TECHNOLOGY DIFFUSION BY WORK GROUPS DURING PROCESS IMPROVEMENT EFFORTS

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ABSTRACT

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In order to thrive in international markets, countries must specialize in products that make the best use of those production factors for which the country is better endowed. In Mexico, as in most developing countries, capital endowment relative to manpower is low, which means that in order to improve their productivity, firms in Mexico must develop ways (technology) to optimize the combination of its relatively abundant manpower and relatively scarce machinery.

The improvement of productivity in a manufacturing process can be carried out by making changes in labor organization or by capital expenditures. These improvements imply the diffusion of some form of technology, such as machinery, work organization in the shopfloor, work methods, workspace layout, etc.

Several strategies for process improvement have become popular lately. These strategies usually require people to work in groups so that knowledge flows in more efficient ways to those who need it. This may become an additional burden for management, who must develop the necessary abilities to understand this kind of work arrangement and must provide the necessary support, in terms of training, material resources and time, for the groups to perform effectively.

This research focuses on work groups as technology diffusion agents; that is, we explore the role that groups play in obtaining, generating, evaluating, using and communicating knowledge about manufacturing processes. Case studies were developed for two Mexican firms, involving several work groups and different sources of evidence, such as interviews, observation and written records. The evidence obtained covers a period of about a year and a half for each work group.

The results of this case study research indicate that there are several activities and organizational settings that do not allow for an effective diffusion of technology. It was found that the relation between managerial and work groups is not constructed in such a way that work groups obtain resources in the required time and quantity from the managerial groups. It was also found that managerial and worker groups develop and use different types of knowledge but the distinction is not clear within the organization, leading to conflicts over authorship.

Another result is that, contrary to other contexts, in manufacturing settings there is not much resistance to technological innovations: workers often demand these innovations be brought into the manufacturing line.

In terms of accomplishments in improving a process, work groups seemed to lack adequate indicators. Often, the improvement was put to work but no formal assessment of its performance was made.

The concepts of technology and process improvement held in a firm are important in shaping strategies to increase productivity; it was found that the concepts of technology and process improvement held in the different firms studied were usually limited concepts: the first is often associated with machinery and the second with corrective maintenance. These conceptions preclude the organization from shaping a more active strategy towards productivity improvement.

The relations among the members of the group and between the rest of the organization were also analyzed. It was found that no general rule can be stated as to where do groups obtain information in the first place: some groups sought information by using first their homophilous relations, and other groups used first their heterophilous relations. The reasons for choosing between one type of relation and another seemed to be rooted in previous experiences, type of knowledge required, etc.

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1. INTRODUCTION

The improvement of productivity in a manufacturing process can be carried out by making changes in labor organization or by capital expenditures. This improvement implies some form of technology, such as work organization in the shopfloor, work methods, etc.

In Mexico, capital endowment relative to manpower is low, as in most developing countries. This translates into abundant, cheap labor. In order to compete in international markets and to reduce its unemployment level, México must develop ways (technologies) to include a significant proportion of manpower in its products and at the same time increase its productivity; in other words, México has to optimize its production function considering as an important variable its vast endowment of manpower.

Furthermore, productivity is increasing constantly in international markets; constant changes in machinery, contractual arrangements with suppliers and new forms of labor organization in the shopfloor produce an almost constant improvement in productivity manufacturing processes. As a consequence, we consider most important to focus on issues of process improvement, and more specifically, on the manpower issues of process improvement (Barrera & Williams, 1990).

Several strategies for process improvement have become popular lately. These strategies usually involve hierachical concepts, such as organizational functions, group tasks and individual tasks. In order to study how these strategies affect performance, these hierarchical issues should be considered, since activities particular to groups are different from activities particular to individuals; in other words, groups exist to achieve goals and perform activities that individuals by themselves could not achieve or perform.

While the final result of process improvement is economically important, we consider that the key to arriving at this goal is the *process* of process improvement, which includes behavioral issues such as training, motivation, feedback, etc. In particular, the transfer of knowledge, or technology diffusion during this process seems important to us, since a great deal of what leads to an improved manufacturing process is knowledge about it. If we understand the process of process improvement, we could *transport* its results from one situation to another.

This research will focus on work groups as technology diffusion agents; that is, we will

explore the role that groups play in obtaining, generating, evaluating, using and communicating knowledge about manufacturing processes.

The main purpose of this research is to test the applicability of several organizational behavior theories in the particular situation of technology diffusion by work groups in manufacturing firms in Mexico. More specifically, we are interested in the evolution of work groups as organizational entities that enable technology diffusion, and the organizational circumstances that affect this evolution.

Our justification for this research topic is as follows. First, research on implementation and technology transfer has been lacking at the worker level; most studies that we found were centered in the managerial or executive level. However, many of the process improvements that lead to higher productivity are handled at the worker level.

Second, groups have received considerable attention lately since they are often the building block for organizational change in quality and productivity efforts; groups have special characteristics that lead to better performance in some tasks when compared to individuals. However, studies of works groups in Mexico are lacking in this area. The studies found usually deal with sociological issues (Abramo, 1988; Neffa, 1982; Márquez; Haug & Dofny, 1977), status or power issues (Berger, 1972; Form, 1976; Marquez), or treat issue with very little detail (López, 1989; Cressey & Williams, 1991; Morgantown, 1979; Carrillo & Michelli,1990).

Third, the meaning of technology is different in developed and under developed countries, so that the "technology" construct tested in most studies reported in the American literature may not be applicable to the Mexican situation. As explained above, availability of capital in México is relatively lower than in the United States and consequently, while American studies on technology revolve around machinery, studies in México need to focus on the human side of technology.

Fourth, methodology and concepts for the diffusion paradigms may be different in Mexico and developed countries, as explained by Rogers:

> [D]uring the 1960s, diffusion research caught on in the developing nations of Latin America, Africa, and Asia. The diffusion paradigm was followed rather closely. Many of the Third World diffusion studies were conducted by sojourners from the United States or Europe, or else by Latin American, African, or Asian scholars who had learned the diffusion approach during their graduate studies in the United States. [...] At first, during the 1960s, it seemed that most diffusion research methods and theoretical generalizations were cross-culturally valid; that is, the diffusion process in

> Third World nations seemed to be generally similar to its counterpart in the richer, industrialized nations of Euro-America (Rogers with Shoemaker, 1971). [...] Similarities in the diffusion process were more striking than differences.[...] But as a major shift occurred in the conceptualization of development in the early 1970s, the role of the diffusion of innovations also began to be more widely questioned. Actually, a newer development paradigm (or paradigms) is only emerging, and there is not consensus in various nations about its exact nature. Nevertheless, emerging alternatives to the dominant paradigm of development contain certain implications for diffusion's role in development. Today, *development* is usually defined as a widely participatory process of social change in a society intended to bring about both social and material advancement (including greater equality, freedom, and other valued qualities) for the majority of people through their gaining greater control over their environment. (pp118-120)"

This may hold not only for diffusion research, but also for research on other areas of social science. As a consequence, we feel that Latin American researchers must begin to question the foreign concepts and ideologies that function as perceputal filters, and they must learn to look at these issues from an enriched paradigm, which integrates past perspectives and new perpectives, relevant to their culture. For this reason, in this work we will be alert to those events that may signal new paths in the development of concepts and models.

Finally, we would like to pursue an idea proposed by Leavitt (1989) by considering groups as the building blocks of organizations. In other words, we will look at organizations as revolving around group behavior.

2. LITERATURE REVIEW and PROPOSITIONS

2.1 Literature Review

2.1.1 Process Improvement Practices: Strategies and Techniques

Several practices are under way in manufacturing industries to improve the performance of their manufacturing processes. While some of these practices imply considerable investments in hardware, other practices are almost purely "software" in nature (Marks et al, 1986); an illustration may be the Japanese management concept of Quality-Control Circles, or the concepts of Just-in -Time, Optimized Production Technology, etc. We are interested in these "software" based practices and our contention is that these labels are meaningful to engineers and managers, but may not be so meaningful to workers and supervisors, since their view of the whole effort and its implications on the firm are, in most circumstances, limited. Also, there are occasions where processes are improved by a group effort without making use of any of these practices.

Process Improvement practices can be classified as strategies or techniques. Strategies are those practices with a broader aim and usually involve a series of techniques. Techniques are detailed procedures, where there is little room for modification on the part of the user.

The practices involve a series of activities. Groups can perform and learn a set of activities from a larger, more general set of activities. Improvement of a manufacturing process means, for a group, to perform the present activities or other activities available in the larger set in different sequences and proportions of time. For example, implementation of Quality Control implies for the group to *discuss* possible causes of defects, while implementation of Just-In-Time implies for the group to *discuss* possible plant layouts, so that in both cases, *discussion* is a common activity.

In other words, our assumption is that when groups become involved in an improvement effort, there is no significant change in the types of activities they must perform; rather, significant change occurs in how these activities are organized, the specific manufacturing event or machinery upon which these activities are applied and what pieces of knowledge are required.

2.1.2 The Concept of PIE

Since our interest is in how work groups perform in transferring knowledge into their daily operations in order to improve them, and not so much in how they follow the activities prescribed by a particular label, we propose a category of manufacturing activities called PIE, for P*rocess* I*mprovement* E*ffort* . By using this category, we will be able to "see" how work is performed without being distracted by the labels used frequently in industry. Also, this categorization will allow us to disregard those activities that, even though they belong to a particular practice or are performed by work groups, are not activities performed by the group to improve the process.

In order to avoid confusion, we will differentiate between tasks and activities: the first refers to those operations performed in order to produce something, while the second refers to those processes oriented towards improving tasks.

One of our first empirical tasks will be to clarify what constitutes a PIE, since some set of activities may be considered a PIE by some firms or groups but not by others. We expect a series of alternatives in PIE, ranging from formally established activities for formally established groups to informal activities performed by informal groups. Because of this, one of the characteristics our sample must have is to include firms where work groups are formally defined and firms where groups are not formally defined but exist and perform as such.

Our first dilemma is whether to define the set of activities involved in PIE *a priori* and then verify their occurence empirically, or else loosely define a set of activities and empirically enrich it as more descriptions are collected. We feel the second option will be more fertile, since the first will limit us to a fixed set of activities and as stated before, informal groups may perform, informally, a series of activities that may lead to process improvement but since they do not belong to the fixed set, they will be overlooked. It may well be the case that some set of informal activities are very successful in improving the manufacturing process and we would like to document them and learn from that experience. Methodologically, this requires a research design that relies more on descriptions and redefinition of issues than on preestablished measures.

Another relevant question is how to measure the results of PIE. For many firms, process improvement means a search for superior quality and efficiency; however, for other firms process improvement means only for the process to keep running. Consequently, there are several measures of improvement, such as: productivity (labor, capital, total), proportion of defectives, failures per period, etc. We feel that a single measure of improvement may not suffice for the

variety of situations we are likely to encounter and hence we prefer the measure of improvement to be determined by the people in the situation at hand, within certain limits we will mention below.

Improvement measures may be important not only for firms but also for work groups, since work groups relate their success or failure to this indicator. We would like to explore the behavior of work groups under conditions of perceived success or failure according to their evaluation of performance measures. It is important to note here that PIE performance measures are not the same as group performance measures, such as cohesiveness and participation. In view of this, we will use the following definition of PIE:

> *A Process Improvement Effort (PIE) is a series of nonroutine activities that an individual or work group identifies as unitary and undertakes in order to improve the performance of a task which is part of a manufacturing process.*

After this definition, several clarifications are in order. First, "unitary" means that the activities included in a particular PIE are those considered necessary and sufficient to undertake it; second, PIEs may be very modest, such as changing the material of a gear that wears out frequently, or very ambitious, such as redesigning the layout of a factory; third, performance measures, as described above, are the same for any instance of PIE; fourth, "continuous improvement", one of the labels used in the Total Quality Management (TQM) movement, may be understood as collection of PIEs, each addressing a different aspect of the manufacturing process.

What is important of this definition is that it focuses on those efforts that work groups can perform, without being restricted to some special cases. Also, it is important to keep in mind that we are interested in the behavioral processes that take place during PIE within the group, and not so much in the characteristics of the workers that lead to improved performance.

The improvement of a process is a form of technological innovation. Several defintions of technology and innovation are given elsewhere and for this section is suffices to consider that a process improvement is the application of some piece of knowledge in a different way. In this sense, technological changes may be very modest, but lead to improvement anyway. What we are going to explore in this work is how groups organize for and transfer these technological changes. In other words, we are interested in how work groups function as technology transfer units when they engage in a process improvement effort.

After this definition, it is worth clarifying some issues that pertain to the organization-group interface. One of them is the relation between organizational change or innovation at the organizational level, and innovation at the group level. Van de Ven (1993: 270) argues that

> [m]anaging these novel changes is far more complex and unpredictable than managing routine changes because the former require developing and implementing new change procedures, while the latter entail implementing tried-and-tested procedures. In other words, novel changes are organizational innovations, whereas routine changes are not.

Those organizations that have developed ways to continuously improve their processes may be difficult to classify by the above criterion, since these firms *routinely* seek ways to improve their processes, as an organizational level dictum, but the solutions offered for improvement may very well be *non-routine* and may even be considered *innovative* at the group level (Luthans & Thompson, 1987). Consequently, by innovation we will understand the meaning given by Rogers (1983: 11): "An innovation is an idea, practice or object that is perceived as new by an individual or other unit of adoption".

For the purposes of this work, organizational change is taken as given in some cases or non-existent in others, but it is not our direct interest: what we are interested in is how work groups handle the activities necessary to diffuse technology in order to improve the process; thus, the extent and direction of organizational change is considered a contextual variable.

2.1.3 The Context of PIE

PIEs do not occur in isolation. Organizational settings and individual characterisitcs may have a strong influence on the performance of PIEs. Among these contextual characteristics, we can mention the task environment, the diffusion process, the work group characteristics, and the state of organizational change the firm is in (Anderson & Tushman, 1990; Ebrahimpour, 1985).

The idea of Total Quality Management, to which the concept of PIE can be associated, requires large-scale organizational change. This change has often taken its directives from the so called quality gurus, who propose a series of guidelines to become a quality oriented organization. However, these guidelines are often biased towards consultancy-service sales. As explained by Cole (1991) when talking about Crosby's approach: " all this sells well with top management, but lacks the operational content that middle managers require to produce the organizational transformation critical to sustained quality improvement (p249)." Other authors have related the

quality movement guidelines proposed recently with other areas of organizational behavior theory (Luthans & Thompson,1987).

Thus, implementing TQM requires a some form of innovation, since some of the guidelines are imported from outside the corporation and others must be developed by middle management, sometimes with no other support than the instincts they have developed during their experience in the corporation. Under this perspective, it is clear that PIEs can only be successful if the organization is an adequate environment for the gestation and maturation of ideas, and this in turn, requires that some form of organizational change towards a receptive organization has taken place (Brown, 1991; Brown, 1989; Capello, 1992; Hatchuel, 1987; Van de Ven, 1986) .

Furthermore, the implementation of organizational change of the TQM kind has the effect of providing the workgroup with some previously inaccessible set of advantages: work groups are given a formal place in the organization, they are trained in the use of improvement tools, etc. Thus, the innovation has the effect of changing the environment where the workgroup performs, even though work groups are performing similar activities to those performed before the change.

The following is a set of contextual characteristics of PIE which we consider relevant. These characteristics will be observed during the empirical part of this work, since our intention is to describe how the context affects the diffusion of technology by work groups. As will be detailed in the following chapters, the importance of these contextual issues is such that it delimits the choice of the research methodology.

2.1.3.1 Technology. This is a very important contextual variable, since technology determines a series of phenomena that can affect the effectiveness of PIE. For instance, technology may allow very little participation of the worker, as in robotics; in other words, tasks for this kind of technology may be more routine and less demanding when compared to other more labor intensive processes.

2.1.3.2 Autonomy of Work groups. This is an organizational variable. Due to the organizational setting and work group characteristics, work groups may have considerable autonomy in improving a process. This autonomy may be the result of training or expertise by the group members, or a result of organizational policies, where considerable latitude for experimentation is given (Chaudron, 1992).

In any case, the expected result is that the more autonomous groups will have greater success rate in PIE since they have a more developed resource base.

2.1.3.3 Environmental Threats. The environment is usually a source of motivation for change. The organization may be immersed in an environment where technology is rapidly changing, or else, a major event may have taken place which changes the rules of the game. This work addresses organizational problems in firms that are threatened by international competition: the competing organizations in each sector have had to take some measures to improve its performance, in order to keep their share of the market. In some cases, the need for change was not urgent when organizational change began and this gave the firms some advantages when more efficient organizations were required.

Sometimes change is the result of a threat and not the result of an ongoing policy (Kremen, 1993; Staw, Sandelands & Dutton, 1981). This may have a profound effect in PIE, since decision making under crisis may have detrimental effects in the decision process, such as restricting the number of alternatives analyzed or forcing groups to take the safest alternative, not necessarily the best.

2.1.3.4 Openness to Change. This is another organizational variable. Some organizations may see change as a necessary effort while others see it as a threat to efficiency. This will translate in norms and rules of behavior that groups must accept in order to fulfill their tasks.

One of the results of TQM is supposed to be a culture of continuous improvement, which is attained by constant change. Furthermore, PIEs usually take place only where change is organizationally welcome. In this research, attention will be given to those behaviors and activities that signal openness or obstacles to change, since if the later exist, it will be difficult for PIEs to be successful.

2.1.3.5 Experience in the Manufacturing Process. Groups may have ample experience in the manufacturing process in question, and this may have a detrimental or beneficial effect in the performance of PIE. If an organization has experience in a manufacturing process it has necessary knowledge about modifications and alternatives, which is an advantage when uncertainty increases; however, this experience may be detrimental since the organization may continue to perform in the safest way, thus limiting its ability to provide creative solutions. If this is the case, an inexperienced organization may have better chances of successfully involving in PIE.

2.1.4. What is Technology ?

One of the main issues in this work is to define what constitutes a process improvement effort. As explained in the previous chapter, PIE implies some form of technology transfer so that the conception of technology to be used must be clarified. Our intention here is not to provide a definition of technology, but rather to illustrate the different uses of the concept so that an intuitive idea of it is developed.

The most elementary conception of technology is the one that associates it with machinery or hardware. However, more refined definitions exist, such as the following one by Rogers (1989):

> A *technology* is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome. A technology usually has two components: (1) a *hardware* aspect, consisting of the tool that embodies the technology as material or physical objects, and (2) a *software* aspect, consisting of the information base for the tool.

The relationship of technology and uncertainty is presented in the above definition. More explicitly, a technological innovation increases some form of uncertainty and reduces another. Uncertainty about the consequences of the innovation on the adopting unit or the change agent usually increases, since there are always obscure issues in technology; but uncertainty about the reachability of an objective is reduced since technology provides the solution to a problem. In other words, technology is seen as a potential solution to a problem and in that sense subjects are motivated to adopt it, but it is also a source of increased uncertainty when the consequences of adoption are not clear to everybody.

Technology has also been defined as "those sets of man-machine activities which together produce a desired good or service." This definition introduces the concept of transformation, which is a common component of the technology construct. However, not all innovations involve transformation (Goodman, 1990: 131).

One of the most influential authors in the field of technology is Perrow (Lynch,1974). Much of the research done in technology in organizations is related to his work. He defined technology as "the actions that an individual performs upon an object, with or without the aid of tools or mechanical devices in order to make some change in that object." His idea of technology implies two dimensions of technology: (1) the number of exceptional cases encountered in the work; and (2) is the nature of the search process that is undertaken when exceptions occur.

Moving closer to the subject of this research, Fry and Slocum (1984) conceptualize workgroup technology as having three dimensions:

Number of exceptions. The degree to which stimuli are perceived as familiar or unfamiliar.

Search behavior. The nature of the search that is undertaken by individuals when exceptions occur. This search may involve a series of rational steps or a seemingly haphazard relation of ideas about the issue.

Interdependence. The degree to which individuals are dependent on and support others in task accomplishment.

Workunit technology definition can be stated as "the extent to which individuals in a workgroup are dependent on the support of others in performing actions requiring search behavior in response to exceptions encountered during the transformation of inputs to outputs" (Fry & Slocum, 1984: 225).

Extending Perrow's definition, Goodman (1990: 139) defines technology as:

> a system of components directly involved in acting on and/or changing an object from one state to another. The word *directly* means that the system of components is proximate in space and time to the object being acted on and/or changed. The system concept is introduced to indicate that technology is made up of multiple components and all those components are interrelated.

Goodman (1990: 141) introduces a series of concepts related to technology from which three are of interest to us. *Technology* is the system of components at the group level that transforms objects from one state to another. *Task* represents the specific programs to accomplish the transformation process. The *labor* component refers to the skills, abilities, knowledge, motivation, and attitudes that characterize work group members. As will be seen later, the relation between tasks and technology is central to the concept of PIE, and technology is somehow restricted to the labor part.

Table 1 summarizes the basic dimensions of technology that we have discussed and some others. It should be noted that the uncertainty concept is pervasive.

Table 1: Technology Dimensions.

Researcher(s)	*Technology Categories*
Thompson (1967)	Long-linked, mediating, intensive
Perrow (1967)	Number of exceptions, nature search process
Hickson (1969)	Level automation, rigidity of work flow, specificity of evaluation, continuity of throughput
Mohr (1971)	Manageability, uniformity, analyzability, complexity
Comstock and Scott (1977)	Task predictability
Schoonhoven (1981)	Technological uncertainty
Argote (1982)	Input uncertainty
Fry and Slocum (1984)	Number of exceptions, analyzability, interdependence
Cummings (1981)	Work flow interdependence, work flow predictability, boundary transaction predictability, spatial and temporal relationships, mechanization

From Goodman,1990.

2.1.5. Technology Diffusion

Diffusion can be understood as a form of *social change,* a process by which the structure and function of a social system are modified. The diffusion of ideas or technologies leads to changes in several social indicators. Several concepts of diffusion are of common use, so that we will explore their applicability to our problem.

In this work, the concepts of technology, knowledge and information may have the same meaning. When confusion may arise, *technology* will be understood in the sense described earlier, *knowledge* will mean the whole domain of data, procedures, etc. that may or may not be currently used in manufacturing tasks, and *information* will be those pieces of knowledge that reduce uncertainty about a manufacturing situation. Of course, information may be about a particular instance of technology or it may come to increase our knowledge base. Transferred data that do not reduce uncertainty because they were already known or because they have no relation with the problem at hand, are not labeled information.

What we understand by "Technology Diffusion" is sometimes called "Technology Transfer" or, as in Rogers (1983), "Diffusion of Innovations". In essence, diffusion is a process by which (1) an *innovation* (2) is *communicated* through certain *channels* (3) over *time* (4) among the members of some *social system.* We will understand Communication as a process by which participants create and share information with one another in order to reach mutual understanding. In other words, diffusion is a communication process which deals specifically with the communication of innovations.

In its most elementary form, a diffusion process involves a particular innovation, a unit of adoption or individual that has knowledge of or experience in using the innovation, a unit of adoption that has no knowledge about the innovation and a communication channel between the units.

The diffusion model we will use in this work does not require a particular "expert" unit of adoption to transfer knowledge to another unit, but rather, it is expected that the unit that will search for relevant information and may even generate it. In other words, we assume that work units may have certain degree of autonomy in transferring knowledge, which is a departure from the classical model of diffusion:

> For decades, one diffusion model dominated the thinking of scholars and policy makers. In this classical diffusion model, an innovation originates from some expert source (often an R&D organization). This source then diffuses the innovation as a uniform package to potential adopters who accept or reject the innovation. The role of the adopter of the innovation is that of a passive accepter (Rogers, 1983: 333).

While Roger's work is centered around innovations, we can translate his ideas into the PIE realm since PIEs may involve innovative uses of knowledge or hardware. We will understand an innovation as an idea, *practice* or object that is perceived as new by a unit of adoption, without regard to whether the idea is absolutely new; it suffices that the unit of adoption considers it as new (Rogers, 1983).

2.1.6. Homophilous-Heterophilous Communication

An important concept in the diffusion theory is the pair heterophily-homophily, which relates to characteristics such as age, religion, etc. that individuals share. Effective communication usually takes place between homophilous individuals, that is individuals that share some of these

characteristics. However, the communication of innovations usually involves heterophilous individuals in the sense that one of them has knowledge about the innovation and the other does not.

Homophilous communication is rewarding to those involved in it, because most individuals enjoy the comfort of interacting with others who are quite similar. *Heterophilous* communication may cause cognitive dissonance because an individual is exposed to messages that are inconsistent with existing beliefs, causing an uncomfortable psychological state. Homophily and effective communication breed each other.

The more communication there is between two people, the more likely they are to become homophilous. Individuals who attempt to communicate with others who have different sets of beliefs or experiences from themselves may become involved in ineffective communication.

The heterophilous side of communication is related to change agents, which usually are more technically competent than the adopters. This difference frequently leads to ineffective communication because they simply do not talk the same language. On the other hand, when two individuals have very similar technical expertise, no information transfer can occur. The role of heterophilous communication is explained by Rogers (Rogers 1983: 275):

> Heterophilous communication has a special informational potential, even though it may be realized only rarely. Heterophilous network links often connect two cliques, spanning two sets of socially dissimilar individuals. These interpersonal links are especially important in carrying information about innovations, as is implied in Granovetter's (1973) theory of "the-strength-of-weak-ties," so homophilous communication may be frequent and easy but may not be so crucial as the less frequent heterophilous communication in diffusing innovations.

Weak ties may be crucial to the diffusion process. While they are not a frequent channel of communication, the information that flows through them may be very relevant for the receiving clique: this information may be precisely what the workgroup as a whole ignores about a task improvement.

2.1.7. Innovation in Organizations.

As explained earlier, innovation in organizations has special characteristics. First, the decision to implement a change is not an individual one; second, the diffusion of the innovation can

follow a rather complicated trajectory, since there are several adopters and sources of information; third, the adoption may not be voluntary so that the innovation must overcome a series of resistances and indifferences. Four kinds of innovation decisions can be found in orgnizations:

Optional innovation-decisions, choices to adopt or reject an innovation that are made by an individual independent of the decisions of other members of a system.

Collective innovation-decisions, choices to adopt or reject an innovation that are made by consensus among the members of a system.

Authority innovation-decisions, choices to adopt or reject an innovation that are made by a relatively few individuals in a system who possess power, status, or technical expertise.

Contingent innovation-decisions, choices to adopt or reject that can be made only after a prior innovation-decision.

Individual adoption decision processes are not directly related to our work, so we will not pursue their description further; collective, authority and contingent innovations decisions are thus the most relevant to our work.

The decision to adopt an innovation can sometimes be influenced by mangement. Research in this area is interesting to us since many of the innovations to manufacturing processes we will study are authority decisions: for example Leonard-Barton and Deschamps (1988) found that the influence of management in the adoption of an innovation is felt more strongly when adopters are *relatively* non-skilled, or low in innovativeness, or for whom the task has low subjective appeal, but not when adopters score relatively high in these measures. These results can be related to our research since individuals in a group may score low in some of the above mentioned characteristics and then PIEs may require some additional effort from management. For the purposes of our research, two drawbacks of Leonard-Barton and Deschamps' study are that results were obtained at the individual level of analysis and that the setting was not manufacturing (Argyris, 1965; Tushman & Nadler, 1986). That the unit of analysis is the individual may lead us to ignore important information about group behavior; and that the setting is not manufacturing implies that the types of knowledge used, as explained elsewhere, may not be the same.

For organizations, a general model of adoption is the following (Rogers, 1983):

a. ***Initiation stage:*** All of the information-gathering, conceptualizing, and planning for the adoption of an innovation, leading up to the decision to adopt.

a.1 Agenda-Setting	General organizational problems, which may create a perceived need for an innovation, are defined; the environment is searched for innovations of potential value to the organization.
a.2 "Matching"	A problem from the organization's agenda is considered together with an innovation, and the fit between them is planned and designed.

b. ***Decision Stage:*** a decision to adopt is made

c. ***Implementation stage:*** All of the events, actions, and decisions involved in putting an innovation into use.

c.1 Redefining/Restructuring	(1) The innovation is modified and re-invented to fit the situation of the particular organization and its perceived problem, and (2) organizational structures directly relevant to the innovation are altered to accomodate the innovation.
c.2 Clarifying	The relationship between the innovation and the organization is defined more clearly as the innovation is put into full and regular use.
c.3 Routinizing	The innovation eventually loses its separate identity and becomes an element in the organization's ongoing activities.

This model of innovation in organizations has been expanded by Van de Ven (1993), who proposes the following elements in the process of innovation:

1. The innovation process consists of numerous events performed by many different people over an extended period of time. This process is not attributable to a single actor on a particular date and time.

2. Direct personal confrontations with needs or problems generate a level of dissatisfaction. Concentrated actions to initiate the process of innovation are triggered by "shocks", which are events beyond a treshold of acceptable dissatisfaction.

3. Once innovation development work begins, the process does not unfold in a simple linear sequence of stages and substages. More specifically, after the onset of a simple unitary progression of activity to develop an innovative idea, the process diverges into multiple, parallel and interdependent paths of activities.

4. Setbacks are frequently encountered during the innovation process, either because plans go awry or unanticipated environmental events occur which significantly alter the ground assumptions of the innovation. These setbacks must be interpreted either as signals of rejection of the innovation or as opportunities for learning through reinvention.

5. Innovation receptiveness, learning and adoption speed are facilitated when the innovation is initially developed within the user organization, and they are inhibited when end users are provided no opportunities to reinvent innovations that were initially developed elsewhere.

6. Management cannot ensure innovation success, but can influence its odds. The odds of success increase with experience and learning from past trials at innovation, and they decrease with the novelty, size and temporal duration of an innovation venture. Thus, the odds of the success are not only a function of the number of times an organization has undertaken an innovation in the past, but also of the complexity of the journey it has chosen to undertake next.

This ideas provide a framework that can serve as the context of this work. While we are not directly interested in companywide organizational change, it is clearly a companywide organizational change that leads to the creation of work groups and their activities in improving the manufacturing processes.

2.1.8. Reinvention

Reinvention, defined as the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation, is another concept worth considering. We expect some reinvention to occur in manufacturing settings, sometimes at the workgroup level, others at the organizational level.

Some types of technological innovations are more likely to be reinvented, and some organizational settings are more likely to foster reinvention:

1. Relatively more complex innovations are more likely to be reinvented.

2. Adopter's lack of detailed knowledge about the innovation leads to reinvention.

3. A general concept or a tool (like a computer) with many possible applications is more likely to be re-invented. If the tool or concept is tightly packaged with other concepts or tools reinvention affects the whole; if the tool or concept is loosely packaged, reinvention may affect only some parts.

