

A PROPOSED MODEL TO INCREASING THE EFFICIENCY OF INTERNATIONAL INTRA-FIRM TECHNOLOGY TRANSFER.

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The present article has as objective, to create an efficient and innovative model for the treatment of information related to alterations of products, under the optics of the information technology and of the administration of international alterations, whose current scenario is not sufficiently developed to meet the requirements. The globalization of the markets has been demanding the internationalization of products and simultaneity of actions accomplished by companies, which possess plants spread by the world, with the intention of supplying to the customers totally interchangeable products and pieces. New concepts will be joined with focus on a global vision, regarding the use of available technological resources, with the intent of reducing the gap time between the introduction of alterations at a parent plant and the other manufacturing plants and the definition of a single configuration strategy to be adopted by them. This configuration should generate a new concept of information exchange during all steps of the process, allowing the visualization of the status of each alteration document generated at any plant in the world. It should also promote the creation of a perfectly synchronized and informed virtual team to guarantee the interchangeability and the excellence of the product.

Information Technology - International Engineering Changes - Technology Transference.

1. Introduction

Many studies have focused on the need of knowing how the organizations deal with information during the development of new products, new processes and their alterations. It is particularly pointed out that the product development process, considering its inherent dependency concerning knowledge, would be one of the best company's activities to develop a work having in view the use of technologies currently available. We can notice here, an intensive work with communication, stressed by the increasing evolution of information technology, simultaneous engineering and works related to virtual teams.

A scenario involving an international auto parts company, having manufacturing units in three continents allows to cross these themes for a more suitable study of their relationships. It also allows a more detailed analysis of technological development factors, to assure the construction of a management proposal for international alterations.

The structure of information proposed in this article results from a principles set based on the analysis of literature consulted and current models of communication among three manufacturing units with different locations (South America, North America and Europe). They will be considered, so much the alteration of the product in a conception of simultaneous engineering as well as the theories and technologies that approach the creation dynamics and transfer of information and development of teamwork.

Generally speaking, to assure quality improvement of services performed, it is necessary to change the way work is structured. Therefore, we can conclude that work should be based on teams, responsibilities should be collective, assuring more empowerment and reliability to the process.

Adoption of an innovation in such case requires both being aware of a knowledge and the decision of implanting it, the basic purpose being to assure benefits with the alteration of a given reality. To certify that an international model provides good results, a local model will be created and tested to check (to prove) the reach of proposed targets. This laboratory will allow benefits quantification, through evaluation of losses eliminated and work qualification after it is implanted.

2. The Problem

Lack of efficient communication and synchrony during the introduction of alterations on products and their parts jeopardizes the interchangeability of components, concerning supply or purchase of CKD (*Completed Knocked Down*) parts among plants.

Taking into account the nationalization (tropicalization) of products, as well as different machines and processes of each manufacturing unit, many components present different status (measuring, tolerances, materials, identifications, colors, etc). Each plant should know exactly what the other plants manufacture, knowing each difference, but current system do not assure it will happen.

The introduction of a alteration on product components, without a previous notice to the other manufacturer/consumer plants, may provoke important losses, both for supplier and purchaser. In 2000 a fact of this nature happened; the Company-Brazil supplied a shipment of parts (CKD) to the head plant, on those parts an external identification had been created (visible), to prevent parts confusion during manufacturing. Since this alteration had not been noticed at the proper time, purchaser's drawing did not present this specification and the shipment was returned provoking financial losses and time on delivery schedule.

As the company works with its suppliers and clients under the assured quality principle, if an alteration on the product "function" is performed without noticing the commercial partner, parts can be assembled with different status. This can provoke several problems which, many times, will only be found out on the field, with damaging consequences both for the client and the supplier.

3. Purposes

- a. To carry out a case study about information system related to international product alterations;
- b. To reduce cycle time for documentation path (diffusion, approval, and introduction);
- c. To propose a local management model and check it. After that, to present a sole solution (international model) to be adopted by the world plants;
- d. To provide an integration of information involved and ergonomics (best utilization and suitability of all resources), assuring a best performance concerning efficiency and efficacy at work place.

4. Bibliographic Review

There are some integration efforts for the management of knowledge between information technology and human factor (MAURER, 1998; SCOTT, 1998). They try to integrate, at technology side, the idea of navigating through knowledge, listing it through hypertext via intranet and internet, and on the human side, the idea of representing an event

(and the knowledge that happened inside it) as the cases, lessons learned, best practices, learning history.

