

Methodology of Innovation and Technological Modernization for the Graphics Arts Industry

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ABSTRACT

At present, the phenomenon of technological modernization becomes a major opportunity for companies in the graphic industry in Mexico, according to information of the Chamber of Graphics Arts Industry (CANAGRAF), the Industrial Union of Lithographers of Mexico (UILMAC), The Latin American Confederation of the Graphic Industry (CONLATINGRAF) and the National Association of Manufacturers and Distributors for the Graphic Industry (ANIDIGRAF). The lack of improved operational efficiency, lack of technological innovation strategies, the need for better financing mechanisms and factors that require a new organization for the new digital technologies of the century, are some areas that demand improvements in the graphics arts industry in Mexico. Institutions related to the graphic sector have pursued strategies that allow them to improve their productivity, profitability and competitiveness. Unfortunately the results are not encouraging as evidenced by the strategic study of the sector to analyze the competitiveness and sustainable development of the production chain of Graphics Arts Industry. Our research is based on an applied work at a lithographic company supported by a qualitative and quantitative approach to determine in a pragmatic way, the path to modernize their processes by applying an original methodology to improve the productivity measured by lead time, waste, make ready and rework. The results of applying this methodology suggest that the most important factors are, (1) the use of mechanisms supported by the scientific method to simplify plant operations (lean enterprise), that at the same time increase overall productivity, (2) the presence of a strong leadership team that promotes cohesiveness, encouraging change, and (3) a strategic environment conducive to the development of a culture of innovation.

Keywords: Strategy, Participative Leadership, Graphic Art, Innovation, Technological Modernization, Productivity and Lithography.

1. INTRODUCTION

Mexico is a free market economy, according to the International Monetary Fund, is the 2nd in Latin America, 3rd in all the Americas and 14th worldwide [1]. The service sector accounts for 63.5% of national Gross Domestic Product (GDP), followed by the industrial sector with 32.6% and 3.9% corresponds to the agricultural sector, according to information from the Central Intelligence Agency [2]. This economy is based primarily on the activities played by micro, small and medium enterprises. For the National Institute of Statistics and Geography, micro, small and medium enterprises represent 98.8% of the economic units in the country and employ 73.1% of the economically active

population, in addition to contributing 52% of National GDP [3]. Because of the various trade agreements, the phenomenon of globalization and the economic and financial crises, micro, small and medium businesses today have had to face intense competition, which has led them to adopt different strategies to stay on the market. These companies have been highly affected to cope with competition due to a number of factors have limited its adaptation to change. Pomar and Ramirez state that: "among the main factors limiting adaptation can be posted to:

1) The difficult access to financing, 2) the lack of information on markets for their products, 3) reduced human capital training, 4) limited use of technology, 5) ignorance of standardization to market their products in international markets, 6) the low spending on research and development, 7) the lack of certification, 8) financial and business culture, 9) centralized decision making and 10) the technological backwardness" [4]. So that micro, small and medium enterprises may face the changing environment and to adjust it properly, a substantial investment is required in product design or process change. Unfortunately this seems to be unreachable because they do not have the knowledge and resources to carry it out. According to Reyes "in the last 25 years the most striking change - in the business architecture - is the speed, diversity and impact of change, so you can ensure that change factors actually changed" [5]. Today the importance of a holistic view that considers the circumstances, context and forecasts are essential for the graphics industry in the new century. So also business strategies have shifted from setting the focus on the opportunity - just in case - to adopt a focus on efficiency - just in time - and more recently in the attribute - just for you -. These last two business strategies require the plant to maintain a new graphical approach to simplify the operations - Lean Enterprise - diversifying the mix of specialties and short production runs. It is in this sense that the core competencies of the graphic arts industry must rely on the capacity of the organization to realize, make sense and take charge. According to the above, the printing industry of the new century searches the mechanisms for technological modernization that allow the flexibility of its processes, increase their production runs, reducing their waste, improving social conditions and the environment. For the sake of increasingly intensive penetration of digital systems, graphic companies should guide and prepare their processes based on Lean Enterprise and Computer Integrated Manufacturing Systems- LE/CIMS - in order to confront an ongoing competitive digital printing technology industry.

