AN APPROACH TO INTEGRATE QUALITY FUNCTION DEPLOYMENT WITH COMPETITIVE TECHNICAL INTELLIGENCE: APPLICATION ON A NEW FOOD PRODUCT

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Summary : This paper proposes the integration of Quality Function Deployment with Competitive Technical Intelligence in a model focused on the planning phase of product development. This model originated from the Total Quality Management state of the art, based on what is known as the "Customer Voice" as well as the "Technician Voice", under a competitive technical intelligence approach. While the Japanese methodology of Quality Function Deployment is applied to build links between the organization and its clients, Competitive Technical Intelligence is applied to monitor the entire environment, pursuing the identification of future opportunities to innovate. This paper proposes the integration of the two methodologies.

Key words : Quality Function Deployment, Competitive and Technical Intelligence Product Development, Planning, Client focus, Innovation

Résumé : Ce document nous présente l'intégration de Déploiement de Fonction de Qualité avec l'Intelligence Technologique Compétitive grâce à un modèle basé sur la phase de planification de développement de produits nouveaux. Ce modèle provient de la Direction de Qualité Total, particulièrement au sujet connu sous le nom de «Voix des Clients » ainsi que celui de « Voix de Technicien », mais sous une approche d'Intelligence Technologique Compétitive. Tandis que la méthodologie japonaise de Déploiement de Fonction de Qualité est appliquée pour établir des liens entre organisation et clients, l'Intelligence Technologique Compétitive est appliquée pour surveiller l'environnement entier, visant l'identification d'opportunités futures à innover. L'intégration de ces deux méthodologies est ainsi exposée.

Mots clés : Déploiement de Fonction de Qualité, Intelligence Compétitive et Technologique, Développement de produits, Planification, Client cible, Innovation

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1 – BACKGROUND

Increasingly aggressive competition has produced specific pressures on the environment, as shown in Figure 1, affecting the success of the products in their development phase. To cope with the new challenges in these conditions of great dynamism several proposals have arisen; the organizations, for instance, need to be more aware of the changes in their environment and to use new approaches to monitor them with methodologies such as Competitive Technical Intelligence (CTI). Alternatively, from the Total Quality Management (TQM) perspective, the planning has been centered on the customer as organizations try to offer products and services that suit most customers' expectations. The common denominator for both perspectives has been innovation, a key factor for the success of the products in the rapidly changing markets (Krishnan and Ulrich, 2001; Tena and Comai, 2003).

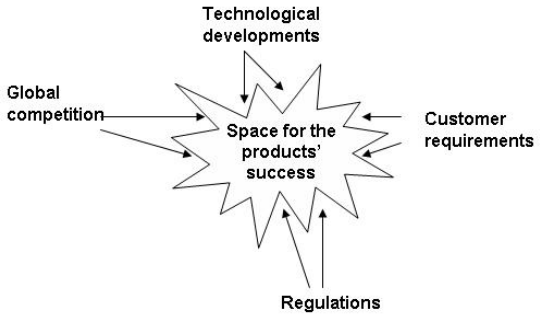

Figure 1. Pressures for the product's success in the development phase.

In this context it is an excellent opportunity to develop the integration of the previous disciplines looking for a process focused not only on the customer, but also on the opportunities and threats existing in the competitive environment. In this sense, the model developed during the master's thesis research of Mora-Roldan (2006) is presented. This model proposes the integration of Quality Function Deployment (QFD) to the cycle of Competitive Technical Intelligence in order to support product planning in the development phase. A brief review of the methodologies from which this model originates is explained in the following section.

2 - COMPETITIVE TECHNICAL INTELLIGENCE (CTI)

Competitive Technical Intelligence focuses on the analysis of competitive events as well as on scientific and technological ones, such as mergers, development of new materials and products, improvements in processes, etc., that may affect the future competitive position of a company (Norling et al., 2000; Rodríguez et al., 2002). In this discipline, technology is visualized as a fundamental driving force for the organization's competitive position.

The intelligence system reduces uncertainty in the decision making process by identifying trends and keeping abreast of future events. Several companies have applied CTI successfully in their strategic planning processes (Nestlé, L'Oreal, Motorola, Procter & Gamble, Johnson & Johnson, Hewlett Packard, among others), resulting in a better market position, among other benefits (Jaworski et al., 2002; Rodríguez, 2001).