4. The degree of reinvention for an innovation will be greater when the organizational problems with which the innovation is matched are large.

There are several benefits of reinvention. For instance, the reinvented technology may better fit the system's problems than the original technology. Also, the reinvention process generates some form of ownership that leads to lesser rejection.

2.1.9. The Change Agent

The heart of the diffusion process is the modeling and imitation by potential adopters of their peers who have already adopted an innovation; this is mainly a subjective process, where evaluations of an innovation mainly flow through interpersonal networks. For this reason, we must explore the existing networks in a social system if we are to comprehend the diffusion process.

An important part of the diffusion network is the *change agent*.. This is one of the issues we would like to explore in this research, since the role of the change agent in organizational diffusion may not be as clearcut as in individual decision processes. We expect that in some cases there will be no individual performing the role of change agent, while in other situations the change agent will exist and may thrive within or outside the group. Also, we expect some individuals in the organization will play a role similar to the role played by aides in individual decisions.

> An *aide* is a less than fully professional change agent who intensively contacts clients to influence their innovation decisions"(Rogers, 1983: 325). [...]"Even though aides have less *competence credibility,* defined as the degree to which a communication source or channel is perceived as knowledgeable and expert, they have the advantage of *safety credibility,* the degree to which a communication source or channel is perceived as trustworthy. Because an aide is a peer to his or her clients, they are not likely to suspect the aide of having selfish motives or manipulative intentions (Rogers, 1983: 328).

2.1.10. Work Groups and Effectiveness

In this section our interest is in describing those models that have been proposed to explain the effectiveness of work groups. We will understand as a workgroup the smallest formal grouping of personnel within an organization. It represents a relatively permanent arrangement of people and equipment (Fry & Slocum, 1984).

An assumption in this research is that if groups are relatively *autonomous*, they must be capable of handling information in complex ways. In particular, they must be capable of observing themselves (Lazega, 1990). We expect fo find groups with different degrees of autonomy, but a certain degree is necessary to study relations between group behavior and effectiveness: if groups were completely non-autonomous, concepts like norms, information links and roles may be dictated from outside the group or would be irrelevant (Chaudron, 1992; Gresov, Drazin & Van de Ven, 1989).

2.1.10.1 Hackman´s Model. One of the more complete models of group behavior is Hackman's Model (Hackman, 1987). As depicted in figure 1, group effectiveness is determined by an organizational context and the design of the group. These two are influenced by the group synergy to yield a group process where several criteria of effectiveness can be observed. This group process is then affected by the availability of material resources, yielding a final group effectiveness.

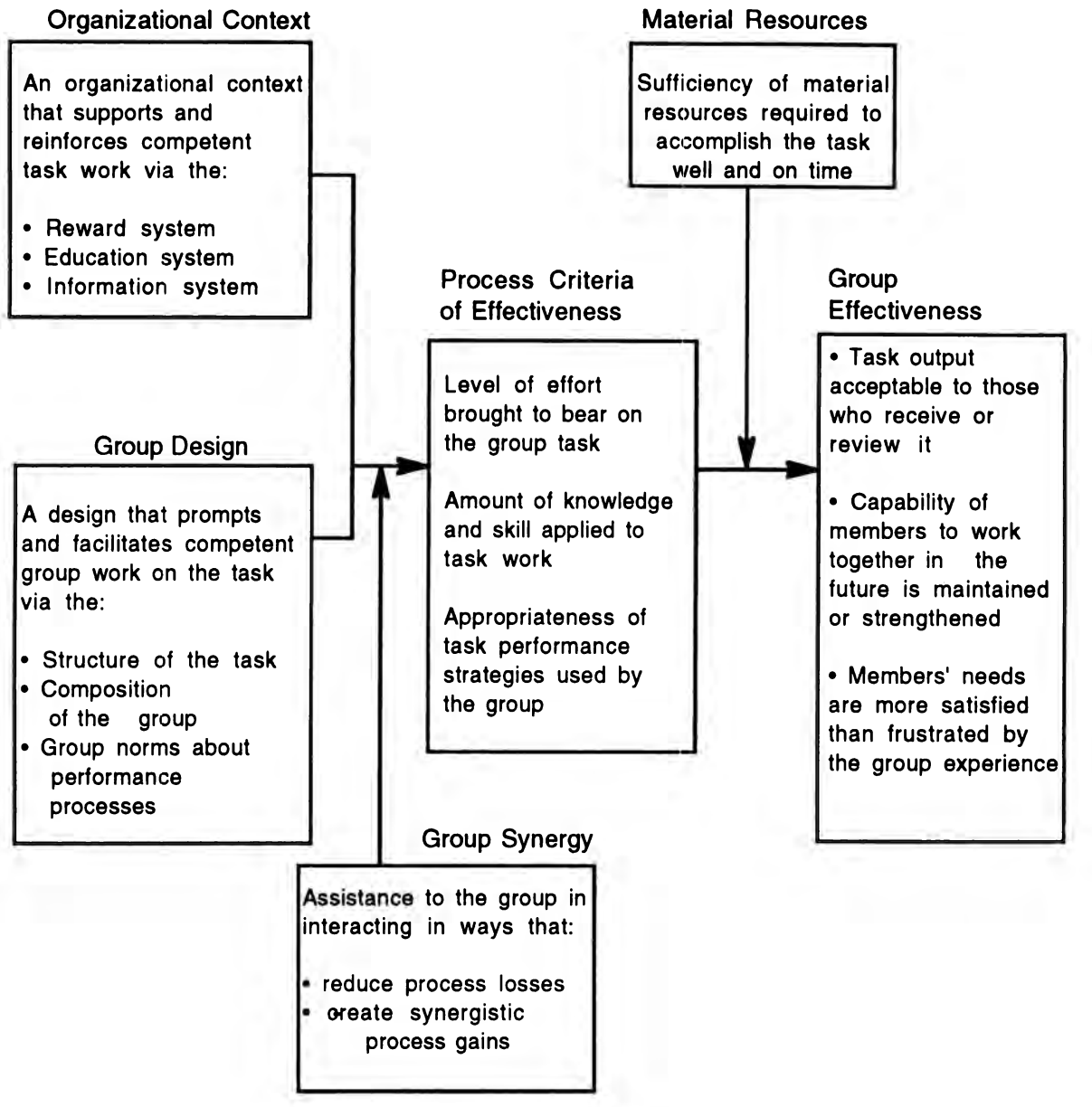

Figure 1: Hackman's 1987 Overview of the Normative Model of Group Effectiveness

The importance of studying how groups transfer knowledge has been recognized by several authors. For instance, in Hackman's normative model one of the criteria of effectiveness is the sufficiency of knowledge and skill applied to the group task. Some conditions that support knowledge and skill are (a) the group has an appropriate number of members with a good mix of

skills, (b) the education system of the organization offers training or consultation as needed to supplement members' existing knowledge, and (c) group interaction avoids inappropriate "weighting" of members' contributions and instead fosters sharing of expertise and collective learning. More detail in each condition is given in what follows.

In the design of the group, it is important to consider the following points: (1) individual members must have high task-relevant expertise, (2) the group must be large enough to do the work, (3) members must have interpersonal as well as task skills, and (4) membership is moderately diverse.

In terms of the educational system, some sort of delivery system must be in place to make the knowledge available to the group. This knowledge may or may not be within the reach of the group, so that this delivery system is a very important part of bringing knowledge to the groups.

In terms of group interaction, the following points must be taken into account: (1) Inappropriate weighting of member contributions must be minimized, by restricting judgment of ideas to contingent factors, and avoiding incongruent factors, such as gender, status, etc. (2) Collective learning must be fostered, sometimes by "cross-training" as done in autonomous groups or by more informal activities that allow members to share their knowledge and expertise.

From the above it is clear that the diffusion of technology is considered by Hackman as an important issue in determining group effectiveness. However, the author does not describe how this process of knowledge transfer is actually carried out; we would like to have a more specific model where technology diffusion were the main focal point. Hackman's model appears to us as a single-group model; that is, a model oriented to analyzing the performance of a single workgroup. In the situation we are studying, networks between work groups, or between individuals and work groups are very important: the essence of technology diffusion is composed of communication within the group, and also of communication of the group with entities outside of it.

2.1.10.2 Socio-Technical Systems Model. Another model that has had widespread acceptance is that of Socio-Technical systems, developed by the Tavistok Institute. The model, depicted in figure 2, is more closely related to manufacturing situations, like the one we are studying (Herbst, 1970; Kiggundu, 1986; Huber & Brown, 1991; Goodman, 1990).

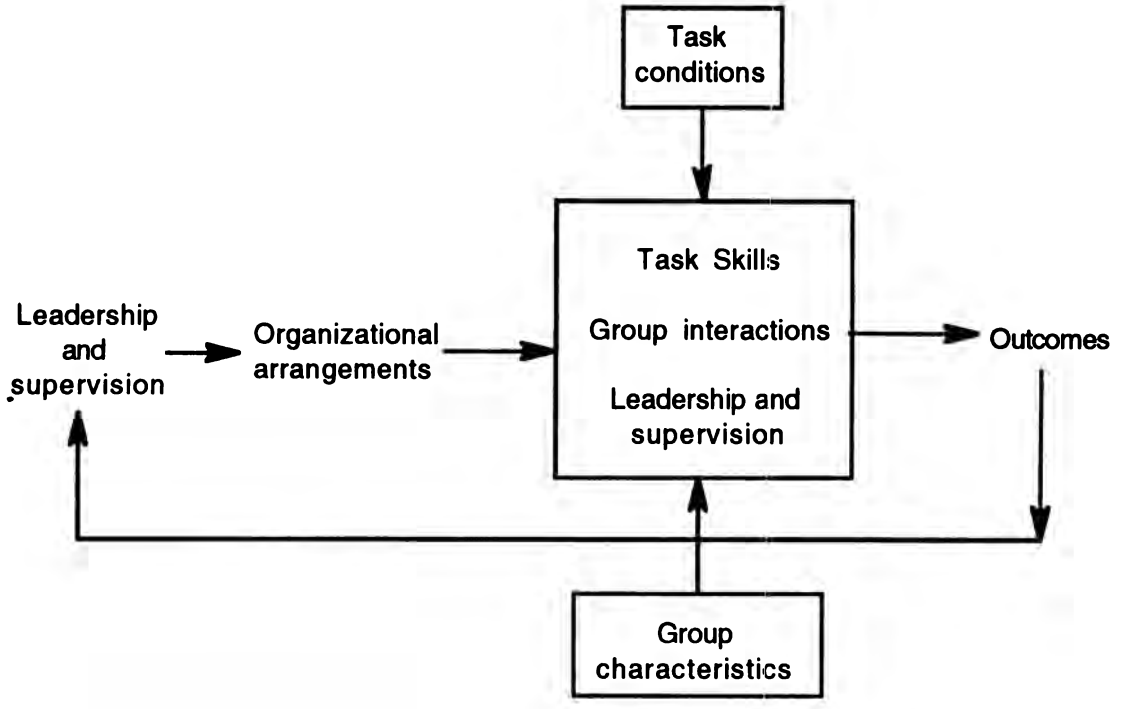

Figure 2: Sociotechnical Systems Model and its Key Variables

Several of the authors using this model have given explanations of the relationships between the entities, so that the model can be considered a tested one. Emphasis in the use of the model has been toward autonomous groups and their relationship with supervision and incentives (Beekun, 1989).

Again, the model may be too general for our purposes since very limited mention is made of the issue of technology diffusion, both within groups and with entities outside the group.

2.1.10.3 Shaw's Model. Shaw (1986) lists a series of circumstances where human factors are important : human factors will be more important in understanding group performance to the extent that (1) there is considerable discretion in the transformation process, (2) the technology makes performance sensitive to variations in human effort, skill, and so on, (3) the redesign of the technological system is controlled by the group, and (4) there are not major exogenous variables that affect group performance (Shaw, 1986: 144).

These factors are related to our interest: as explained elswhere, technology is a determinant in group performance during PIE, involving issues like re design, autonomy, participation, etc.

2.1.11. Work Groups and Tasks

The task environment of groups has been given considerable attention, but many issues still remain open. A task is a subcomponent of technology; it is a set of operating rules, heuristics, and criteria for the transformation process.

In an earlier chapter, PIE was defined as *a series of nonroutine activities that an individual or workgroup identifies as unitary and undertakes in order to improve the performance of a task which is part of a manufacturing process* ; in this chapter we will describe the possible activities that are involved in PIE, keeping in mind that PIE is a task whose intention may be to improve another task.

Tasks are very important to us since they are the target of process improvement efforts: after PIE, what has been modified are tasks performed by the workgroup, either because a piece of equipment has been modified or because a new way to perform tasks has been found. PIEs give as result a new set of tasks or the same set of tasks performed in an improved way.

In earlier sections of this work, we give a definition of technology by Goodman (1990: 140); within this definition, he defines a *task,* which is a subcomponent of technology: "It is a program or a set of operating rules, heuristics, and criteria for the transformation process". In methodological terms, (Goodman, 1990: 147) proposes the following:

> We would represent the task programs by drawing process charts of work. To begin this description we need to look at a particular technological system and product. Then we would identify the task core programs and describe the processes involved in each task. The process description identifies the steps in the work cycle for that particular task.

Shaw (1986) generated six dimensions along which group tasks varied: (1) intellectual versus manipulative, (2) task difficulty, (3) intrinsic interest, (4) population familiarity, (5) solution multiplicity versus specificity, and (6) cooperation requirements.

Difficulty can be defined as the total effort required to carry on a task. Tasks vary in the difficulty dimension from easy (few operations, abilities or knowledge are required) to difficult (many operations, abilities or knowledge are required). *Solution Multiplicity* is the degree to which more than one correct solution to the problem exists. *Intrinsic Interest* is defined as the degree to which the task by itself is interesting, motivating or attractive for the group members.

Task vary from boring to extremely interesting. *Cooperation Requirements* can be defined as the degree to which an integrated action by the group members is required. Tasks located in the superior extreme of this dimension require from the members to perform their actions so that each one performs the appropriate function in the right moment in relation with the other members of the group. The *intellectual-manipulative* dimension is defined as the relation that exists between rational demands and motor demands of the group task. *Familiarity of the Population* refers to de degree to which members of society at large have experience in this kind of task.

Herold (1978) presents a scheme based on the complexity of technical and social demands on the group. Task complexity is based on three criteria: (1) the programmability of task activities (the lower the programmability, the more complex the task); (2) difficulty of task activities (the greater the effort, number of operations, and number of skills required —measures of difficulty— the greater the complexity of the task); (3) the diffusion of task information (the less knowledge is centralized, the greater the task complexity). Social demands refer to the quality of social interaction necessary for the group to perform effectively (Goodman, 1990).

Gresov, Drazin and Van de Ven (1989) studied the relationship between work-unit task uncertainty, design and morale. They found that morale of a work unit depends on both the unit's task and its design taken together; each of the variable does not independently serve as a good predictor of morale.

The following table depicts the different task dimensions proposed by several researchers. Our interst in these dimensions is that we would like to observe work groups while making efforts to improve tasks, and in order to have a systematic method of observation, we will use several of them.

Table 2: Group Task Dimensions.

Researcher(s)	Task Categories
Carter, Haythorn, and Howell (1950)	Clerical, discussion, intellectual construction, mechanical assembly, motor coordination and reasoning
Shaw (1973)	Intellectual versus manipulative requirements, task difficulty, intrinsic interest, population familiarity, solution multiplicity versus specificity, cooperation requirements
Steiner (1972)	Unitary, divisible, conjunctive, disjunctive, additive
McGrath (1974)	Generate, choose, negotiate, execute
Herold (1978)	Task complexity, social complexity
Tushman (1979)	Routine, environmental uncertainty, interdependence

(after Goodman, 1990)

2.1.12. Evolution of Work Groups

Work groups usually go through a series of stages in their maturation. During some of these stages, the group is likely to function effectively but in others, behavioral issues consume a great deal of effort and the task is then not carried out as effectively.

It is our contention that technology diffusion is carried out more efficiently when groups have reached some level of maturity; in other words, technology diffusion is more efficient when characteristics such as cohesiveness, norms and leadership have been developed (Mudrak, 1989).

2.1.12.1 Norms and Behaviors. The evolution of a work group implies some form of norm development. While there can be many types of norms, our interest centers in those norms used to evaluate information coming into the group. Also there may be set of norms for information coming while in PIE and norms for information coming during routine operations (Lazega, 1990; Feldman, in Matteson & Ivancevich, 1989).

Information or knowledge transfer in work groups may be complicated since members can influence and control each other's decisions at the level of everyday-life communication by creating norms and parameters to evaluate information (Lazega, 1990).

Work groups may also evolve by developing behaviors that make them more efficient and effective when involved in PIE. As explained elsewhere, groups not only gain technical knowledge, but also behavioral knowledge, and this may well be the core issue in this work. Our interest is *what* behaviors are developed and *how* these behaviors are generated, tested, discarded or accepted as a group gains experience.

Figure 3 depicts a model for norm development which will guide our inquiry about norms for evaluation of information (Bettenhausen & Murighan, 1991; Schriber & Gutek, 1987).

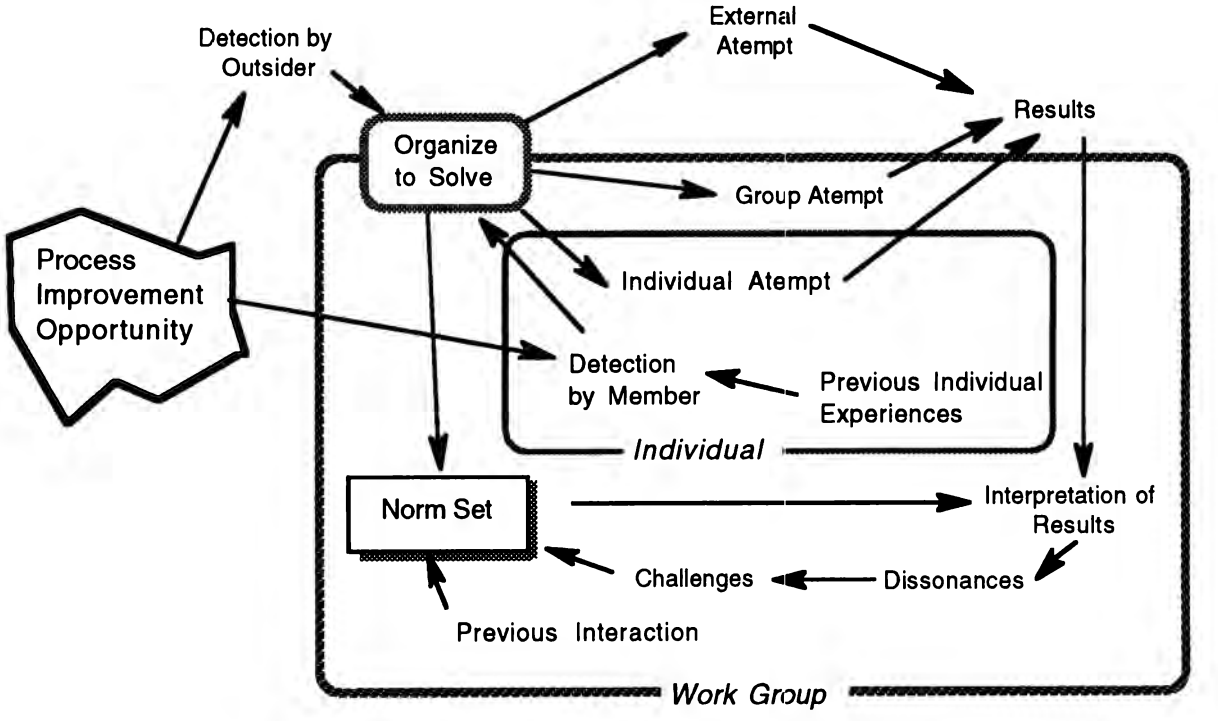

Figure 3: Norm Development Process

2.1.12.2 Task Knowledge. The evolution of work groups may also lead to greater knowledge about tasks . Work groups that have been together for some time or that have been involved in more PIEs will have more expertise in the manufacturing process at hand.

This expertise may be lost or impaired when one of the members of the group leaves. We expect to find situations where member tenure has drastically changed and this group will have greater trouble going through a PIE.

2.1.12.3 Variety of Roles. As groups evolve, several distinctive roles appear as a result of the experiences the groups has had. The set of roles developed is contingent with the environmental characteristics the group faces. For example, some groups may find it necessary to develop a liason role, while others may need a technical expert role (Beebe & Masterson, 1986).

2.1.12.4 Information Links. Information links are developed as work groups evolve. In their daily operation, work groups tend to use certain information links more often than others; this may result because in routine operation, information needed is provided by these frequent contacts. Other contacts can potentially provide information, but that information is not useful at the moment.

As a result, after some time in operation, work groups have developed weak and strong communication ties with other individuals or groups.

2.1.13 Task Knowledge Requirements of Work Groups

A great deal of research has centered on the factors that affect performance of tasks by groups; however, not much research was found related to how knowledge about tasks is diffused by work groups. We consider this an important issue since work groups need technical information in order to perform their work better, which is the main purpose of PIE. In other words, when trying to improve a manufacturing process groups must obtain information about such things as mantainance, design, alternatives settings, etc. While some of this information may be provided by the supervisor or engineers, the greater the autonomy the group has, the more important technology diffusion issues become.

An author that has developed ideas around this problem is Friedlander (1987); this author proposes that a work group can be disrupted by the flows, into and out of its boundaries, of technology, people and information. In particular, Friedlander proposes that when an imported

technology differs from the group's previous technology under use, the group will resist this technology or will try to adapt it so that it resembles its previously used technology.

An important concept in studying how work groups diffuse information is Granovetter's (1973) theory of "the-strength-of-weak-ties." It must be kept in mind that weak-ties may be defined as groups evolve; thus, in their daily operation, work groups themselves define the links that will be weak or strong.

One source of uncertainty are *unanalyzable situations*, in which workgroup members have to spend time thinking about what to do or actively search for solutions. This implies going beyond normal procedures (Fry & Slocum, 1984). PIE may have elements of unanalyzable situations, since the group may not have the expertise to categorize a problem or to discriminate between relevant and irrelevant information.

2.2 Propositions

The literature review suggested the following propositions about Technology Diffusion by Work Groups in Process Improvement Efforts. As will be explained in the methodology section, these propositions can be refined further as more evidence is found during the research. For convenience, the propositions have been grouped by major themes. Since many of the constructs used are expected to be given special meanings by workers, details about how evidence about these constructs is to be collected are explored further in chapters to follow.

2.2.1 Propositions Related to Performance

In this section we state propositions about the importance of performance of work groups when transferring knowledge about tasks. Our initial conception of this construct is related to questions such as "How fast did the workgroup improve the process ?" or "How much was efficiency (or failure rate, etc.) improved ?" or "How many trials did the workgroup do before success ?" or "Does the group consider PIE complete ?" or "Did the workgroup learn something about transferring task knowledge?". We expect empirically found meanings of "performance" to modify this initial conception, but as explained in the methodological section, the use of case study methodology is flexible enough to accomodate this (Martell & Guzzo, 1991).

p1. *The perception of a group's performance by other groups affects the work of the first group as change agent.*

As explained in section 2.1.9, a change agent is usually of a higher status in a social system. In manufacturing contexts, status may be confered by superior performance, so that groups that have been good performers will be seen by other groups as models.

This proposition is related to the ecology of work groups (Friedlander, 1987), since our interest is in relations between work groups and not so much in relations between individuals in a group. In this proposition, we convey the idea that in order for changes and organizational learning to take place, each group must know about the performance of other groups. In the case that the performance of groups is not communicated to other groups, no group can act as a change agent, and consequently, diffusion will hardly take place. It may also be the case that certain group is perceived as a change agent by other groups without knowing it; however, we believe that the actions that the other groups take in relation with this first group will in the end be a sign that it is considered a change agent.

p2. *The expectations of the group depend on past performance in PIEs.*

This proposition is based on traditional motivation theory, which we would like to apply to the case of how groups define their objectives when trying to improve a manufacturing process (Shaw, 1986).

Our interest here is that we feel the objectives of the workgroup may not be explicit, and some of the members may have more optimistic objectives than others due to their different stories (Senge, 1990; Kim, 1993). We expect this to have a major influence in group behavior, since different, non-explicit objectives may lead to lack of trust and reduced efficiency (Shaw, 1986; Goodman, 1990).

2.2.2 Propositions Related to the Diffusion of Information and Knowledge

In this section we group the propositions that we feel are related to the diffusion of information or knowledge suffers when moving from one place or individual to another who is supposed to use it. As explained earlier, we use a rather loose definition of information, which may in some instances be assimilated to knowledge. When the distinction is important, we use the concepts as different.

One assumption here is that work groups are very important subsystems in transferring knowledge. Our contention is that information or knowledge does not flow directly from individual to individual, but rather a process of evaluation and assessment takes place during the transfer process and this evaluation process is greatly influenced by the group's norms and past experiences.

The concept of information we are using is that of a piece of data which has meaning within the context and for the uncertainty the group is facing. This information was not available to members in the workgroup and allows them to perform their tasks in a different, hopefully better, way. When groups receive data which allow them to perform better but which they already knew, it is not considered information; in other words, information makes a difference.

Knowledge, on the other hand, is data (procedures, specifications, mechanical knowledge, experiences, etc.) about tasks that some or all of the members of the workgroup possess and which they may be using or saving for later use.

p3. *When an imported technology differs from the group's previous technology under use, the group will resist this technology or will try to adapt it so that it resembles its previously used technology.*

This proposition is related to the ecology of work groups (Friedlander, 1987) and also to the diffusion literature (Rogers, 1983) and the organizational change literature (Staw, Sandelands & Dutton, 1981).

Our interest in this proposition is that we feel that when a technology is first tested in a manufacturing environment, where no previous evidence of its use is available to workers, they will resist its introduction due to fear of lowered performance.

However, we think that: (1) if the introduction of the innovation is done when another group has tested it, other groups may be more willing to try it; (2) if the organizational context allows for certain latitude in performance when introducing innovations, work groups may be more willing to try it; and (3) if the initiator groups are voluntary, work groups may be more willing to try it.

It should be kept in mind that we are not dealing with hardware innovations, so that literature dealing with technological innovations (for example, Pietro & Masaro,1987) may not apply or must be taken with reservations.

p4. *During reinvention, groups may have considerable discretion in technology diffusion; this may not be the case in "packaged" PIE, where the group must conform to specifications and cannot use its network freely.*

Reinvention is another of the important constructs in this work. By reinvention we will mean the changes, eliminations, or additions that an innovation to a task undergoes from the moment it is known by the workgroup until it is implemented.

Some innovations may be modified by the workgroup but others must be implemented the way they are acquired. The issue of reinvention is related to the concept of autonomy, since the more autonomy a group has, the more it is allowed to reinvent.

While reinvention has been studied in several contexts, this proposition is directed toward a more specific issue during the reinvention process; reinvention is also related to the relative

knowledge that a group has about an innovation. As explained in section 2.1.8, during reinvention the adopting unit adapts the innovation to the use it is intended for. If the technology is not packaged, groups may have the opportunity to device changes in several components of the technological package. To generate and evaluate this changes, according to our proposition, groups will use their communication network in order to obtain the necessary bits of knowledge.

In packaged PIE, little reinvention is possible and consequently, diffusion of the innovation is usually carried out by the supplier of the technology. In other words, groups cannot devise changes beyond those proposed by the supplier, and thus, there is no use for the group's network.

Briefly stated, when a technology can be reinvented, groups will play an important, active role in its diffusion; when the technology is packaged, groups will play a more receptive role.

p5. *When searching for technical information about tasks, groups will use first their homophilous relations, and if these are unsuccessful, they will use heterophilous relations.*

As described earlier in section 2.1.6, communication between similar people tends to be gratifying for the people. For this reason, individuals will tend to seek missing or relevant information among their peers, specially when it is related to an innovation. These peer relations may be the result of psychological closeness or physical closeness due to specific characteristics of a manufacturing setting.

Work groups, as stated earlier, may be an important subsystem in the diffusion process since they are the closest individuals for each person. Thus, individuals in work groups will seek information first within their workgroup and if this interaction is not fruitful, they will search for information in other groups.

One of the areas this study will address is the kind of relation that takes place in the information transfer process. We think that we will find individual-individual relations, individual-group relations and group-group relations. When an individual obtains valuable information, we expect her to spread it to her group.

p6. *When undergoing PIE, group members obtain information from sources that are not the same in essence or frequency as those sources used when the group is not under PIE.*

When groups are performing routine tasks, their information channels are already developed and through these groups can obtain the information they need. However, when in PIE, information requirements change, in some cases drastically, and common sources of information may not be capable of delivering the information that a group needs to improve its tasks. For this reason, groups will develop new sources of information, and they will use these in a frequency different than that from which these groups obtain routine information (Lazega, 1990).

p7. *The behavioral criteria for considering a PIE complete do not depend on the type of PIE in question; the technical criteria for considering a PIE complete depend on the type of PIE in question.*

The technical criteria for considering a PIE as completed are usually quantitative, such as number of defectives, failure rate, etc. so that work groups may set quantitative goals. Each PIE has a distinctive set of technical criteria. However, some criteria of completeness may be behavioral and common to all kinds of PIE. For instance, perceived uncertainty, which we assume is reduced when PIE is complete, will be different for different groups. Thus, the more inquisitive groups will consider they are still under PIE when other groups consider that the improvement effort has been completed.

2.2.3 Propositions Related to Work Groups

In this section we list the propositions that deal with group characteristics and its dynamics. These characteristics and dynamics are equivalent to the traditional ones, but in this work we focus on those that seem relevant for work groups under PIE.

p8. *As work groups evolve, efficiency and effectiveness in technology diffusion increase.*

Several authors concede that as groups evolve, they concentrate more on tasks and less on group maintenance (Shaw, 1986). We feel that as work groups in manufacturing settings evolve, they become more efficient since information networks are established, as well as norms for the evaluation of information.