2. THE GLOBAL GRAPHIC ARTS INDUSTRY

According to the General Graphic Arts Glossary, Graphic Art is defined as: "The professions, business and industrial

occupations related to the creation of printed products. Graphic design, prepress, printing, binding and similar occupations are directly related to the graphic arts. Advertising, writing, photography, drawing, painting and the like are occupations that may be related to the graphic arts” [6]. In general terms we can understand all this printing technique used for the reproduction of characters, images and shapes through the use of tooling and intervention ink or without them, allowing us to clearly see the results of such combinations. According to Graph Expo the world market for printing is distributed as follows [7]:

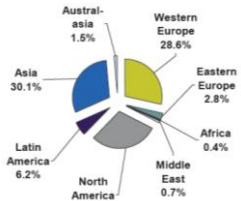


Figure 1 World Market for Printing
Source: Graph Expo (2007)

According to PRIMIR 'World Wide Market for Print' by Pira International the markets leading in the printing industry are [8]:

Rank	Country	2006 Sales Millions Dollars	Growth 2005-2006 (%)	2011 Sales Millions Dollars	Growth 2006-2011 (%)
1°	USA	182000.7	2.8	196722.7	8.1
2°	Japan	84976.0	-3.3	88363.7	4.0
3°	China	41200.0	17.0	65934.1	60.0
4°	Germany	38974.2	1.5	43329.9	11.7
5°	UK	34937.0	4.0	39030.6	11.7
6°	France	23251.5	2.9	26731.4	15.0
7°	Italy	23096.3	2.6	26000.4	12.6
8°	Canada	16136.4	11.6	17792.2	10.3
9°	Spain	13856.0	4.1	16074.4	16.0
10°	Brazil	12552.2	18.5	19192.2	52.9
11°	México	12277.5	7.1	16550.4	34.8
12°	India	12131.0	7.8	20990.7	73.0

Table 1 Ranking International Printing
Source: PRIMIR (2011).

According to the Center for Production Studies the main products and printing systems are [9]:

Printing Systems	Characteristics	Main Products
Offset	Indirect printing mode water based ink and flat tooling.	Continuous forms, posters, stationery, labels, magazines and books.
Flexography	Direct printing mode based ink and rubber sheet.	Stickers, corrugated packaging, flexible packaging and values.
Rotogravure	Direct printing mode based ink and tooling to low relief.	Labels and flexible packaging.
Serigraphy	Direct Print Mode based ink and nylon screen.	Security Printing and values.
Digital	Model-based direct printing and laser xerographic principles.	Works on order

Table 2 Main Printing Systems and Products
Source: CEP (2011)

For Payne and Terni the world market of printing is characterized by a break in the demand for printing in developed regions, fragmentation of societies, surge of globalization, the internet as the main competitor for printing, rupture of GDP (Gross Domestic Product) in developed countries, and the pressure to improve social and environmental conditions [10], [11]. According to Payne, the market outlook for printing is promising based on global trade trends. America will remain the largest market of printing, the emphasis should

be placed on the change from the developed world to the emerging world, and the products with decreasing demand in developed markets should be well received by emerging countries, since manufacturers need to look at markets with large populations and rapid growth ratios [10].

3. THE GRAPHIC ARTS INDUSTRY IN MEXICO

Division IV of the economy in Mexico is made up of two main branches: (1) branch 31, known as paper and paper products (covers the pulp and paper companies, which are medium to large capital-intensive) and (2) branch 32, referred to as printing and publishing (including predominantly micro and small enterprises). In figure 2 a broad overview of the characterization of the Division IV is presented [12].