All innovation shall stimulate an organization change. It means that, as long as the organization accepts the situation, no paradigm ruptures can occur. According to BRIDGES (1997, p.39), “relevant changes are those which force us to reconfigure the organization to make good use of them or even to survive them. These changes are, in general, related to technology developments and technology is essential for them in three different ways: (1) People are forced to learn new and complete ways of doing the same things or communicating. (2) These changes allow rapid alterations on products and services and even force other organizations to follow progress. (3) Improved communication means that changes that were only locally visible are now experienced simultaneously everywhere”.

MCFURLAN (1984), describe some of the important relations between information technology and strategy. The conquest of advantages requires a large management of information systems, a dialog with the user and also imagination. It is mainly due to the fact that several products of information systems are strategic, but their potential benefits are very subjective and their evaluation is difficult.

Besides the approach of integration of information technology with human factor, LEONARD (1995), states that work with knowledge at the company is optimized through the performance of four interrelated activities (strongly linked to products alterations): sharing of the task of solving problems, trying to group different approaches; implantation and integration of the solution being developed in the environment where it will be used; the existence of a climate which accepts and even stimulates the experiment and visualization of solutions through the creation of prototypes; and the capability of importing and absorbing technological knowledge.

DAVENPORT (1998) uses the concept of knowledge maps that point where is the knowledge and how to acquire it, without containing the knowledge. It is a guide (or inventory) and not a repository (or a library). Tools such as *Lotus Notes* and intranet (Web browser) systems are the mostly used ones to make available the map of corporate knowledge, at a more elementary level it is also achieved by some ERP tools, such as the R/3 of SAP.

STALK JR. (1988) introduces the importance of the time factor as a strategic resource. He considers that when time consumption is reduced in all business aspects, companies also reduce costs, improve quality and remain close to the clients, their competition features being also improved. Competition advantage is a target that is continuously moving. Today, time is a key-advantage. As a strategic weapon, it is equal to money, productivity, quality and even, the innovation..

Software enterprises are continuously improving their products to meet needs arising from this market which is more and more competitive. Decision relies on support information and decision making timing is getting closer to an instantaneous range, in such a manner that time resource is considered as a strategic matter of the highest importance, similar to the Information Technology (KEEN, 1988). The competitive renewing of enterprises based on time resource is performed by means of massive investments concerning telecommunications and information interactive technologies.

Executives shall actively participate of development, devoting their time to the definition of management information. Concerning operations, information must be of high quality and with the interface providing easy information navigation and selection, the executive would be more efficient during search and inter-relationships with information.

From RAINER JR. (1989), we can mention some success factors for an operating Information System in what it refers to the typology of quality of information: (a) Accurate information; (b) Timely information; (c) Updated information; (d) Relevant information;

(e) Information rapidly available; (f) Necessary information; (g) Suitable information; (h) Reliable information; (i) Brief information and (j) Centralized information.

Efficacy of technology transfer largely depends on the type or features of technology involved. Comparing to the Technology imbedded in the product, the other ones (Imbedded in the Process and in the Person) are considerably more difficult to transfer to other countries, where cultural and management factors involved represent a more relevant role. Recently, almost all technology transfers involve products, processes and people, although some of them are clearly centered on one of the types.

The need for excellent communication among plants is critical for an effective technology transfer. Much of this communication can be performed through electronic media, reports and global data networks, i.e., impersonal media. However, for several stages of the innovation cycle, face-to-face communication remains of mandatory importance. Personal contacts have a prevalent role for the knowledge diffusion among plants and the utilization of research results. Maybe it explains the large number of international trips of engineers and technicians from companies having operations abroad.

Information flow among plants must also be stimulated through: (a) a policy of constant contacts among technology experts, using conference call and video conference, phone calls and e-mail; (b) a company culture which emphasizes open exchange of information; (c) creation of international work teams or project teams, to stress interaction among them; (d) active policy of job rotation at external plants; (e) languages training.

5. Field Research

The purpose of field research is to know the rule for international treatment of product alterations (limiting), as well as the current features of internal (local) and international communication about products manufactured in Brazil and at head plants of these products at enterprise taken into consideration.

5.1 – General Rule for Alterations Treatment of International Products

A company's employee, from any manufacturing unit related to the product may propose an Alteration Suggestion (AS) on the drawing, specification or structure (bill of materials) of the product. To perform it, he shall request approval from a superior or from the product engineering. After that, AS shall be sent to the competent sector at the head plant, that will distribute it to all branches involved.

At that moment, Document Control Sector (DCS) of each unit concerned shall distribute it to all sites involved, asking their opinion about Alteration. DCS shall inform its opinion within a period of five working days. Answers can be "we need more time to analyze, approve or reject it for local unit". AS can only be approved if all sectors involved agree with that. When head plant receives the opinion from all plants, it will define the way alteration will be introduced or will cancel AS. If approved, this document will be called Introduced Alteration(IA). An introduction can be valuable for one or more units and differences shall be described on documents (drawings, lists and specifications). A time to perform this task shall also be stipulated.