By *efficiency* we mean the amount of output obtained for a given input and by *effectiveness* we mean the degree to which a PIE contributes to improvement of the whole manufacturing process, not just a local improvement (Mark et al., 1986). It should be noted that a group which is efficient during PIE isn't necessarily efficient in normal conditions.

p9. *Effective work groups have structural characteristics appropriate to their level of technological uncertainty; less effective units have a "mismatch" between technological uncertainty and structure.*

Some characteristics of work groups make them more efficient or effective during PIE. It is expected that more heterogeneous work groups will be more efficient during PIE since a greater pool of ideas about a particular problem is available, even though these groups may be less efficient during routine situations (Hackman, 1987; Fry & Slocum, 1984). It is also expected that effective or efficient work groups have distinctive interfacing roles which allow them to interact with other groups or individuals in a more effective way.

p10. *Work groups create norms to determine what information, from what source, under what circumstances is adequate.*

Since not all data are useful, groups must be capable of discerning useful from useless data. This requires the development and acceptance of norms which the group uses in discriminating.

Development of norms is a process that relatively mature groups undertake; so, this contributes to the higher efficiency of mature work groups. This process may not be straightforward, since it depends on previous experiences, compatibility of individuals, certainty of results, etc. Further, norms may blind a group from useful information.

3. METHODOLOGY

3.1 About the Research Method

3.1.1 Methodological Considerations

The purpose of this section is to describe the issues that seem relevant in choosing the research methodology. While the previous chapters dealt with the theory behind our propositions, this chapter deals with the problem of how are we going to do a rigorous inquiry about this subject.

Involvement in a PIE implies a change in the way work is organized and groups must learn how to perform in this new organization. Also, groups must learn how to organize to implement PIEs in order to become more effective when a new technology problem arises. As a consequence, there are two levels of learning: changes in group behavior in order to perform a particular, technology-related task, and changes in group behavior in order to increase efficiency in assimilation of technology-related tasks. It is our feeling that some groups will perform both kinds of learning, while others, due to some organizational circumstances, will never progress to the second type. For this reason workgroup evolution and performance must be analyzed during some time to determine their efectiveness in process improvement.

We consider this to be a study using many of the concepts of diffusion of technology. However, we will focus on the process of transferring knowledge from one individual or group to another and not so much on how individuals make decisions to adopt. This is what Rogers (1983) calls *innovation-process studies:*

> [These] studies stress the implementation phases involved in putting a new idea into use in an organization; as such, these studies have improved upon previous diffusion research, which generally stopped short of investigating implementation by focusing on the decision to adopt or reject (p348).

Further, we will focus on diffusion inside organizations, which as explained in earlier chapters, may be mandatory:

> And compared to the innovation-decision process by individuals [..], *the innovation process in organizations is much more complicated.* The latter may involve a number of individuals, each of whom plays a different role in the innovation decision (p348).

The definition of *boundaries* between PIEs may be an important issue to consider. Since a workgroup may be involved in several PIEs at the same time, they may have difficulty determining when one PIE ends and another begins. This seems to be a common problem in difussion research: "In essence, the practical problem is how to determine where one innovation stops and another one begins" (Rogers, 1983: 14).

Another issue in diffusion research is that of the *unit of analysis*. Much research has focused on the individual as the unit of analysis, but this approach ignores the importance of network relationships. As we will explain later, networks, and specifically communication networks, seem to be one of the most relevant issues when studying diffusion by workgroups, since there appears to be two kinds of networks: one internal to the group, and another by means of which the group communicates with its environment. An author that used this approach is Coleman, who included indicators of network communication behavior among the independent variables of study and found these network variables to be important predictors of innovativeness (Coleman,1958). Several propositions for the unit of analysis are given. Among them, network links are important:

> [..] diffusion scholars began to plot sequential-over-time sociograms of the diffusion of an innovation among the members of a system. And tentative steps were taken toward using network links as the units of analysis. This advance allowed the data analysis of a "who-to-whom" communication network, and facilitated inquiry into the identification (1) of cliques within a total system and how such structural subgroupings affected the diffusion of an innovation, and (2) of specialized communication roles such as liaisons, bridges, and isolates, thus allowing diffusion research to proceed well beyond the relatively simpler issue of studying just the characteristics of opinion leaders (Rogers, 1983: 111).

Methodology of diffusion research has been given considerable attention. In his account of the evolution of diffusion research, Rogers (1983) cites the anthropological current as one the basic ones and the oldest of all (p47). This author associates the anthropological current with participant observation, non-participant observation and *case-study research* . The following are some reasons why the methodology used in the anthropological current is worth considering for diffusion studies:

1. As a result of the anthropological perspective, an account of the situation from the respondent's viewpoint is obtained. This account is surrounded with an in-depth understanding of the situation, which helps the researcher to avoid, among other things, the pro-innovation bias.

2. It is well known that successful innovations leave traces that can be followed. However, unsuccessful diffusion does not leave traces and investigation must rely on informant's descriptions. What is important here is that theoretically, unsuccessful diffusion is as important as successful diffusion.

3. Rejection, discontinuance, and re-invention may occur when technology is transferred, and depending on the adopter's point of view, this behavior may be justified. The problem for diffusion scholars is to understand the context of the relations between the individual's perceptions of the innovation and of his situation.

4. Since the impact of an innovation may have effects on several people, all the participants should be involved, including potential adopters, in the definition of the diffusion problem. A consequence of this is that as the research advances, new kinds of adopters may become relevant. Case studies are specially flexible and can accomodate the entrance of unforeseen adopters into the research.

5. "Diffusion is a process that occurs over time, so there is no way to avoid including time when one studies diffusion" (Rogers, 1983: 113). This implies that linking of events in a diffusion process may be the best way to proceed. This calls for special designs, either of the statistical or the case study kind. For gathering data about the time dimension in the diffusion process there are: (1) field experiments, (2) longitudinal panel studies, (3) archival studies, and (4) case studies

More quantitative methods of research have been used by several diffusion researchers. However, these methods may not be appropriate for our purposes. The main disadvantage found is that the context in which the innovation takes place is not recorded and human behavior is destructured, and this context may have an important effect in the process of diffusing an innovation. In the words of Barton:

> Using random sampling of individuals, the survey is a sociological meat-grinder, tearing the individual from his social context and guaranteeing that nobody in the study interacts with anyone else in it. It is a little like a biologist putting his experimental animals through a hamburger machine and looking at every hundredth cell through a microscope; anatomy and physiology get lost; structure and function disappear and one is left with cell biology (Barton, 1968, as quoted in Rogers 1983: 110).

Another relevant problem is related to *informants*. A usual source of information about the progress of diffusion in an organization has been chief executives. However, it is suspected that data provided by this people may not represent the behavior of those more directly related to the diffusion (Rogers, 1983: 357). In order to avoid this, our informants will be those more directly involved in the diffusion, which in our particular case are workers.

The more traditional quantitative approaches to research have had a pro-innovation bias and have tended to focus on correlation between variables, ignoring to a certain extent the issue of causality. As a consequence, a great deal of the richness of the situation has been lost and explanation has not been very powerful (Rogers, 1983: 115).

Assumptions about *technology* may modify the research method chosen. One extreme, technology is assumed to be a given or a stable variable; on the other, we would expect continual change in aspects of technology due to efforts by the workgroup or other forces (for example, market forces). Clearly, our position is that technology is a changing entity and this change is in some way under the control of the people involved in its implementation.

The relation between *technology and the effectiveness of workgroups* may present some methodological problems. One problem is that of informants, and another is how to aggregate individual level data to represent workgroup characteristics (Fry & Slocum, 1984).

While many of the studies of diffusion are done under the grounded research label, we feel that our approach is not fully within that context. The essence of grounded research consists of two conditions: (a) the use of close-up, detailed observation of the natural world by the investigator, and (b) the attempt to avoid prior commitment to any theoretical model (Martin & Turner, 1986; Van Maanen, Dabbs, & Faulkner, 1982). While we are interested in the first point, we do not completely suscribe to the second, since we would like to have a minimal theoretical guide. This is illustrated by Carr, when referring to the method in history:

> No, facts are not similar at all to fish exposed in the marketplace. Rather, facts are more like fish that swim in the wide and sometimes innaccessible ocean; and what the historian catches depends in part on luck, but specially on which part of the sea he decides to fish and on the apparel he has chosen, both factors determined, of course, by the kind of fish he wants to catch. In general, it can be said that the historian will find the kind of facts he wants to find[Carr, in Schaff, 1974: 243].

3.1.2 Research Method

A conclusion from the above is that case study methodology is the most appropriate for the purposes of this research. As can be seen in the following table taken from Yin (1989), case study methodology is the technique to use when we are trying to explain the who and why questions of contemporary events. In this work, we are interested in the behavioral processes occurring during PIE, which in turn means responding questions such as "Why did this workgroup perform as it did during PIE" or "How did this workgroup obtain the required information ?". These questions deal with causal links and events that must be traced over time, instead of just their frequencies.

Case study research can be used for various objectives such as theory building, exploration and explanation (Eisenhardt, 1989). In this work, we will use case studies mainly as an explanatory tool and to some extent as a theory building tool; exploration is not considered appropriate since a considerable research has been done in the field. In the words of Yin (1989: 19):

> The case study is preferred in examining contemporary events, but when the relevant behaviors cannot be manipulated. Thus, the case study relies on many of the same techniques as history, but it adds two sources of evidence not usually included in the historian's repertoire: direct observation and systematic interviewing. Again, although case studies and histories can overlap, the case study's unique strength is its ability to deal with a full variety of evidence — documents, artifacts, interviews, and observations.

Briefly stated, a case study is an empirical inquiry that *(1) investigates a contemporary phenomenon within its real-life context; when (2) the boundaries between phenomenon and context are not clearly evident; and in which (3) multiple sources of evidence are used* (Yin, 1989: 23).Case studies also provide some form of flexibility, since data analysis and data collection can overlap. This way, some important, unforeseen threads of evidence may be followed as they appear. While this is not possible in more rigid research methods, it does not mean that case study research can forget about the guiding propositions of the research (Eisenhardt, 1989). Also, an important part of case studies is the interpretation of results in the light of theoretical frameworks (Meredith, 1989).

Table 3: Relevant Situations for Different Research Strategies

Strategy	*Form of Research Question*	*Requires Control Over Behavioral Events ?*	*Focuses on Contemporary Events?*
Experiment	how,why	yes	yes
Survey	who,what,where, how many, how much	no	yes
Archival analysis (e.g., economic study)	who,what,where, how many, how much.	no	yes/no
History	how,why	no	no
Case study	how,why	no	yes

From Yin, R. (1989: 17)

Figure 4 depicts the relevant steps in the proposed research method, which are described in what follows. We feel that this methodology is consistent with what some authors suggest (Yin, 1989; Eisenhardt, 1989). A review of the relevant literature (1) is performed in order to develop an understanding of the issues of group dynamics during PIE. In this review, attention is given to those parts of the theory that have already been worked out in order to use them as a foundation for the preliminary hypotheses or propositions, (2) which are developed as guidelines in the development of the field work. These preliminary hypotheses may not be expressed in the most adequate form for the study, so that changes may take place. Also, these preliminary hypotheses help us in defining the subjects of study: the cases to be chosen are those that appear to give more light to the confirmation or disconfirmation of the propositions (3).

Once the cases are chosen, a description of the relevant events and its consequences (4) is sought. This implies a series of techniques, such as inteviews, archival search, etc. The sequence of events becomes a backbone upon which other pieces of evidence are structured. In order to obtain the best description, key informants and groups are identified. One of the relevant pieces of data to gather at this moment is the perceived extent of PIE, since the improvement effort may have had some modifications and may not be perceived the same way by everybody.

Having obtained the sequence of events, an analysis of the group processes that led to them is performed (5). This implies identifying the activities and decisions and changes that the groups

underwent while the improvement effort was taking place, and setting these processes in a general language with which propositions can be compared.

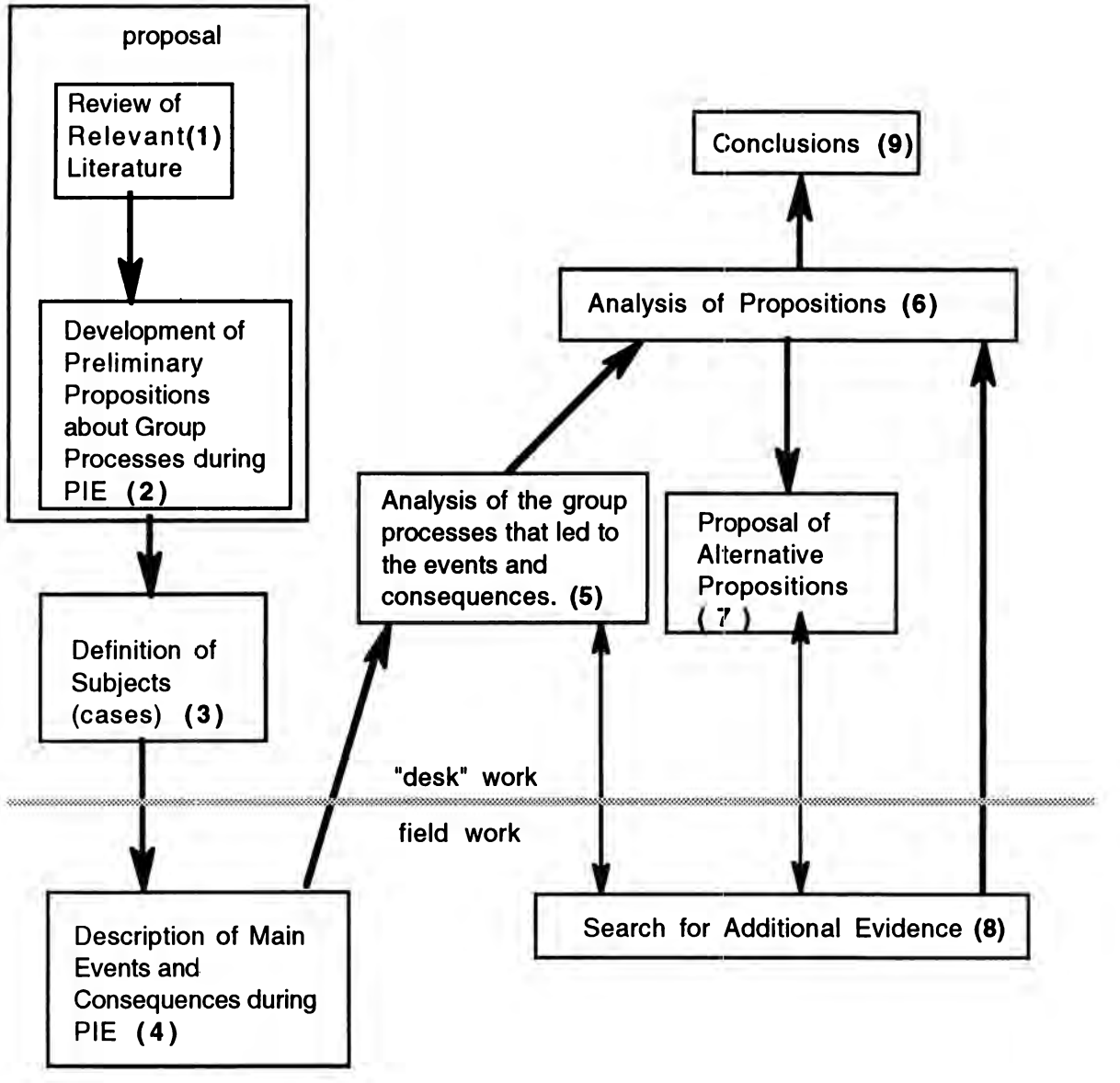

Figure 4 : Research Method

An analysis of the propositions (6) is made in order to determine which of the hypotheses hold under the given circumstances and an explanation is sought. If the explanation does not seem convincing enough, alternative hypotheses are proposed (7) and new evidence sought (8). If the explanation is adequate, conclusions are drawn (9).

The above procedure includes the relevant parts of a case study according to Yin: (1) a study's questions; (2) its propositions, if any; (3) its unit(s) of analysis; (4) the logic linking the data to the propositions; and (5) the criteria for interpreting the findings (Yin, 1989: 29).

The cases to develop may be determined by using the following guidelines. It must be noted that the selection of cases is done by a theoretical sampling, that is, selecting those cases that seem to fit better our constraints (Eisenhardt, 1989). The logic for inference in case studies is not that of sampling. Rather, each case should be considered as an experiment, i.e. an instance where variables take specific values. The analysis of several cases is then analogous to a comparison of several experiments.

> A fatal flaw in doing case studies is to conceive of statistical generalization as the method of generalizing the results of the case. This is because cases are not "sampling units" and should not be chosen for this reason. [..]Multiple cases, in this sense, should be considered like multiple experiments (or multiple surveys). Under these circumstances, the method of generalization is *analytic generalization*, in which a previously developed theory is used as a template with which to compare the empirical results of the case study. If two or more cases are shown to support the same theory, replication may be claimed. The empirical results may be considered yet more potent if two or more cases support the same theory but do not support an equally plausible, *rival* theory (Yin, 1989: 38).

The development of a theoretical framework is an important step previous to the development of a case study. The framework needs to state the conditions under which a particular phenomenon is likely to occur as well as the conditions when it is not.

The determination of the number of case studies is another issue worth considering. Because a sampling logic is not be used, the usual criteria regarding sample size are irrelevant. The number of case studies to develop is best determined by reflecting on the number of replications desired. For situations where gross differences are expected, two cases may suffice, and even for some particular situations a single *critical* case may be enough.

Case study research implies the risk of rationalizations by the actors in the light of results. Our first task in this direction will be to develop a convenience sample, where PIEs have already

been under way for some time, but not for so long as to contaminate the study with rationalizations about the causes of performance.

In the following chapter will present some of the finer detail in the proposed methodology, such as proposed sites, informants, interview guides, etc. (Yin,1989; Dutton & Dukerich, 1991).

3.2 Techniques Used

One of the interesting aspects of case study research is that evidence collection and analysis usually go hand in hand. New evidence may lead to a redefinition of the context where the phenomenon is studied, and consequently to a reassessement of the validity of the propositions made (Van de Mark, 1991).

In order to gain theoretical sensitivity and to have a sound basis to determine the validity of propositions, a series of techniques will be used. The first set of techniques deals with the methodological task of uncovering and surfacing relevant issues in the research (Strauss & Corvin, 1987; Gioia & Pitre, 1990); the second set of techniques deals with the issue of evidence, considering its sources and its value in supporting a proposition (Freeley, 1993); and the third set of techniques deals with the analysis of this evidence and the logic followed in arriving at conclusions (Freeley, 1993; Larroyo, 1973).

In terms of cogency, the purpose of these techniques is to determine how to qualify our propositions. The propositions can be qualified as *certain, probable, plausible or possible.* These degrees of cogency are explained below.

certainty: This degree of cogency means that the statement is true and it is clear to everybody that it is true. This degree of cogency does not lead to argumentation.

probability: There is high degree of likelihood that the conclusion is true. This is where most of the argumentation takes place.

plausibility: This degree of cogency has a lesser degree of likelihood than the probability degree. In an argument, we try to move from this degree to a higher degree of likelihood.

possibility: This degree of cogency gives us the information that the truth of the argument is not impossible, but little less.

3.2.1 Enhancing Theoretical Sensitivity

Several techniques for enhancing theoretical sensitivity are described by Strauss and Corbin (1987). We will use these as guidelines in analyzing the evidence supplied by the cases and in determining what leads are worth pursuing. Figure 5 depicts the relevant questions that can be made about a proposition. This diagram should be kept in mind when interviewing people since during an interview a new lead may appear. The elements on this diagram are explained in what follows.

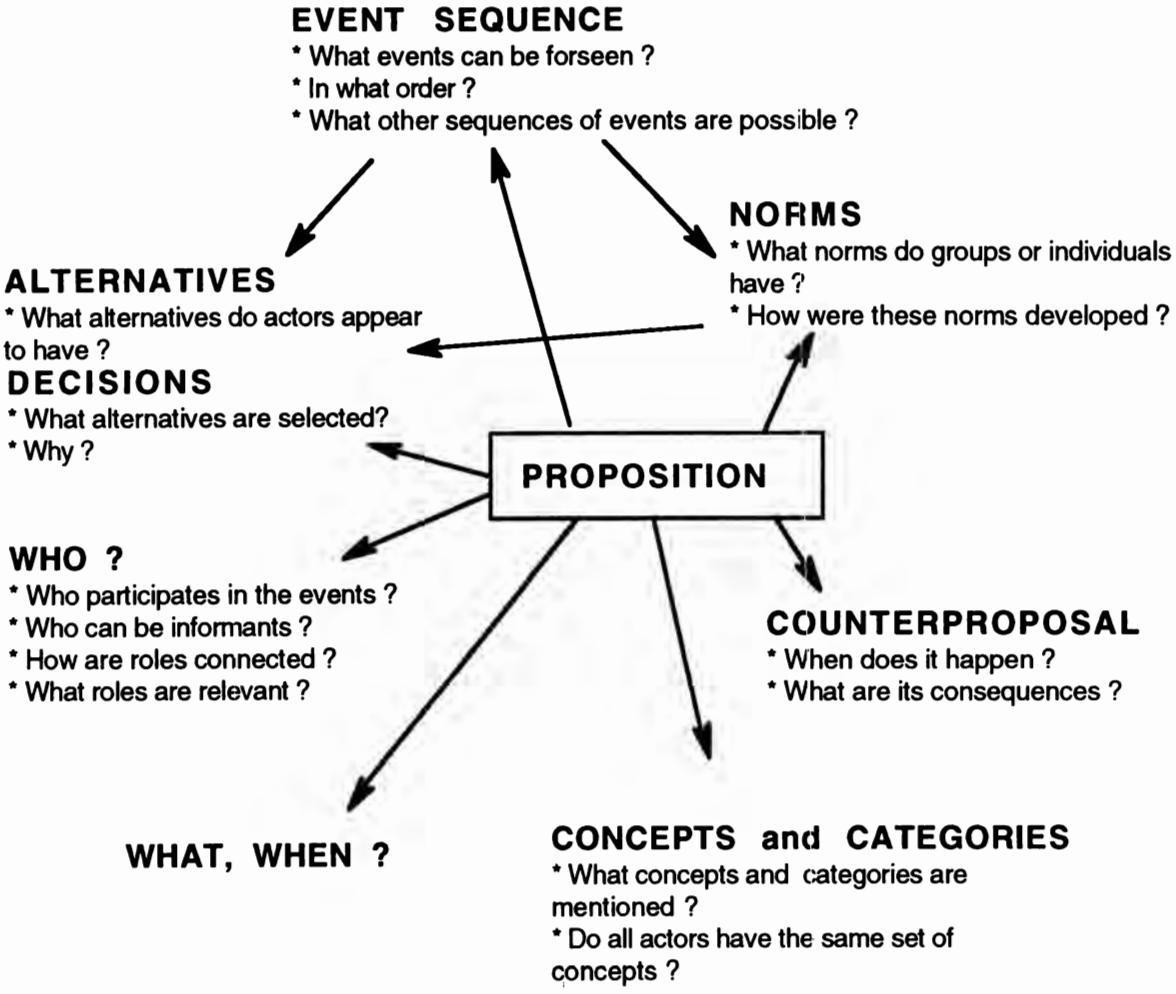

Figure 5: Questions for Enhancing Theoretical Sensitivity

3.2.1.1 Event Sequence. This technique consists of ordering the relevant events on a time line. The development of an event sequence is a very helpful tool in finding out patterns of behavior across time. Also, frequent events having a common cause can be discovered by this technique.

3.2.1.2 Alternatives and Decisions. The analysis of individual or group decisions about an issue can also lead to interesting findings; organizational values and norms can be uncovered by analyzing the way people develop and choose between alternatives.

3.2.1.3 Who? This is an important question to ask when an event or decision is analyzed. The answer can lead us to uncovering the informal structure of the organization and the roles people perform in it.

3.2.1.4 Norms. The discovery of a norm of behavior is usually an important piece of the puzzle; norms' pervasive impact in decision making stimulates the quest for their structuring in the organization.

3.2.1.5 Counterproposal. Also known as the "flip-flop" technique, this procedure forces us to see the inverse of the proposition or claim we are trying to establish. It may well be the case that there is more evidence supporting the counterproposition than the evidence that supports the proposition.

3.2.1.6 Concepts and Categories. Since one of our assumptions is that the reality within the organization is socially constructed (Berger & Luckmann, 1991), we must get an understanding of the meaning that people within the organization give to concepts and what actions derive from the interpretation of these concepts.

3.2.1.7 What, when ? It is also important to know what happened and when did it happen. While part of this is captured in the event sequence, it may happen that a unique event is so important that it must be considered.

3.2.2 Types of Evidence

In what follows we will present the types of the evidence used. The value of evidence is related to how useful it is in deciding on the truth value of a proposition and this in turn is determined by the type and quality of evidence. In order to determine the usefulness of evidence, several tests are possible (Freeley, 1993).

The following categories help us in determining what type of evidence is being used in this work; it must be noted that one piece of evidence can belong to several categories.

3.2.2.1 Primary or secondary. *Primary evidence* is the best evidence that the circumstances admit. It leads to the greatest certainty of the matter in question; *secondary evidence* is evidence about which we think there is better evidence of the matter in question.

3.2.2.2 Written or Unwritten. *Written* evidence is evidence supplied by writings of all kinds: books, newspapers, magazines, graffiti and signs carved on buildings. *Unwritten* evidence includes both oral testimony and objects under personal inspection.

3.2.2.3 Real or Personal. *Real* evidence is furnished by objects placed under inspection. *Personal* evidence is evidence furnished by persons, and it way be in the form of oral or written testimony. The credibility we attach to personal evidence depends in large part on several traits we attribute to the person providing the testimony.

3.2.2.4 Lay or Expert. *Lay* evidence is provided by persons without any special training, knowledge, or experience in the matter under consideration. Such evidence is useful in areas that do not require special qualifications. *Expert* evidence is evidence provided by persons with special training, knowledge, or experience in the matter under consideration. In this work, evidence is considered expert since informants are choosen so that they have had sufficient access to the social processes involved in group problem solving.

3.2.2.5 Negative. *Negative* evidence is the absence of evidence that might reasonably be expected to be found were the issue in question true. This type of evidence may be difficult to use, since the fact that evidence is missing, after careful investigation, may not mean that it is missing for the reasons we claim.

3.2.3 Value of Evidence

Further, the evidence found has a particular probative force, which can be *partial, corroborative, indispensable or conclusive.* The value of evidence is contingent on the situation at hand so that the value of particular pieces of evidence will be determined when each proposition is analyzed.

3.2.3.1 Partial. *Partial* proof is used to establish a detached fact in a series of facts tending to support the issue in dispute. Evidence that only partially substantiates a proposition is of little value in itself. However, when several pieces of partial evidence are brought together, their combined effect may be very strong and taken together they might become conclusive.

3.2.3.2 Corroborative. *Corroborative* proof, also known as "cumulative" or "additional" proof, is strengthening or confirming evidence of a different character in support of the same fact or proposition.

3.2.3.3 Indispensable. *Indispensable* is that evidence without which a particular issue cannot be proved.

3.2.3.4 Conclusive. *Conclusive* proof is evidence that is incontrovertible because it is strong and convincing enough to override all evidence to the contrary and to establish the proposition beyond reasonable doubt.

3.2.4 Tests for Evidence

In order to determine the quality of our evidence, independent of its probative force, we must test it by using the appropriate combination of the following tests. Due to the contingent nature of evidence, these tests are to be performed when the evidence is used to support or refute a proposition. Several of the tests for the evidence used in this work are avoided by choosing the adequate informants for each situation.

3.2.4.1 Sufficiency. Enough evidence must be provided to support the matter at issue. How much is enough? Logically, evidence must be provided that is more convincing than the opposing evidence. Conclusive evidence is one such case, but since such evidence is often unavailable, we must settle for a fair preponderance of evidence.

3.2.4.2 Clarity. Evidence that is clear must provided or that, by means of additional evidence, can be made clear. The clarity of evidence in this work is obtained by pondering statements and reports and seeking clarification during interviews.

3.2.4.3 Consistency with other evidence. Evidence must be consistent with other known evidence. This may be the hardest part of the analysis, since evidence is collected from different sources and it must be assessed.

3.2.4.4 Consistency with itself. Evidence must be consistent within itself; that is, pieces of evidence must not contradict other pieces presented together.

3.2.4.5 Verifiable. As scientists, we must always be able to verify evidence; that is, we must be able to authenticate, confirm, and substantiate it. We should also be careful to identify the source of the evidence so that others may verify it themselves if they wish.

All the evidence supplied in this work is verifiable by consulting the minutes, consulting reports or interviewing the informants.

3.2.4.6 Competent source. The source of the evidence must be actually qualified to testify on the matter at issue. In this work, evidence comes from competent sources since the informants are selected paying attention to their ability to reflect about their situation.

3.2.4.7 Unprejudiced. In many cases persons testify about matters in which they have an interest; in some cases those who are personally interested in the matter at hand are the only witnesses available. We must check that these persons are free from prejudice.

In this work, most evidence is unprejudiced; however, in some instances we will encounter informants who are in some way prejudiced and we will try to obtain additional information from other sources.

3.2.4.8 Reliable. The source of evidence must be trustworthy, as demonstrated in previous opportunities. The reliability of evidence in this work is guaranteed by the choice of informants.

3.2.4.9 Relevant. The evidence must be actually related to the matter at issue. In this work, evidence is considered relevant since only the inquiry design proposed in figure 4 allows us to seek only the evidence that is relevant to the propositions that are being analyzed.

3.2.4.10 Recent. Old evidence may sometimes be more valuable than recent evidence. Often, however, the recency of evidence is an important factor in establishing its value. If the facts of a situation are subject to change, or if opinions about a certain matter are subject to revision, then we want the most recent information available.

3.2.4.11 Cumulative. Although one piece of evidence is sometimes sufficient to establish a given contention, we will be usually in a stronger position if we can offer several pieces of evidence from different sources or of different types to substantiate our propositions.

3.2.4.12 Critical. We may have evidence, but do we have the critical evidence, the evidence we really need to know in a particular situation? In may cases evidence made available to us is distorted.

3.2.5 Sources of Evidence

The following are the sources of evidence used in this work. Along with their description, we include some evaluation of their strength, according to the guidelines described in the preceding sections.

3.2.5.1 Archives. This source furnishes evidence about the organizational settings expressed in the form of unfulfilled demands, effort spent pushing the innovation, etc. The results obtained from this source of evidence are long term group performance issues, as well as group-structure changes.

The archives and documents where information can be found are the work group minutes, operating records, etc. In those cases where formal work groups do not exist, there is not archival evidence about their performance, and we must resort to other sources of evidence.