3-QUALITY FUNCTION DEPLOYMENT (QFD)

Quality Function Deployment was conceived in Japan at the end of the 60's. Although Japan was devastated by World War II and the first efforts to survive were through imitation, QFD arose as a methodology focused on originality (Akao and Mazur, 2003; Chan and Wu, 2002; Day, 1993). The Japanese expression *«hinshitsu kino tenkai»* corresponds to "Quality Function Deployment", where *function* refers to the analysis of the business process in order to improve the quality of the development process of products and services (Akao and Mazur, 2003).

QFD is a methodology that links an organization with its customers - both intermediate and final. To accomplish that purpose it is important to know the customers' needs (Customer Voice) so they can be involved from the first stages of the planning process. This implies implementing technological solutions by specialists (Technician Voice) to determine the customers´ requirements. The application of QFD is based on a configuration matrix named "House of Quality", as sketched in Figure 2.

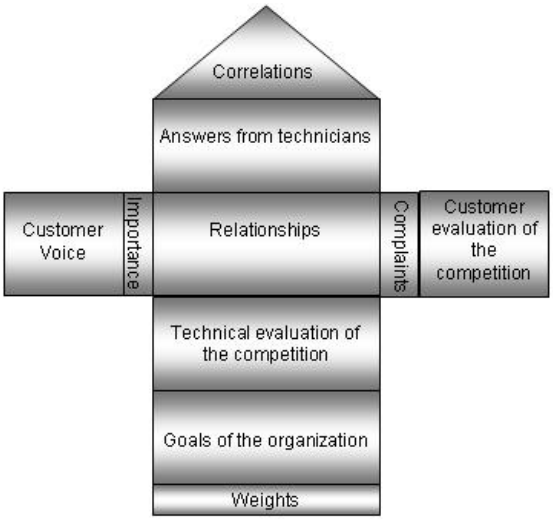

Figure 2. House of Quality

In a comprehensive manner QFD involves a process characterized by the following (Day, 1993):

1. To define key inputs of the planning process.
2. To serve as an important information warehouse using specific formats (matrixes).
3. To focus the organization's efforts towards priority actions based on the competitive aspects of the market and technology.
4. To define the outputs of the products´ planning process.

QFD provides important benefits, such as: reducing costs, decreasing times of product development, speeding up changes during the different stages, etc. Because of this, with time, this methodology has become a popular support to the product planning process (Akao and Mazur, 2003; Chan and Wu, 2002; Day, 1993). Thus, many companies have applied QFD for the analysis of competitors, the development of new products, the identification of control points, the communication among participants of development of products, the redesign of products, market analysis, etc. (Akao and Mazur, 2003).

4. MODEL OF QUALITY DEPLOYMENT WITH COMPETITIVE TECHNICAL INTELLIGENCE: INTEGRATION OF METHODOLOGIES

The model proposed in this document is based on a systematic process which aims to support the planning of product development, to reduce uncertainty and to provide greater customer links. Generally speaking, the model is based on five stages, shown in Figure 3, and explained in the following sections.

4.1 Planning: Formulation and Understanding

This stage is crucial for the successful implementation of the methodology, since with a correct plan and a suitable definition of the problem to solve, the attainment of a solution becomes easier. This stage basically involves:

- ⇒ Definition of objectives (general and specific), specifying what is desired to achieve at the end of the implementation as well as throughout the subsequent stages.
- ⇒ Definition of the area of investigation (customers, competitors, etc.) and its scope.
- ⇒ Characterization of the type of customers to study.
- ⇒ Definition of the resources required (human, time, monetary, information, etc.).
- ⇒ Definition of the activities to perform.

4.2 Collection of Information: Exploration of the Competitive Environment

The proposed methodology starts by creating a combination of the information sources: primary (field research, mainly focused on the competitive aspects of the market, and technology), as well as secondary (published and public information). Following

the approach of Total Quality, the Voice of the Customer and Technician Voice will be identified; these refer to the specific requirements established regarding the product.

Sources of Secondary Information: Customers and Technicians

Considering what was established in the planning stage, secondary information collection is initiated in order to have a base with the customer once the collection is performed directly. The collection of information will be oriented toward the competitive and technological environment, to acquire a broad vision, this allows the identification of a global group of requirements to develop the product that, subsequently (once the field research is done), will be prioritized.

