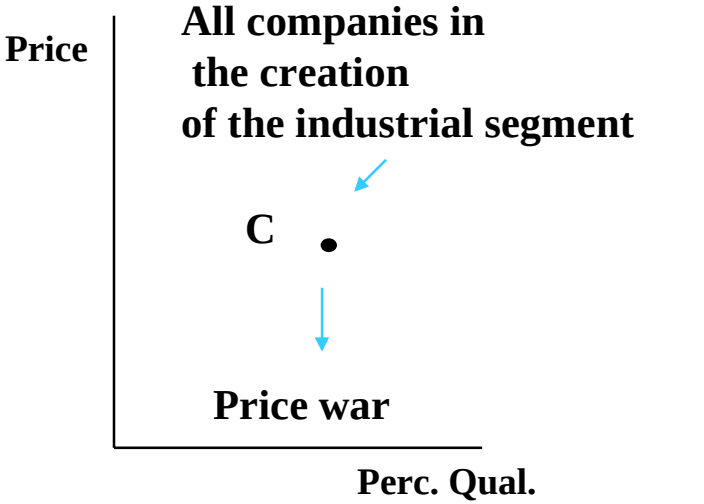
- ✔ Based on the relation between:
  - ☛ **Cost and Quality**
- ✔ Competitive Adavantage:
  - ☛ **Cost Leadership and Differentiation**
- ✔ Generic Strategies to attain a Sustained Competitive Advantage:
  - ☛ **Cost Leadership, differentiation and focus.**

The Four Competition Arenas

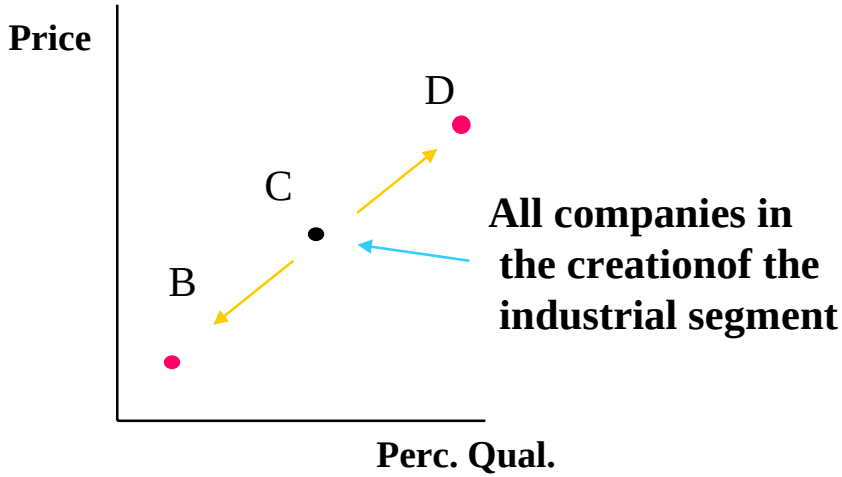
- ✔**Price and Perceived Quality;**
- ✔**Time and Technology;**
- ✔**Barriers Against Newcomers, and**
- ✔**Financial Reserves.**

D'Aveni, 1995

Price and Perceived Quality



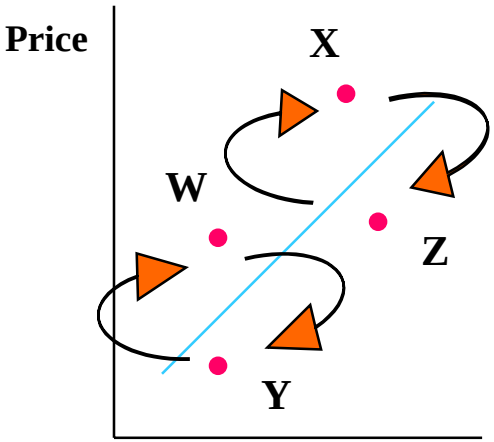
When Quality is not a Preponderant Factor