This kind of evidence is a very powerful one. First, the written records of work groups are the most objective source for their performance; this makes minutes a primary source of evidence, and thus, other sources of evidence are used for issues not covered by them. Second, the cogency value of some propositions can be supported by negative evidence in this source. Third, since we are studying how groups diffuse technology and minutes are written by these groups, evidence found in minutes is usually expert.

3.2.5.2 Meeting Observation. This source leads to an appreciation of how a solution is built around a problem in a meeting. The evidence found in the coding of these meetings is information about performance of the group when working *as a group.* While archives may give us information about the performance of the group in the organizational context, the meeting observation gives us information that is usually not captured in minutes, such as roles, participation, etc.

This source of evidence is also a powerful one where meetings are taking place. First, the evidence obtained is primary, since there is no better way to know how groups behave during a meeting; second, it is also expert evidence, since it is the very participants in the process who are providing evidence; and third, negative evidence can be obtained from this source in considerable amounts.

3.2.5.3 Interviews. This technique confirms findings of the other techniques and also helps in surfacing issues not likely to be written down in minutes or expressed in meetings. Where work groups exist formally, this is usually secondary evidence since informants tend to rationalize their actions after the fact and may not be objective enough; however, there are several propositions where this is our primary form of evidence. Where work groups are not formally established, this is a primary source of evidence.

This source usually provides expert evidence, since informants are choosen in consideration of their expertise. This is also a primary source of evidence for leads and concepts common to each organization; these concepts are usually not written down, since documents are meant to be read and thus only accepted terminology is used. However, coloquial expressions usually leak into interviews and are good leads for inquiry.

3.2.5.4 Observation. Observation can take place together with other techniques. For instance, during group meetings, observation of behavior usually takes place. However, this is usually a secondary source of evidence, usually providing leads for further inquiry.

3.2.6 Reasoning Processes Used

Case study methodology usually revolves around a small number of instances where the relevant phenomena occur. Thus, statistical analysis is not a convenient tool and we must search for alternative techniques for analysis.

As in any scientific research, the problem the case-study researcher faces is how to conclude from a limited, however large, number of instances that his propositions or hypotheses are true, or at least have a considerable chance of being true. In other words, the researcher must assemble and analyze evidence in such a way that his conclusions have a high degree of cogency. Several techniques can be found that help us in arriving at this degree of cogency and in testing the reasoning processes leading to it; statistical inference is one among these methods.

The flexibility of the case-study methodology allows us to use different sources of evidence, such as interviews, memoranda, etc. As explained above, evidence has different degrees of usefulness, depending on the context and the kind of evidence, so that we must weight the relative quality of evidence in order to decide if the proposition being analyzed is supported or not. This is done by a reasoning processes that may take several forms as explained below.

Before explaining these reasoning processes, let us describe our analysis problem as determining if the evidence found supports the propositions as they are stated or not (Freeley, 1993). The evidence needed must be obtained from the sites visited, whether on a first visit or on any subsequent visit. We will encounter situations were the evidence in favor of the proposition is balanced with the evidence against it. In these situations, more evidence, of a stronger type, must be found to break this balance and decide if the proposition is supported or not.

The elements of an argument are *claims, grounds, warrants, backing, rebuttals, and modal qualifications* (Toumlin, in Freeley, 1993). The descriptions of these elements are the following: *claims* are the elements of the argument that serve as the conclusion we seek to establish by our argument; *grounds* must be advanced in order to establish the foundation of our claim, by providing evidence and reasoning to establish that our claim is solid and reliable; *warrants* allow us to justify the move from the grounds to the claim, by establishing that the evidence and reasoning we have offered as grounds apply in this particular instance; *backing* allows us to support our warrant, since warrants are not self-validating; *modal qualification* is the expression of the degree of cogency that we can attach to our claim; *rebuttals,* and their backing, are introduced as evidence and reasoning that will destroy the effect of the argument so that we will

either have to drop the claim or assign to it a considerably lower degree of cogency. These elements are assembled diagrammatically in figure 6. The reasoning processes which we consider relevant for this research are described next.

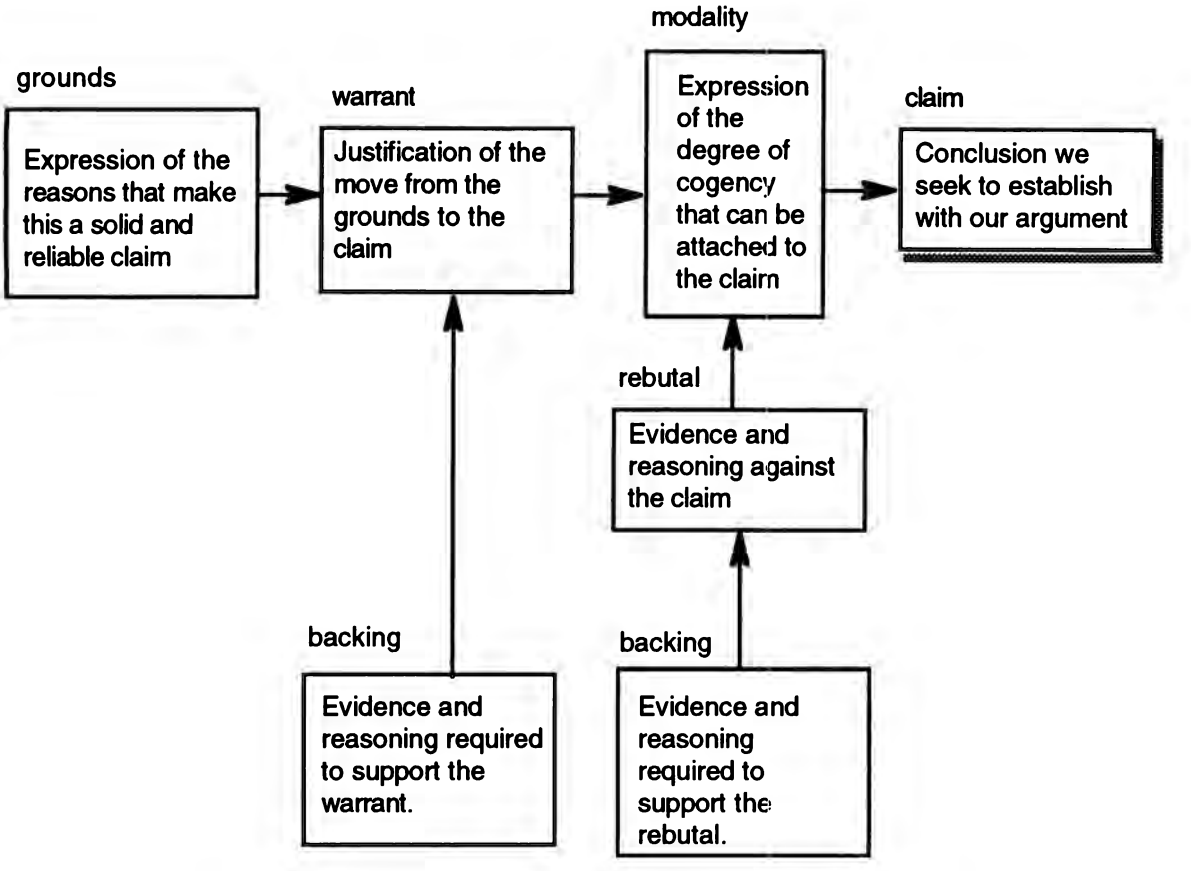

Figure 6: Structure of an Argument

3.2.6.1 Reasoning by Example. In reasoning by example, conclusions are inferred from specific cases. Sometimes, a single case may be used to establish the conclusion or generalization. However, in most cases more than one example is needed. Reasoning by example involves cause or sign reasoning, since we are trying to establish that the examples or cases are the cause or sign of the propositions presented. Reasoning by example can be tested by using the following questions:

Is the example relevant ?
Is there a reasonable number of examples ?
Do the examples cover a critical period of time ?
Are the examples typical ?
Are negative examples non critical ?

3.2.6.2 Reasoning by Analogy. The process of reasoning by analogy consists of making a comparison between two similar cases and inferring that what is true in one case is true in the other. Reasoning by analogy is a form of inductive reasoning.

The analogies used must be *literal,* that is, the cases compared must belong to the same category in some classification scheme. The following questions are used to test reasoning by analogy:

Are there significant points of similarity ?
Are the points of similarity critical to the comparison ?
Are the points of difference noncritical ?
Is the reasoning cumulative ?
Are only literal analogies used as logical proof ?

3.2.6.3 Reasoning by Sign. This process consists of inferring relationships between two variables. These relationships are often called correlations. The argument goes that if two variables are
closely related, the presence or absence of one may be taken as *indication* of the presence or absence of the other. In other words, we are assuming that there can be an attribute of a phenomenon which behavior is correlated to the behavior of the substance of the phenomenon. The following tests are used in sign reasoning:

Is the alleged substance relevant to the attribute described ?
Is the relationship between substance and attribute inherent ?
Is there a counterfactor that disrupts the relationship between substance and attribute ?
Is the sign reasoning cumulative ?

3.2.6.4 Causal Reasoning. In causal reasoning, an inference is made that a certain factor is a force that produces something else. The direction of this kind of reasoning can be cause-to-effect or effect-to-cause. It is important to recognize, when using this kind of reasoning, that several causes may be at work in a given situation. The following tests are applied to causal reasoning:

Is the alleged cause relevant to the effects described ?
Is this the sole or distinguishing causal factor ?
Is there a counteracting cause ?

Is the cause capable of producing the effect ?

3.3 CASE STUDY GUIDE

3.3.1 Introduction

This case study guide is the result of the theoretical framework reviewed in earlier chapters, the methodological considerations and of a partial study in one firm. That partial study allowed us to detect some problems in our preliminary question guides, which were corrected to the form we present below.

The proposed research method allows us to improve the question guide as we advance in our inquiry process, so that we do not expect this to be our final instrument. However, we feel that the most important shortcomings have been eliminated from it, so that we feel confident in using it.

3.3.2 Concepts and Roles

One of the modifications to our instruments was the addition of a section for important concepts and roles. The purpose of this section is to remind us of the concepts which meanings we must constantly investigate and of the roles that appear, explicitly or not, in the work groups. These concepts and roles will help us shape a theory in case we find that no theory in our review considers them, or else, considers them with meanings that are not relevant to our situation. From the preliminary study, the following concepts and roles appear to be worth considering:

Change Our perception is that change is not a pervasive or positive concept in every situation. Some workers feel that the process should not be changed because performance may be lower, or because they do not feel authoritative enough to suggest changes.

Process Improvement The concept of process improvement is not generally understood at the site of our preliminary study. While this concept is related to change, its meaning is different since process improvement is understood in the literature as incremental, positive changes in the "hard" or "soft" parts of process in which workers have some form of participation. This concept was also found to be understood as *maintenance* : process improvement was usually associated with *problem* or *failure* and not so much with improved performance.

Technology Technology is usually understood on the shopfloor as machinery. "Soft" technology is not usually understood as a distinctive form of technology, so that a conceptual

"vacuum" exists.

Expert In our preliminary study we found some people were considered experts by management. However, as is clear from the recorded conversations, workers do not seek them for advice and usually go by themselves when in trouble even though they recognize them as experts.

Informant During group sessions, it was usual that a single person gave all the information requested and the rest made only minor comments. This behavior can be related to tenure, since the informants were also the ones with more time in the job. However, this may not be true in mature groups, where norms for participation have already been established.

Worker The operator is the person in direct contact with the process, and thus receives the benefits or shortcomings of technology, whether hard or soft. These people usually try to solve their machinery problems by themselves before seeking help

This list of roles and concepts will be modified as more of them appear relevant when further research is done. We expect the meanings to be modified since the first firm we studied did not have formal work groups and their improvement efforts, although existent, have not been labeled that way.

3.3.3 Case 1: Compañía Nacional de Harinas (CNH)

3.3.3.1 Description. CNH does not have an ongoing quality and productivity program, even though it is one of the main suppliers of wheat flour for the central region of México.

For reasons that are yet not known to us but which will be explored in the development of the case, CNH decided to begin a quality and productivity program, and our institution was called in to participate.

Our institution was required to help define the "quality and productivity indicators" (QPI) for CNH. While this is a necessary step in every quality program, it is only a starting point and one of our worries is that this might be the last step if a sufficient amount of information is not given to the stakeholders.

As part of the definition of QPI, groups will be formed to obtain the required expertise in the

manufacturing process. These groups include workers from the different operations in the process and if the quality program continues, they will continue working together. Up to this moment, there have been no formal workgroups established in CNH.

Our contact here is Miguel Angel Bravo.

3.3.3.2 Why is this case Important. This case is important for the purposes of our research for several reasons, which may be advantages or disadvantages.

First, it is a very rare opportunity to witness the birth of workgroups in manufacturing settings. Since workgroups imply a modification of the organizational setting, corporations tend to be very cautious and outsiders are not usually allowed to observe in the initial stages.

An advantage of this is that measurements about efficiency of the groups will serve as benchmarks, since these groups will have no experience in solving problems together. Also, it is interesting for us that these groups do not have any kind of norms at the moment and we will be able to witness their evolution.

Second, the groups in this situation will be formed for a very specific process improvement effort, which is the definition of the relevant indicators of the process. This is precisely the focus of our research.

Third, we do not know if these groups will survive after this PIE is over. This may turn into a disadvantage if we would like to have a follow-up of the behavior of these groups.

Fourth, the inexperience of the researcher may find its way into the process, leading to not very desirable results. Also, the duration of this effort is relatively short, consisting of meetings of three or four sessions of about 1 hour each for each group. We expect to require additional information gathering activities before and after the meetings.

Fifth, this situation may be called the "no-groups" situation. For some propositions this may be an important benchmark, since one of our assumptions is that workgroups and individuals have different patterns of behavior when diffusing knowledge.

3.3.4 Case 2: Eaton Manufacturing

3.3.4.1 Description. Eaton is a multinational firm which in México produces power transmission trains for trucks. There is an ongoing process improvement program that relies on workgroups; this program has been in operation for about 2 years.

As of October 1993, there were 43 workgroups companywide each with a specific purpose, such as scrap reduction or safety issues. Some of these groups are formed by workers, and the others, called Support Groups, are formed by managers and superintendents.

Due to a reduction in sales, a considerable number of workers have been laid off; consequently some work groups have fused and others have disappeared. Everybody in the corporation had previously received training in group problem solving, so that fused groups have some common language.

Our main contact in the firm is responsible for the creation and development of these work groups as part of the quality improvement program. He reports that some groups do not behave yet as groups, being dependent on him and behaving in ineffective ways.

Our contact here is Edgardo Jasso.

3.3.4.2 Why is this case Important. This case represents an opportunity to study groups that are halfway in their maturation process and that have had some obstacles in their integration. We feel that this situation stresses in some way the relationships within the groups and may lead to non-productive behaviors.

On the other hand, we have found that the perception that groups in Eaton have of themselves is very optimistic, so that group performance may not be affected by the situation of the company.

3.3.5 Testing of Propositions

As explained earlier, the analysis of some of the propositions requires information during group interaction while others require information that can be obtained before or after group interaction. Propositions are marked as those that require information during interaction (**D**), after interaction (**A**) and before interaction (**B**). This distinction is important specially when PIEs are not a common practice, as in CNH.

Another source of information is group memoranda. This memoranda are filed in Eaton and are a valuable source of information, since they contain the agreements arrived at in meetings, the suggestions made and the written demands made to other departments. This information is available in Eaton but not in CNH.

p1. *The perception of a group's performance by other groups affects the work of the first group as change agent.*

Description. In the particular situation of CNH, there were no groups with which to compare performance. Also, since this is a relatively new situation and may not persist, we my not have enough information from continued performance. This proposition will not be studied in that case.

Empirical Procedures. For firms where workgroups are already operating question # 13 included in part A of the questionaire attempts to obtain information about this subject. For each group, performance measures, technical and behavioral, as expressed by people will be recorded.

Informants. Our informants will be workers and supervisors
Data Collection. Data will be collected in the shopfloor and meeting rooms.

p2. *The expectations of the group depend on past performance in PIEs.* **B**

Description. Since in the particular case of CNH there were no groups already formed, we had to resort to previous experiences of the members when acting individually. This is an important issue for us, since it determines the expectations that individuals have about group performance.

As explained in previous sections, the process of norm development must take into consideration the addition of members to the group as well as their previous individual experiences. Thus, the addition of members may be have a positive or negative effect on expectations, which interacts with the previous experiences of the group.

Empirical Procedures. A set of questions will be asked to the members that will form a group, in order to determine their previous experience in improving the process and their satisfaction with that experience. The questions will be open and will allow us to understand the process and to detect other leads for research. Examples of these questions are the following and the scale of agreement is given in parentheses:

- Have you done or tried to do something to improve the process before ? (never, sometimes, often, very frequently). What was it ?
- What is your evaluation of your performance in that situation ? (poor, acceptable, good)
- Why ?
- Do you think this group activity we are proposing will yield positive results? (definitely yes, somehow, definitely no)

Also, group memoranda will be analyzed.

Informants. Our informants will be workers and supervisors
Data Collection. Data will be collected in the shopfloor and meeting rooms.
Related Questions: 2, 2a, 17 of Part A of the questionaire.

note: Evidence for propositions 3 and 4 will be collected with the same set of questions.

p3. *When an imported technology differs from the group's previous technology under use, the group will resist this technology or will try to adapt it so that it resembles its previously used technology.* **B,A**

p4. *During reinvention, groups may have considerable discretion in technology difussion; this may not be the case in "packaged" PIE, where the group must conform to specifications and cannot use its network freely.*

Description. In the particular case of CNH there were no groups already formed, so we had to restore to previous experience of the members when acting individually. However, we will try to

find out if informal groups are formed when new technology arrives and how they behave. A word of caution is that the concept of technology may be that of hard technology *only* and we would like to explore also some forms of soft technology.

Empirical Procedures. Open questions, such as:

- What new technologies have arrived to your work place ?
- Have there been changes in the way you must perform your work that do not include machinery ?
- How do you go about learning and adapting it ?

Also, group memoranda will be analyzed.

Informants. Our informants will be workers and supervisors
Data Collection. Data will be collected in the shopfloor and meeting rooms.
Related Questions: 5,6,7 of part A of the questionaire

p5. *When searching for technical information about tasks, groups will use first their homophilous relations, and if these are unsuccessful, they will use heterophilous relations.* **B,A**

Description .There were no formal work groups in CNH case, so we will try to find out how individuals relate to their informers when in need of technical information. This propositions will be used in the general conclusions to determine if workgroups and individuals develop structurally different information networks. In firms where groups are already established, we must first explore the concept of PIE and then determine whether information sources are different when in PIE and when not in PIE.

Empirical Procedures. Direct questions will be asked to determine who do workers refer to when in need of technical information. Examples of these questions are:

- When you need information about the process, whom do you ask ? (nobody, name)
- Why ? (no experts here, friend, expert, friend and expert)
- If they do not know, whom do you consider next ?

Since we also need to know how the homophilous relations are structured, we will also ask questions about closeness or friendship such as these:

- How long have you been here ?
- Who are the people you consider closest to you ? (have no friends, names)

For this final question we must be aware of defensive answers, such as "We are all friends here" which were obtained in the CNH case, and may be a lead to further insights about the informal relationships in the plant.

Informants. Our informants will be workers and supervisors
Data Collection. Data will be collected in the shopfloor and meeting rooms.
Related Questions: 8,11,13,14,15 of part A of the questionaire

p6. *When undergoing PIE, group members obtain information from sources that are not the same in essence or frequency as those sources used when the group is not under PIE.* **B,A**

Description. CNH was the "no-group", "no-PIE" case for this proposition. People in firms where groups do exist will be asked where do they receive information from when in PIE and when not in PIE.

Empirical Procedures. Direct questions about sources of information in PIE and outside PIE. Since sources of information about PIE have already been obtained in proposition **p5**, only questions about routine information will be asked, such as :

- Whom do you get information about your everyday tasks, such as production goals, etc. ? (nobody, supervisor, fellow workers, other)

Informants. Our informants will be workers and supervisors
Data Collection. Data will be collected in the shopfloor and meeting rooms.
Related Questions: 12 of part A of the questionaire (plus questions for previous proposition)

p7. *The behavioral criteria for considering a PIE complete do not depend on the type of PIE in question; the technical criteria for considering a PIE complete depend on the type of PIE in question.* **A, D, B**

Description. This appears to us as one of the most difficult propositions, since we will not have many types of PIE. Our hypothesis is that the technical criteria are usually objective events, such as a drawing, a diagram, a decision to replace a spare part, time limits, etc. However, behavioral criteria may be expressed by such things as "OK, let's try this","We don't have enough information, but we have to finish", etc.

Empirical Procedures Questions will be asked to participants as to what they consider is the final product of the interaction, and if they consider it complete.

- What is the product or result you expect from this interaction ? (diagram, etc.)
- Do you think this is complete ?
- Why ?

Behavior during interaction will also be observed. Particular statements such as "we are getting nowhere", "we still have a long way to go", etc., will be recorded to determine if, when PIE is considered technically complete, participants are satisfied.

Also, group memoranda will be analyzed.

Informants. Our informants will be workers and supervisors
Data Collection. Data will be collected in the shopfloor and meeting rooms.
Related Questions: 2a of part A of the questionaire, and part B of the questionaire

p8. *As workgroups evolve, efficiency and effectiveness in technology difussion increase.* **A,D,B**

Description. As groups evolve, they use resources such as time and information for the completion of the task more frequently and reduce the use of resources less frequently for activities not related to the task. This is what we will call efficiency. Also, experienced groups will tend to give the right solution to the problem more frequently; that is, they are more effective.

Empirical Procedures. Time will be one resource to measure during group interaction and when developing individual tasks. We will what proportion of group activities are spent in (1) Norm Development, (2) Task Performance, (3) Informing (gathering information, explaining, validating), (4) Group Maintenance, (5) Session Maintenance. Interactions will be coded and recorded in special format, described in Appendix V.

When other objective measures of effectiveness exist, such as charts, these will be used. When these are not available we will rate the solution arrived at in order to measure effectiveness.

Since this proposition can be used in the overall conclusions, groups of several tenures and number of experiences in PIE will be studied. In the case of CNH we have a zero tenure, that is, zero experiences workgroup. We will also pay attention to the emergence of roles.

Also, group memoranda will be analyzed.

Informants. We will observe behavior of workers and supervisors.
Data Collection. Data will be collected in the meeting room.
Related Questions: 2, 2a of part A of the questionaire, and special format for coding evolution of group interaction.

p9. *Effective workgroups have structural characteristics appropriate to their level of technological uncertainty; less effective units have a "mismatch" between technological uncertainty and structure.* **A, B, D**

Description. We will measure technological uncertainty as the individual self-reported expertise in the problem in question and a group measure will be the number of suggestions made for a particular problem before consensus is arrived at. Our assumption here is that when technological uncertainty is low, a solution to a problem is built in a few exchanges during group sessions.

The more heterogeneous work groups will be more efficient during PIE since a greater pool of ideas about a particular problem is available (Hackman, 1987; Fry & Slocum, 1984). It is also expected that effective work groups have distinctive interfacing roles which allow them to interact with other groups or individuals in a more effective way. So, we expect that groups whose participants belong to different departments or groups whose participants have roles or functions that allow them to interact with other groups to be more effective. Thus, our measures for structure will be number of departments represented and visibility of the participants in the group.

Empirical Procedures. Direct questions about perceived expertise in the problem will be asked to participants. During interaction, traits of visibility (such as expressed relations with other departments, convincing others, acquisition of information from outside the group, etc.) will be observed. Effectiveness is measured in the previous proposition.

- How expert do you consider yourself in this problem ? (Very much, somewhat, not at all)

Also, group memoranda will be analyzed.

Informants. Our informants will be workers and supervisors
Data Collection. Data will be collected in the shopfloor and the meeting room.
Related Questions: 13, 17, 20 of part A of the questionaire and part B of the questionaire

p10. *Workgroups create norms to determine what information, from what source, under what circumstances is adequate.* **A,B**

Empirical Procedures. Observation of behaviors and statements that help the group decide about the appropriateness of information.

Also, group memoranda will be analyzed.

Informants. Our informants will be workers and supervisors
Data Collection. Data will be collected in the shopfloor and meeting rooms.
Related Questions: 5,6,12, 16 of part A of the questionaire

3.3.6 Strategy of Analysis

The strategy that will be followed to analyze the information obtained is described next. The purpose of this procedure is to analyze evidence in a sistematic fashion, so that the maximum of the relevant information available is used, and that evidence is properly assessed.

a. Select one work group
b. Select one proposition
c. Browse the available evidence (interviews, meeting codifications, minutes, observation reports) for that proposition
d. Find facts (oral, written, observational)
e. Interpret the findings in the light of the theoretical framework and of other evidence. This step defines the cogency of our proposition.
f. *If necessary,* design instruments to obtain additional evidence.
g. Integrate the interpretations and findings with the conclusions.
h. Repeat steps **b** to **g** until no more propositions are left.
i. Repeat steps **a** to **h** until no more work groups are left.

4 CASE 1: COMPAÑIA NACIONAL DE HARINAS

4.1 Description of Company and Technology Diffusion Issues

Compañía Nacional de Harinas, CNH for short, does not have an ongoing quality and productivity program, even though it is one of the main suppliers of wheat flour for the central region of México. An organizational chart and a process flowchart are depicted in figures 7 and 8.

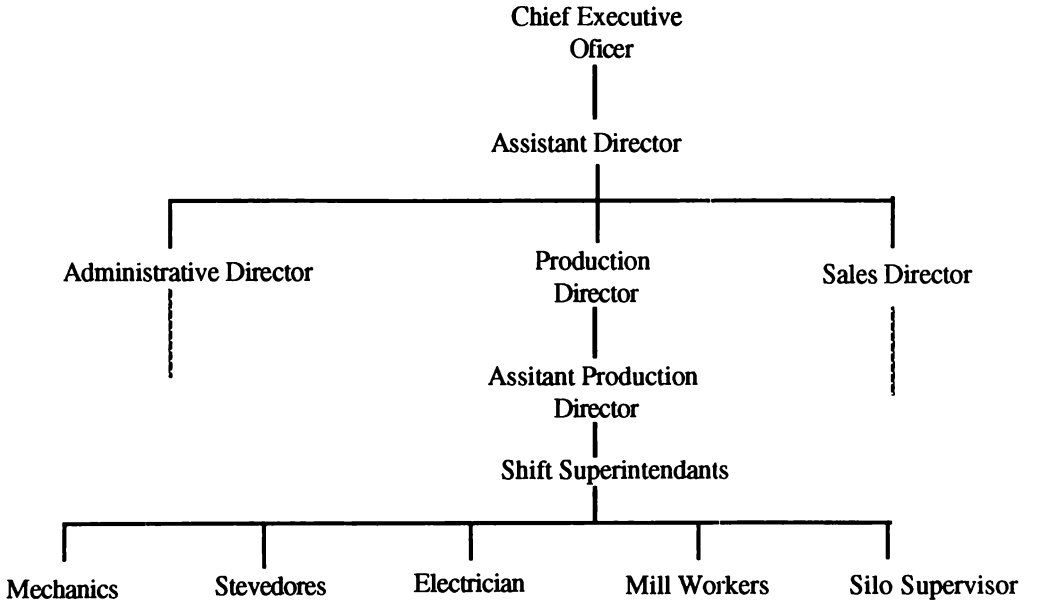

Figure 7: Organization Chart in CNH

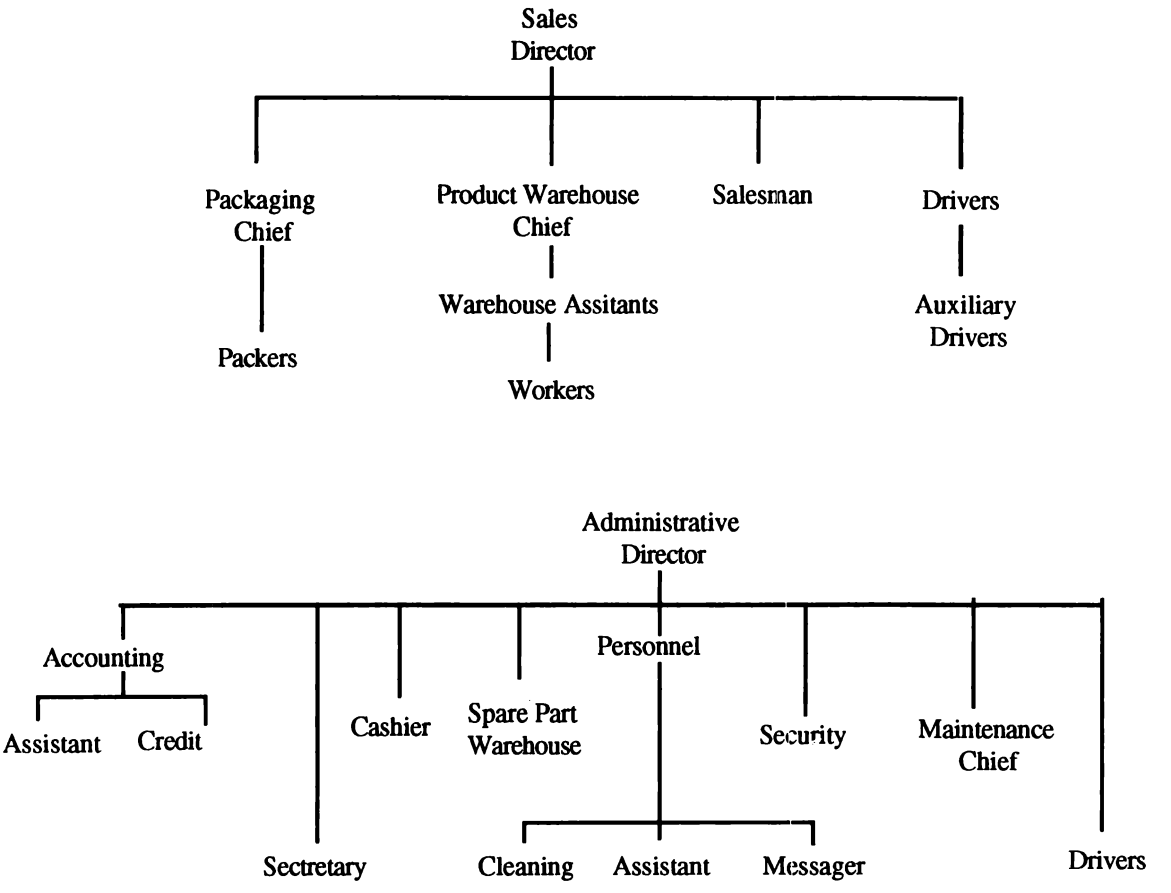

Figure 8: Organization Chart in CNH (cont.)