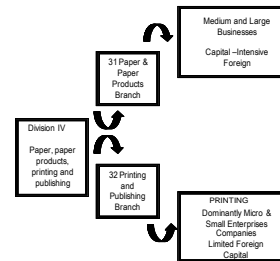


Figure 2 Characterization of the Division IV
Source: National Financial (2010)

It is composed almost entirely by micro enterprises, many of which are family legacy, is shown below the structure of the industry by size [13]:

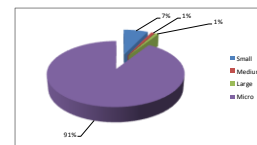


Figure 3 Structure of the Industry by Size.
Source: CROMATICA (2010)

As a buyer, the printing and publishing sector performed 82% of their purchases from the following sectors [12]:

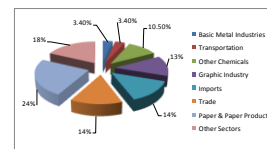


Figure 4 Procurement in the Graphic Arts
Source: National Financial (2010)

As a seller, printing and publishing 68.8% offer the following sectors [12]:

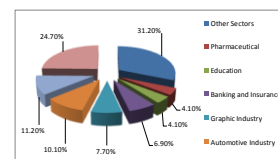


Figure 5 The Sales in the Graphics Arts
Source: National Financial (2010)

The Printing Technologies most used in the printing industry in Mexico and according to their importance are: Offset or Lithography, Rotogravure, Phlebography, screen printing, typography and digital printing. Parallel to this analysis the printing industry in Mexico has the following areas for improvement: (1) Renewal technology of products and processes, (2) Creating new business models, (3) Training and organization of digital technologies, (4) Flexibility of materials and processes, (5) Productivity Improvement, (6) Strategies for technological innovation, (7) Better funding mechanisms, and (8) Access to global markets. It is in this sense that the graphics industry in developed and emerging countries tends to look to similar new technologies to break into global markets, to elements of the organization, to modernization and business innovation and to improvements in productivity and flexibility of their processes to meet to a changing and fragmented market. In terms of openness towards digital technology processes the graphics printing industry should seek business modernization strategies to offer unique value propositions in the context of an increasingly globalized economy.

3.1 Technological Modernization of the Printing Industry in Mexico

According to Porter “the term strategy is any action that makes it different bringing a competitive advantage” [14]. For Porter competition becomes destructive when companies compete on a similar basis, hence the strategy is to seek a new way to compete by creating a different value for the consumer allowing the company to prosper and achieve higher profitability. According to Dombois and Pries “industrial or business modernization changes refer to organizational changes along with technological changes in production processes” [15]. According to the authors this is a systemic evolution born in Japan in the mid 50's and spreading with multiple variants worldwide. These new technologies facilitate the production of differentiated goods and services, increasing productivity and thus enhancing capital value. According to Gamboa and Nava in order to carry out the modernization, enterprise companies execute business strategies that are understood as: “the means of achieving changes in medium and long term periods for comparative advantages purposes or actions proposed to counteract current or future competitors. Besides there are underlying principles, values and goals that determine the direction of the business. The strategy has a number of efforts to integrate and coordinate resources and operations in a coherent whole in terms of goals or general purposes” [16]. For Hernandez “technological modernization means to improve or modify products or processes that are being used by a company, as in the case of the pilot plant construction, development and prototypes production, pre-runs of product introduction, the introduction of technology for production management, quality that enhances productivity, and all activities in the transition from a pilot stage to industrial stage” [17]. For Gamboa and Nava companies currently make use of technological modernization in production to coordinate dispersed activities, increase flexibility, access to global markets, alter production design and effectively control plant personnel [16]. In the article “Eight Business Technology Trends to Watch” by Manyika, Roberts & Sprague they explain how eight technology trends are changing the way we do business, including expanding the frontiers of automation [18]. Besides Porter & Millar claim that

