DESIGN AND DEVELOPMENT OF A DIDACTIC EQUIPMENT BASED ON COMPETITIVE AND TECHNICAL INTELLIGENCE

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Résumé

Cet article vise à décrire une méthode pour concevoir et développer, un équipement didactique basé sur l'intelligence économique et la veille technologique.
Cette méthode contient plusieurs étages, incluant la compréhension des opportunité, le développement de concept et le développement de produit. Afin de confirmer l'utilité de la méthodologie dans un environnement concurrentiel, la première étape est appliquée dans un laboratoire de système logique de l'Institut de Technologie et d'Etudes Supérieures de Monterrey (ITESM), Mexique, dans le but de créer un projet qui permettra au groupe projet des laboratoires sur d'autres campus de la même institution. Le laboratoire proposé sera capable de concurrencer les concurrents identifiés dans l'étude de cas, en ayant un avantage compétitif, basé sur son design didactique pour un apprentissage actif.

Summary

This article aims to describe a methodology to design and develop a didactic equipment based on competitive and technical intelligence, concurrent engineering and new product or process development. This methodology contains different stages, which include the understanding of opportunities, concept development and product development. In order to confirm the utility of the methodology in the competitive environment, the initial stage is applied in a logical systems laboratory of the Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM), Mexico in order to create a project that will allow its group members to create laboratories in other campuses of the same institution. The proposed laboratory will be able to compete with the identified competitors in the case study by having a competitive advantage based on its didactic design for active learning.

1 Introduction

Currently the Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM) has a project to design, construct and develop an automatic logic station to impart laboratories of logical systems design of the mechatronics engineering degree. Even though the sole purpose of the project is to create project for in campus benefits, the team members would also like to identify the market opportunities of the business in order to create more laboratories in other campuses of the same institution. Given this situation, the project presented in this article has been developed with the objective of establishing a methodology that supports the design and development of the didactic equipment by creating a standard guide that allows the group to have a documented process to obtain a teaching guide of logical control. According to time and resource constraints of the case study, the following ranges will be taken into consideration:

- With respect to the didactic equipment, only the laboratory of logical systems in the ITESM (Monterrey campus) will be studied
- Only the users from the institution that use the equipment will be taken into account
- In order to validate the methodology, only the first stage will be applied since this stage only takes into account its design

2 Background Information

2.1 Competitive Intelligence

Competitive intelligence is defined by the Society of Competitive Intelligence Professionals (SCIP) as "the process of monitoring the competitive environment and analyzing the findings in the context of internal issues, for the purpose of decision support…involving the legal and ethical collection of information, analysis that does not avoid unwelcome conclusions, and controlled dissemination of actionable intelligence to decision makers" [1]. Even though various authors [2,3,4] present different steps in this process, the majority of them coincide in the following: planning and direction; selection of databases; processing and collection of information; analysis of information; and diffusion of results. Competitive Intelligence traditionally appears under a pattern of an information cycle that has been extensively presented and occasionally mistrusted [5, 6, 7]. For this project, we have adopted the spirit of the cycle and we have left aside some of its drawbacks.

During the first step of planning and direction, the company must develop a plan according to the company's needs by identifying goals and activities that support a technological research and the strategic actions that must be taken. Of course, strategy and information are linked, going to and from one another, but in this situation, the project starts with a vision of an unclear opportunity. To that respect, we notice that a first strategic intent is rather before information. Therefore, the situation is rather a competitive intelligence approach rather than a (technological) watch approach. When selecting databases, an evaluation must be developed to select which primary and secondary sources of information allow the company to obtain critical and trustworthy data. To process and collect information it's necessary to define a strategy that allows information to be obtained adequately and in less time that can be registered by affinity (groups, years or relevance) or by keywords to be easily identified. Also, within this database searching, rational search plans are associated with a more lucky approach like berrypicking [8], reconsidering the search at each bit of information we encounter [9]. Information Overload is an issue that has to be taken into account in order to work with a satisfying quantity of information, considering that too much information can detrimental to a Competitive Intelligence activity, and considering that information may not always be a good thing [10]. Finally, the diffusion of results stage must include all the persons involved in the process [11] allowing them to improve their decision making process about the development of products and services that help them anticipate market changes. All these steps must primarily focus on distributing aggregated value information to decision makers in order to take correct decisions that will impact in a medium to long-term development of the company.