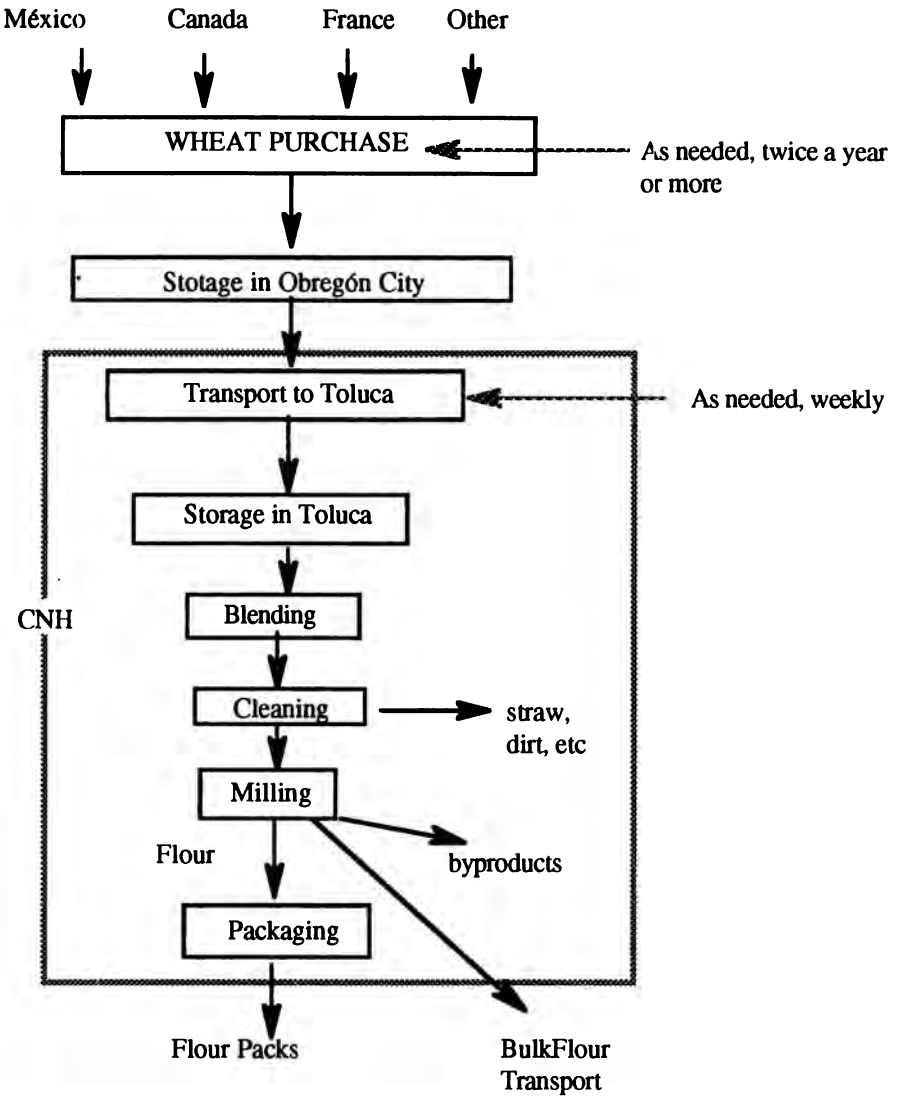

Figure 9: Flour Production Process

Due to a desire to expand into North American markets, CNH decided to begin a quality and productivity program since their quality levels were not enough to satisfy the FDA specifications.

Our institution was called in to participate in helping define the quality and productivity indicators (QPI) for CNH. While this is a necessary step in every quality program, it is only a starting point and one of our worries is that this might be the last step if sufficient amounts of information and motivation are not given to the stakeholders.

One reason why external help was called in is that no one in CNH had experience in statistical quality control and this had become a must in order to keep the product within specifications. Also, a productivity bonus for workers has become mandatory in Mexico (Hernández, 1993), and CNH had no formal measures of productivity.

Our intervention is described as follows. A group of seven students of different programs doing summer school was formed, coordinated by the author. This group was divided in areas according to the manufacturing process stages. These subgroups conducted a series of interviews with the personnel in the firm in order to obtain the necessary information to draw the flow diagram of the process and obtain the relevant variables in each stage.

During these interviews, we detected those people more likely to become informants. The conditions sought were a willingness to communicate, some tenure in the firm and a positive attitude. The selected persons, including those in the managerial group, are listed below under the "informants" heading. This guaranteed that our evidence was unprejudiced, reliable and from a competent source. We can classify the evidence obtained from these informants as primary, expert, personal evidence, which makes it good evidence in analyzing our propositions.

Some of these informants were interviewed in special sessions, and others, due to the continuous interaction with them implied by the intervention, were asked questions as our understanding of the situation evolved.

As part of the definition of QPI, groups of personnel were formed to obtain the required expertise in the manufacturing process. These groups include workers from the different operations in the process and if the quality program continues, they will continue working together. Up to this moment, there have been no formal worker groups established in CNH, except for the Improvement Group.

This case study is different from the other case studies in this work in that no formal work groups exist in CNH. This led us to consider this case as a baseline case from which the other cases were considered as departures in the path of group evolution. With this in mind, we were specially perceptive to whatever organizational event or characteristic appeared before us that could serve to build a framework to structure the other cases.

Another issue of interest is that the sources of evidence in this case are less abundant and diverse than in the other cases. In CNH there was no group-meeting memoranda, nor group

sessions of any sort, and workers were not used to communicate their ideas as in the other cases. As a consequence, our research tools were less intrusive and more interpretive than in the other cases.

Our presence in the organization led us to define the following as the important elements in the organization for the purposes of this study.

4.1.1 Informants

A brief description of the importance of the informants we found is given below. These informants could be grouped in different work units and levels, as was done in some of the interviews. The importance of a good choice of informants was stated in chapter 3. Due to the short period of our intervention (two months) and to the organizational climate, we chose the less intrusive methods possible, and thus not all information was recorded, some of it being observational. Our advantage was that we were seven people in the research group, and discussion of events and evidence resulted in what we consider to be unbiased interpretations. Also, the several observations made about each event serve to have cumulative evidence about it.

4.1.1.1 Don Emiliano. He is the most knowledgeable person about the process in CNH. He has been with the company for about 30 years, having a technical degree in milling. He has seen several technical changes in the company, as explained elsewhere.

Don Emiliano may be the most valuable informant in CNH, because of his tenure; however, getting information from him proved a bit difficult since a moment came when he felt threatened by the intervention and changes proposed.

Don Emiliano is also an example of a person who must hide his knowledge from strangers because life has taught him so; in later contacts with him, when the Improvement Group was started and this meant for him that a recognition for his knowledge would be given, he had occasion to prove his worth. When asked a question about some part of the process, Don Emiliano has a tendency give a lecture on all the issues that are related to it, without regard to its level of detail. Conversations with don Emiliano tend to become a monolog where information at all levels of detail is intermixed, making it difficult to follow his line of reasoning. This was evident in the first sessions of the Improvement Group, where he kept telling people that "there are a lot of details to this; everything is related to everything else!" without giving others a chance to speak.

Perhaps by his lack of more advanced training, or perhaps due to his lifelong work habits, don Emiliano is not very able in communicating by numbers. This helps us explain why he felt threatened when statistical process control was proposed in the plant.

However vast don Emiliano's experience is, he does not get everything he asks for in the company: in one of the meetings of the Improvement Group he complained that money should be invested in improving the process and not in buying furniture.

Don Emiliano's leadership can be understood by considering several events and behaviors in his tenure. First, he trained most of the supervisors in CNH, thus becoming a tutor for them; also, he functions as the interface with management to obtain improvements in the quality of work life for supervisors and workers. All these factors make don Emiliano an indispensable source of evidence, as explained in Chapter 3.

4.1.1.2 M.A. Bravo. He is the Managing Director of CNH. With a tenure of six years, he knows the process relatively well, in spite of his non-technical background (accounting). However, he is not likely to contradict Don Emiliano's judgment and decisions, even when he may not agree completely with them. M.A. Bravo proved to be a very open informant, having no secrets for our group.

4.1.1.3 R. Velázquez (fictitious name). R. Velázquez is the Sales Director in CNH. With a tenure of six months, he is relatively new to the organizational arrangements that people like Don Emiliano or M.A. Bravo have come used to. Despite his short tenure, he wasn't very open to suggestions by our group and this made him a somewhat difficult informant.

He insisted on reducing personnel in the packaging area, even though an analysis described earlier showed that this was not the best place to begin cutting costs. This rigid attitude prevented him to see potential benefits from the collaborative work in the Improvement Group: we feel that his interest in the group was based on the benefits he expected to get from the group and not so much on a desire to contribute to a better performance of the firm.

4.1.1.4 A. Rojas. A late entrant in the company, he was hired as Assistant Production Director during our intervention. His position in CNH was sandwiched between don Emiliano, his boss, and the supervisors reporting to him but who were loyal to don Emiliano.

He showed great interest in the project and was a candidate for change agent, but from our point of view he lacked legitimacy, due to his short tenure, with the people supposed to implement the changes. He can be classified as an unprejudiced and reliable source of evidence.

4.1.1.5 Julián Pérez. He is a supervisor and son of another supervisor. He had a technical degree in electricity and had learned the ropes *in situ.* Julián is a rough but intelligent person who gave us a lot of information about the process. As is evident from the analysis of interviews, he clearly feels part of the supervisory group which he also considers to have a higher status in the firm. He is an expert, thus the evidence obtained from him can be classified very valuable.

4.1.1.6 Juan Carlos. He is the operator of a milling section or "floor", which includes about 10 machines. His job consists on monitoring the performance of the machines and making adjustments if the quality of the product is not right. He also has to make adjustments on the flow of wheat. For instance, if the mill is too "tight", the flour results very "fine" (small particle size) but the flow is reduced and electricity consumption increases.

Juan Carlos cannot make decisions about the blend of wheats entering the mill, nor about cleaning efficiency, which is controlled by air valves, nor about humidity of the product.

If something goes wrong, usually in the mechanical sense and not the quality sense, he can fix some minor problems with the help of people in other floors; for instance, if due to high humidity the process "gets stuck" he can stop the process and ask his fellow workers to help him clean the tubes.

Juan Carlos has a tenure of three years in the company, which makes him an expert in the social organization for work and thus, his evidence is very valuable.

4.1.1.7 Benito and Pablo. They are also operators but with a much lower experience than Juan Carlos. As a matter of fact, they are learning from Juan Carlos. This apprenticeship approach to training seems to be common in CNH, since many people mentioned it as the way to learn. As Juan Carlos, they are experts in technology diffusion issues, since they have lived the apprenticeship process common in CNH. The evidence they provide is corroborative.

4.1.1.8 Horacio. He is the operator of the packaging machine. He is also an expert in this machine since he has been studying and fixing it for some years. According to our

observations, this packaging work unit is strongly dependant on the packaging machine: there are several functions that do not involve the machine but cannot be performed if the machine is not working properly. Being the expert in the machine makes Horacio a leader in the work unit, and the evidence he supplies is expert and reliable.

4.1.1.9 Tomasa and Maribel . These women are also in the packaging work unit. Their task is routine and requires low skills. The evidence they provide is corroborative, since they *have seen* the progress in the machine as Horacio tunes it up.

4.1.1.10 Vidal. He is in charge of the truck loading system. These trucks are filled by a pneumatic system that transports flour from the silos to the trucks via a network of valves and pipelines. Vidal does not supervise anybody.

He has been in the organization for three years, during which he has seen no new technology arriving in his workplace. He entered at the lowest level of the organization, as a stevedore, and received no training to operate the process he now controls. He admits that he has never proposed an improvement to the process. He is also considered an expert in the social aspects of technology diffusion in CNH since he has lived the apprenticeship process in CNH.

4.1.1.11 Eusebio. Eusebio has a similar job to Vidal; however, the process under Eusebio's responsibility is performed manually by an army of workers who must fill, weight and load the flour sacks into trucks. Eusebio has previous experience in grain storehouses and a short tenure in CNH. The evidence supplied by Eusebio is very valuable, since he has experienced the technology transfer issues in other companies.

4.1.2 Groups

These are informal groups. Our decision to define them the way we did is based on the flow of information and technical information, and their authority to make decisions about technology diffusion.

4.1.2.1 managerial group: The managerial group was an informal group consisting of those people in charge of the administrative tasks of the firm; there was no one really involved in the technical part, even though some of them had been for several years in the company. In this group we placed the Sales Director, the Administrative Director, the Personnel Manager, and lately

the Production Assistant director.

The Production Assistant Director was a technical person with an engineering degree, but had no experience in producing wheat flour. This put him on a disadvantage to the Production Director, who had ample experience in producing flour. The Production Assistant Director was hired during our intervention in CNH, and was seen as a threat by the Production director, so that a great deal of time was spent by both in defining their respective territories.

4.1.2.2 supervisory group: this informal group was led by the Production Director, don Emiliano, and a set of people who were loyal to don Emiliano. Most of these people had been trained by him and had spent considerable time in CNH. This group is informally in charge of quality and productivity issues.

Don Emiliano was in charge of hiring workers, but he felt unable to hire more qualified workers because of the low wages offered by CNH. He felt comfortable with this supervisory group.

4.1.2.3 worker group: The worker group suffered the highest degree of alienation of the three groups; these were usually people with nothing but basic education, who were not related to the supervisory group and who had very short tenure in CNH. Most of them were put to work without any training and if they were interested, they "learned the ropes" by watching others. Many of them quit the company in a few months due to very low salary.

4.1.2.4 work units: informal, their influence is not really important when compared with the relations between the other groups. These correspond to the areas in which CNH is divided: storage, milling, packaging, etc.

4.1.2.5 improvement group: this group was created in order to initiate a process improvement effort in CNH. The group was formed by most supervisors, don Emiliano and the managerial group.

4.1.3 Concepts

The following are the concepts that help us construct the weltanschauung of the people in CNH(Berger, 1991; Checkland, 1981). We consider important to analyze the meaning of these concepts, since this case is particular in the sense that little training has been given to people, and thus their conception of PIE is not standard.

4.1.3.1 process improvement: the concept of process improvement held in CNH is a relatively reactive one; by "process improvement" workers and supervisors understood something similar to "corrective maintenance", which is the concept held in organizations where the importance of preventive maintenance and performance improvement by process modifications is not yet assimilated. For instance, in an interview with Juan Carlos the following exchange occurred:

> Q: As workers that have been in there for some time, what processes or what do you consider you can change or improve, something you have seen is wrong ?
> A: [...F]or example, that day when the transmission belt broke, it was only him and me working on it.

The underlying concept of improvement or change is that of repair. We will accept this common sense definition (Freeley, 1993) in CNH as a starting point; this allows us to perform a better inquiry into the organization by progressively refining the meaning of the concept.

4.1.3.2 process knowledge: the concept of process knowledge held in CNH is in some form superstitious: don Emiliano determines, by organoleptic testing, when the flour is "ready" and when is it necessary to mix it with other batches to improve some characteristic. It is interesting to note that for most of these decisions, a laboratory analysis is available but not used; this analysis would provide more objective and precise measurements of the variables.

By relying on these tests for years, knowledge about the causality of the process variables on the product (that is, technology) has become the exclusive asset of the supervisory group: the managerial group does not have an understanding of the way variables affect the final product and thus has to trust the supervisory group. Furthermore, those in the worker group who "learn" about the process do not learn about the relations between variables objectively by analysing laboratory reports, but rather are disclosed the secrets of organoleptic testing.

There is no doubt that a person with the experience of don Emiliano can determine the quality

of the product with these organoleptic tests within certain limits; however, the precision required to enter international markets makes laboratory tests unavoidable.

An interesting issue about process knowledge is that the knowledge about the impact of variables on quality is different from work unit to work unit. The flow diagram had inconsistencies between stages of the process and these had to be resolved in meetings with a special group (which latter became the Improvement Group). An instance of this became evident when an interview was held with one of the customers of CNH: he told us that the most important variables for him were *gluten content* and *ash content;* in CNH, gluten content was never mentioned as a relevant variable.

These inconsistencies support the idea that knowledge in CNH is in many occasions superstitious, as described by March and Olsen (1975); while March and Olsen are dealing with the issue of organizational learning, we think that the concept of superstitious learning is applicable to a technical issue like this one. The problem is that technical knowledge, by definition, shouldn't be superstitious and thus in CNH we perceive some problems in the diffusion of process knowledge.

4.1.3.3 efficiency: the concept of efficiency held in CNH had a detrimental effect on productivity. Efficiency was usually understood as the *quantity* of product obtained, while a more reasonable definition would be the *relation* between the raw wheat fed into the process and the amount of flour obtained.

An example of the effect of the concept of efficiency held was found in the packaging operation. The area manager thought that there were "too many people, doing nothing at times". An analysis of the operations was done and it was found that given the characteristics of the work being done, workers were performing very well; furthermore, if improvements in costs were to be done, manpower is the wrong place to begin: it represents only 3% of costs, while the cost of wheat is about 82% percent, so that a small improvement in the flour yield would easily outweigh a large improvement in manpower productivity. As stated by the experts in one meeting, an increase of 2% in flour yield could easily be attained, so that in our view, efforts to increase productivity should be aimed at increasing the efficiency of the operation and not the efficiency of workers. But this ran against the common view held in CNH (and in many other plants) that productivity is increased mainly by reducing manpower.

4.1.3.4 worker responsibilities: the responsibilities workers understand they have are varied but limited in scope; they do not understand as their responsibility to propose

improvements to the process and they limit themselves to work in order to reach the volume goals set by their supervisors.

The supervisory group thinks that workers do not have a clear understanding of the process. For instance, in an interview with Julián P., a supervisor, he gave us information about the impact of some process variables (humidity) on quality; we told him that workers had given us information that was somehow inconsistent with the one he was giving us, to which he replied: "Oh, well, workers do not know very much about the process; you shouldn't trust them so much." *This kind* of statement has been heard also from don Emiliano on several occasions, especially in the initial meetings of the Improvement Group.

4.1.3.5 technology: on several instances statements were given that lead us to believe that the concept of technology that people in CNH have is the usual machine-related definition. For instance, Don Emiliano frequently spoke of outdated technology when referring to mills, or to unapproapriate technology, when referring to the mills having to process a different kind of wheat than the one common in Europe, where the machinery was built.

We never recorded a statement where the concept of technology included things such as work organization or inventory management, which are also part of technology but not "machine" related. We feel that this is related to the concept of process improvement held in CNH.

4.1.4 Roles

4.1.4.1 manager. Management in CNH can be seen to have low involvement in production issues. Responsibilities for management and production are seen as separated and thus management sees its task mostly as controlling resources and setting goals for production. Several times managers expressed their dissatisfaction with the way production was carried out in terms of efficiency but no one in the managerial group seemed interested in providing an organizational setting where an increase in productivity could take place; for instance, wages were low, no training of workers ever took place, discussion of technical issues didn't involve management, etc.

This created a sense of detachment between managers and the other groups: management saw workers and supervisors as another piece of machinery that could be bought and exchanged anytime; the importance of knowledge and abilities residing in people was often overlooked.

4.1.4.2 change agent: as explained before, Don Emiliano's leadership can be explained by the fact that he functions as the interface between the supervisory group and management to obtain improvements in the quality of work life for supervisors and workers. Also, he functions as a technical expert for workers and supervisors.

This makes us believe he is the best choice for a change agent. The problem is how to make him buy the ideas of change. Our intervention in CNH did not last enough to follow the development of these events, but on the first meetings of the Improvement Group, don Emiliano's attitude was very supportive for changes, although tainted with criticism: our interpretation for this behavior is that he perceived the formalization of the improvement process as a commitment from management to support his long held ideas.

4.1.4.3 worker: workers' role in CNH is perceived as executors of orders; they usually have no influence on technological decisions and their technological uncertainty is usually low. Since they only have to know how to keep the process running, without worrying about quality and productivity issues.

4.1.5 Events

The following is a sequence of the events that we feel are important for the purposes of this work. In the description of the event, we include the actors and the effects of the event on people, concepts, etc.

4.1.5.1 Rejected product at the U.S.-Mexican border. As we learned from our interviews, many people in CNH knew that the quality of CNH products was below standards. The corporate lab routinely sent reports indicating that some variables were out of specifications. However, nobody paid attention to this in part because the major customer of CNH are the other firms within the corporation and they thought that rejecting the product of another firm in the corporation would hurt the corporation.

The triggering event for the change in CNH was the rejection by the FDA at the Mexican-American border of a series of shipments of cookies that are made by a customer of CNH within the corporation. An analysis of the rejected cookies indicated that the source of problems was CNH and this prompted a response by the firm's management.

4.1.5.2 National Productivity Agreement As part of the national economic policy in México, a productivity agreement is recommended between the unions and the firms. This agreement ties wage increases to productivity increases in the firm. Most firms in México are trying to make sense out of this agreement since they don't have a measure of productivity, and many do not have information on which to base their productivity indices (Sumanth, 1985). CNH was no exception and they had to figure out how to measure productivity in order to be in line with official requirements.

4.1.5.3 Outsiders's Intervention Our intervention in CNH and its causes were explained above. The importance of this event is that the outsider supplies an external, objective point of view to the problems of CNH and helps break the cycle created by tacit agreements developed through the years (Argyris & Schön, 1978).

Our intervention was helpful, hopefully, in surfacing technology related issues that the organization had not considered before or was trying to avoid, but that were eroding its competitiveness; one issue is that management and the production groups were not understanding each other; another, more related to this work, is that process knowledge presented several

inconsistencies from group to group, and even from company to company within the corporation; and a third one is that objective measures of quality are needed if entrance to international markets is desired. All these together require CNH's to evaluate it's current practices and change them if a more competitive corporation is sought.

4.1.5.4 Hiring of the Assistant Production Director Halfway through our intervention, an engineer (the first in the company in several years) was hired to perform some duties in the production area. This hiring seems to respond to the need to have someone who can handle the technical issues in a more rational way; however we feel that this person will have to get acquainted to the setting in CNH before he can begin performing and this may take several months.

4.1.5.5 Initial definition of Improvement Group by the Managerial Group

When it became evident that inconsistencies existed in the process knowledge that groups had, the formation of an Improvement Group was proposed. This group was meant to resolve these conflicting issues and to promote the organizational change towards a quality oriented organization.

The initial definition of the group was done by the managerial group, and it included people from the different areas. However, sensing that this group may become a forum to legitimize the decisions of the managerial group without seriously considering the opinion of the production or supervisory group, don Emiliano rejected this initial proposal and handed in an alternative one. He argued that "all supervisors have to know what decisions we make here, so they must all be here."

4.1.5.6 Redefinition of the Improvement Group by don Emiliano The final composition of the Improvement Group consisted of two outsiders (temporary), three people from the managerial group and eight people from the supervisory group. This implied bringing people from the third shift to the company at noon, but don Emiliano felt satisfied with the "power balance." This group held two meetings before we left the company and in those meetings relevant behavior for this work was observed, as explained elsewhere.

4.2 Analysis of Propositions

In this section we analyze the propositions in the light of the evidence found. It must be noted that in this firm there are no formal work groups, so that we will use the term "work unit" instead of "work group" in the analysis of propositions (but not in the propositions themselves). Furthermore, we will treat evidence from the three work units analyzed as one, since we do not have a justification to think that each work unit is organizationally distinguishable from the others since the members can be shifted from one area to another if the need arises.

Furthermore, as the concept of process improvement and related activities are not part of the organization, the activities carried to improve the process are really corrective maintenance in most cases. This was explained before, when the concept of process improvement in CNH was analyzed.

p1. *The perception of a group's performance by other groups affects the work of the first group as change agent.*

While in CNH there were no formal work groups established, the three major groups identified could watch each other performing. Also, work units could observe other work units perform.

We will analyze this proposition in the between-groups dimension first. The managerial group could not function as a change agent since their knowledge of the process was very low. The evidence for this statement comes from the observation of meetings, where the supervisory group did almost all the talking when technical issues were discussed. Usually, they were seen as restrictions or as the ones who provided production goals for workers. Their participation in technological changes was limited to the purchasing of equipment, usually suggested by the supervisory group.

The supervisory group usually made the suggestions for technological improvements. These suggestions were always on the hard side of technology. Their suggestions were the result of the experience on the process and thus were quite rational: for instance, the installation of a wire mesh at the beginning of the process was proposed in order to eliminate large sized particles that were appearing stages ahead in the process in the form of impurities or dark powder.

When a suggestion was made by this group, it generally had the approval of the experts in the supervisory group and was the result of the discussion of several alternatives. Consequently, the acceptance of the technological improvement by the users was no problem, although financial issues prevented their immediate implementation.

The worker group did not seem to participate in these technological decisions; although during the Improvement Group meetings it was accepted that workers had sometimes come up with solutions to problems, this was not the rule. Furthermore, as explained before, the worker group did not feel its role was to make suggestions; they usually accepted what the supervisory groups decided.

In the between-work units dimension, the situation was different. People in different work units (packaging, storage, milling) could exchange information without problems due to their physical proximity. When work groups are formally established in a firm, there can be several work groups performing the same task and they can make comparisons about performance; the fact that no work groups existed in CNH did not allow for this kind of comparisons within a work unit. The comparisons are then made with other work units, but since different work units have different technologies, observation of performance, however successful it was, did not lead to learning or technology diffusion outside the performing unit. While we expected to find that help came from other units in some cases, negative evidence was found.

Our conclusion about this proposition is not clear-cut: the evidence indicates that the proposition holds when the groups in question are the managerial and the supervisory groups: the supervisory group's performance in diffusing technology has been far better than that of the managerial group and consequently the supervisory group is considered the change agent of the two. But when the worker group is included, we cannot conclude that the proposition holds, since this group has not taken an active part in the technology diffusion process and thus its performance in this process cannot be assessed. Furthermore, no evidence was found in the interviews that hinted that the supervisory group was considered helpful by workers.

p2. *The expectations of the group depend on past performance in PIEs.*

The expectations that a group builds depend on how successful it has been in performing some task before. In the case of CNH, people could not develop expectations about PIE in the sense defined in this work because they had never engaged in it. However, they have had experience in "solving problems" which in CNH acted as a proxy for PIE; it is under this problem-

solving concept that we will analyze this proposition.

The expectations of the work units in this case have the following characteristics: (a) fix-it unless you can´t; (b) if you can´t fix it, call maintenance; (3) learn by yourself and by observing others; (d) if there is an emergency, workers from other floors will help you. These expectations can be derived from the interviews with Vidal, Benito and Juan Carlos. Since the persons interviewed come from different work units, we consider this evidence sufficient.

On the other hand, the supervisory group had its problems: in the first meeting of the improvement group, our intervention was limited to allowing people to "speak-out"; this led to illuminating exchanges. For example, in one occasion don Emiliano, as he usually did, had begun to list all the possible improvements to the process. We held the belief that he may be resisting the change to other work methods, so we asked why if he knew of all these improvements, none had been implemented; the answer was simple and straightforward: "Because I don't get support from management. I don't understand why the money is going to buy furniture for manager's offices, while we need it to make improvements in the mill." Management's answer was silence.

In several interviews, we found that no one expected management to support production in any way: problems in production were expected to be solved by production. However, several problems in production could well receive a helping hand from management. Such is the case of training, were management could allocate some time and other resources for workers to receive training (Hackman, 1987). More important perhaps, but harder for the people in CNH to discover, management could help in building an improvement oriented culture, as opposed to the "if it ain't broken, don't fix it" culture that existed. This negative evidence leads us to believe that management could play a very important role in the performance of improvement efforts. The behaviors and expectations found in the supervisory and worker groups may be the result of years of denial, where support is not given to what they consider important.

Furthermore, Don Emiliano´s comment about low quality of the workforce due to low wages may help explain the gap between the supervisory and worker groups: since workers leave after very short tenure, supervisors cannot count on them as an technically able group. Another piece of evidence that supports this proposition is the following, taken from an interview with Eusebio:

Q: Wouldn't you like to be trained, to have people come here to teach you things ?
A: Oh, it would be fine; it would be good to have people trained in the mill's techniques. Training in other issues wouldn't be beneficial, since people would find jobs elsewhere and it would only be wasted money for everybody.

Our conclusion is that this proposition holds for the case of CNH, since expectations are derived from previous experiences in PIE. An interesting issue for further research is to determine the structure of expectations that the groups holds in different dimensions; for instance, the worker group has a set of expectations about the managerial group, the supervisory groups has a set of expectations about the worker groups, etc., and the interrelation of these may have a detrimental effect if organizational changes are to be brought about.

p3. *When an imported technology differs from the group's previous technology under use, the group will resist this technology or will try to adapt it so that it resembles its previously used technology.*

Technological changes in CNH were not frequent. Major technological changes had been few, according to don Emiliano's recollections. None has been in the soft part of technology.

A series of statements made by several of the workers in the plant lead us to believe that rather than reject technology, people in CNH would like to have more advanced machinery. In those cases where new technology proved a bit difficult to master, this was considered as part of the job, rather than a reason to go back to earlier types of technology.

In the case of CNH, one of the technologies that arrived in the workplace was the packaging machine, which Horacio set up for operation. While some modifications were made to this machine, these modifications were not intended as modifications to resemble previous technology, but rather to start-up the machine.

Another technical innovation that arrived in CNH was the dry-cleaning process. Previously, the wheat was cleaned in a water bath, where most of the dirt and soil was removed; this process also helps in humidifying the wheat so that it is easier to process into powder or flour. However this process wasted a lot of water and municipal regulations forced CNH to shift to a dry process, using air as a cleaning agent. Don Emiliano thinks that the earlier process was more effective and they have had to make a lot of adjustments in the process in order to bring it to its present performance level. However, it would be hard to think that people in CNH were trying to adapt technology to resemble the wet process.

The first technological innovation of the soft kind that arrived in CNH was quality management. This technology implies the use not of machinery but of statistical and graphic tools to improve the process. The acceptance of the technology was not without problems, and as a

matter of fact, when we left CNH it was not fully accepted yet. Our conclusion is that the soft technologies are very novel concepts for the people in CNH and they may have problems accepting it. For example, when the problem of humidity was raised in a meeting, several supervisors said that it would no longer be a problem since the new humidity controlling machine would take care of that. Our interpretation of this is that the group prefers technology in the form of machines rather than technology in the form of statistical analysis.