5.2 – International Communication Features for Ancient Products

One of the plants creates the suggestion and mails it to the head plant and the document delay between three and ten days to arrive.. Some plants generate their AS's via electronic medium and send it via e-mail (immediate transmission).

Head plant evaluates and numbers the document. If AS is approved, it will be distribute via Fax to all plants affected by the alteration. In this case, several plants will ask more time to analyze it, since, taking into account operating matters, five days are not enough to get the opinion of all sectors. Some head plants make document digital and send

it via e-mail. It improves distribution conditions and optimizes answering process, but they cause problems related to network overload.

When the answers from plants involved are received, this AS is treated during a meeting (generally monthly), where time for introduction is defined. Meeting report is forwarded to the plants involved via e-mail. When the head plant introduces the alteration, a paper copy is mailed.

Average lead-time between suggestion creation and the arrival of the document introduced by the head plant, is 75 days. Another important factor that should be mentioned is that plants involved will know which of them followed the alteration only when the head plant introduces it.

5.3 – Current Features of International Communication for the New Product

For this product (subject of our study), the situation is more complex. One of the plants creates suggestion, generates files in an electronic medium and sends it, via e-mail to the head plant.

Head plant evaluates and numbers the document. If AS is approved, head plant stores it in a specific area (folders of plants involved), in an electronic medium (weighty digital file) and informs, via e-mail, that these documents are already available. Both transfer via FTP (electronic medium) and file transformation to make it available on intranet are very long, encumbering schedule for answers return. As head plant does not provide reports concerning AS's Status or dates to perform IA's, sectors involved cannot start required procedures and schedule introduction.

Only after alteration performance on its documents, head plant will forward IA containing validity dates of modified documents. From that time on, it is necessary to control introduction at German unit, to allow it to be processed in Brazil. As these dates are not previously informed, introduction cannot be simultaneous and time gap is larger when introduction in Brazil requires more time than in German unit, due to suppliers' limitations or manufacturing process equipment.

North-American head plant was recently incorporated to the group and it is not completely adapted to the procedures of the internationalization of manufacturing, information exchange, international documents and its systems do not interact with SAP (Company's world wide "Bill of Material" system). For this reason, all official documents (drawing and bills) are concentrated at German unit, and it is necessary to have a double control of IA's introduction.

5.4 – Local Communication Features for Ancient Products

When a AS is received from the head plant for local opinion, DCS generates paper copies for each sector involves and distributes them via mail. Sectors answer it during a weekly meeting. DCS informs the head plant via e-mail. When the document introduced by the head plant arrives, it is presented to concerned sectors during a monthly meeting and introduced within a period of 5 to 60 days after approval. Average gap time between introduction at head plant and in Brazil is 60 days.

For these products a Database was created and has been used and improved since 1996, to control status, dates, meeting, sectors involved, time and automatic generation of meeting invitations and reports, as well as, statistical data and indicator for services management, through reports and graphics. The purpose is to facilitate and improve access to AS's e IA's information, reducing physical research time.

Till the beginning of 2000, when someone needed some of these information, it was requested to Document Control Sector, via phone call, e-mail or personally. The responsible person of each product devoted about 10 to 20% of his work to the manufacturing support related to this information. Then, an intranet application was

developed at sector's site, making access to this Database available for all collaborators, improving responsible person's productivity.

Since there was no constant supplies and purchases of CKD parts for these products, introduction simultaneity was not so demanded, since each plant created its own documents. Differences had to be informed to the head plant, to allow it to update international documents. In pursuance of it, AS's and IA's distribution has been performed through paper copies via internal mail, original ones being files in a physical medium (metal archive).

6. Proposed Models

New products demand entire interchangeability as a consequence of an intensive supply and purchase of CKD parts, as well as, of product supply from different plants to a common market.

No parallel documents are allowed for these products. All modifications concerning drawings and process specifications are performed by the head plant and suited to the system by the German unit.

6.1 – Model for Local Communication for a New Product

A Database (BD) was developed, similar to ancient product ones, emphasizing international IA's introduction and control of sectors opinions and opinion from Brazil to the head plant.

This BD contains the following information: (1) AS/IA number (for document identification); (2) Proposal creator and date of proposal (for identification of requesting plant); (3) Brazil position; (4) Status (for follow-up); (5) Introduction dates in Brazil, USA and Germany; (6) Brief summary of alteration (for subject identification); (7) List of affected products (for identification of AS/IA universe); (8) Reason for the Suggestion (quality improvement, rectification, supplier request, client request, etc.); (9) Remarks / Comments (to allow follow-up of tests or process relevant information); (10) Table listing sectors involved with AS/IA, with respective date of answer and opinion

Here, a more refined intranet application was also created, allowing access of all sectors involved, both in Brazil and Germany and USA, making information available for on-line follow-up. In this case, search can be performed using document number, sector involved, initial date or status, simultaneously or separately.