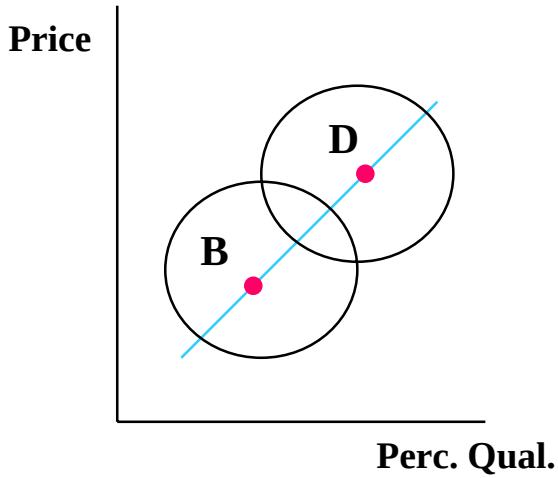
Generic Strategies

D'Aveni, 1995

Price and Perceived Quality



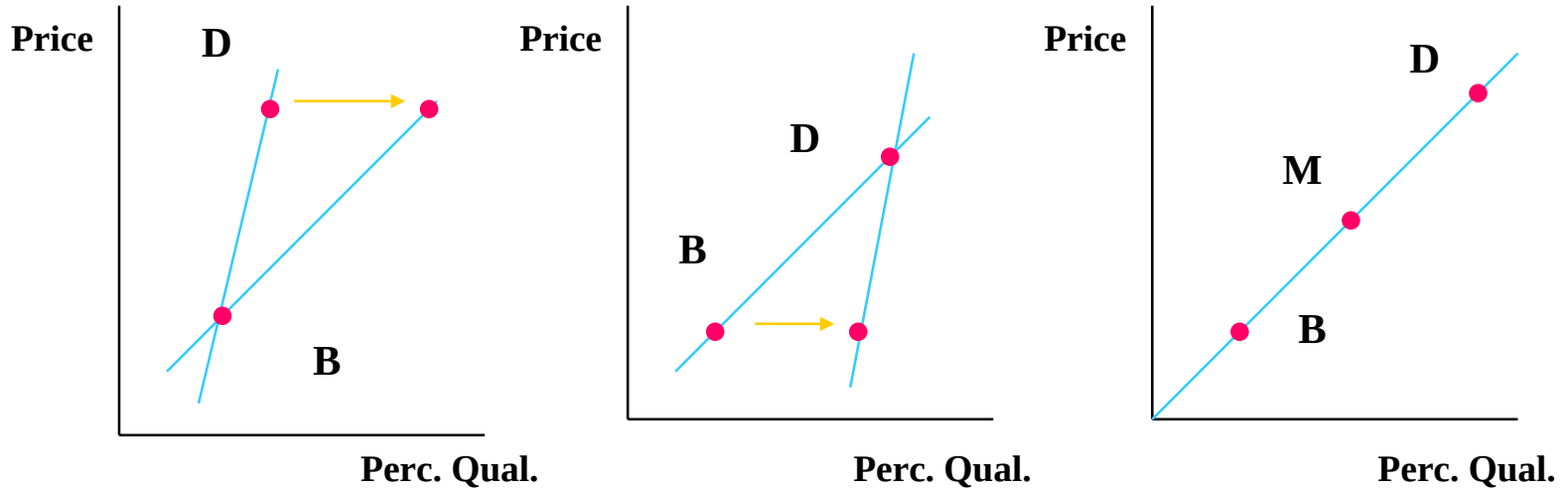
Competition within a Segment



Segment Superposing

D'Aveni, 1995

Price and Perceived Quality



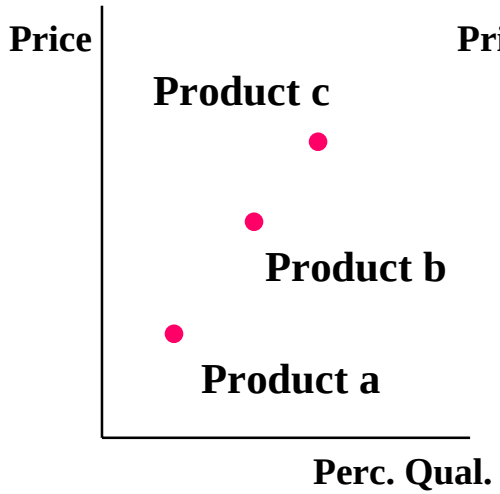
The Differentiator Increases Value

The Low Cost Producer Increases Value

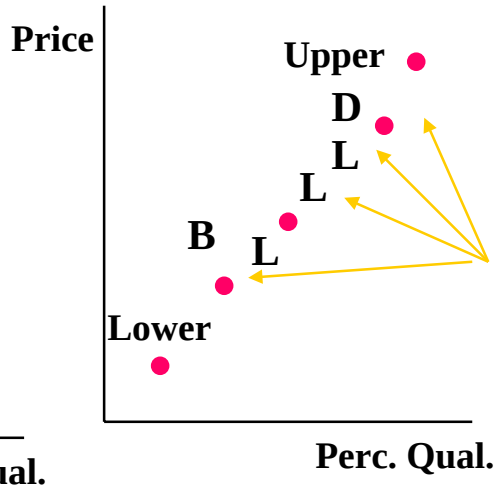
The Intermediate Path

D'Aveni, 1995

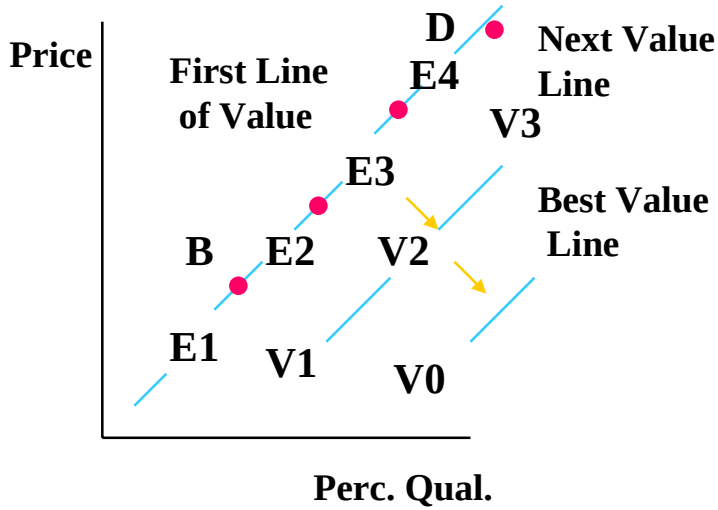
Price and Perceived Quality



The Full Product Line



Typical Entry of Flank and/or Niche Occupation



Movement towards the Optimum Value Ofter

D'Aveni, 1995

Time and Technology

Technology - a driving force capable of conditioning the strategic future.