In conclusion we can say that in CNH people did not reject new technology if it was in the form of machines; as a matter of fact, they are eager to have new technologies of this kind. But if the technology is soft, they indeed have problems accepting it. In other words, the perceived gap between different vintages of machine technology is much less than the gap between hard technology and soft technology, and thus it is easier for the people in CNH to accept new machine technology than new soft technology. Using the concepts of Rogers, soft technology may be relatively complex and thus, subject to rejection.

p4. *During reinvention, groups may have considerable discretion in technology difussion; this may not be the case in "packaged" PIE, where the group must conform to specifications and cannot use its network freely.*

The main issue in this proposition is to analyze how do work groups go about modifying an innovation in order to adapt it to the organizational setting, considering if it is packaged or not. In the particular case of CNH, there are not many examples of reinvented technology.

The most vivid example we met was the modification of the packaging machine undertaken by Horacio. This example is interesting since the technology (machine) is supposed to be packaged and thus, little reinvention would be allowed. But the case is that the machine did not work properly since its acquisition and no technical support was available, thus personnel had to make the necessary modifications.

More specifically, the process that is of interest to us is how does Horacio go about in obtaining and disseminating technological "bits" (that can take the form of custom-made spare parts, special materials, information, etc.) that can be useful in improving the machine.

What we learned from this situation is that several technological bits have been obtained by Horacio from several sources: for instance, the plate that puts the glue in the paper bags cannot be

too hot because this burns the glue, making it useless and the plate becomes sticky, creating problems for the paper bag advancing mechanism; also some pneumatic transport mechanism have been modified in order to have bags with better "form". These modifications have been diffused to other parts of the company by a process of observation and suggestion. Maintenance has learned from Horacio what the critical parts of the pneumatic mechanism are, and Tomasa and Maribel have learned when it is time to clean the glue plate.

The evidence doesn't seem to support the proposition: while dealing with a packaged piece of technology, Horacio has been allowed to obtain the necessary technological bits from wherever he considers best. The result has been that the machine is working more or less regularly now, without the intervention of external help. This leads us to believe that organizations have the potential to supply the missing pieces of a technological puzzle, even though their approach to it involves a lot of trial and error.

Other instances of technology have been introduced into CNH cannot be used to verify this proposition. For instance, there is a computer controlled weighting mechanism for wheat. This is an important piece of technology, since if the flow of wheat is not controlled properly, it may lead to plugging problems in the line. However, this technology was not reinvented in any way, and hasn't been diffused either: only a small group of supervisors understand the results of the machine and the necessary adjustments to the weighting mechanism.

p5. *When searching for technical information about tasks, groups will use first their homophilous relations, and if these are unsuccessful, they will use heterophilous relations.*

Eusebio reports that the way new workers obtain the technical information necessary to perform their job is by working with a more experienced worker. When Eusebio considers they know enough they are left to work alone or with a novice element; thus, relation building and technical information transfer go hand in hand. Heterophilous relations, such as those held with maintenance, are only used when a problem arises. This process is illustrated in figure 10. In an interview with Vidal, we learned that the process he underwent since he came to CNH had the same characteristics: first as stevedore, then as responsible of the bulk loading area. This is probably best stated by Juan Carlos, who said:

> For example, him [Benito] and me have been around for some time and we can do certain things [repairs]; we do not need them [maintenance] to come. [...] As I told this guy [my assistant], if you have problems, you can get together with others and learn.

Our conclusion is that the process by which workers in CNH obtain technical information relies heavily on homophilous relations as a way to "learn the ropes"; heterophilous relations are used only when the problem at hand is beyond the group's capabilities.

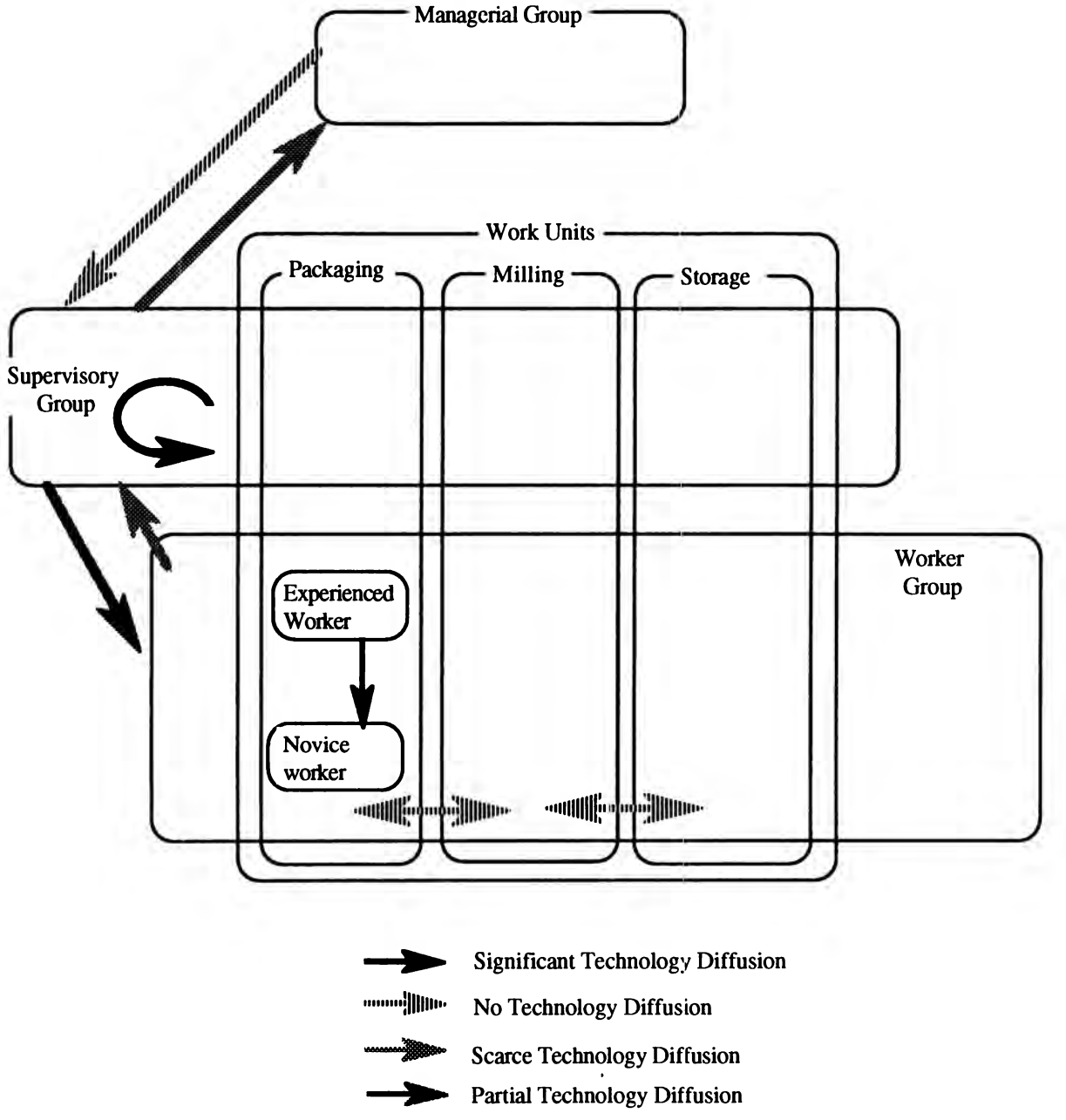

Figure 10 : Internal Process of Technology Diffusion in CNH

p6. *When undergoing PIE, group members obtain information from sources that are not the same in essence or frequency as those sources used when the group is not under PIE.*

Different inteviews in CNH allowed us to verify this proposition. For instance, Vidal told us that the loading program is communicated to him by his boss, Ricardo Gómez-Bravo. When information about the process is needed, he consults with his fellow co-workers. This was found to be same with the people in milling (Juan Carlos, Benito and Pablo), in packaging of the product.

This is one of the propositions for which we feel more confident. While the concept of PIE is not exactly the one we defined, the work units in CNH clearly obtain information from different sources in each case.

p7. *The behavioral criteria for considering a PIE complete do not depend on the type of PIE in question; the technical criteria for considering a PIE complete depend on the type of PIE in question.*

This is one of the propositions where we had more trouble. Evidence for it is not very clear, and further, there are not many cases of process improvement, even under the relaxed definition which we accepted for the analysis in CNH.

In general terms, the behavioral criteria for considering a PIE complete are defined implicitly by the supervisory group. That is, until the supervisory group considers the improvement is complete, the improvement keeps being worked upon. The supervisory groups considers that a PIE is complete when they have adequate understanding of the controlling mechanism; that is, when they understand the effect of certain variables on product quality. On the other hand, this degree of control has not been enough to reach international quality standards, as has been found out in different circumstances.

The technical criteria for considering a PIE complete are not as difficult to surface as in the case of behavioral criteria: the technical criteria are usually associated with the "delivery" of the technological package by the maintenance department or whatever other department was in charge. In the case of work units, the predominant technical criteria for considering a PIE complete was the starting of the machine after a failure.

In conclusion, we learned from this proposition in CNH that the behavioral criteria for considering a PIE complete depend on the perceived amount of control the group has on the improvement, which is an innovation in the beginning of its implementation, and on how routine this improvement has become as time passes.

p8. *As workgroups evolve, efficiency and effectiveness in technology difussion increase.*

In CNH, there is not much evidence of groups diffusing technology before the creation of the Improvement Group (an example is the packaging machine in Horacio's unit). Figure 10 depicts our conception of technology diffusion before the Improvement Group was created; in this figure we tried to capture the organizational contracts that had been shaped through years of operation and coexistence of the groups.

The state of technology diffusion in CNH may be one of great efficiency, since technology is diffused only when needed and only to the persons who would make use of it; in other words, technology diffused in the direction from the supervisory group to the worker group only. However, the work units may have useful suggestions that are not taken into account by the supervisory group because this is not an observed practice.

We can conclude that the between-groups situation is as follows: the present contracts lead to a very efficient diffusion of ideas and suggestions from the supervisory group down to the worker groups; however, the organizational contracts are not very good in surfacing all the suggestions possible, since suggestions from workers are not usually taken into account. Thus, effectiveness of technology diffusion may be low.

Since the organizational setting in CNH, determined in part by the contracts informally accepted between groups, is not new, we can conclude that the tenure of work groups in itself does not lead to increased efficiency and effectiveness. There must be other variables that help determine whether a group will become effective or not, and this evolution cannot be expected as a result of time alone.

p9. *Effective workgroups have structural characteristics appropriate to their level of technological uncertainty; less effective units have a "mismatch" between technology and structure.*

This proposition will be studied in the work unit dimension, since there are no formal work groups in CNH. The work units are listed in what follow along with their main form of technological uncertainty. Effectiveness in this case is understood as the ability of the work units in fulfilling their tasks.

Storage. The main source of technological uncertainty in the storage area was the management of the wheat inventories. It should be noted that this is a soft form of technology, requiring management to analyze current inventory levels, reorder points, etc. The consequences of not having an adequate inventory management leads to problems such as malting of the wheat, due to the high humidity and long holding time. The malting of the wheat leads to lower yields.

Decisions about wheat management come from outside the unit. Their task is to move the wheat from one silo to another or to the process. This does not require very much training when compared to the knowledge necessary to determine when to buy wheat, from what kind, and how to blend it. But the making of these decisions rested in the supervisory group, who had to absorb all the uncertainty about the process.

Cleaning. During cleaning, the problem is to make a tradeoff between the amount of wheat that is lost in dirt and straw and the dirt that makes it into the flour. In an ideal process, a perfect separation between flour, dirt and straw could be possible, but in reality a great deal of expertise is needed to make the necessary adjustments to equipment in order to optimize the separation.

Decisions about adjustments to equipment are made by the supervisory group, not by the work unit. Again, as in storage, the work unit is limited in responsibility to implementing the changes proposed by the supervisory group. The work unit may not even be aware of the results of its operation since lab results are never shown to them.

Milling. Milling is a very important stage in the process. As explained elsewhere, the granulometry (distribution of particle size) and the separation between bran and flour are determined by this operation, and this is the main technological uncertainty: the relation between the variables is not very clear to everybody, as observed in the interviews, so

that a bit of guesswork is necessary. Suggesting solutions under this uncertainty is the job of the supervisory group.

Packaging (sacks) This is where Eusebio works; the technological uncertainties found here are related to the filling, sewing and transporting speeds, and the precision of weight. All these are in some way fixed by machinery and layout, but Eusebio doesn't seem to have a say on layout changes nor on machinery adjustments.

Packaging (bags) This is where Horacio works; the main technological uncertainty comes from the packaging machine itself, since its start up has been complicated. Horacio says that humidity has an impact on the weight (if flour is too humid, it doesn't flow well), but the supervisory group doesn't think so, as expressed by Julian.

Loading (bulk) In this operation, worker intervention is limited to pushing buttons and monitoring dials. Worker technological uncertainty is very low. However, the logistics of bulk loading are not so simple, since enough product should be available to fill the trucks and this is usually a problem for the area supervisor.

In all these operations, it was seen that work units did not have an in-depth knowledge of the operation being performed. It must also be recognized that the work unit's role is seen in CNH as limited to monitoring the process, not being responsible for the quality of the product.

This is in line with the general conceptualization of the organization in CNH, as consisting of three groups, one in charge of managing resources, another in charge of production and quality, and a third one in charge of executing orders and monitoring the process. For this last group, technological uncertainty is very low, since their only job is to keep the machines running and that does not require very much knowledge.

Within each unit, some form of structure is present, but it is difficult to relate it to effectiveness. The analysis of interviews in the packaging, milling and bulk loading units shows that there is always someone who dominates the conversation. This person is in all cases the one with more experience and thus may be understood as the leader. Juan Carlos, Eusebio and Horacio are the more experienced workers in their areas and are the ones that do most of the reporting during interviews. In chapter 2 we stated that the relevant variables of structure are variety in the departments present in a work group and the quantity of participants with interfacing roles. In the case of the work units, it was found that interfacing roles and variety were low.

The impact of this structure on effectiveness is seen in how they solve their technological uncertainties. For instance, the structure in the packaging unit where Horacio works has had a positive effect on effectiveness, since Horacio has been able to put the machine to work, while listening to the suggestions of the women. It may be difficult to think that this could had happened if someone like Horacio were not in the unit.

For the supervisory group, on the other hand, the technological uncertainty is relatively high, since as we have mentioned earlier, a considerable part of the process knowledge they hold is superstitious. We could also consider this group as less effective, since they haven't been able to meet quality specifications.

If we compare the worker units with the supervisory group, we find that the supervisory group's structure includes people far more experienced, with more interfacing roles and from more departments than the work units; however, *relative to the technological uncertainty of each group,* the supervisory group has a more serious mismatch between structure and uncertainty than the worker group. In conclusion, we feel that the prosposition holds in the light of the evidence found.

p10. *Workgroups create norms to determine what information, from what source, under what circumstances is adequate.*

As there were no formal groups in CNH, norms had to be found in the work units. Some of these norms are described in what follows.

In the first sessions of the Improvement Group, Don Emiliano showed a tendency to give a lecture on all the issues that are related to a particular problem, without regard to its level of detail; he kept telling people that "there are a lot of details to this; everything is related to everything !" without giving others a chance to speak. When given a second thought, we came to the conclusion that it was not that the others participants didn´t have a chance to speak, but rather that they were content not to speak, being used to follow don Emiliano´s advice.

Also, some results about the quality of the flour were routinely received by don Emiliano from the corporate laboratory; however, as we found out in several interviews, this information was not disclosed but to a select group of supervisors. Usually only a decision about what to do next, not the lab results, was transmitted to supervisors. Our interpretation of this fact is that don Emiliano considered his job to make decisions without having to explain his reasons.

These facts clearly indicate that the most trusted source of technical information is don Emiliano, even though, as explained before, some of his knowledge may be superstitious.

Lower level workers tended not to get involved in technical problems; with the exception of Horacio, our informants in the lower levels reported that they were used to call in the maintenance department in order to have their problems solved, unless it was a relatively simple one, such as changing a transmission belt. Again we find that norms about the sources of information are well established.

We may wonder why did Horacio had such a different behavior, but the reason is expressed by him in an interview: "As the operator or the machine I have to know all its tricks, so that if the maintenance people can't fix it, we can". This is a recently acquired machine, imported from abroad, that had start-up problems which haven't yet been fully solved. For this reason, Horacio had the authority to "play" with the machine until he knew all its tricks. In other words, Horacio was the most knowledgeable person in this aspect and thus need not consult anybody to make a decision or to get a problem solved.

Within Horacio's group, we also found evidence of norms about information use and evaluation. In the interview held with Maribel, Tomasa and Horacio, we found that Horacio answered most of the questions, even though these were not addressed to him directly; the women limited their intervention to support Horacio's comments. However, this was not due to the women lack of knowledge: for instance, when asked (directly in this case) if they saw any problem besides those described by Horacio, they said "No, not really", but Horacio intervened and said "Don't lie girls. Look, these girls often give me hints about the state of the machine, they have given me clues on how to fix the machine". From this we conclude that within this work unit, Horacio is the leader, but he accepts that the women can give him useful information about improvements.

From our point of view, the evidence presented supports this proposition. It may well be that this proposition holds for any kind of group, formal or informal, since in the CNH case, groups are informal and the proposition is supported.

5. CASE 2: EATON MANUFACTURERA, SA de CV

5.1 Description of Company and Technology Diffusion Issues

Eaton is a multinational firm which in México produces power transmission axles for trucks. There is an ongoing process improvement program that relies on workgroups; this program has been in operation for about 2 years.

Due to a reduction in sales, a considerable number of workers have been laid off; consequently some work groups have fused and others have disappeared. Everybody in the corporation has received training in group problem solving, so that fused groups, while having members from different groups, have some common language.

Another issue at Eaton, is that work tends to concentrate at the end of the month, leading to a "end-of-the-month" syndrome. This is not due to production programming failures, but to a pervasive attitude in Eaton, sometimes reinforced by managers.

The manufacturing process in Eaton consists in the following steps. First, steel in form of billets is forged to a desired shape, either for axles or gears. This part of the process is the most physically demanding for the workers, due to heavy weights transported and high temperatures. It is also where the more skilled workers are required.

Second, a process of machining is performed, where the bores for the moving parts and the gears are made. This part of the process consists of working with machine-tools of different types. Most of the process is performed manually, while some parts are performed by numerically controlled machines.

Finally, the parts are assembled together. Some parts of the axle are brought from suppliers from Eaton Corporation in other parts of the world or from outside suppliers.

Some of the groups in Eaton, called Support Groups, are formed by managers and superintendents; other groups, called Work Groups, are formed by workers an in some cases their immediate supervisor. There is an important difference in what work groups and support groups are capable of doing, as will be explained later.

5.1.1 Informants.

The following is the set of persons from which we obtained information in significant amounts or quality; there were other persons from which we also obtained information, but this information was not as relevant for the purposes of our research. It is important to note that much of the information for this case came from minutes, written by people who no longer work in this firm.

5.1.1.1 Edgardo Jasso. He was our initial contact in Eaton. He was responsible for the creation and development of these work groups as part of the quality improvement program and was promoted while evidence was gathered in the firm. He reports that some groups do not behave yet as groups, being dependent on him and behaving in ineffective ways, but his work load prevents him from making improvements. Jasso has an engineering background and has been with Eaton for about 10 years.

5.1.1.2 Rolando Guadarrama. He took the place of Jasso when he was promoted. He comes from the engineering department, dedicated mainly to design, so he spent some time adapting to the more human-resource oriented job of coordinating work groups.

5.1.1.3 Arturo Villaseñor. He is in the Maintenance department, where he has seen a lot of improvements made to equipment. He has been in the firm for 10 years. As described in the interview transcriptions, he considers that the best way to do work is with "the boys", that is, his subordinates.

5.1.1.4 Concepción González. He is a worker in the rear axle area. He has been with Eaton for 3 years, two of which he has witnessed the evolution of the Geniecillos Brillantes group. He is a very active person, leading the group to reach the goals or resources needed. In the group sessions we witnessed, he showed some degree of frustration for the lack of interest in work groups.

5.1.1.5 Antonio Hidalgo. Antonio is a forklift operator. He has been with Eaton for 13 years; he feels that the group activities are good in improving the process. He was included in the group in order to have someone in the group with a point of view from outside the area of the Geniecillos Brillantes group (rear axle).

5.1.1.6 Rafael González. Rafael is a warehouse clerk. He has been with Eaton for 3 years, in the warehouse area; he was included in the group in order to have someone in the group with a point of view from outside the area of the Geniecillos Brillantes group (rear axle). He is a silent person, who seldom comments during the session. However, he shows one of the lower absenteeism rates in the group.

5.1.1.7 Silverio Cedillo. Silverio is supervisor of the tooling department; he is in charge of building and giving maintenance to the dies used to forge steel billets. He has a technical school background and has been with the firm for 14 years.

5.1.1.8 Gustavo Escamilla. Gustavo is a supervisor in the quality department. He has an engineering background and has been with Eaton for 15 years. He holds a lot of information about improvements and use of improvement tools.

5.1.1.9 Arizmendi. He is the safety engineer in Eaton. He is responsible for a series of activities that range from signing illness leaves to testing safety equipment.

5.1.1.10 Narciso. Narciso has been with Eaton for 1 year. In the las meeting of the group we witnessed, he expressed a lot of criticism against the way groups were treated. We feel that he was so verbal because he felt that something could still be done, in contrast to Concepción, who thought that things would never get solved, no matter what they did.

5.1.1.11 Antonio Enriquez. Enriquez is supervisor in the forging area. He takes part in several groups in Eaton, such as Impulsivos and Protección Personal, and believes that groups really make a difference.

5.1.2 Groups.

As of October 1993, there were 43 workgroups companywide each with a specific purpose, such as scrap reduction or safety issues. The names and purposes of these groups are displayed in appendix IX.

5.1.3 Concepts.

The following are some of the concepts that we think are relevant in understanding the social

arrangements in Eaton.

5.1.3.1 Process Knowledge. As will be explained later, process knowledge in the firm could be divided in sets of knowledge types managed by workers and knowledge types held by supervisors. Workers, as expressed by Narciso in one session, felt that support groups or technical departments considered that their knowledge of the process was very low, so that their suggestions were frequently ignored.

5.1.3.2 Process Improvement. In Eaton, two meanings for process improvement could be found: the first, held by worker groups was related to maintenance, although some idea of continuous improvement and of analysis of common causes was present; the second, held by support groups, was clearly oriented toward continuous improvements and special cause elimination.

5.1.3.3 Production vs Improvement. As is common in many manufacturing settings, a continuous negotiation took place between time allotted to production activities and to improvement activities. Due to the "end-of-the-month" syndrome, time reserved for improvement activities was reallocated to production activities. This indicates to us that the priorities in the firm are still biased towards the short-term.

5.1.3.4 Technology. The concept of technology held in this firm is biased towards "hard" technology. The improvements mentioned were usually to machinery, with some exceptions in the SOL group.

5.1.4 Roles.

5.1.4.1 Managerial Person. In Eaton a distinction was informally made between people in the managerial areas and engineers. The first were usually "clean", wore suits and worked with papers. Engineers spent most of their time in the manufacturing process or in design tables and spoke about types of steel. While the distinction between managerial and engineering roles is common in manufacturing settings, it became evident in support group meetings. People in these groups understood that they needed each other, but when conversation shifted towards technical issues, those in managerial functions remained silent.

5.1.4.2 Group Coordinator. The group coordinator was the person who facilitated meetings. While this is a formal position in support and work groups, this role was usually taken

by aggressive people, like Concepción González, who could make the rest of the group participate. These people usually decided when discussion had gone long enough and a decision should be made. In support groups, this role was usually taken by the person with more seniority.

5.1.4.3 Secretary. The secretary is the person who takes notes during the meeting and develops the minute. This is also a formal position in the group. Its role is to capture what happens in the session with enough detail and to remind people of their commitments during the previous session.

5.1.4.4 Supervisor. In the view of the participants in a work group, the supervisor is the person that suggests what has to be done and that tries to obtain the required resources. From the support group point of view, the suppervisor is the person who can coordinate workers to implement ideas developed within the group.

5.1.4.5 Expert. The role of expert was played by different people in a group, according to the context of discussion. For instance, Jorge Alvarez was the expert in the different types of steel and steel handling in the Impulsivos group; Arizmendi was the safety expert in the SOL group. When the expert talked, the rest of the group listened and there was little contrasting of his opinion.

5.1.4.6 Policeman. This is an informal role. The policeman frequently reminds people of their commitments beyond what the secretary does and makes the group aware of schedules and deadlines. This role was played in Impulsivos by Cedillo, according to the rest of the participants.

5.1.4.7 Worker. Workers felt their role was to do the simplest of improvements, besides their routine tasks. They felt that they were not as intelligent as supervisors, as expressed in the meetings of the Geniecillos brillantes group. A lack of control over resources and of power to summon people was felt as part of this role.

5.1.5 Events.

The main events related to group development at Eaton are described in what follows.

5.1.5.1 Training of coordinator. A person was trained outside Eaton in group dynamics and was named coordinator afterwards. This person took in his hands the task of training the rest

of the workers and employees. This training took about 8 hours per person. The coordinator served also as facilitator for beginning groups.

5.1.5.2 Integration of Committee. A committee was formed with the task of giving direction to the group effort. This committee had several changes in scope and participants before it came to its current form.

5.1.5.3 Integration of First Support Groups. The first workgroups were formed in what the coordinator considers a slightly inappropriate way: people were chosen and pushed "a bit" to work in the group. This, in the words of the coordinator, contradicts a principle of workgroup formation which is that participation should be voluntary (Nemoto, 1987). However, he concedes that otherwise implementation of group sessions would have been difficult.

The first group formed consisted exclusively of employees with a superintendent or manager level. This group was intended to function as a seed for other groups.

5.1.5.4 Integration of other Support Groups. Once the initial group had gained some maturity, other groups were formed in the different manufacturing areas. These groups had different rates of maturation, which created some conflict as will be explained below.

The coordinator says that being in all groups and facilitating interaction began to represent a burden for him.

5.1.5.5 Integration of first Work Groups. The work groups stemmed from the support groups, by gathering some workers around a supervisor or other higher level person, known as the *process engineer,* in the support group who eventualy would leave the group. The first work groups were formed once the corresponding support group achieved some level of maturity. At one moment in time, workers in other areas considered they were ready for group integration even though their support groups were not mature enough. This proved a difficult time, since workgroups that formed while the support group was not mature yet required a great deal of supervision, thus requiring additional time from the coordinator.

5.1.5.6 Redefinition of Coordination Scheme. This prompted the administrator and the steering committee to redefine the coordinating mechanism. The area superintendent would then become responsible for the performance of the group, even though he may not be part of it.

5.1.5.7 Disintegration and Fusion of Some Workgroups. Due to a market contraction, many workers were laid off. This forced the coordinator to reassemble groups with elements from other groups. This reassembling led to a series of changes and disorganization. However, as Enriquez puts it, the fact that workers had already worked in groups before coming to their new group was an advantage and reorganizing took less time.

5.1.6 Specific Issues about Groups and Group Meetings

5.1.6.1 Group: Geniecillos Brillantes (Brilliant Little Geniuses)

This group is a worker group in charge of Safety, Order and Cleanliness in the rear axle area. Cleanliness is not directly related to PIE. However, Safety and Order are directly related to PIE, since unsafe work conditions lead to accidents and reduced productivity, and order reduces preparation time: for instance, having materials and tools ready for the beginning of the next day reduces set-up time and increases productivity.

This group has had an interesting development. It was one of the first groups formed and it performed very well, frequently mentioned as an example by the coordinator. However, due to a reduction in production volume in Eaton, some of its members were reallocated to other areas and scheduling meetings became a problem. At a certain moment, a person who was not the direct supervisor of this group told them to abandon their weekly meetings. The workers tried for a while to find a way around this decision but finally gave up. Two months later, the coordinator discovered this and reassembled the group. By then, morale was low and a common theme during the first meeting was questioning whether the support from management was for real.

Before meetings were abandoned this group had achieved most of their objectives and new objectives were taken. However, the interruption caused a decrease in performance and earlier objectives had to be retaken.

As a result of the "end-of-the-month syndrome" this group had to suspend its second meeting after their first "post-reactivation meeting, that was supposed to take place the 26/10/93.

The analysis of session codings indicate that this group has an evenly distributed participation of workers during sessions; on both sessions observed, the facilitator (a manager) made 26 out of 74 interventions, but the workers made on average 8 interventions. The discussion during the group also indicates that participation is oriented towards problem solving (62

interventions related to "information" and "decision making" out of 74) and not so much to session or group maintenance (6 out of 74), which we interpret as an indication of maturity in the group.

5.1.6.2 Group: Albatros

This group was not actually observed during meetings or during tasks performance because when we arrived in Eaton, it had been dissolved. However, the group had been very successful in performing some improvements and they produced very good minutes of their meetings on a regular basis. For this reason, the performance of this group could be analyzed with a lot of detail. The most important PIEs that this group got involved in are described below.

Impact Wrenches: These are pneumatic wrenches used to tighten nut on assemblies. They have the advantage that the worker does not get tired because it does not require a considerable physical effort; on the other hand, being a more complicated mechanical device than a wrench, they are prone to a series of mechanical problems. Also, changing the size of the tool may be complicated, which is what this group tried to solve.

Safety Fittings: The are assemblies of pipe used as handrails and other devices used as support in order to avoid accidents in machine tools. A problem here is that these devices may be missing from some machines, making them unsafe.

Pneumatic Hammers: These are similar to pneumatic wrenches, only that they are used to assemble pieces by pressure. A problem here was that the hammers were not of good quality and tended to break after some use.

Material and Subassembly Racks: These are containers where materials and parts are kept. The design and location of these can have a significant effect on productivity, since a lot of time is often wasted in transporting materials. The groups had standard racks, provided by the company, but they wanted to modify its design to have better reachability to parts for assembly.

Greasing Machine: This is a machine that supplies grease for bearings in assemblies. The problem with this machine was that it was not greasing the bearings adequately and they had to be reprocessed.

Differential -Holder Height Caliber: A measurement instrument used to determine an important spatial parameter in the transmission axle. Precision measuring can take a lot of time, so that this group asked for calibers designed for quick measurement.

Head Tester: A device to test the performance of a subassembly before it is assembled into the axle. As with other PIEs this group got involved in, the purpose here was to be able to test the head in less time.