Besides, there is no more circulation and filing of paper AS's and IA's. For each one of them, an electronic file is generated (digital) compatible with the application, stored in a specific area and accessed via intranet, through a constant link of the presentation screen of document information in the Database.

This screen available on intranet allows all people involved to know AS/IA status at any process stage. And it also meets all conditions required for an information system success, since it provides accurate, updated, timely, rapidly available, convenient, reliable, brief information at one sole place.

With these tools, when DCS Planner of the new product is informed that there are files in "BRAZIL" folder of North-American server: he transfers these files, transform them into a compatible format (.pdf), store them in the local server, creates the cadaster and informs representatives of each sector involved via e-mail. This process delays approximately three hours. Before, with the system of copy distribution via internal mail, this process took about two days till everyone could receive the document.

Each document contains in average 3 sheets (A4 and A3 models) and 15 people receive it. This saves 45 photocopies of the document, 1 hour of work at the copies room per document, 1,5 day more for AS's analysis by the planner involved and about 1 hour (per document) of internal mail services. With an average amount of de 560 AS's / year,

only for photocopies there is a benefit of about 25,000 units, considering only documents distribution to get local opinion. Subsequently, original document distribution is also performed, if the head plant introduces it. The distribution of document translated and introduced in Brazil is also performed. Another verified gain is the physical place, since digital documents are stored on a hard disk of local server, steel archives used to file papers are eliminated. Access is faster, more efficient and document can be visualized from any place where a computer, linked to company's Intranet network, is available.

To have weekly meetings, at a sole place, at the same time, with a group composed of representatives from all sectors involved, discussing suggestion approval is a difficult and expensive process. With this system implantation, each representative is informed on his computer that he shall give his opinion about AS and that shall analyze and answer it, via e-mail, within a period of three days, weekly meetings are not required any more.

In the ancient product model, an alteration requested performed by the client takes, in average, four months to be implanted in all plants. Today, with the new system, this document is introduced in less than thirty days.

6.2 – Model for International Communication for the New Product

Concerning international model we propose to create a system similar to the local model one, creating and maintaining a Database containing information concerning each manufacturing plant, instead of each sector (as in the local model). Creation of an application on intranet network, allowing access to all BD information, to all units involved and their respective positions on the same site, as well as, introduction dates of each unit.

The availability of electronic files (digital documents) compatible with the application, accessed via corporate network (intranet) through a link on this screen, would reduce physical space used on local networks. It would allow a rapid access to any document, as well as, to information related to any manufacturing unit, concerning each existing AS/IA.

Using this system with search tool similar to local model, it is possible to reduce average time period from client request to introduction at world plants to less than twenty days. This process centralizes files generation (digital documents) compatible with the system, on just one person (at head plant), preventing duplicate services from people responsible of these products at DCS of each manufacturing unit.

Implantation of this model is simple and presents low costs, since it is based on software, equipment and technologies already available at corporation.

7. Conclusions

Presently, products development process and continuous improvement, as well as manufacturing processes globalization, require information flow, among manufacturing units, to be more and more improved, maintaining its reliability. Thus, the subject of information improvement and integration, among clients and suppliers sectors inside a plant or among plants of the same corporation, located on different continents, is a critical factor to assure company's competition features.

In this scenario, the implantation of a information management model in the productions alteration process proposed on this article, assures effective and significant improvements. This is evidenced both in financial savings and in strategic commercial factor, created from interchangeability among components of products manufactured in different continents.

Benefits obtained through the implantation of local model were: rapid access to any information at any process stage; reduction of DCS area and sectors involved (related do documents filing); reduction of bureaucracy; answer rapidity; reduction of time to meet

client's request and information unity. Besides, taking into account only time reduction of people involvement (salaries) and photocopies, local model implanted represents an yearly saving exceeding R\$ 20,000.00 (US\$7,700.00).

The implantation of the international model proposed here, will allow a real time follow-up of all product alterations, at all manufacturing plants involved in each process stage. It will also provide substantial benefit concerning time devoted to communication, allowing a larger productivity of people responsible for these products at Documents Control Sectors at all manufacturing units. When the information flow is faster, relationship with Clients and Suppliers is also improved, easing communication and generating commercial gains.

This article, synthesizing increasing needs concerning information integration in companies' administrative routines, specially in the alterations process for international products, presents a Global Model, based on information technology and competition strategic factors concerning international business. It is an indication of one of the ways to be followed by companies in the present moment, to assure their success in the future.

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