This deals with transforming the collected information toward specific customer requirements (Voice of the Customer) and how they can be satisfied through technological solutions (Technician Voice), depending on the type of product.

Sources of Primary Information: Customers and Technicians

This stage is directed toward field research with the consumer and the people responsible for the technological process, key actors in the development of a product. For this, the gathering of information begins by analyzing the market and the type of customers identified in the planning stage. In this sense, there are different techniques, particularly focus groups and interviews, that are traditionally used in Quality to know the Voice of the Costumer and may be applied in this model. The analyzed information will identify the requirements (needs) established by the customer, which must be weighed in order to determine priorities. In this manner, the most important requirements, according to the customers, will be identified. This information will serve as an evaluation element of the product proposed and of the competitors' products.

Once the information from the Voice of the Customer is ready, the Technician Voice is collected. The intention is that experts in the field give specialized answers (mainly linked to the production and design process), which are also quantifiable, to attend the needs, wishes or expectations of the customers. That is, the information gathering is oriented to find technological solutions according to each requirement previously established in the Voice of the Customer.

Once both types of information (customer and technician) are gathered, an integral analysis will be performed in the following stages with the purpose of finally achieving new proposals for the product's development.

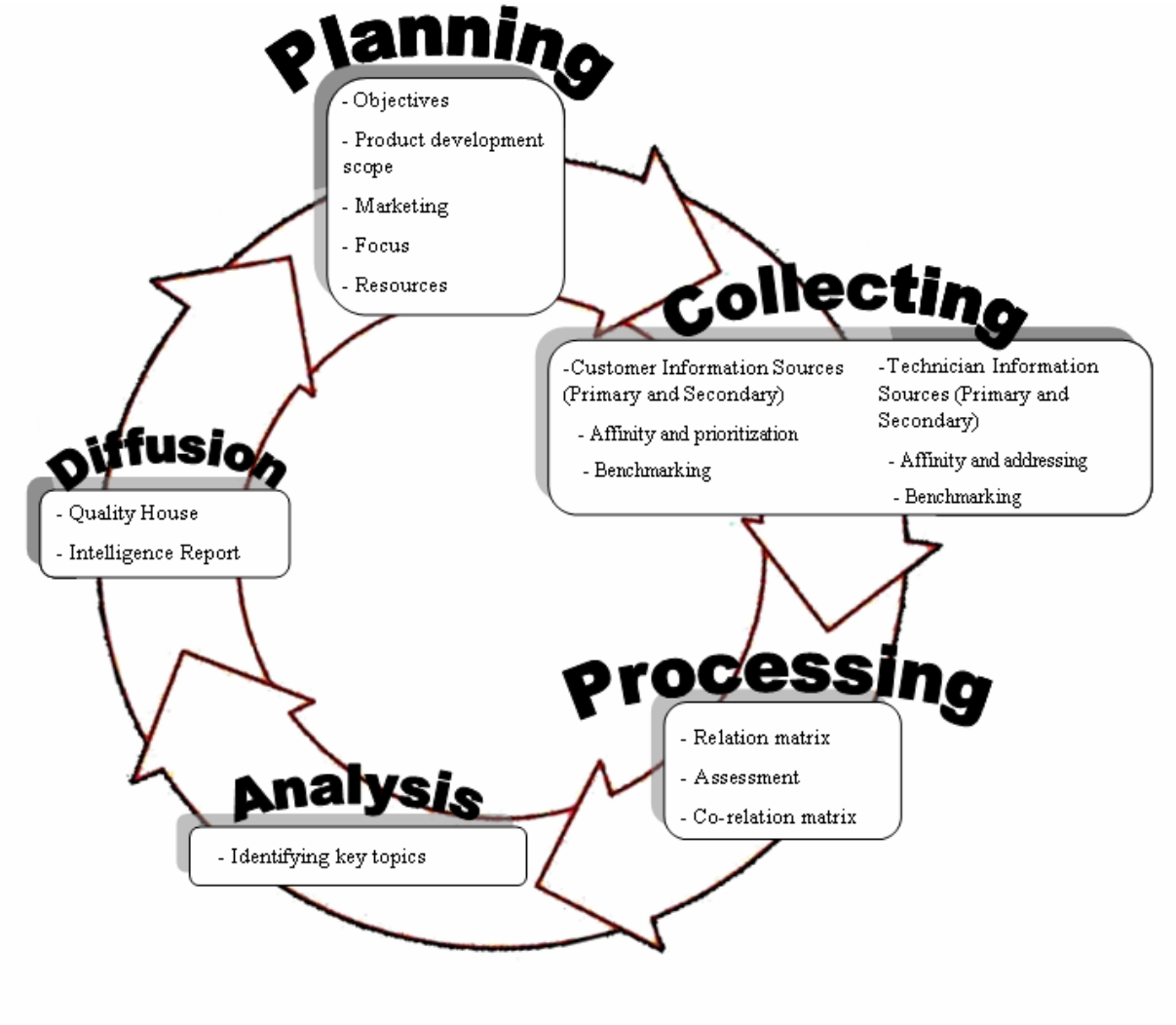

Figure 3: QFD Model with Competitive Technical Intelligence

4.3 Processing of the Voice of the Customer and the Technician

This stage begins by identifying the relationship between each customer requirement and the technological solutions proposed. These also determine the impact (strong, medium, weak or void) that each technological solution can have on each customer requirement. For this reason, interaction with the group of experts is fundamental.

Once these relations and their impact have been identified, a new comparison is undertaken. Based on the importance that a customer gives to each requirement (identified in the previous stage), the proposed technological solutions are reconsidered. The purpose of this process is to identify the degree of importance of these solutions according to the needs of the customer. Then, this information is considered together with the previous information, assigning the greatest values to those solutions that have a strong impact on the established requirement and where this requirement is of high priority for the customer.

Finally, the possible co-relations are identified between the technological solutions determining how one solution can affect another. By doing this, the determination of strategic, synergetic solutions that may apply to several requirements, is sought avoiding possible negative effects.

4.4 Analysis and Development of Alternatives