5.1.6.3 Group: SOL (Safety, Order and Cleanliness)

This is a support group created to coordinate the companywide effort for safety, order and cleanliness; while the tasks of safety, order and cleanliness may seem unrelated to productivity improvement, their effect is very important: having a good record on safety reduces the amount of days lost due to accidents and also the payment rate to social security institutions (firms with a record of frequent accidents on a year pay a higher rate per worker for the next year). Order and cleanliness also help in reducing tasks that do not add value to the product, such as searching for tools and material transportation. Recently, this group was assigned the environmental quality tasks of Eaton, which was added to their traditional objectives.

As an example of the performance of this group, the following table is given; this table includes the three areas for the group.

Table 4: SOL Group Performance Statistics

year	1991	1992	1993 (goal)
accidents	350	149	120
days lost (DL)	3750	2395	2000
index(IN)	21700	7776	7000
order and cleanliness	30%	72%	80%
savings:			
Δ DL	reference	60975	17775
Δ IN	reference	651350	154764
$	reference	712335	172539

It is evident from this table that the area to which the group pays more attention is that of safety, for which objective, quantitative goals were set and achieved.

The analysis of the minutes of the SOL group shows that this group has a clearly defined structure of activities for problem solving, which is important to describe in order to analyze the technology diffusion issues. This structure is depicted in figure 11, and is described in what follows. During the period analyzed, a pervasive event is the analysis of accident statistics during group sessions (07/May/92, 09/Jun/92, 16/Jun/92, 4/Aug/92, 29/Sep/92,6/Oct/92, 13/Oct/92, 20/Oct/92, 10/Nov/92, 01/Dec/92, 12/Jan/93, 2/Mar/93, 30/Mar/93, 13/Apr/93, 30/Apr/93, 27/Jul/93, 28/Aug/93, 26/Oct/93); this is important information for this group, since the most important measure of performance is the number of accidents. It should be noted that the other objectives (cleanliness and order) do not appear nearly as frequently in this group's minutes.
Thus, it is clear that *monitoring* is an activity that the group has clearly established as part of their improvement procedures (Capello, 1992).

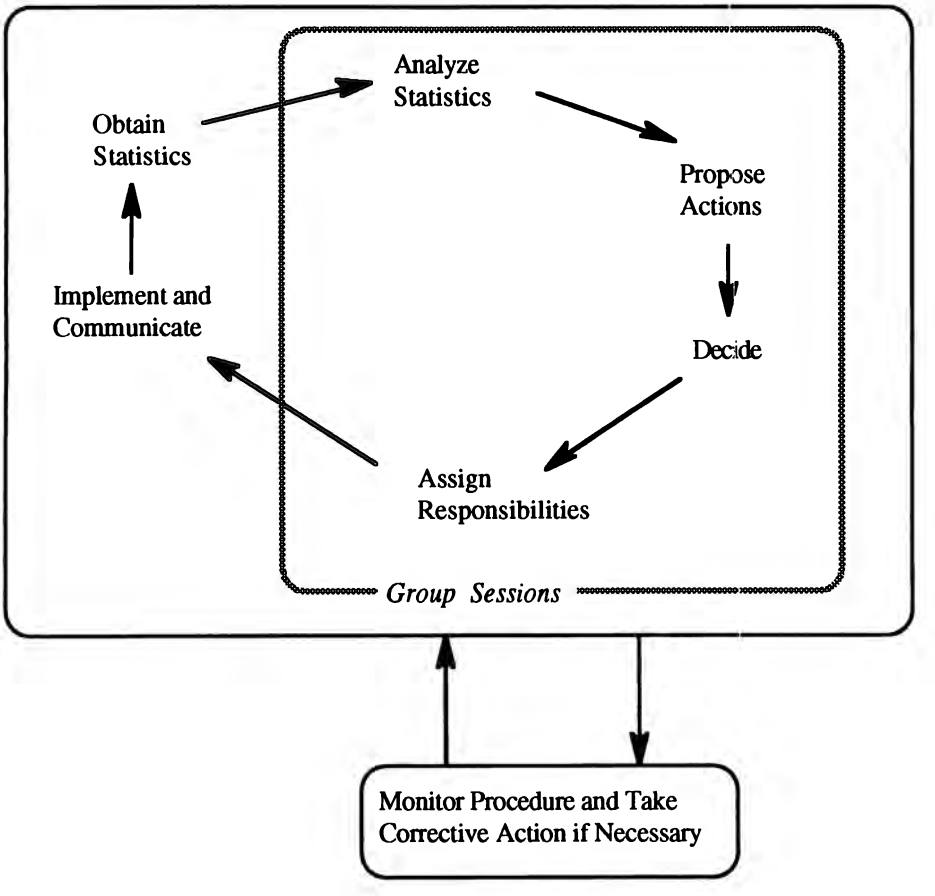

Figure 11 : Improvement Procedure for the SOL group

In the sessions observed, it was the found that, independent of whatever other issues were discussed, one of the participants displayed a series of graphics about the accident frequencies, from which actions for improvement were developed; these involved a group discussion of alternatives.

On several occasions, the group got involved in improving not the manufacturing process, but the *improvement procedure;* that is, the group analyzed the way the improvement procedure performed, and if necessary, changes were made. This was the case on 12/May/92, 16/Jun/92, 07/Jul/92, 26/Jan/93, 02/Feb/93. This prompted us to include the "corrective actions" block in figure 11.

It must be observed that the process depicted in figure 11 is not new; the purpose of including it is twofold: first, it must be recognized that this group has and follows a formal procedure for improvement; and second, the activities belonging to this procedure for improvement must be "removed" from the rest of the evidence in order to allow us to distinguish the most important evidence in *process improvement.* In other words, the analysis for this group must be done at two levels of resolution: one is the *manufacturing process improvement,* which involves "technical" tasks, and the other is the *improvement procedure improvement,* which involves the involvement and performance of managerial tasks. Activities in both levels lead to improvements in the process; thus, both can be considered PIE.

5.1.6.4 Group: Impulsivos (Impulsives)

This is a support group dedicated to the reduction of scrap in the forging process. It is formed by managers and supervisors from the distinct forging areas.

The meetings of this group tend to have a slightly hostile atmosphere and some participants arrive late, as in 28/Oct/93 , where some participants arrived 20 minutes late for a 60 minute meeting. However this group has been very successful in reducing scrap as described in the following figures: their initial percentage of scrap was 2.4 and they have reduced it to 1.58.

In this group, we can consider that scrap reduction is the only PIE, since all participants understand that the group's purpose is to reduce scrap and that several tactics can be used to this

purpose; all information obtained and all discussions are oriented towards this end. This is different from other groups, where several improvement efforts could be directed to a more abstract goal. For instance, in the SOL group, the definitions of the goals of the group require the definitions for "safety", "order" and "cleanliness", which may be elusive; however, the definition of "scrap" is straightforward.

The participants of the Impulsivos group are very confident about their knowledge of the process; they consider that they have the required expertise for the very specific improvement effort they are involved in. Also, they exhibit some pride in behaving like a group in spite of several changes.

5.2 Analysis of Propositions

p1. *The perception of a group's performance by other groups affects the work of the first group as change agent.*

The evidence used to analyze this proposition comes from minutes, which, being written documents, have a high degree of credibility and verifiability; also, evidence is obtained from groups sessions and interviews, which together with minutes make evidence primary. Thus, evidence for this proposition is of good quality.

The following evidence was found in the case of the Albatros group: on 5/Jun/93, a mention is made in a minute by the Albatros group that a technical result is ready for use by other departments; that is, the intention to communicate a result is evident. However, the consequences of the communication of this result may be various: the group may become a change agent or it may simply become one in many providers of locally developed (or reinvented) technology.

In the files of the Albatros group, evidence can be found that after a document dated 19/Jan/93, the group began receiving more support from the Excellence support group. This as an indication that after this date the performance of the Albatros work group was considered adequate, maybe because the courage needed to send a memorandum to this support group was interpreted as a commitment to improvement.

In the case of the Geniecillos Brillantes group we didn't find evidence of the group being considered as a promoter of change by other work groups; evidence obtained on the 22/Mar/1994 interview indicates that the group does not know if their results are used elsewhere and that the groups are not allowed to "take a look" at how other groups are performing. When asked about the persons or groups they considered more knowledgeable about the process, they referred to persons within the group or area, or to departments that are organizationally supposed to make changes, such as the industrial engineering department. No mention was made of a group or person whose capability to promote change goes beyond their function description.

However, it is interesting to analyze the relation with the support groups. The first successful PIE of this group was the greasing machine relocation. This PIE was initiated with a suggestion by the work group on 03/Feb/93, when a memo is sent to G. Dominguez (engineering manager)

asking for an dedicated area to grease ball bearings and save grease. On 16/Mar/93, a decision is made to relocate the greasing machines to a single area and observe improvements. This doesn´t affect quality or productivity; simultaneously, the assignment of resources to other PIEs (spare part containers) is conditioned to the success of the relocation of greasing machines. On 23/Mar/93, successful results are obtained with the relocated machines and a meeting is called to communicate these results to other areas.

This success seems to have affected the perception of the group´s performance by the support groups, since from that moment on several other PIEs were assigned resources in several forms and reached their finishing criteria (some technical and some behavioral), and a more ambitious PIE (forklifts) was proposed by the group and supported by the support groups. Our interpretation is that if the support groups had not considered Geniecillos Brillantes as a group capable of undertaking change activities, their support for them would have been minimal and they wouldn´t have accepted a more ambitious PIE such as forklifts.

The evidence obtained from the analysis of the minutes of the SOL group helps us explore this proposition. In the words of one informant of the SOL group during an interview, "I think SOL is the more solid group in EATON; however, I acknowledge that I do not know about the performance of other groups".

We would expect to find reports of events where one of the groups that has successfully reduced their accident rate was used as a model for the rest; however, the only reports found related to this proposition are those where the groups coordinators whose group performed the worst are summoned to a meeting with SOL (25/May/93, 08/Jun/93). Thus, negative evidence about SOL (or another group interacting with SOL) functioning as a change agent leads us to believe that there are no groups around SOL which can be considered change agents, and our inquiry indicates that the reason is that successful groups do not receive public recognition of their success.

The evidence for the Impulsivos group indicates that they consider themselves a very capable group but, as in the case of the SOL group, they did not know about the performance of other groups. Our informants say that this group was created considering the participants expertise in the process, so that they imply that no one in the firm knows more about the process than them; this in turn leads them to believe that they do not need to obtain knowledge from other sources and consequently they cannot obtain valuable information from inside the firm, whether it is about technical issues or group organization issues. Furthermore, during one of the sessions of this same

group, it was found that another group was working on an idea similar to one of theirs, but the communication between groups was imperfect, in part due to problems of authorship.

When comparing results of the support groups (SOL and Impulsivos) with the Albatros and Geniecillos Brillantes groups, we found that one of the criteria for determining whether a group is considered a change agent (being capable of obtaining required resources) is not applicable here, since the participants in the SOL and Impulsivos groups already have, by their position in the organizational structure, the control over resources: it is not a measure of their success as change agents the capacity to assign resources that are already under their control.

The evidence indicates that in EATON, the performance of groups is not communicated to other groups, at least formally. This is clearly an obstacle for becoming a change agent, since groups must first be recognized within the organization as successful. The reason may be that the organization wants to avoid an environment of unfair competition between groups but the effect of this strategy is that formal channels for communicating the achievements and strategies for other groups are not well developed, and thus groups are unable to learn useful behaviors from other groups. Thus, the proposition holds, since there is no public information about the performance of groups, there is no way a change agent can develop, and consequently, none of the groups can act as a change agent.

p2. *The expectations of the group depend on past performance in PIEs.*

An example of the way expectations are shaped when groups are in PIE is the following, based on evidence of the Albatros group. The evidence for this proposition came mainly from minutes. As explained before, the evidence obtained from this source is a very strong one, so that we can be confident of the result obtained from the analysis.

The analysis of the event sequence yielded negative evidence about answers from support groups in many of the weekly reports. After some weeks of work, the Albatros group asked for an organizational chart, since their demands had not been paid proper attention, maybe because they were addressed to the wrong people. This can be interpreted as a consequence of a minor frustration on the part of the group.

Later, a memo sent to a manager is answered by someone of lower rank. This could be interpreted as the group not being given the importance it has or as a poorly addressed document.

By 19/Jan/93, no PIE of the several in which the group was involved had been successful. In a meeting with the support group "Excellence", several issues are surfaced, some of which are new: before this meeting, the PIEs the group was working in were three; in the meeting, seven issues were surfaced, only one of which had been considered earlier. Besides, none of the earlier PIEs had been finished.

This abundance of new issues may be interpreted as a way the group uses to add momentum to their request: they feel that they may not get support for every demand, but if managers see a long list, they will support more PIEs than if the list were shorter. This again indicates that the work group does not expect full, immediate support.

After this meeting, results began to appear, as support was given to several PIEs. While these events add a positive feeling to the group, they also confirm their expectations that a great deal of effort must be spent in pushing PIEs through the organization and not only in devising ways to improve manufacturing process performance.

The results lead the group to seek additional ways to improve the process, as recorded on the 22/Jan/93 minute, so that we can conclude that the group´s expectations are still optimistic.

On 19/Jan/93, Albatros sent a memo to a support group called Excellence asking for support in order to achieve the Albatros group´s objectives. In this document, a hint of frustrated expectations was found, since the group complained that they had suggested improvements on several areas and they had received support only in one area.

Some participants were added to the group on 21/05/93. The reason for these additions may respond to the need of the group of some form of expertise which they did not have or because the new entrants considered this to be a good group to be with.

On 02/Jul/93, another memo demanding support is sent.

The amount of time and effort spent in pushing the improvement proposal through the company has an effect on the expectations of the group; even though a group does not yet have results of a proposed improvement, their expectations may be low if they have spent a great amount of effort in gaining support for it.

An important piece of evidence supporting this proposition came from the Geniecillos

Brillantes group. This group had been performing very well until Eaton came across the difficult situation explained earlier and which led to a reduction in the workforce, including some members of Geniecillos Brillantes.

While the group tried to keep their meeting schedule, one of their supervisors told them to stop meeting since people were needed in the production line, so that the meetings were suspended for about a month. When the workgroup coordinator found out this, he gathered the people again, stressing to them that they had been a very good group and that there was no reason to expect anything less from them. The group accepted this and began meeting again.

Another interesting situation occurs in the analysis of the evidence about the Geniecillos Brillantes group. In the case of the ball-bearing container improvement PIE, a modification was suggested on 29/Jan/93. On 3/Feb/93, a memo is sent to G. Dominguez (area manager) asking for support. By then, the workgroup had developed a container which worked properly, but seven additional containers were needed and the group did not have the required resources, such as material and time.

On 16/Mar/93, information was found in the minutes indicating that the ball-bearing PIE was in a standstill, waiting for results from another PIE. On 23/Mar/93, a promise by the support group is communicated to the group. On 30/Mar/93, the group was still waiting for an answer about the construction of the containers. On 13/Apr/93, a decision is made to ask for support from A. Cisneros. On 20/Apr/93, the group receives a promise from the support group to develop a cost analysis of the container.

It is interesting to note that this group had to ask for support on several occasions in order to have their effort implemented. This may explain the strategy followed in the PIEs that followed. An example is the forklift PIE, in which a full blown strategy, consisting in memoranda to superiors, information gathering from several sources and a detailed analysis of the situation was performed. All this was mounted in one week, indicating that the group considered this strategy necessary to have the PIE implemented. Also, it is interesting to note that the workgroup was confident in their strategy and suggestions, since the forklift PIE was well beyond the group's authority limits: the forklift operation is under the responsibility of the warehouse department, not under the workgroup's responsibility.

These two instances of the Geniecillos Brillantes group clearly indicate that this was a very motivated group, that did not lose courage with difficult situations or accumulating frustration; however, evidence obtained from interviews on 22/Mar/94, after implementation of these PIEs had major setbacks, indicate that the group was already "burnt-out" and that they consider process improvement a very difficult task. Evidence from this interview indicates that the group feels that information can only be obtained from within the group or area, and from specific persons; the rest of the organization may not be helpful. Thus, the proposition is supported, since poor performance in previous PIEs led the group to very low expectations.

In the case of the SOL group, a situation almost opposite to the one just described prevailed: expectations were high because the group had been performing very well and they had no major problem in achieving their goals. This group set a goal of reducing their accident index from 21 200 to 11 360, and the days lost each year due to accidents from 3700 to 1850, for a population of about 1000 workers. As displayed in table 5, the group had achieved its goals. On 20/Oct/92, a self-evaluation of group performance was satisfactory and more ambitious goals mentioned and set, such as including is the statistics all accidents, not only those treated outside the plant. These results were reported on the first days of December 1992. These statistics were used as a measure of success on 12/Jan/93, which led the group to "increased morale" and set higher performance standards for the new year; on 8/Jun/93, the group decides to participate in an open national contest for SOL groups. However, these successful events became less frequent during 1993: on 22/Jun/93 an increase in the number of accidents was detected, the group did not make it to the semifinals in the contest and the numeric goals were not met. This however did not discourage the group but made them more sensible to the difficulties in reaching goals.

From the discussion of the SOL evidence, we can conclude that the proposition is supported: the improvements in the manufacturing process led to more ambitious goals for the group; and the failures led to a more conservative and realistic attitude as reported in minutes.

Our analysis of the evidence from the Impulsivos group helps us support the proposition. As stated earlier, the Impulsivos group had been very successful in reducing scrap. As explained by one of our informants on 21/Oct/93, the success of the group in reducing scrap have led them to higher expectations about their performance and they have set more ambitious goals.

Several of the changes carried out by this group have been successful and thus their satisfaction is high. As explained by Escamilla on 21/Oct/93, after an analysis session, it was found that a particular piece of foundry was subject to overheating; some changes were made and the operation improved. Another success story is given by Cedillo (21/10/93), where visual markers were designed for a foundry part, with successful results.

Our informants say that their expectations are high because they have been successful in reducing scrap, and also the participants of the group are still the same that led them to this successful performance.

From the discussion of the Impulsivos evidence, we can conclude that the proposition is supported: the improvements in the manufacturing process led to more ambitious goals for the group in their main indicator : scrap percentage.

p3. *When an imported technology differs from the group's previous technology under use, the group will resist this technology or will try to adapt it so that it resembles its previously used technology.*

The main technological events are recorded in minutes, which are a powerful source of evidence; because of this, we can be confident in the results of our analysis, whether it leads us to support or reject the proposition.

In the case of the Albatros group, no technology was imported that was conflictive with the previous technology; this may be because the group is the one demanding a technological improvement. In the case of the impact wrenches, a sequence of evetns indicates that some tuning up was required for the PIE to proceed smoothly; this tune-up required modifications (additions) in the maintenance procedures applied to these wrenches; however, this cannot be taken as a desire to go back to the previous technology under use. A similar situation occurred with the moving crane.

In the case of the Geniecillos Brillantes group, no evidence about "hard" technology coming to their domain was found; "soft" technology, in the form of tools for improvement, was accepted by the participants of the group but not extensively used, even though on several occasions its application seemed straightforward, as stated in the 22/Mar/94 interview.

A special mention should be made about adaptation. According to our 22/Mar/94 interview

with the Geniccillos Brillantes group, they felt there was no freedom to make adaptations; this makes the analysis of the proposition more difficult, since if the group perceives that no freedom to adapt exists, they will not try to adapt, even though a technology would require it. Since we found no evidence to clarify this issue, the proposition cannot be supported or rejected for this group.

The evidence from the SOL group helps confirm this proposition. The soft forms of technology included the process improvement procedure, depicted in figure 11, and which represents the main template with which the group is working. In this PIE, there seems to be no resistance, since the group accepted the procedure and made minor improvements on it according to minutes; there is no minute where rejection of this form of technology is recorded.

Of the hard technologies, the machine-tool lubricants (16/Jun/92) represent perhaps the most innovative technology. These lubricants were put to work on different machines and the opinion of workers was obtained; however, the group itself did not resist the technology.

The analysis of the Impulsivos group evidence leads us to believe that the proposition cannot be supported. Our informants report that there have not been many technological changes in the firm; one of them is a robot used in lubrication; it required a modification in the basement of the building but it was done with no problem. Another informant states that one of the technological innovation is the change in maintenance policies, which changed from corrective to preventive maintenance, and he considers that an improvement was made with this. It should be noted that this is a "soft" form of technology. Still another change reported is the introduction of work groups, which the same informant considers good: "Work groups are positive. A considerable improvement is observed when compared to the previous period (Escamilla, 20/10/93)". We can conclude that for the Impulsivos group, the new technologies have not represented a problem, and have been accepted readily.

The lack of supportive evidence about a major resistance to a particular piece of technology existing in the groups studied leads us to believe that this proposition cannot be supported. This issue is explored further in the conclusions.

p4. *During reinvention, groups may have considerable discretion in technology difussion; this may not be the case in "packaged" PIE, where the group must conform to specifications and cannot use its network freely.*

Research in the archives of the Albatros group indicates that several of the PIEs undertaken by the group are amenable to reinvention by the work group, as explained below. We will describe how each PIE is diffused depending on whether it can be reinvented or not.

Impact Wrenches. This is one of the PIEs that could not be reinvented by the workgroup. The technology is acquired, whether from inside or from outside the firm, but all the workgroup could do was to test it to see if it was satisfactory.

As explained above, this PIE implied several aspects. We will be interested only in its most significant aspect which is the installation of the fast change line for impact wrenches; the other aspects, which are the straightening of the wrenches and maintenance do not have a significant impact on productivity.

The first event in the adoption of this piece of technology was the workgroup's demand for straightening of the wrenches on 1/Nov/92. This was accompained by a demand to install a fast change line and a standarization of the wrenches. On 19/Jan/93, mention was made during a meeting about the poor state in which the wrenches were due to lack of maintenance.

On 4/Feb/93, the fast change line is put in place. The work group considers this a trial period. Failure in this line is later detected and assigned to lack of maintenance; the Maintenance and Industrial Engineering departments in Eaton decide to analyze the situation to determine the best fast change system for each task. One of the participants prepared an impact tool to test its performance.

On 5/Jun/1993, the group considers the fast change line is working properly and that this technology will be recommended for those departments using pneumatic tools.

In this particular PIE, the group did not have much capacity for reinvention, due to the highly technical characteristics of the equipment. However, it is clear that the group acted as a change agent, since they prevented the diffusion of the innovation until they agreed that the technology was working properly.

As expected for a packaged technology, the group used the organizationally prescribed ways of redesign, such as the Maintenance and Industrial Engineering departments in Eaton; however, they exhibited some form of control on the diffusion process, since they could decide when was the technology was ready for use by other departments. Proposition 4 holds in part in this PIE: while the group has relatively low *technical* knowledge about the equipment they have relatively high *use* knowledge, and this later kind of knowledge determined the moment when the technology is ready for diffusion.

Safety Fittings. Safety fittings are usually designed under some industrial safety rules but there is considerable margin as to the specific design since every tool or machine where the fitting is set is different. Consequently, this is a PIE where considerable reinvention is expected.

The concept of reinvention may not be particularly suited for this situation, since safety fittings are not considered an innovation by this work group: new equipment usually has this fittings and it is only when wear makes them useless that another fitting, posibly with a new design, is called for.

Pneumatic Hammers. The pneumatic hammers are similar to the impact wrenches in that it could not be reinvented by the workgroup. This technology is acquired from outside the work group; all the workgroup could do was to test it to see if it was satisfactory.

Parts and Subassembly Racks. This is an innovation with great potential for reinvention. The concept of rack is not new for these groups, since these racks have been in use for some time. What makes this an innovation is that the concept of rack is now understood not only as a short term storage but also as a piece of equipment that must be designed to help the worker in reducing the time spent in valueless operations, such as transporting; this design is specific for every part, subassembly and machine. In other words, racks are now a complex, non-standard piece of equipment.

Workers spend a great deal of time in performing routinary operations, some of which are valueless; consequently, they know better than anyone else in the plant how a rack could help in reducing these operations.

On 19/Jan/93 the group had developed a design for racks that was considered worth proposing to management; on 4/Feb/93 the answer from management was that the cost made the acquisition of these racks impossible for the time being. This was the last reference to this PIE in

the files of Albatros.

The analysis of these events shows us that while this PIE involved some reinvention by the group, it was cut short by lack of funds; the interesting issue here is that if the group were functioning as an adequate change agent, they might have told other groups in other areas about it and maybe these groups could have obtained the required resources for their own benefit; on the other hand, maybe the design was so specific that it was useless for other groups in other areas.

Differential -Holder Height Caliber. This is a case of a packaged technology. As explained above, the purpose of this caliber is to measure the precision with which two subassemblies are assembled. Since this is a precision instrument, there is not much the work group can do to modify its design. What the work group can do is to judge between different types of calibers and select the most appropirate for the operation.

The analysis of difussion discretion during reinvention in the Geniecillos Brillantes group considers the following improvement efforts: *ball-bearing container design, greasing machine relocation, oiling machine improvement, subassembly container-carts, forklift operation improvement and nut -and-bolt drawer identification.*

Ball-bearing Container Design. This is an innovation that can be reinvented by the group. The concept of rack is not new in this firm, since these racks have been in use for some time. What makes this an innovation is that the concept of container is now understood not only as a short term storage but also as a piece of equipment that must be designed to help the worker in reducing the time spent in valueless operations, such as transporting; this design is specific for every part, subassembly and machine. In other words, racks are now a complex, non-standard piece of equipment, which can be reinvented to meet a particular manufacturing environment.

Greasing Machine Relocation. The situation for this PIE is similar to the one encountered in the design of the ball-bearing container in that a general concept, "location" in this case, is adapted to the particular manufacturing environment of the Geniecillos Brillantes group.

The diffusional issues in this PIE are first seen when the group gathered the required intelligence to define the problem and propose solutions. This initial effort, as many in the work groups studied, was not the result of a formal analysis, but rather of a experience sharing process where ideas about the improvement came from different sources and the "improvement" gradually takes shape.

When the idea was satisfactory for the group, they decided to ask for support. In this particular PIE no technology diffusion took place in any direction, since the work group provided a complete design and the support groups did not use the design by themselves. Once the PIE achieved success, the work group choose the channel they considered best for diffusion.

Oiling Machine Improvement This PIE involved some expertise the group did not have; while the group was successful in defining the problem, they could not solve it. They asked for some information about the machine (02/Apr/93) but never got it. This PIE is a mixture of packaged technology and reinventable technology: the packaged part is the machine itself that cannot be opened or moved by the workers themselves; the reinventable part is the relocation of the machine. Due to the packaged nature of the technology, the group had to use the established channels of diffusion (that is, their supervisors) and could not resort to the network the used in other PIEs.

Subassembly Container-carts. This is another instance of packaged technology. All the group needed was more units to separate parts in temporary storage for different assemblies. This PIE involves almost no innovation, since the carts are standard equipment in the firm; the process improvement comes from the differentiated storage capactiy.

The technological issue here is how many carts to allocate for parts of each assembly; too many carts reduce moving space and too few lead to confusion, since parts for several assemblies are held in the same cart. However, the diffusion of this technological bit is no problem since the technology is not innovative: it has been in use for some time and most workers know abut it. Thus, there is no useful information in the evidence obtained from this group to support or reject the proposition.

Forklift Operation Improvement. This is the most complex PIE undertaken by this group, involving several technological pieces, such as relocation of equipment, modification inspection procedures and material movement scheduling; no packaged technology is involved in it. As in other cases of reinventable technology, there is a basic concept of inspection and a basic concept of location, which can be understood as soft forms of technology. What makes this a situation worth reinventing is that the location, inspection and scheduling concepts must be adapted to the details of the particular situation to obtain an optimal solution; in other words, technology must be adapted to this situation. Thus having a better layout, a more refined inspection procedure and better scheduling of material movement makes the process more productive.

The diffusional issues in this PIE involve the acquisition of technical information, the promotion of the idea to areas where the group performs and the verification of the implementation. Information required to redefine the layout was obtained from within the group, since the group has been working with the present layout for some time; information about inspection procedures comes from the quality supervisors, who determine which steps of the inspection procedure can be modified and which cannot (8/Jun/93); information about scheduling comes from forklift operators and warehouse managers (8/Jun/93, 15/Jun/93).

It is interesting to note that this PIE did not unfold in a linear sequence of discrete events; rather, the group tried to promote the improvements and when information was missing or no support was obtained, appropriate action was undertaken.

Nut -and-Bolt Drawer Identification. This PIE was under development when changes in the workforce began to take place. The latest report about it is that the drawers have not been painted in different colors yet. In this PIE, the technology in question is "identification" technology, a reinventable technology which the group had since identification by colors is a common task. The group obtained this technology by informal methods, such as observation of other identification schemes used in the firm.

For the Geniecillos Brillantes group, we can conclude that the group can use its network freely when they are diffusing bits of technology; however, when a complete technological package is to be diffused, whether into or out of the group, the diffusion channels are nonexistent.

As described by some of the participants in the SOL group, one of the new technologies arriving at the plant are the "worms", which are cylindrical pieces of absorbent material used to clean lubricant spills; these are used in the oil industry and are now under testing in Eaton to substitute cloths and sawdust. Also, some filters for machines have been adapted; some have been used directly, but when there is a need to perform an adaptation, these are done with no problem .

Another interesting PIE is the forklift scheduling improvement, where this group had to synthesize a series of minor improvements, just as the Geniecillos Brillantes group did. The resources they used to diffuse technical knowledge into and out of the group included video recording (10/Nov/92, 20/07/93), Gantt charts with information from different sources, and search by members of the group into the procedures for forklift operation. This is a very reinventable technology, including location, scheduling and other technological bits, which the group obtained

by freely using their network.

Also, the process improvement procedure developed by the group suffered a series of modifications and adaptations; while the general framework of operation remained fixed, as series of modifications took place, such as devising an evaluation method (9/Jun/92), changes to the audit formats (16/Jun/92) and accident sheets (16/Jun/93).

Our informant in the SOL group told us that people in Eaton have always been free to adapt if they have to; this has increased a bit since the advent of work groups (Villaseñor, 26/Oct/93). Thus, we conclude that for this group, being technically best equipped than the Albatros or Geniecillos Brillantes groups, considers a technology as packaged and thus not reinventable, only when it has a very high degree of technicall complexity. The use they give to their network indicates that for packaged technology, their network includes other engineers or managers but not workers.