production factor → competitiveness factor

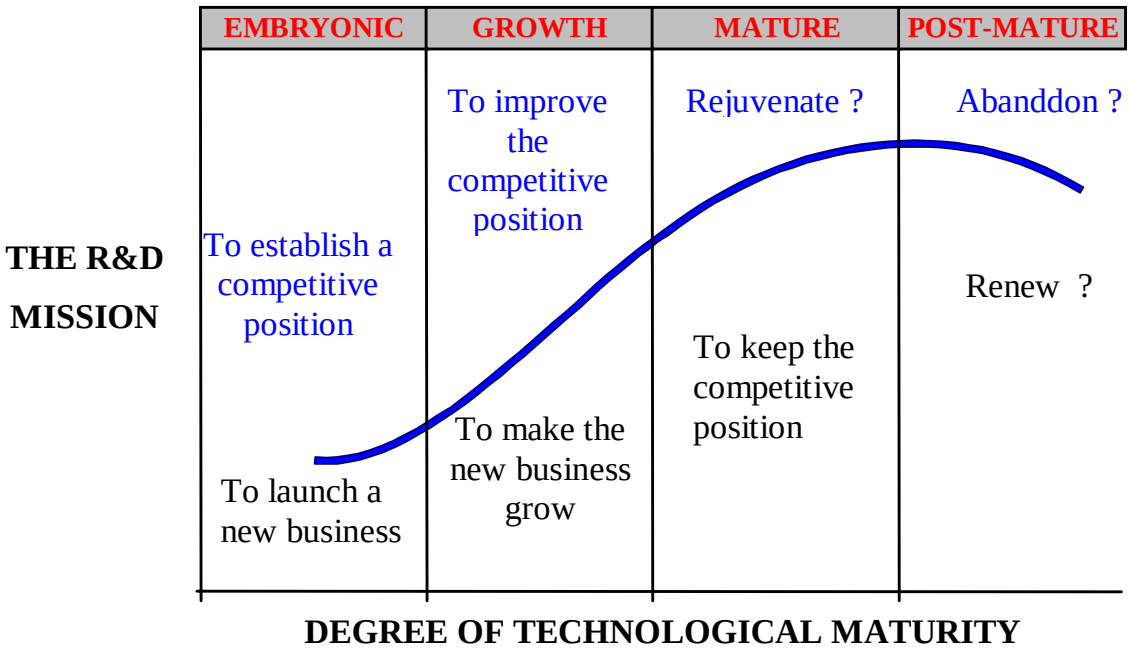
In the strategic environment, R&D must have three purposes:

- To defend, support and expand the existing business;
- To drive new business, and
- To enlarge and deepen the company's technological capabilities.

Roussel et al, 1992

Technologycal Maturity and R&D as a Competitive Advantage

The mission of R&D changes as a function of the maturity degree in which the technology to be adopted by it is at a world level.



Source:Roussel, 1992

Areas Benefited by Technological Intelligence

- ✔Definition and Revision of Business and Technological Strategies;
- ✔Technology Selection and Acquisition;
- ✔Management of the Technological Portfolio;
- ✔Investment Founded on New Technologies;
- ✔Formation of Technological Partnerships and Strategic Alliances and
- ✔Production Operations.

Asthton,1996

Industrial R&D Management Models

1º Third Generation Model of R&D Management: Roussel et al

CENTRALIZATION OF R&D	***DECENTRALIZATION OF R&D***	***INTEGRATION OF CENTRALIZED AND DECENTRALIZED R&D***
Non-explicit technological strategy	Technological strategies unconnected from corporate strategy	Technological strategies vital for corporate strategy
Project planning with emphasis on resources	Project planning, evaluation and control	
TECHNOLOGICAL MONITORING AND PROSPECTING in an isolated way and an operational level	**TECHNOLOGICAL MONITORING AND PROSPECTING** in departments	**TECHNOLOGICAL INTELLIGENCE SYSTEM** in networks
1st GENERATION	***2nd GENERATION***	***3rd GENERATION***
1950 – 1974	1975 – 1990	1990'S

Source: Roussel, 1992

Industrial R&D Management Models

2º Fifth Generation Model of the Technological Innovation Process: Rothwell

- ✔First generation: *technology push;*
- ✔Second generation: *demand pull*;
- ✔Third generation: combined model;
- ✔Fourth generation: integrated model;
- ✔Fifth generation: network integration of systems and model.

Industrial R&D Management Models

3º Three Paradigms for the R&D Organization
R&D: Coombs and Richards

Paradigm 1: centralization and predominance of R&D management at the corporate level;

Paradigm 2: decentralization and predominance of R&D development by business units;