2.2 Product Design and Development

The design stage plays an important role when developing a product since it defines the physical form of the product to adapt accordingly to the client's needs [12]. In order to personalize a product, companies can design based on user insights allowing it to specify its properties by defining the desired requirements for its use [13].

Ulrich and Eppinger's [12] new product development process contains six stages that guide a company to design and produce a product that they wish to market. Rosenthal [14] also presents a new product development process having various stages considering the conception of the idea and the required tools that facilitate the development process. Otto and Wood's [15] process contains three stages allowing the company to take decisions with regard to the possible success of the product and production, which will be used to create the proposed methodology. Concurrent engineering was also considered in the research allowing the company to simultaneously make different product development activities. Its objective is to reduce the total time of the process by concurrently executing the different activities related to design and production [16].

2.3 Active Learning and Didactic Equipments

The didactic equipment is the physical mechanism that students use to develop their skills and formation to obtain a better learning. The student teams help the instructor with its teaching work through active learning of the student since they will be able to carry out the activities that help them create its own learning. This equipment will therefore construct a similar working environment where real problems will be analyzed and students will need to propose real solutions using the various tools that are available in the workstation. Learning based on experiences allows the student to learn by himself and adjust according to the characteristics of the academic environment and teaching styles [17].

3 Description of the Proposed Model

The proposed methodology that takes into account the design and development of a didactic equipment based on competitive intelligence is shown in Figure 1. Some considerations that must be taken into account when applying the methodology are the following:

- The process used for the designing will be integrated in a concurrent way in each of the steps and the group workers will work in teams and with constant communication.
- Since this design is focused on teaching, the intelligence process must be based on internal and external clients.

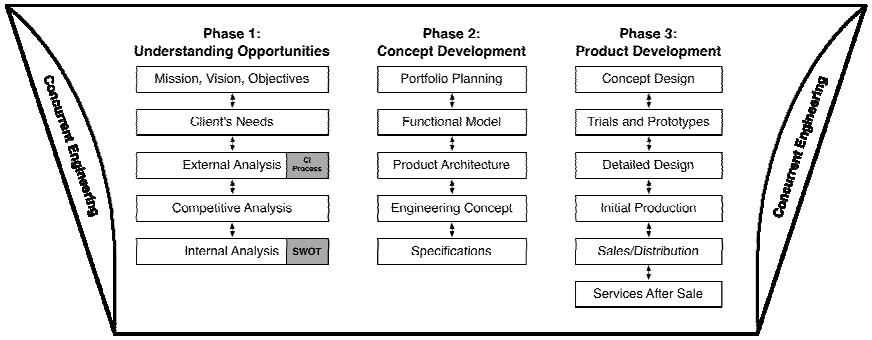

Figure 1 : representation of model

3.1 Understanding Opportunities

In this first phase all aspects related to the conception of an idea for development will be known by understanding the market opportunities related to the client's needs, and the strengths and weaknesses the company has. This work will allow the company to accomplish its goals according to the client's needs to continue being competitive in its industry. The steps that should be completed in this initial phase are:

Mission, Vision, and Objectives: The company should start by stating its mission showing why the company exists or why it is in its actual industry. With regard with the definition of the vision by the company, it should be developed considering the following two aspects: what makes the company exist and the long-term future aspirations of the company [18]. By stating the objectives, the company will try to accomplish its own goals that will be transformed into action plans allowing the company to fulfill them.

Client's Needs: Initially it is important to know who the client is and what he is searching, but to determine its needs, the company should use interviews, questionnaires, polls, and other means to obtain all the information directly from the client.

External Analysis: This step allows the company to determine new developments, techniques, products or opportunities that are related to the company's industry. Dishman & Calof's [19] competitive intelligence process is very similar to the standard competitive intelligence process, however the difference exists in the communication step by creating awareness and an organizational culture to improve its effectiveness.

Competitive Analysis: This analysis is developed to determine the precise location of the company and its competitors in the market to determine the differences or advantages the company has or doesn't have to be more competitive.

Internal Analysis: This step contains an analysis of the company's actual status and the adequate tool to use is the SWOT (Strengths, Weaknesses, Opportunities, Threats) matrix [20]. This matrix can be developed with the help of the information obtained from the previous analysis made and can include the opinion of the board of directors to determine with priority and accuracy each of the points the tool has.