This stage intends to identify key topics for the development of the product, considering the most important requirements of the customer and, at the same time, those that are technologically feasible to carry out. As

previously pointed out, the synergies between the solutions are also considered with the purpose of achieving global results for different requirements in parallel. This process of alternatives development also implies the analysis of the technical-economical feasibility of each proposed solution.

4.5 Spreading of Results and Recommendations

The objective of this phase is the generation of results and specific recommendations for the different stages of the development process of products. An Intelligence Strategic Report is elaborated, showing the most important results according to the outcomes of the previous stages. The execution of the recommendations will depend on the type of project, the persons to whom it is addressed, and the policies of the organization in question. Depending on the project's approach, the generated results will be processed again to reach other proposals, for instance, applying tools for the solution of problems of inventiveness, as in the case of TRIZ (Russian acronym for Solution of Inventiveness Trouble Theory) or any other.

5 – APPLICATION

Here, an application of the proposed model is presented, following the approach identified in the Quality field as Total Planning and refers to the strategic combination of Customer's and Technician's Voice. The evaluated product is a food, a snack proposed by a student majoring in Food Engineering, during an Entrepreneur Development program at *«Tecnológico de Monterrey (Instituto Tecnológico y de Estudios Superiores de Monterrey)»*, Campus Monterrey. As a brief reference, this Institute is one of the most important private academic institutions in Latin America and is located in Monterrey (in the North of Mexico). Founded in 1943, the *«Tecnológico de Monterrey»* has grown into a nationwide university system of 33 campuses with headquarters in Latin America and connection offices in the USA, Canada, Europe, and Asia. Since its origin, the institute has developed strong relations with the industry and is distinguished for its training and consulting services to companies. *«Tecnológico de Monterrey»* also promotes the development of new businesses among its students and has a program to support entrepreneurs by incubating potentially successful new products or services.

The general objective of the project was to identify, in an academic context, areas of opportunity to improve the initial design of the product. The product was a snack made from a dehydrated vegetable and seasoned with chili pepper, lemon, and salt. Its direct competitors were defined as other snacks, based on potato chips and salted peanuts.

Although it is true that the creator of the product had perform a previous analysis, which allowed her to arrive at the creation of the product, the proposed methodology intended a more in depth investigation that would allow her to identify the key market requirements and the necessary technology for the product's final development.

The first stage of the project was to define a plan which involved the integration of QFD to the intelligence system.