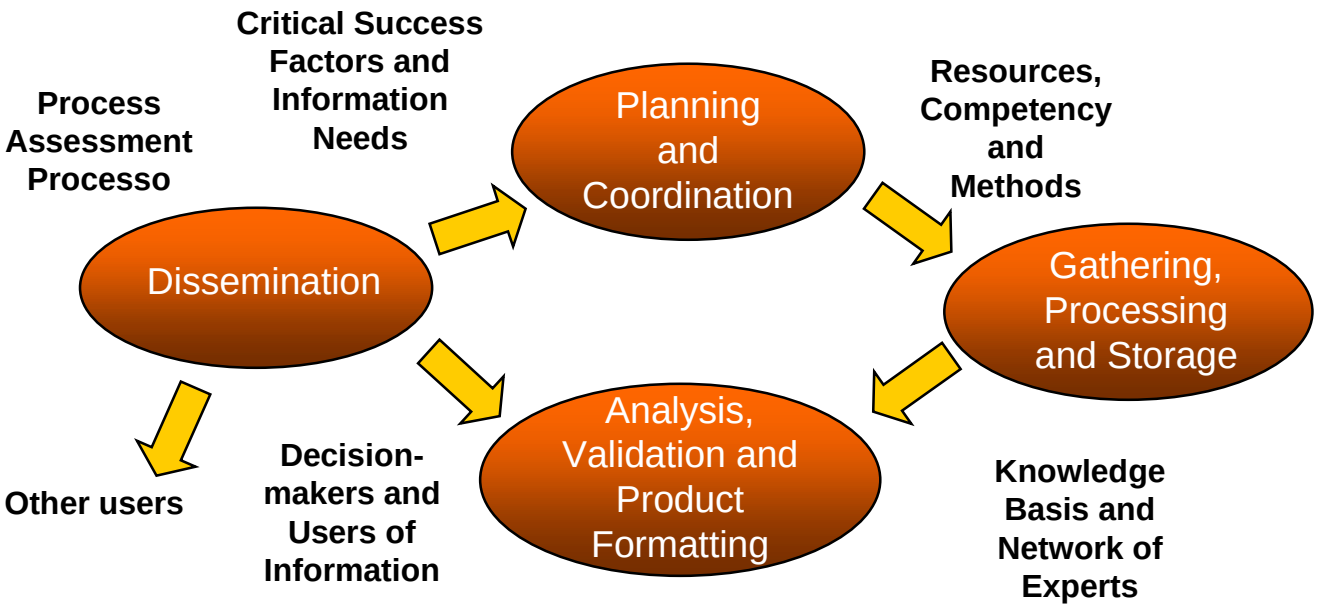
Paradigm 3: shared management by the R&D portfolio and of resources, involving integration mechanisms of corporate level with the units and vice-versa.

Industrial R&D Management Models

Model	Scope	Emphasis	Application
3rd Generation	R&D management and organization (focus on management)	Strategic management and integration of R&D within organizations	Mostly practiced in big size organizations
5th Generation	Innovation process as a whole. Internal and external factors relevant for the process	Shared management in the organization and external technological cooperation. Integration of systems and models in networks.	Mostly practiced in big size as well as in small and medium size organizations
Three Paradigms	Organization and management (focus on organization)	Strategic management and integration of R&D within organizations	Mostly practiced in big size organizations

Source: Stollenwerk,1999

THE TECHNOLOGICAL INTELLIGENCE METHODOLOGY



Source: Adapted from Herring, 1997

Planning and Coordination

- ✔Objective and scope;
- ✔Definition of the strategy and the implementation plan;
- ✔Selection of information sources;
- ✔Definition of infra-structure, methods and tools needs;
- ✔Organization model;
- ✔Proposal of a budget and allocation of human resources and
- ✔Proposal of a management system and process evaluation.

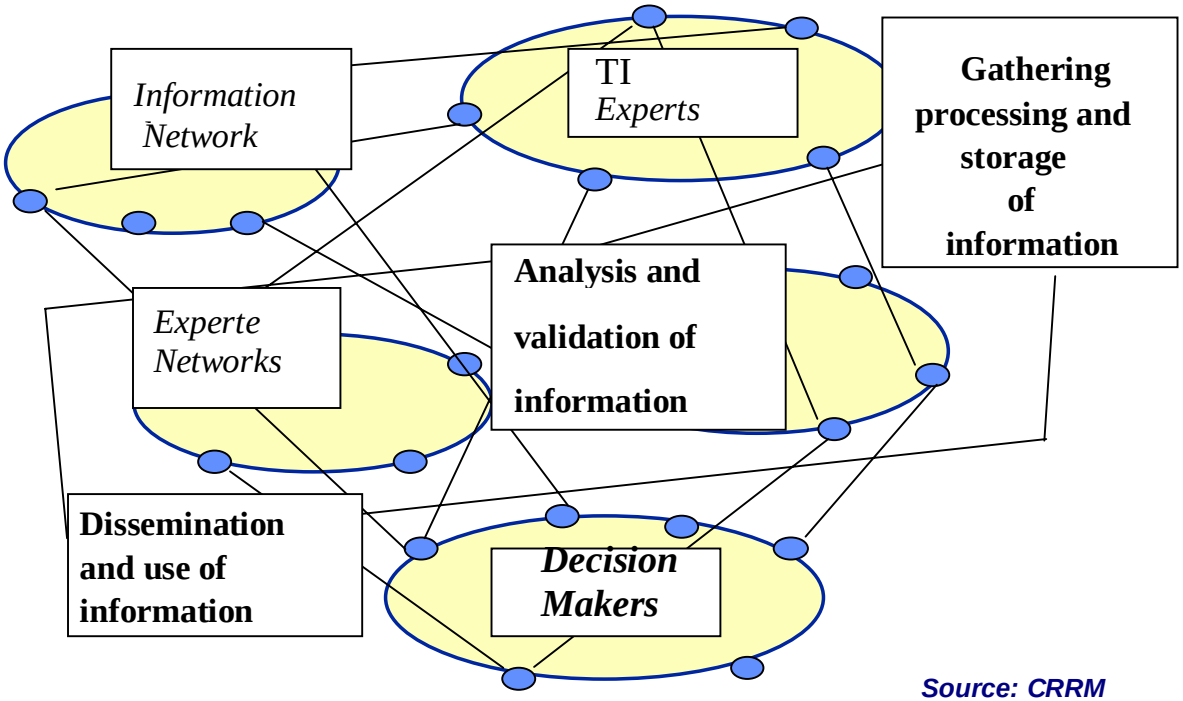
Gathering, Processing and Storage

Storage of industrial information:

1. Scientific,
2. Technical,
3.Technological,
4. Technical and economic,
5. The environment and safety,
6. Regulations and legal aspects and
7. Other information.