companies are undergoing a technological revolution due to the advancement of technology, hence plants must use these tools to take control of the business or the companies will be forced to use them even if it is too late [19]. Hence Computer Integrated Manufacturing (CIM) is for Mendoza “a new way of organizing the resources of the company, which allows real time control of all activities that occur in the company, both internally and externally” [20]. For Montañó “the process of technological modernization in Mexico is a result of globalization from a double transition: the crisis of productivity in developed countries and the financial funding crisis of Mexican development” [21]. Montano (2008) also states that : “while not all companies have developed explicit strategies, the ones that have done it, follow a general pattern or are poorly organized” [21]. In addition, Hernandez considers that industry is experiencing a shift from an import substitution model to an export promotion globalized model where the process of modernization begins. This is a restructuring process where the entrepreneur is the center of the decisions, assigning responsibilities to reorganize the company in order to be competitive [17]. Carrillo and de la Garza [22], [23] show that early in the new century there are many small and medium enterprises that have failed even to start their modernization. De la Hoz and Quintero [24] believe that due to technological upgrading computer-controlled production has shifted from basic innovation to the widespread of radical and mature innovation. According to the author, this is due to two trends: a technology push that has facilitated the use of computers and the demand pressure in the manufacturing industry to machinery, equipment and processes to be more productive and flexible. Finally for Lopez and Martinez innovation and technological modernization are instruments that are generating large gaps between transnational corporations of developed countries against small and medium enterprises in developing countries like Mexico [25]. In summary the introduction of technological modernization in the graphics industry in Mexican is characterized by: (1) The lack of mechanisms to modernize equipment, (2) Absence of an innovation-oriented culture, (3) A slight opening to markets Overall, (4) Need for operational efficiency improvement, (5) Lack of training of operating personnel, (6) Lack of a strategic and holistic industry, (7) Need for new ways to organize production and (8) Lack of a methodology for technological modernization [26], [27].

4. RESEARCH METHODOLOGY

This research has begun with the analysis of general information, which subsequently led to conclusions very particular, so for the design of the methodology of modernization and for the implementation of the model. Considering the nature of the study, the research methodology employed has been referred to as a Case Study. According to Hernandez “Case Study” is a quantitative and qualitative research process that analyzes an integral unit to respond to the problem statement, hypothesis testing and developing theory [28]. This research methodology has been divided into two stages: (1) Design Methodology: We used a transversal, qualitative, and non-experimental (preguntar) approach, for it were available tools such as: (A) The exploration of manufacturing systems used by the plant graphics to modernize its processes, (B) Observation and direct intervention in the case

study and (C) Open interviews with managers and operational people at "The Firm". These tools were applied to personnel involved in this success story, which together with the graphic information institutes have joined to form this design; (2) Implementation of the Methodology: Consists of a transversal, quantitative and pre-experimental approach, for which statistical tools were used for productivity indexes including Lead Time, Waste, Make Ready, & Rework. It has been possible to demonstrate this methodology in conjunction with the history of the plant.

4.1 Design Methodology

According to research manufacturing systems employed by the company in order of importance are:

Elements	Manufacturing Systems			
	FPS	TPS	CIM	LE
Product Line	Straight	U ó L	Hybrid	U
Product Life Cycle	Decade	Annual	Monthly	Monthly
Flexibility	One	Multiproduct	Multiproduct	Multiproduct
Organization	Vertically	Flat	Network	Flat
Ability of HR	Basic	Multifunctional	Expert	Plurifunctional
Material Handling	Chain	Flexible Band	VGA	Flexible
Foundation	Perfection	Integration of Tasks	Intelligent Integration	Strategic Integration
Unity	Station	Cell	Cell	Cell
Strategy	Reduction in Costs	Working Method	Innovation	Value Proposition
Structure	Asynchronous	Synchronous	TR	TR
Responding Change	Limited	Adaptable	Instant	Adaptable
Machine/Operator	One	A Group	A Set	A Group
Bureaucracy	Very High	Low	Nil	Very Low
Market	Closed	Open	World	World
Value Proposition	Nil	Medium	High	Very High
Crisis Response	Reduces Staff	Flexibility	Advance	Strategic
Economic Lot	High	Low	One	One
Core Process	Rigid & Inflexible	Rigid & Inflexible	Technological	Lean
Innovation	Limited	Open	Constant	Continuous
Methods & Techniques	Conventional	Techno - Human	Advanced	Techno - Human
Leadership	Autocratic	Group	Managerial	Participatory
Vision Improvement	Process	Company	Global	Holistic
Management	Push	Pull	Pull	Pull
Core Business	Productivity	Flexibility	Innovation	Strategic
Stakeholders	Only	Limited	Definite	Wide