Following this plan, the initial activities were focused on the collection of secondary information. The Internet (Google, CODEX Alimentarius, and the Official Catalogue of Mexican Norms) was used for this purpose, as illustrated in Chart 1, as well as the available databases (EBSCOhost EJS, Google Scholar, ProQuest, Euromonitor Global Market Information, Infolatina e ISI Emerging Markets) at *«Tecnológico de Monterrey»*'s digital library, as illustrated in Chart 2.

Internet pages	Access
CODEX Alimentarius	http://www.codexalimentarius.net/
Oficial Catalogue of Mexican Norms	http://www.economia-noms.gob.mx/
Google	http://www.google.com

Chart 1: Internet sources of information

Name	Type of Information
EBSCOhost EJS	Complete text of more than 800 magazines from different editorials with topics such as: Medicine, Business, Technology, among others.
Google: Scholar	Google Met browser which mainly finds research articles, books, university Web pages.
ProQuest	Indexes and summaries of more than 6,000 magazines in English. More than 3,300 magazine titles in full text.
Euromonitor Global Market Information	Market analysis, market parameters, market forecasts, information of companies and product brands, market profiles form different countries of the world.
Infolatina	Historic heritage of more than 270 journalistic sources of information from Mexico and Latin America to consult simultaneously with financial, legal, political or business.
ISI Emerging Markets	Financial and economic information of more than 25 emerging countries in Asia, Latin America and Europe.

Chart 2: Databases for the dehydrated vegetables project**.**

The purpose of searching in these sources was both to find the demands of the market and to identify its respective technological solutions. For the first case it was found, for example, that the product was healthy, crunchy, spicy, eye-catching, economical, etc. Whereas for the second case, new processes of dehydration were detected: different types of ovens, characteristics of packaging design, to mention some.

Hereafter, the collection of primary information was produced; the objective in this case was to identify the requirements of the product from both the Voice of the Customer and the Technician Voice, and subsequently, to determine the most important. To accomplish this, it was necessary to produce just enough of the product in the pilot plant to distribute along with the surveys. Given the fact that the project had an academic context, a sample of the *«Tecnológico de Monterrey»*, Campus Monterrey community was surveyed. The Voice of the Customer was analyzed first. To do this, 57 random surveys were applied to young people (between 18 and 29 years old) obtaining a return rate of 85.71 %., according to the following formula:

$$n = \frac{k^2 N(0.25)}{e^2(N-1) + k^2(0.25)}$$

Where N is the size of the population, 16979, a figure that corresponds to the number of students of *«Tecnológico de Monterrey»*, Campus Monterrey, registered for the 2006 August- December term: The constant K is related with the level of confidence, in this case we used K of 1.15, which gives a result with a 75% confidence level.

During the surveys, in addition to requesting the desired attributes (requirements) of the product, the assignation of priority for each requirement, using the numeric scales from 1-5, where 5 was of greatest importance, was requested. Given the fact that not everyone expressed the same requirements or assigned

the same priority to each requirement, averages were calculated according to the following equation.

$$PC_{QUE} = \frac{\sum_{i=1}^{a} PCi}{a}$$

Where:

PC_{QUE}, is the average priority of each customer requirement

$\sum_{i=1}^{a} PCi$, is the addition of all the priorities assigned to that requirement by each customer and a, is the total number of times each priority has for each requirement

Afterward, the team of technicians was interviewed in order to identify the possible technological solutions to the previous requirements. To do that, Affinity Diagrams (Cause and Effect) were used. After that, a work team, formed by the creator of the product together with two more food engineers was organized. They were asked to complete these diagrams where the possible answers for each requirement would be shown. Twenty-one cause and effect diagrams were elaborated in total, each one containing one requirement to attend. For this, the following classification was used:

- Machines and Equipment
- Work Methods
- Measure Processes
- Human Resources
- Raw Materials

The collection of primary information also included an evaluation of competitor products (potato chips and salted peanuts) by both the Voice of the Customer and the Technicians. This benchmarking provided very valuable information for the product development.

With the objective of processing the primary and secondary information, the typical approach of Quality Function Deployment was applied beginning with the matrix of relation, the weighing of columns and the co-relation matrix. For the first case, the customer and technician requirements were linked through symbols and numbers that expressed void, weak, medium or strong relations. On the other hand, to determine priorities, a numerical weighing of the matrix columns was performed, where the customer degree of importance of each attribute was evaluated. The co-relation matrix was integrated to identify the links that may exist among the different technological proposals (positive, negative or void).