Jakobiak (1991)

Analysis and Validation of Information



Source: CRRM

Typology of Information

✔**As a function of their content:** scientific, economic, managerial, etc.

✔**As a function of its distance from the authorship:** primary, secondary and tertiary.

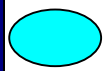
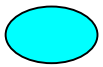
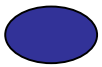
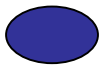
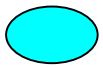
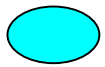
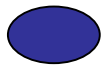
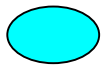
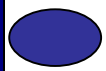
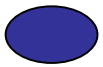
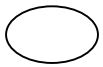
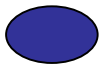
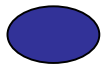
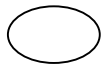
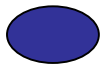
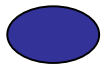
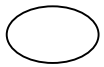
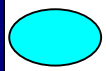
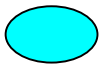
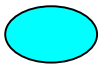
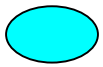
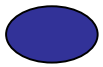
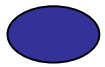
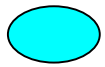
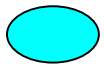
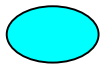
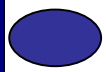
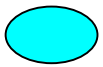
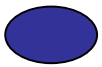
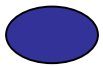
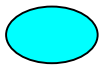
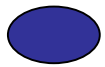
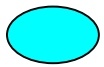
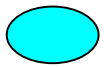
✔**As a function of their nature:** formal or text and informal or not published.

Information for Competitive Intelligence:

- **formal or text: 40%,**
- **informal: 40%,**
- **experts: 10% and**
- **exhibitions and seminars: 10%.**

Dou, 1995

Typology of Information

Sources/ Indicator	Ease of Access	Cost of Access	Availability	Quantity of Information	Quality of Information	Stand-Alone Value of Information	Informational Scope	Ease of Processing	Timeliness	Actionability
On Line Data Base										
Experts										
Panel of Experts										
Patent Analysis (Trends)										
Internet										

The Main Products - TIS

✔oral communications: oral presentation to decision makers;

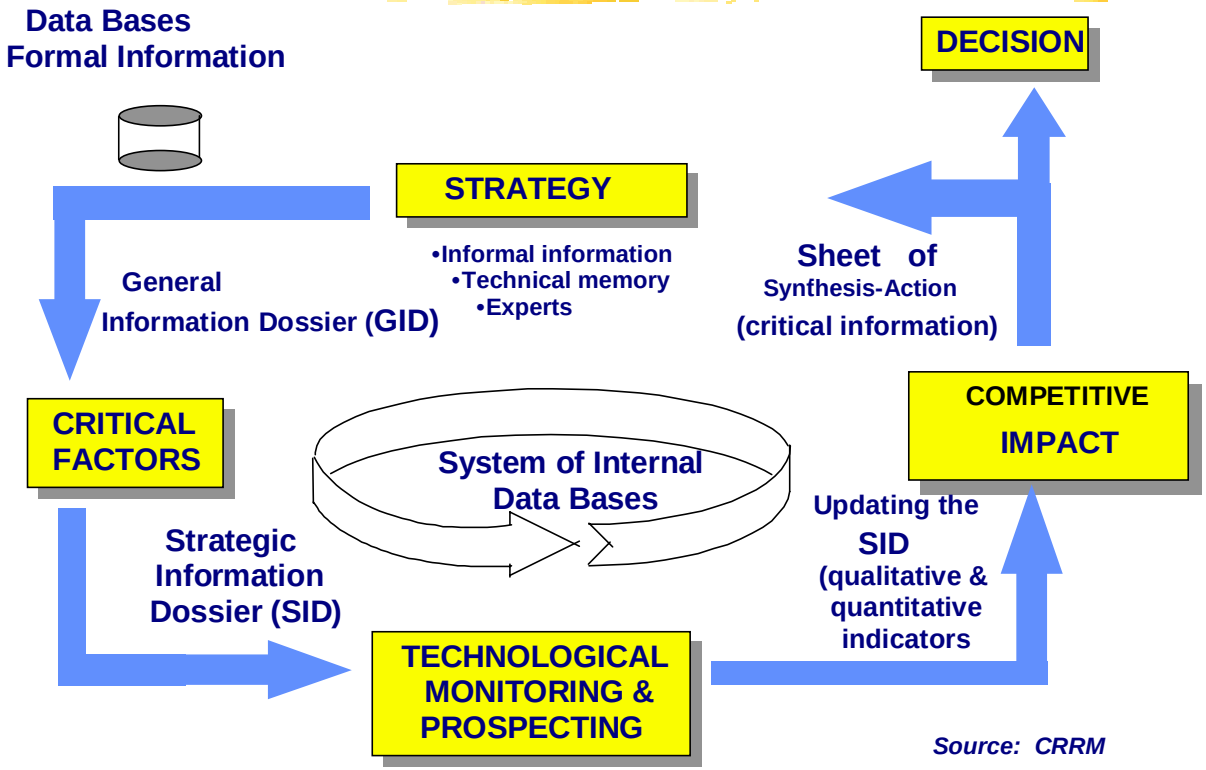
✔executive reports on Technological Intelligence: synthesis-action sheets, normally comprising 1 to 5 pages;

✔detailed files on Technological Intelligence: a general information dossier (GID) and a strategic information dossier (SID);

✔warning bulletins: short reports on signals of changes in the external environment with an indication of sources.