FPS: Ford Production System, TPS: Toyota Production System, CIM: Computer Integrated Manufacturing, LE: Lean Enterprise

Table 3 The manufacturing system employed by the company
Source: Personal Development

According to the observations and interviews with operational staff and managers, they never pursued the technological modernization of the company as an end or goal, rather they seek to improve the productivity of four basic indicators: (1) Lead Time (2) Make Ready, (3) Waste, and (4) Rework. The reconstruction methodology used for the improvement of these indicators is presented next:

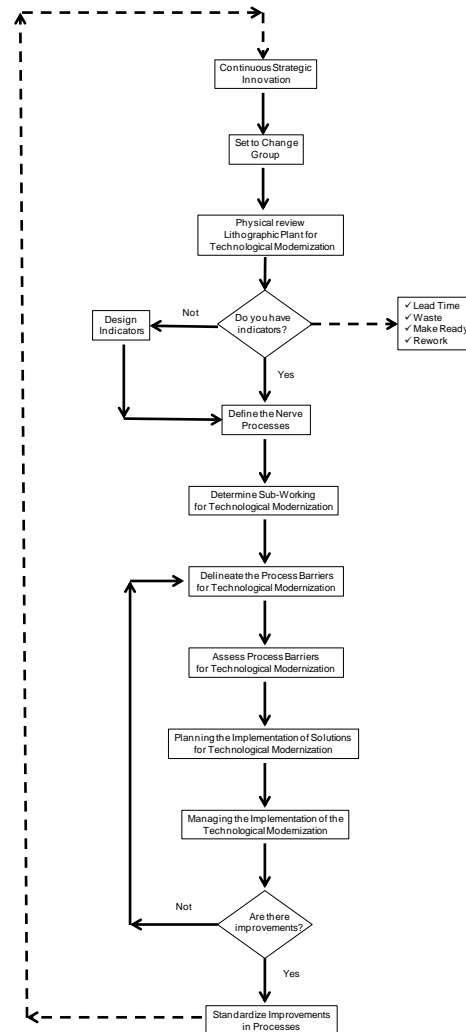


Figure 6 Technological Modernization Methodology
Source: Authors Creation

4.2 Implementation of the Methodology

"The Firm" - as we will call from now on – is a corporation, whose business is lithography, this can be classified as medium enterprise (120 workers, including operational and administrative). It started operations in the late 60's in the first workshop of the Moctezuma vicinity in the state of Mexico, with the following features:

- Location: State of Mexico
- Distribution of Plant: Process
- Type of Organization: Vertical
- Production System: Ford Production System

Infrastructure: 15 presses and 6 collectors
 Technical and Support Staff: 67
 Main Products: Print Set
 Main Suppliers: GP, Sandvik, Zeller and Sicpa

Set to Change Group

A group called "change group" was formed with the help of the general management and it was comprised by the superintendent of production and planning, the headquarters of maintenance and quality, as well as sales management and accounting. This group of people was created naturally and motivated by a strategic and participatory leadership, which initially was led by the superintendent of production and whose main goal was the improvement of productivity indicators.

Physical Review

Initially, visits were made within three working periods. We could observed the following problems: The delay in the delivery of planned orders that caused bottlenecks, the high volume of waste at the plant, the delay in shifts in the preparation of runs, and the high rate of rework in the shipping area.

Determination of Indicators

The team agreed to design and improvement of the following indicators: Lead time (days), Waste (% of Total), Make Ready (Hrs.) and Rework (% of Total).