Once all of the collected information was processed, the stage of analysis proceeded with the purpose of identifying those topics that would be most important for the product development. To do this, the diagram known as House of Quality was used, which allows for the identification of critical points, areas of opportunity, important threats, latent opportunities, and opportunities for advertising, among other elements. Regarding the critical points where the product had had a low performance, requirements from the voices of the Customer and the Technician's were identified. On the other hand, the areas of opportunity detected high priority customer requirements where there was a feasible technological solution that allowed a better performance than the competitors'.

Likewise, important threats resulted from high priority customer requirements where the competitors´ products were better evaluated. It dealt with market and technological expectations that were not being satisfied by the current product.

Moreover, customers' requirements rated as low priority can be considered to be latent opportunities when the competitors had better performance regarding product's characteristics. It involved requirements that at present did not represent an important necessity, but in the future could become important. As for advertising opportunities, requirements satisfied by the product were identified, and when compared with the competition they offered a better performance according to the customers and technical aspects. The final phase of this activity consisted in an integral and global analysis of all results, where points of convergence and synergies were found to identify the most appropriate technological solutions.

Once all these evaluations were completed, the lines of action were identified which allowed

redefinition or redirection of the product development, considering both the expectations of the customer and the feasibility in the production and launching, including technical, economic, organizational restrictions, etc.

In this manner, the last stage consisted of the elaboration of a strategic report of intelligence. This report included a series of recommendations to be carried out which would greatly impact the direct attributes of the product (sensory, design, chemical aspects, etc.) as well as recommendations for its production process (types of ovens, temperatures, ingredients, stages of development, etc.).

6 – CONCLUSION

The process of product development has undergone vertiginous changes in recent years due to elements such as market globalization and the arrival of new information and production technologies. In this context, it is essential to generate new approximations in strategic planning where not only market and technology are analyzed, but also future changes of the global environment are predicted.

Although it is true that there are numerous ways to approach this topic, the context of Total Quality Management was chosen, since it traditionally has had a fundamental role in project development. This document presents a model that integrates the disciplines of Quality Function Deployment and Intelligence Systems. It attempts to offer a holistic vision where the Voice of the Customer and the Technician's are analyzed in a synergic manner, together with research of the competitive intelligence.

The basic elements that comprise the model are displayed, as well as an initial application, where a food product is used and arises in an entrepreneur program.

There is still a great deal to do. The case presented here is only an initial approach to a more advanced and complete application of the proposed model. Although it is true that important opportunities of improvement and latent threats were identified, and that these results are being considered to achieve a better product development, it is still an initial application within the academic context. However, the Model presents an attractive alternative to be considered in future development of products.

REFERENCES

Akao, Y., Mazur, G.H. (2003), «The leading edge in QFD: Past, present and future», *International Journal of Quality & Reliability Management*. Vol. 20, n° 1, p. 20-35.

Chan, L., Wu, M. (2002), «Quality function deployment: A literature review», *European Journal of Operational Research*. Vol. 143, n° 3, p. 463-497.

Day, R.G. (1993), *Quality function deployment: Linking a company with its customers*, ASQC Quality Press, Milwaukee.

Jaworski, B.J., Macinnis, D.J., Kohli, A.K. (2002), «Generating competitive intelligence in organizations», *Journal of Market - Focused Management*. Vol. 5, n° 4, p. 279-307.

Krishnan, V., Ulrich, K.T. (2002), «Product development decisions: A review of the literature», *Management Science*. Vol. 47, n° 1, p. 1-21.

Norling, P.M., Herring, J.P., Rosenkrans, W.A., Stellpflug, M., Kaufman, S.B. (2000), «Putting competitive technology intelligence to work», *Research Technology Management*. Vol. 43, n° 5, p. 23-28.

Rodríguez, M. (2001), «De la información a la inteligencia tecnológica: Oportunidades para la innovación», *Revista Transferencia*. Año. 14, n° 54, p. 28-29.

Rodríguez, M., Eddy, A., Garza, R. (2002), «Industry/University cooperative research in competitive technical intelligence: A case of identifying technological trends for a Mexican steel manufacturer», *Research Evaluation*. Vol. 11, n° 3, p. 165-173.

Tena, J., Comai, A. (2002), «Cómo la inteligencia competitiva apoya a la innovación», *Puzzle Revista Hispana de la Inteligencia Competitiva*. Vol. 2, n° 8, p. 14-18