Stollenwerk (1997)

Methodology for Technological Intelligence - CRRM



Source: CRRM

The Main Methods of Analysis in Technological Intelligence

- ✔**The Method of the Critical Success FactorsTechnological** (Rockart, Jakobiak and Leidecker e Bruno)
- ✔**Monitoring and Prospecting** (Monitoring, Panel of experts, Trend Analysis, Modeling, Scenarios and Benchmarking)
- ✔**Analysis of the Competitive Impact** (Roussel)
- ✔**Portfolio Analysis** (Competitive Technological Force, Technological Maturity, Competitive Impact and Attractiveness of tht R&D Project).

BIBLIOMETRICS AS A TOOL FOR TECHNOLOGICAL MONITORING AND PROSPECTING

the application of mathematical methods to books and other communication media. (Pritchard, 1969).

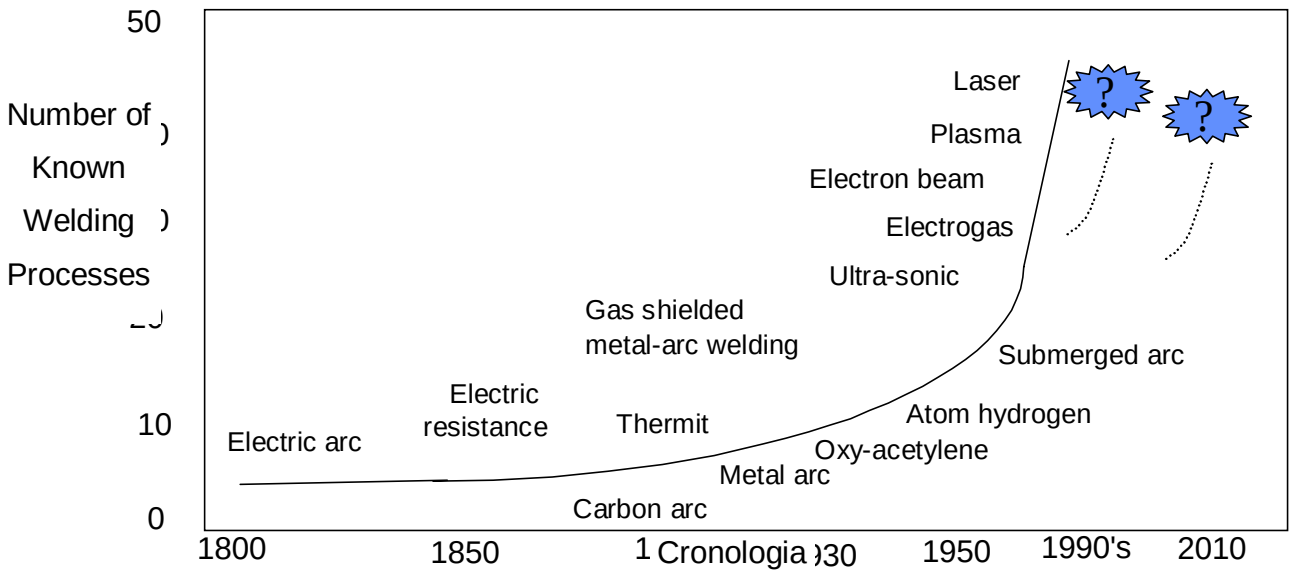
✔Survey on literature, including via complete text at different levels;
✔Creation of useful indicators to the development of science and technology;
✔Statistical modeling of literature dynamics with adjustments from good to excellent, and
✔An increase of the relevancy in recovering information.

Bibliometric of Data Bases and Patents

	INVENTORS	PRIORITY YEAR	COUNTRY OF PRIORITY	CODE OF IPC	COMPANIES	PATENT FAMILY	FAMILY SIZE
INVENTORS	Network of authors	Evolution of inventors' activity	Country of origin of inventors	Experts per subject	Connection between inventors and companies		
PRIORITY YEAR			Evolution of activity per country	Evolution of code appearance	Evolution of companies' activities	Evolution of the interest of markets of countries	Evolution of patent extension
COUNTRY OF PRIORITY				Range of activities per country	Country of deposit of companies	Strategy of deposit at the level of countries	Strategy of deposit at the level of countries
CODE OF IPC				Co-relation of codes	Range of activities of companies	Range explored per country	
COMPANIES					Collaboration between companies	Strategy of depositing	Strategy of depositing
PATENT FAMILY							
FAMILY SIZE							

Santos, 1997

The Need to Monitor the Market and Technologies



Source: Adapted from Taniguchi,

Evolution and Perspectives of the FBTS Context

The Shipbuilding Industry

- ✔In the beginning of the 80's: 30 ships/year - 40.000 jobs
- ✔Fineshed 90's: 3 ships/year - 5.000 direct jobs

Trend:

- ✔The construction of 150 ships in 10 years
- ✔New rules for the safety of the environment
- ✔Merchant Marine Fund: US$ 500-Million (96 US$ 150 Million only were applied)

Evolution and Perspectives of the FBTS Context

Oil and Petrochemicals

- ✔Flexibility to the monopoly;
- ✔Competition in all segments
- ✔The Concession Contracts: 1% (min.) in R&D
  - ☛ 50% in R&D projects, developed by national universities and research institutions