Nerve Processes

The working group defined as nerve or spinal process to activities that are important for the productivity of the lithography system. The aim was to provide quality products at the agreed time, at reduced cost. The nerve process found were: The nerve process solution (Sales), Programming nerve process (planning), the elaboration nerve process (production), nerve distribution process (Departure), the nerve satisfaction process (Customer).

Delimiting Sub-Working

The change group agreed the creation of small working subgroups according to the nerve processes and not more than five people who would be the link between the strategic part and the operational part.

Delineate the Process Barriers

The change group and subgroups of work were aided by process barrier diagrams to define the obstacles that did not add value to the product and limited operational efficiency.

Assess Process Barriers

Once the boundaries of process were defined, we proceeded to assess the impact of the solution and the difficulty in implementing the recommended ideas. According to the group only seven actions were filtered having the greatest impact and relative least difficulty: definition of the business strategy, market analysis, application of lean thinking, using the concept

of group technology, manufacturing cell design, real-time communication, innovation in all areas.

Planning the Implementation of Solutions

The detailed implementation of the solutions for each nerve process and delineated responsibilities was accomplished in with the aid of an activity scheduler.

Managing the Implementation of Ideas

With the help of a diagram called management of the implementation of ideas, bulletin boards were used to indicate the process improvement activities, entering activities, and activities awaiting implementation.

Process Improvement

The comparative solutions after the implementation are shown below.

Indicator	Present	Future
Lead Time	7 days	2 days
Waste	21 %	4 %
Rework	5 %	0.5 %
Make Ready	1 day	0.5 hr.

Table 4. Comparatives Improvements, 2010-2011
 Source: Plant data

Standardized Solutions

Once barriers are solved, nerve processes are standardized and communicated. However, the strategic solutions used in the manufacturing plant are not absolute, they are continually changing and improved through a continuous strategic innovation program.

5. RESULTS

First, based on the application of a qualitative research methodology, we could show that the manufacturing systems most used by the company in order of importance are: the Fordist manufacturing system, the Toyota manufacturing system, and to a lesser extent the computer integrated manufacturing system and the lean enterprise system. There is a belief in the graphics industry in Mexico of the need to adopt digital printing technologies. However, companies do not have an organized approach yet for implementing technological modernization. With respect to the observations and interviews in the field, there is evidence of the presence of a strong strategic leadership, participatory and teamwork, besides the use of lean manufacturing enterprise principles, including: value proposition, streamlining operations, pull principles, continuous improvement and the application of computer integrated manufacturing concepts, such as group technology, cellular manufacturing systems and real-time communication. It finally shows the presence of an environment having strategic innovation culture and group leaders. Second, according to the quantitative stage of research, there is a substantial improvement in operational efficiency indicators: lead time reduction from 7 to 2 days, reduced waste from 21% to 4%, Rework reduced from 5% to 0.5% and decreased make ready

from 1 day to 0.5 hrs. The improvement of these indicators was possible in one year.

6. CONCLUSIONS

We argue that technological modernization methodology is the result of the pragmatism of a group of people, called, "change group", whose main motivation was the improvement of some productivity indicators such as Lead Time, Waste, Make Ready and Rework. Hence, the technological modernization has not become an end, but the means to achieve operational efficiency.

The initial outcome of the methodology has provided:

- 1) A model for the technological modernization of the printing industry.
- 2) The methodology is based on the creation of a group called "change group" having in mind three elements: competitiveness, productivity and innovation.
- 3) The model seeks to integrate the human factor as a trigger for change and not the technology as the key to productivity improvement.
- 4) The methodology uses the scientific method, so that the implementation of solutions is constantly tested.
- 5) The business model is suitable for small and medium size graphics companies that require immediate responses to improve their operations without a large investment,

The methodology is focused on streamlining operations before plant automation stressing the need of a continuous strategic innovation and communication channel to promote and encourage new ideas.

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