3.2 Concept Development

This second phase takes into account the functional and design aspects in order to define its structure and finally its production and distribution. The steps that should be completed are:

- *Portfolio Planning:* This step consists in the definition of the different products offered by the company and should include an initial drawing and brief description of each one of them.
- *Functional Model:* To clarify and design the architecture of the product it's necessary to create a model to see how the product should work by determining the logical sequence according to the inputs, interconnections and outputs [15].
- *Product Architecture:* This step takes into account the critical decisions related to the physical operation of the product [15] in order to see if the concept can really be developed since there should exist a connection between the functions and the physical form of the product.
- *Engineering Concept:* During this step, designers apply their creativity to generate innovative concepts since they select technologies and developments that meet their actual demands.
- *Specifications:* Once the work team defines the quantitative specifications, they are transformed into production requirements that define each detail of its structure to be considered in the activities that follow the development of the product.

3.3 Product Development

This phase is titled 'Product Development' and takes into account the steps needed to create the product, starting with its design and finalizing with the development of the physical product.

- *Concept Design:* This step considers the relationship with the other activities related to the product's development by creating initial sketches that express the creative ideas of designers based on the accomplishment of demands, the technical viability, costs and manufacturing considerations.
- *Trials and Prototypes:* In this step, initial and non-working models are created allowing clients to offer feedback and consequently refine the final concept. Prototypes should constantly be modified to effectively meet the client's needs.
- *Detailed Design:* During this step, the product's characteristics are specifically defined by designing the functional part of the product and decisions are taken according to the geometry, the materials used and the unique parts of the concept.
- *Initial Production:* Once the production plan, the available resources and the assembly process are developed, an initial production of the product is made to obtain the clients approval and make final modifications in the product or production process.
- *Sales/Distribution:* Since the production has already been controlled in the previous step, it is now necessary to synchronize the work related to the other parts of the company: sales, marketing, advertizing, inventories and distribution.
- *Services After Sales:* The greatest benefit of this step is to maintain the communication with the client to improve and lengthen the relationship that will allow them to know new preferences or needs that may be required by the product.

4 Application

This case study shows the application of the proposed methodology where the concept's development is accomplished through the completion of the steps that form part of the initial phase. Three aspects that should be taken into consideration are:

- The application will be related to the teaching environment since the didactic equipment is used for the student's learning

- Given the scope of the case study, the limited time frame and its purpose, only the first phase of the proposal will be completed
- Even though the case study is developed in the Monterrey Campus of the Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM), the development of the didactic equipment will be treated as an external company by taking into account the competitors involved in the teaching industry

Below you will observe the outcomes of each step in the initial phase of the methodology that will help determine the planning concept based on the needs and results made from the analysis:

Mission, Vision, Objectives: According to the model developed by Collins & Porras [18] the mission, vision, and objectives in their given time frame are:

- *Mission 2009-2012:* We are a company that offers didactic stations of automatic logic controls for active learning to universities, academic institutions and industrial training facilities in Monterrey, N.L., having the competitive advantage of its didactic design for active learning.
- *Vision 2010-2015:* We offer didactic stations of automatic logic controls trying to be the principal suppliers of the service to universities, academic institutions and industrial training facilities of the country.
- *Objectives:* Design a didactic equipment for active learning, improve the design of the actual equipment, commercialize the didactic equipment, and establish an advertizing strategy based on the identified benefits for universities, academic institutions and industrial training facilities.

Client's Needs: The client's identified for the case study are the following: the company in study (board of directors); Mexican universities, academic institutions and industrial training facilities; instructors of the logic control lab (3 instructors in ITESM); and the students using the logic control lab (approximately 100). After making various interviews with the potential clients, the following needs where identified as critical: design focused on active learning, improve the financial status of the company and improve the teaching methods.

External Analysis: Using the Competitive Intelligence process proposed by Dishman & Calof [19], the results in each of the steps are the following:

- *Planning and Direction:* Some of the intelligence objectives proposed by Cisneros [20] that will be used for the planning process are the following: a description of the competitive environment to strengthen the competitive advantage, use intelligence to implement and adjust the strategy for the changing competitive environment, and identify market opportunities to determine the strategy.
- *Collection:* After carefully selecting the adequate databases that meet certain criteria, it was possible to identify the following competitors: FESTO, ARMFIELD, FEEDBACK, AMATROL, and ECP. FESTO is the leading competitor in the industry since they focus on different research areas including electrical processes, fluid processes, motors, chamber devices and electrical connections.
- *Analysis:* Once the information was processed, the following conclusions were defined:
    - The current trend to take these courses is through virtual laboratories (with help of remote access).
    - The competitors offer various didactics for the technical training of people in the academic and industrial sectors by developing their personal teaching systems and designing the courses, materials and softwares used.
    - The majority of the patents registered by FESTO are related to the fluid process control.
- *Communication:* The key decision makers are introduced to Competitive Intelligence by allowing their participation in any one of the steps defined previously and they can also check the progress through a web page. They can also use periodic meetings to give feedback about the expected and delivered results.
- *Decisions:* The following considerations have been established in order to formulate the adequate strategy:
    - Design an interactive equipment that offers virtual opportunities with a user friendly software
    - A didactic equipment that allows the student to construct industrial processes

- Design a course that doesn't omit the didactic part where the student is supposed to learn in an active way
- A prominent focus towards the industrial processes related to the management of fluids

Competitive Analysis: This analysis will be used to compare the different didactic equipments with the ones identified in the competitors by its similarity. The outcome of this step is to define the competitor's characteristics and determine the necessary adjustments in the actual design. According to the comparative results, the following information was obtained from each competitor:

- FESTO: Its workstations are much more structured by having more than one system (distribution, storage, classification and separation). Its learning system gives the participants theoretical and practical insights related to design, assembly, detection of flaws and maintenance of industrial automated systems.
- *ARMFIELD:* They offer multifunctional didactic training systems to control processes, which give the students complete stations to experiment with by making the corresponding exercises. It focuses on the application of process control systems by having teams that can be configured to make these activities.
- *FEEDBACK:* They offer training teams depending on the course subjects allowing the student to experiment in the typical learning environment to control industrial processes. Its portability allows students to only focus on one methodology at a time.
- *AMATROL:* Its advantage of offering mobile stations allows it to be used independently and in combination with other stations. The equipment is complemented by an integral mechatronic system with the use of sensors, valves, pneumatics, robots and PLC.

Internal Analysis: Using the information gathered and analyzed in the prior stages, a SWOT analysis can be developed and is presented in Figure 2.

Strengths	**Weaknesses**
- Considering active learning to design the didactic equipment - Equipment focused on didactics - Station that integrates the industry's application control (PLC, pneumatic, electric, electronic) - The exercises allows interactions with students that have similar problems - The didactic doesn't only focus on the use of the equipment	- Low relationship between the design department and the final user - Low integration in the organizational structure in the development process - There is no detailed definition in the organizational structure by functions and specific activities - Lack of development process control throughout the supply chain
Opportunities	**Threats**
- The application of active learning can be made in virtual labs - Use of virtual interaction in the teaching method - An improvement in the definition of functions and corresponding roles in the design and development process - Competitors define their own courses - Competitors design their didactic allowing the student to see and learn the industrial applications	- FESTO currently has more patent applications - AMATROL is focused in developing mechatronic stations - ARMFIELD offers stations for process control stations

Figure 2 : SWOT analysis

5 Discussion

Only the development side of Competitive Intelligence has been presented here. Of course Competitive Intelligence also includes some concerns about protection of information and ethics in looking for information for instance.

6 Conclusions

With respect to the case study, recent publications have shown that tools with remote access have been used in virtual labs, as well as for the design of the courses related to the didactic teaching taking into account the application of activities that prepare the students for the industry processes. After taking into consideration the results from the SWOT analysis, the following concept definition has been made: improve the teaching method by modifying its design in a compact way to be combined with other equipments allowing it to diversify its activities to improve the active participation of the student.

In the proposed methodology, only the first stage was applied since the other phases determine similar activities to the existing development processes. With this study, it's possible to determine relevant aspects of the environment by using Competitive Intelligence, which makes it possible to use the best advantages. The internal analysis made was useful to determine the key points in development by identifying opportunities and threats that make it possible to know the key competitor characteristics. This methodology is useful to design and develop a didactic equipment by using competitive intelligence since it helps determine the relevant aspects taking into account the external and competitive environment in education.

For future research, it's recommended to apply the next two stages of the proposed methodology in order to use the identified needs and concept strategies to finally develop the desired concept. Another recommendation is to perform studies for different laboratory didactic equipments, where the student needs to experiment with the results of the exercise. The final recommendation is to design academic programs that use the didactic equipment considering active learning and allowing students to experiment with the exercises in the laboratory.

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