Petrochemicals:

- ✔Investments: US$ 1-Billion/year (from 1997 to 2000)

Evolution and Perspectives of the FBTS Context

Capital Goods

✔The opening that ocurred in foreign trade, from the beginning of the 90's: significantly reduced setorial competitiveness;

✔The consumption of capital goods has been very low in comparison to the situation in developed countries, and emerging Asian economies;

✔The performance for exports: Reached considerable volumes;

- ☛The main sources of technological innovation: R&D and Technology transfer

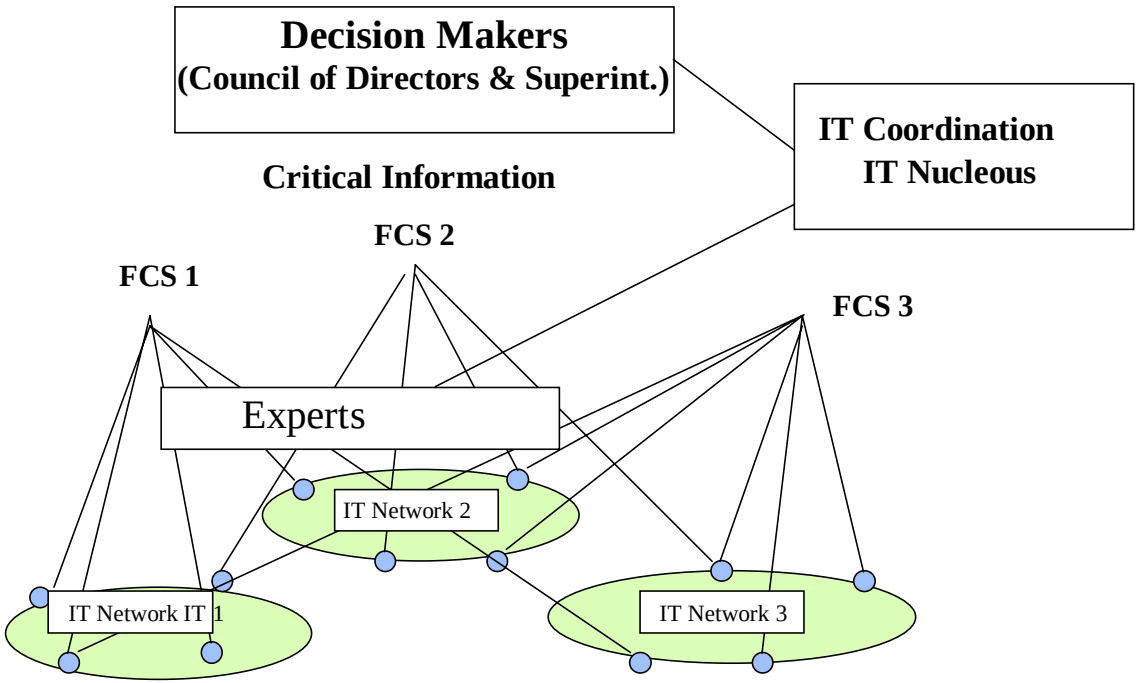
A Proposal for a Technological Intelligence System for FBTS

Multiclient Technological Intelligence System

It System shall be conceived with a strategic, multifuncional and multidisciplinary view, involving the following areas:

- ✔Executive Council of Directors;
- ✔Superintendence;
- ✔Techinical Department;
- ✔Quality Certification Department;
- ✔Department of Courses and
- ✔Information and Technical Documentation Sector.

Technological Intelligence System of FBTS



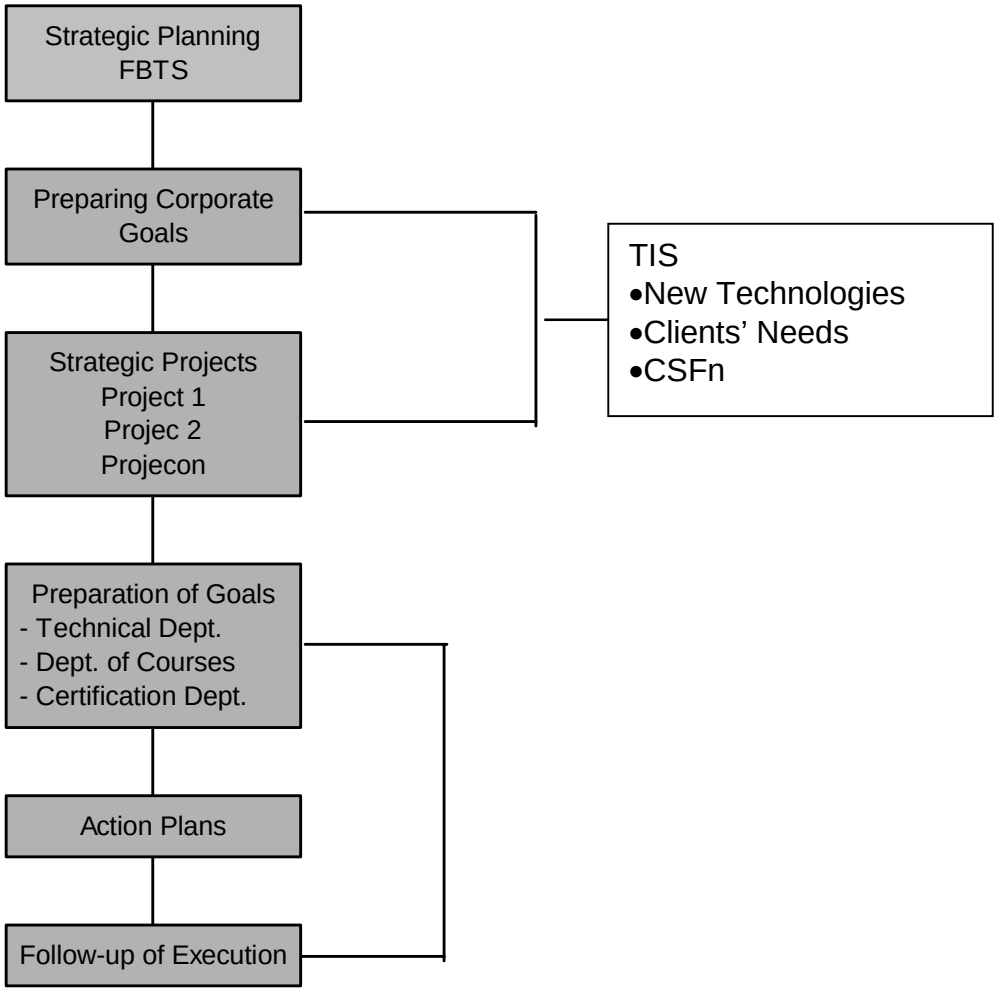
Source: Adapted from StollenwerK, 1997

Technological Intelligence System of FBTS

The Critical Factors:

✔Desire and commitment from decision makers;
✔Well defined needs for information (critical success factors related to the business and technology);
✔Critical mass with competency in gathering, processing, the analysis and dissemination of strategic information;
✔Collaboration of internal experts in departments involved;
✔Strong internal and external articulation;
✔Permanent assessment of the IT System, in order to provide sustenance and credibility and continuous improvement.

Key Processes of Decision at FBTS



Prospecting Methods and Tools with Application of the IT System

PROSPECTING METHODS AND TOOLS	PHASES OF THE IT PROCESS				
	Planning and Coordination	Gathering, Processing, Storage	Analysis and Validation	Dissemination and Utilization	Evaluation
Brainstorming techniques	x	x	x		
Access to on line data bases	x	x	x		
INFOTRANS and INFOBANK		x	x		
IDEALIST and similar		x		x	
OFFICE (Microsoft)	x	x	x	x	x
INTERNET and INTRANET	x	x	x		
DATAVIEW, DATALIST MATRISM		x	x		
TOAK (Georg Tech-EUA)		x	x		
TETRALOGIE		X	X		
STATION		X	X		
ARISEM		X	X		
STATISTICA, SPSS and similar		x	X		
Intelligent Mine (IBM)		x			
INFOVIEW (Derwent)		x			
Portfolio Analysis	x			x	
Research of Opinions		x	x		x
DELPHI Technique		x	x		x
TQM (5W1H)	x	x	x	x	x
Technique of project evaluation	x	x	x	x	x

Source: Adapted from Stollenwerk, 1997

Actions to Implement the IT System

ACTION	INTERVAL (estimated)	CSF SUFFERING IMPACTS
Conceiving and nstitutionalization of the IT system	1 year for preparation and institutionalization	⇒ Desire and commitment from decision makers ⇒ Other factors
Set up of the Technology Council and the IT Nucleus	3 months	⇒ Desire and commitment from decision makers ⇒ Critical mass with competency in IT ⇒ Collaboration of internal experts
Set up of national and international	It is part of the initial learning process and has a permanent character	⇒ Strong internal and external articulation
finition of information needs – critical success factors business and technology)	6 months after the implementation of the Technology Council of the IT System	⇒ Desire and commitment from decision makers ⇒ Well defined information needs
apacitating the IT Nucleus in Technological Intelligence	1 year of training for obtaining the DEA at CRRM with permanent character (international missions, visits, professorship and doctor degree – CRRM)	⇒ Critical mass with competency in IT ⇒ Strong internal and external articulation
reation and implementation of the IT Networks	6 months after the definition of critical success factors to be monitored	⇒ Desire and commitment from decision makers ⇒ Strong internal and external articulation ⇒ Collaboration of internal experts in the various areas
evelopment and set up of IT roducts (contents, form and supporting means)	6 months for the first product with a permanent improvement	⇒ Desire and commitment from decision makers ⇒ Critical mass with competency in IT ⇒ Permanent evaluation of the IT system
Preparation of the process standard (5W1H) for anaging the IT System and definition of an evaluation system (indicators) for the process	6 months after the beginning of the IT system and with a continuous character.	⇒ Permanent evaluation of the IT system, in order to provide for its credibility and continuous improvement.

Source: Pereira, 1999

CONCLUSIONS

The potential benefits for FBTS and its clients, upon implementing a Technological Intelligence System, are:

✔**Decreasing risks upon taking decisions;**

✔**Incorporating a strategic attitude and a prospecting view;**

✔**improving the knowledge of the competitive position of FBTS and of business alternatives;**

✔**Identifying partnerships and strategic alliances;**

✔**Anticipating signals of impact in respect to changes in the external technological environment (warning);**

✔**Optimization on allocating resources for R&D and strengthening central competencies;**

✔**Reducing IT costs by means of a Multiclient Technological Intelligence System.**

The commitment of the Council of Directors and the Superintendence, the collaboration of experts in the various areas of FBTS and partnerships formed with national and international institutions, as a function of the Technological Intelligence System implementation, will be fundamental for its development and for obtaining benefits, as predicted in this dissertation.