This is one of the propositions where the evidence obtained from interviews and minutes is sufficient to validate our results and support our proposition. Since support from other groups is usually obtained by means of memoranda, which is kept in files, the channels of diffusion are easily obtained.

p5. *When searching for technical information about tasks, groups will use first their homophilous relations, and if these are unsuccesfull, they will use heterophilous relations.*

Evidence for this proposition comes from two reliable sources: first, meeting observation and coding (except for the Albatros groups) provide evidence about the homophilous relations within the group; and second, minutes provide information about relations of the group with other elements of the organization, among which, heterophilous relations are found. Thus the conclusions obtained from this analysis are strong on the side of the reliability of evidence.

We will analyze first the evidence obtained from the Albatros group, and within it, we will study the greasing machine PIE. This greasing machine is an instance where the Albatros work group could act on at least two dimensions. First, the machine was not working properly and second, its location within the shopfloor was not adequate according to the workgroup. In terms of our definition of PIE, both dimensions had to be attacked in order for the improvement to be

really significant.

On 19/Nov/92, the first record of the problems with the greasing machine appears. A decision was made to study the problem with this equipment; this task was assigned to two group members. On 19/Jan/93 the assigned group members reported that the injection system was out of order and a decision to fix them was made. On 4/Feb/93, the greasing machine was put on trial after being fixed.

Another instance where the Albatros seems to have followed this strategy is in the moving crane PIE; here, several ideas of how the fixture could be improved were given but an outside supplier was called in to give a solution.

These are examples where the work group first obtained information about the situation by Homophilous relations; but the situations required mechanical expertise that the work group did not have. The group then used its heterophilous relations to obtain the required results.

There are several instances, however, where the work group did not try first to obtain information from within the group. The reason appears to be that the group recognized from the beginning that they did not have the required expertise within the group and consequently decided to obtain information from what they consider to be more knowledgeable, while heterophilous, sources.

The evidence from the Geniecillos Brillantes group led us to the analysis of the following PIEs:

Ball-bearing Container Design and Greasing Machine Relocation. In these PIEs, the homophilous relations were used to obtain the design of the container and the location for the greasing machine; then, heterophilous relations were used to obtain additional material resources (materials and floor space, respectively), not information. In these PIE, homophilous relations were successful, so that there was no need to use heterophilous relations to obtain information.

Oiling Machine Improvement. Evidence to support the proposition is obtained in this case since first the group arrives at an agreement about problems with this machine (30/Mar/93); since the group does not have the required information to solve the problem, additional information is sought from heterophilous relations on 14/Apr/93.

Subassembly Container-Carts. This is a packaged piece of technology, where the group can only determine how many carts should be added. This was done using the comments of the group, which indicates the use of homophilous relations.

Forklift Operation Improvement . In this PIE, the group first used the homophilous relations between the members to perform an analysis of the problems found in the forklift operation (25/May/93, 8/Jun/93). Then, additional information is obtained from forklift drivers and warehouse responsibles, which are heterophilous to the group.

As explained earlier, the solutions to this problem were constructed along the way, more than designed once and for all. This implied the use of heterophilous relations not only for obtaining technical information, but also for obtaining support.

Nut -and-Bolt Drawer Identification. As explained earlier, there was no technological complication in this PIE; homophilous relations between the members of the group were used first and a solution to the problem was found. Thus, no need for heterophilous relations existed.

This proposition has interesting implications. As revealed in the 22/Mar/94 interview with the Geniecillos Brillantes group, they usually used their homophilous relations first and if these were unsuccesful, they tried to use heterophilous relations; however, these heterophilous relations were not always available. This clearly makes it difficult for the group to progress in their PIEs.

The evidence for the Geniecillos Brillantes group indicates that the proposition can be supported.

According to our informants in the SOL group, information is usually obtained from the most technically qualified person, which can be within the group or outside; often they obtain information from the literature and suppliers. He never mentioned workers as a source of technological bits.

In the analysis of the minutes of the SOL group, the above strategy is seen to be followed in the development of the Process Improvement Procedure, where the modifications to formats (9/Jun/92) and the explanations about the use of statistical tools (7/Jul/92) come from the members of the group.

Further evidence to support this proposition comes from the session codings; an example occurred on 22/Oct/93, where an interchange about corrective actions for unsafe situations involved a great deal of "asking", "contrasting" and "complementing" by the participants; later in the discussion the participation of the Industrial Engineering department, an heterophilous relation, was suggested.

The analysis of the evidence of the Impulsivos group does not clearly support this proposition. On one hand, our informants say that this group was created considering the participants expertise in the process, so that they imply that no one in the firm knows more about the process; this in turn leads them to believe that they do not need to obtain knowledge from other sources. However, one of our informants told us that the place to find technical information is the Manufacturing Services Department: "If they cannot provide the information, I am confident that the Impulsivos will help me solve the problem". This same point of view was expressed by another informant, who said that, depending on the type of information, suppliers or the industrial engineering department are called first and if the problem cannot be solved, then the group is summoned. When further inquiry into this point of view was made, our informants told us that the relations between people here are only work-oriented and that there were no "friends" here; their job is carried out with the help and helping fellow supervisors or subordinates.

Our interpretation of this is that homophilous relations in this group are not defined by affective ties but rather determined by the area where work is performed and the frequency of interaction with others, making the relations between the members of the group the homophilous ones. In this sense, the proposition does not hold since homophilous relations are used only when information cannot be obtained from heterophilous sources.

Our conclusion from the analysis of the evidence for the different groups is that the proposition cannot be supported as stated. A rephrasing of this proposition and its analysis is presented in the conclusions to this work.

p6. *When undergoing PIE, group members obtain information from sources that are not the same in essence or frequency as those sources used when the group is not under PIE.*

Evidence for this proposition comes from two reliable sources: first, meeting observation and coding (except for the Albatros groups) provide evidence about the homophilous relations within the group; and second, minutes provide information about relations of the group with other elements of the organization, among which, heterophilous relations are found. Thus the conclusions obtained from this analysis are strong on the side of the reliability of evidence.

In the Albatros group case, the sources of PIE are those groups which are technically better prepared; evidence for this is obtained on 14/May/93 or 11/Jun/93, where the help of departments such as maintenance is sought; in other occasions, technical information is obtained by the work group by performing a series of activities, as explained in the minutes of 19/Nov/93, 4/Feb/93 and 14/May/93.

In the Geniecillos Brillantes case, there is ample evidence about this proposition. For example, one of their most successful PIEs is the forklift PIE. In this PIE, information from the following sources, different from the usual, non-PIE sources, was obtained: forklift drivers (they were invited to discuss the issue with the group, and on several occasions they were asked an opinion); warehouse supervisor (their opinion was obtained about the issues in question); supervisors from other areas (A. Paz committed to watch the operation of forklifts and gave information about possible changes); and managers (information about oiling devices was obtained from G. Dominguez, manufacturing manager). Since the workgroup obtains most of the required routinary information from its supervisors, as obtained in the 22/Mar/94 interview, we can say that the proposition is supported in the Geniecillos Brillantes case.

In the case of the SOL group, our informant told us that information abut daily tasks is obtained from the their boss, the area manager, and the information about improvement efforts usually comes from the group meetings, from other departments within the firm or equipment suppliers, depending on the situation at hand, which further supports the proposition in question.

The evidence of the Impulsivos group also leads us to support this proposition. As explained in the analysis of the earlier propositions, the Impulsivos group obtains information from very different sources, which include suppliers, technical departments within the firm and sometimes workers (21/Oct/93). On the other hand, information about daily tasks is obtained from the

monthly production program supplied by the plant manager and from the direct supervisor. Since the evidence is clear, we can state that this proposition is supported for the Impulsivos group.

p7. *The behavioral criteria for considering a PIE complete do not depend on the type of PIE in question; the technical criteria for considering a PIE complete depend on the type of PIE in question.*

This is a proposition where evidence may not be as good as we would like, for the following reasons: first, "behavioral criteria" is a concept which cannot be obtained directly from the different sources of evidence, such as informants, meeting recordings or minutes; it must be obtained as an interpretation of the behavior of the group when confronted with the results of the PIE in question. Second, this criteria may change over time, for a number of reasons; for example, after successful performance the group may set higher standards for itself, thus modifying the criteria for completeness; it may also be the case that the group may modify its interpretation of the results of previous PIEs as part of its evolution, changing the interpretation of a result from good to modest or viseversa, in the light of new achievements.

By analysing the event sequence, it is found that in several occasions the Albatros group was satisfied when a promise of action about a proposed PIE was given by the responsibles. In other words, the reduction of uncertainty about support for the PIE is again a behavioral criteria for considering a PIE complete when the resource allocation decisions are beyond the group's authority.

The technical criteria for considering a PIE complete are related to the PIE in question as is evident in the moving crane PIE, where the technical criteria for completeness is arrived at when new material is found.

The analysis of the evidence from the Geniecillos Brillantes group comes next, divided by PIE.

Ball-bearing Container Design. The technical criteria for considering this PIE complete is the construction of the containers; an intermediate technical criteria, which defines when the group began searching for support, is the elaboration of the prototype container. As with other PIEs, these events signify when the group is going through a transition between one set of tactics and

another. In terms of behavioral criteria, the group seemed satisfied when a promise to allocate resources to this PIE was given; no further mention of this PIE is found in their minutes.

Greasing Machine Relocation. In this PIE, the technical criteria for completeness is satisfied when the machine is found to work properly in its new location; in this particular case, the technical and behavioral criteria coincide.

Oiling Machine Improvement. For this PIE, there is no event or statement in the minutes which we can consider a completeness criteria. Only events leading to "partial" completion are found when the group decides to ask for more information after a suggestion about what the problem may be is arrived at. It must be mentioned that the last mention to this PIE was on 13/Apr/93, which means that circumstances outside the will of the group ended the effort.

Subassembly Container-Carts. In this PIE the completeness criteria is the agreement arrived at with support groups about the acquisition of more carts; in this case, the group considers that their job is finished by now and gets involved in other efforts.

Forklift Operation Improvement . This is a mixed situation. While promises are given in some instances (15/Jun/93, 30/Jun/93), these are not considered satisfactory by the group, which makes additional demands on forklift performance on 22/Jun/93 and 30/Jun/93. Not having behaviors indicating satisfaction with results in this important PIE may indicate that after a success the group became more demanding.

This PIE involved the participation of several departments, which increased its complexity. Identifying criteria to determine the completion of the PIE may be difficult for the group, since success in one issue may be diluted with failure in other, so that clear cut criteria are difficult to find.

Nut -and-Bolt Drawer Identification. In this particular effort, the analysis of the minutes didn't yield anything that could be understood as a completion criteria. Even though this PIE is very simple, we didn't find evidence about the group considering this PIE complete in either behavioral or technical terms.

From the 22/Mar/94 interview with the Geniecillos Brillantes group we obtained enough evidence to state that the behavioral criteria for completeness had not been met. The group had a sense of failure, since many of their PIE had been abandoned by lack of support or their solutions

were so transformed that they did not resemble the original proposition. An example is the ball-bearing container, with which design the group felt satisfied, but the use given to these containers by people outside the group was not the intended one.

In the case of the SOL group, an intermediate technical criteria for completeness are the statistical tables and tools frequently used by the group; for instance, as reported on the first days of December 1992 in a Paretto diagram, the performance of the group had led to an improvement in the number of accidents. The Paretto diagram is an intermediate result for the group since it indicates the frequency of the sources of accidents on each period studied; from this intermediate result, decisions are taken in order to move the performance measures towards the goal. These statistics were used as a measure of success on 12/Jan/93, which led the group to set higher performance standards for the new year.

The behavioral criteria for completeness in this case are also clearly stated: under a continuous improvement culture, excellence is not achievable but rather a continuous move towards it is sought; in other words, the group does not expect to finish its intervention on any time soon and the behavior of the participants reflects this.

For this group, evidence is clear and sufficient to support our proposition; further inquiries did not seem necessary.

From the evidence of the Impulsivos group, we observe that the technical criteria for completeness are stated by our informants in several occasions. In one of the interviews, our informant told us that a specific improvement was considered complete because the cause of the problem was found; this indicates that the criteria for completeness for this problem was simply finding the cause. On another ocassion, training of the operator led to a reduction in defects, so that the improvement was considered finished (21/10/93).

The behavioral criteria for completeness in the Impulsivos group are clear as in the case of the SOL group: under a continuous improvement culture, a continuous move towards excellence is sought; in other words, the group does not expect to finish their scrap reduction efforts on any time soon and the behavior of the participants reflects this.

For this group, evidence is clear and sufficient, to support our proposition and further inquiries did not seem necessary.

p8. *As workgroups evolve, efficiency and effectiveness in technology difussion increase.*

As explained earlier, by efficiency we mean the amount of output obtained for a given resource input, and by effectiveness we mean the degree to which a PIE contributes to improvement of the whole manufacturing process, not just a local improvement. From the literature review, we expected that as groups evolved, they would concentrate more on tasks and less on group maintenance, information networks and norms for evaluation of information would be established, making the group more efficient.

The evidence used for the analysis of these propositions comes from two reliable sources: group meeting observation and coding, and minutes. We consider our conclusions to be reliable, since besides strong evidence, the concepts of evolution, effectiveness and efficiency can be clearly analyzed.

The evidence obtained from the minutes of the Albatros group is described next. From the event sequence depicted in the appendices, we can see that this group began developing its information network (which is associated with a "help" network) when they asked for an organizational chart. This helped them in understanding where they were located organizationally and defining the paths that led to easier access to information (19/Nov/92). The second step in the establishment of the information network occurred when the work group made contact with the manager of one area via a memorandum, which was delegated to another person, who finally became the contact with the work group in that area (24/Nov/92, 26/Nov/92). Another event that helps define the information network for the work group is the meeting with the "Excellence" group, which is a support group; the result of this meeting is a promise to help the Albatros group is several issues, one of which is obviously information (19/Jan/93). Later, the relation with this group was used when problems appeared, which indicates that this link was clearly established.

The events described above indicate that this work group successfully established an information network; in the analysis of proposition #10, it is also clear that the group established norms for the assessment of information. These two facts indicate that the group evolved in the terms defined for this work.

However, it is also clear from the event sequence that the work group had to spend some amount of effort in having their demands heard, which means that their efficiency is not at a maximum; their effectiveness level may not be increasing either, since the final PIEs in which the group was involved were not more complex or important than the first ones.

Evidence found for this particular PIE in the Geniecillos Brillantes group leads us to believe that the effectiveness increased as the group matured. The group got involved in several efforts that had some effect on productivity (for instance, relocation of the greasing machine saved money in grease); however, as time passed the group became more able in the use of the resources within its reach and thus decided to go for a more ambitious improvement effort, involving resources from several departments. The result of this effort is improvement in a wider range of departments than the previous PIE, leading to more effectiveness of the group.

The efficiency of the group does not seem to be in its maximum; as explained earlier, the group is investing a great deal of resources in promoting their efforts (for example, on 16/Jun/93 and 22/06/93), and not in devising better ways to improve the process. Thus efficiency may not be what it could be, even though the group has evolved.

It is interesting to note that this group's effectiveness was very low the last time we observed it (22/Mar/94), but this reduction of effectiveness was not due to causes attributable to the group, but to causes within the organizational environment. Some indications of this appeared earlier (16/Nov/93), when one of the participants stated that his suggestions were not taken seriously.

The evidence obtained for the SOL group indicates that the group has become more effective and efficient as it evolved: a decision to make statistics the way to communicate results was made on 7/May/92 and confirmed on 29/Sep/92. The statistical analysis are refined to include only the necessary information and it is displayed in a more efficient way. Other tools were also included (7/Jul/92). The effectiveness of the group is such that the group decides to meet every two weeks, instead of every week, thus reducing the time spent in meetings. (This meeting schedule was changed on 28/Aug/93, when the group began meeting every week again; the reason is an increase in the accident rate, due in part to the reallocations of personnel made as response the reduction in sales). The effectiveness of the group is also evident in the achievement of their goals.

In the case of the Impulsivos group, we found in the session codings that the group did exhibit a lack of efficiency in the use of the meeting time; as stated elsewhere, some participants arrived late to meetings, and some of the meeting time was used to comment about non-relevant issues. While these time could be considered as "group maintenance" since it reinforces ties between participants, it nevertheless consumes time that could be used for other productive activities. However, it should be mentioned that out of these session codings it can be concluded that when the discussion starts, it is of very high level and leading to complete exploring of issues.

The evidence about performance of the Impulsivos group indicates that this group has been very effective in the PIEs it has been involved in. However, it is difficult to relate the present effectiveness with the present state of evolution of the group.

The evidence presented leads us to believe that while it is true that work groups increase their effectiveness and efficiency levels, these levels reach a maximum and stabilize after some arrangements with other organizational entities have been made. It is true that norms about information are developed and that an information network is established, which means that the *group* has evolved; however, this does not lead to a better performance after a certain level has been achieved. In other words, work groups cannot dedicate their efforts completely to the task they are immersed in, but must spend some effort in constantly keeping track of organizational issues.

p9. *Effective workgroups have structural characteristics appropriate to their level of technological uncertainty; less effective units have a "mismatch" between technological uncertainty and structure.*

In this proposition, the main sources of evidence are interviews with participants and minutes. The later are analyzed in order to discover the "technical uncertainties" and the first are used to determine what the structure of the group is. In the interviews, we are interested in discovering what roles does the group participants play, and what assets does the group have. We feel that evidence in this case is secondary since the best evidence would have been obtained if we have had the chance to analyze the roles played by the participants since the beginning of the group and in different circumstances. Due to time limitations, only a snapshot of the roles can be obtained.

In the case of the Albatros group, some participants were added on 21/05/93. The reason for these additions may respond to the need of the group of some form of expertise which they did not have or because the new entrants considered this to be a good group to be with.

In order to determine if the Albatros group has the adequate structural characteristics for the level of uncertainty it faces, an analysis of the technological uncertainty for selected PIEs is done next.

Impact Wrenches and Pneumatic Hammers. These are a packaged form of technology; as such, there is little the group can do to reinvent or modify it. The technological uncertainty the

group faces in this case is in the operation and maintenance schedule of the wrenches or hammers. While the group can arrive at acceptable operation procedures by experimentation, this is not recommended due to the risk of product out of specifications and lost productivity. Thus, they must obtain the required information from sources which are external to the group.

Safety Fittings. The safety fittings are custom made pieces of equipment. Since their design must satisfy the users in terms of safety and comfort, it is the users who can define the best design. Thus, the group has the structure required to handle the technological uncertainty.

Racks for Parts and Subassemblies. These are also custom made pieces of equipment; their design depends on the operation the worker is performing and on the assembly he is working with. The purpose of these racks is to facilitate the location and transport of parts and subassemblies that the worker handles manually. Thus, the technological uncertainty is amenable by the structure the group has, since most of the workers in the group have enough expertise in the common operations performed.

Differential-Holder Height Caliber. This is another example of a packaged technology. This case may be non-reinventable even for the support groups in Eaton, since this is a precision instrument. The technological uncertainty in this case is how to operate the instrument. In this case, the group does not have an expert in this, and must ask for help from supervisors who have used a similar instrument.

In the case of the Geniecillos Brillantes group, the set of PIEs that were analyzed are listed below, along with the technological uncertainties associated with them.

Ball-bearing Container Design. These are also custom made pieces of equipment; their design depends on the operation the worker is performing and on the assembly he is working with. The purpose of these containers is to facilitate the location and transport of parts and subassemblies that the worker handles manually. Thus, the technological uncertainty in this case is "use", which is amenable by the structure the group has, since most of the workers in the group have enough expertise in the common operations performed.

Greasing Machine Relocation. The technological uncertainty in this case is "location", which the members of the group can handle properly since they have a knowledge of the operations and

movements the worker has to perform.

Oiling Machine Improvement. In this case, the technological uncertainty the group faces is about the design of the machine, information which is needed to determine under what conditions must the machine be moved. This uncertainty cannot be handled by the group alone and thus they had to ask for information from their supervisors or support groups (13/Apr/1993)

Subassembly Container-Carts. In this PIE, there was almost no technological uncertainty, since the carts were known to the group and all they had to do is to ask for more of them according to their needs. This is so because an important structural characteristic, tenure, was adequate to the improvement effort undertaken; had the tenures of the members of the group been shorter, maybe this PIE wouldn't have been so easy.

Forklift Operation Improvement. The main technological uncertainty here is the schedulling of the forklift route and the material replenishment to the production line; it is interesting to note that several algorithms exist for optmimizing these problems, but the firm decided to let the group firm find a heuristic (Daellenbach & George, 1978) solution to the problem, considerng the experience of the group. In this particular PIE, we may consider that the group has the required structure since they are capable of determining the best amount of material to stock and the schedulling of forklifts, and they also have the required relations with personnel in other areas to get things done. Evidence for this is seen in the several minutes where they contact Rocha, Paz, Morales and other people that may help them (8/Jun/1993, 16/Jun/1993, 30/Jun/1993/ 6/Jul/1993); this could not have been done if the structure of the group did not include roles dedicated to interact with other areas.

Nut -and-Bolt Drawer Identification. In this improvement effort, the technological uncertainty of the group is simply determining the best colors to identify the drawers; since the group has experience in the needs for identification and has a good dynamic in making decisions, as is evident in their decision to change the coordinator and secretary posts regularly (03/Aug/1993), there is no structural problem in deciding the best colors to identify drawers.

Evidence about the structure of the group leads us to believe that in terms of knowledge and interfacing, the group was doing very well when they called two persons from another area to participate; for example, in the 22/Mar/94 interview, they mention a co-worker as the most knowledgeable person about the process, which means that by some interfacing role this person is within reach. However, in later moments the group had lost several members and did not have

distinguishable roles for the participants. From this we can conclude that during the period where the group was highly effective, its structure was aligned with its technological uncertainty.

The main technological uncertainty the SOL group faced was determining how to reduce the frequency of accidents in the plant and how to improve on cleanliness and order. The reduction of the number of accidents seems to consume most of the time the group is in session, and the reason is that the reduction of accidents involves "hard" as well as "soft" knowhow: while unsafe conditions usually require an intervention on the equipment, whether it is a purchase, modification or enhancement, unsafe acts require a modification of attitudes and this is no simple task.

At that time, the structure of the group could be analyzed following several dimensions. One of these dimensions is tenure, in which the group had no problem since the participants had several years in the firm and some of them had more than ten. Thus, there was no shortage of expertise.

A second dimension of analysis is knowledge, and in this dimension the group did not have a problem either: the participants included the plant's safety engineer, the plant's physician, managers of different areas, the coordinator for work groups and the plant manager.

A third dimension of interest is leadership. In this dimension, the group had a strong leader in the plant manager, who was respected by the rest of the group. He could be considered a somewhat authoritative leader.

A fourth dimension of interest is participation. In this sense, as can be seen from the session codings, there was no problem either, since everybody felt free to participate.

Another dimension of interest is autonomy; the evidence found on this dimension refers to an October 1993 meeting, when the group made a self-appraisal to decide if the number of participants was adequate; this decision indicates a high degree of autonomy.

The uncertainties that the group faces were solved internally in the sessions we observed; for instance, in the case of the development of what we have called the Process Improvement Procedure, the main suggestions and the information about possible adaptations came from within the group (9/Jun/92). Also, when instruction about an improvement technique is needed, the group need not an outsider's help, as is the case of the "fishbone" diagram (7/Jul/92).

Our conclusion here is that the structure is aligned with the technological uncertainty that the group faces, which in turn and according to our proposition, leads to the effectiveness this group has shown.

The analysis of the evidence of the Impulsivos group indicates that the main technological uncertainties the group faces are related to foundry and forge processes, part design and manufacturing operations. The structure of the group is very well aligned with these technological uncertainties: in terms of tenure, for example, the participants have more than 10 years of experience in these processes, so that they know the processes and their evolution very well. In the expertise dimension, the group also has very good assets: for the particular purpose of scrap reduction, the most knowledgeable people are there and the variety is also adequate, since there are experts in metallurgy (J. Alvarez), in manufacturing procedures (Cedillo), etc. It is also important to note that several informants considered that the group was not meant to be a social club but a work group, so that a common understanding among the members is that the sessions' objective is to work as a team. Another dimension of interest is that of power, where some of the participants have the power to obtain any information about the company that is needed. And finally, all members of the group participate freely, an indication of a flat structure within the group. Furthermore, in one of the session a "policeman" was said to exist, meaning that this person is in charge of following the evolution of projects.

Since this has been a very effective group, we consider that the proposition can be supported with the evidence found.

From the analysis presented, we conclude that the alignment of the structure of the work group with the technological uncertainty is a necessary but not sufficient condition for successful performance: there are examples where the structure is aligned with the technological uncertainty faced by the group but results were hard to obtain.

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From the analysis presented, we conclude that the alignment of the structure of the work group with the technological uncertainty is a necessary but not sufficient condition for successful performance: there are examples where the structure is aligned with the technological uncertainty faced by the group but results were hard to obtain.

p10. *Workgroups create norms to determine what information, from what source, under what circumstances is adequate.*

In order to determine if the work groups in Eaton had developed norms about information, we analyzed the minutes of each date, across the several PIEs included in each. This way we could see if a pattern was forming from minute to minute. Further, interviews with participants were used as a source of confirmatory evidence. While for this proposition evidence from minutes is not clear and inteviews may be biased, we feel that both sources of evidence complement each other so that we have a well supported argumentation about the proposition.

In the case of the Albatros group, the first indication that norms were developing is the statement that "research about [safety] devices must be done with those responsible [area supervisors]"; A second fact is the announcement of a talk about impact tools, indicating that suppliers are an acceptable source of technical information; on a later date, the group decides to "expand", as detailed in the analysis of proposition 8, by asking for an organizational chart and by proposing to send memoranda to those responsible. This indicates the existence of a norm that allows access to superiors who can be helpful.

Later, action is evidenced by sending the memoranda proposed and obtaining results. The action stage is important, as described in the literature review, since it reinforces the existing norms; in this moment, the group had incipient norms about how to access information (along with other forms of support, as evidenced in the minutes) and the action stage proved to be a significant event in this respect.

Since support was not obtained in the conditions desired by the work group, a meeting with a representative of the "Excellence" group was demanded. The representative offered to give support, which reduced the uncertainty of the group in terms of the support they could expect from the other groups.

A memorandum was sent to the "Excellence" group, in which the lack of support for several PIEs was surfaced; it is interesting to note that while the group had been working on a few PIEs, in this memorandum several more were added. We interpret this fact as some form of "shootgun" approach: the group considers that this may be a rare chance to be heard and thus sends all the possible demands, with the hope that at least some will be heard. If this is the case, a norm about information may be evident: the group does not still trust their superiors and thus these "tricks" are a rational way to get things done.

Again the dynamics of the situation take us to the action stage, and it is evident from the event sequence that more attention is paid to the group after this memorandum. Thus, the strategy of sending demands to the "Excellence" group, and maybe more demands than the group considers important, seems to be reinforced.

In later stages of the evolution of norms (30/Apr/1993, 7/May/1993, 5/Jun/1993), the group is seen to have developed the following norm: if information can be obtained by the group in their daily tasks, it will be obtained this way; however, if information is seen as beyond the capabilities of the group, the help of superiors will be sought. That the "Excellence" group is still a source of support is evident in a minute where the results of a meeting with that group are commented.

In the case of the Geniecillos Brillantes group, evidence is not as clear as in the case of the Albatros group, but can serve as additional partial, corroborative evidence. What we found in the Geniecillos Brillantes group is that depending of the PIE in question, the group established communication with someone with sufficient information and relative decision power in the organization; for instance, in the case of the first PIEs, container modification and greasing machine relocation, the group had communication with G. Dominguez, manufacturing manager.

For the forklift schedule improvement effort, the group established and used communication channels with J. Rocha, production manager (8/Jun/93, 16/Jun/93), F. Morales, warehouse responsible (15/Jun/93, 30/Jun/93), and O. Garcia, in quality control (8/Jun/93, 15/Jun/93, 22/Jun/93). These people were committed in several instances to devoting time to observe anomalies and report suggestions to the group.

This pattern of communication between the group and the organizations leads us to believe that the group has developed the norm of establishing communication with people with decision making power in the organization in order to increase their effectiveness.

The analysis of the evidence of the SOL group provides evidence to support this proposition. For example, on 9/May/92, the SOL group decided to include in all its minutes the following phrase: "In this meeting, your opinion is most important; please don't keep it to yourself". This indicates the establishment of a norm about the sources of information within the group; this norm makes it clear that no matter what the status of the person is within the organization, it has important information.

The use of statistical information is also evidence of the development of norms within the group; the corresponding norm about information is that information that can be arranged in the form of statistics leads to a standard format for analysis and is valuable to make decisions. However, from our point of view, these norms were not very well established, since on several occasions (10/Nov/92, 8/Dic/92, 2/Mar/93, 30/Mar/93) internal audit reports were not delivered on time and reminders were sent to supervisors. We can conclude that even though a technique for the analysis of information is approved and adapted to the situation by the group, the required norms of behavior were not fully developed and internalized by the members until nine months later, when the last mention to missing audit reports is found (30/Mar/93).

The analysis of the evidence for the Impulsivos group indicates that for this group the proposition holds. First, the norm of obtaining information from the most knowledgeable source was expressed by our informants, leading us to conclude that this group is free from the "not-invented-here" syndrome. Second, our informants expressed that the way to attack a problem is to define the problem, then propose alternatives in group sessions, select one and assign responsibilities; we interpret this as a norm for problem solving that the group has.

Considering the quality of the evidence supplied, we consider that this proposition holds for the groups studied.

6. CONCLUSIONS and QUESTIONS for FURTHER RESEARCH

In this section, the conclusions from a cross case analysis are presented. These general conclusions are obtained from the analysis of the particular conclusions obtained for the different propositions and from observation.

Questions which we feel merit further research are developed and included in this section, sometimes as part of the conclusions.

6.1 About the Methodology Used. The use of a case-study approach for this research allowed us to modify, and consequently learn about, the concepts involved in our propositions. It is interesting to note that the research activities followed a path far from linear, as the following account describes:

Literature review. The literature review was the initial step in this work, but also occurred several times during the empirical activities to corroborate with other authors, and during the conclusion development stage. In our view, the case study research flexibility allows us to include relevant literature as new avenues of inquiry are developed in the course of the research.

Formulation of hypotheses: The formulation of hypotheses (propositions) resulted in a series of statements, flexible enough to accomodate concepts that were not clearly defined from the beginning. This was the case of proposition #4, for example, where the concept "reinvention" was not directly used by our informants but whose meaning was derived from the analysis of their interviews.

Information gathering, first case study : In the first case study, our approach was to use an open questionnaire for a series of groups. It must be remembered that groups in this situation do not have a formal place in the organization, so what we made was to explore the use of concepts and the relationships within the people. As a second step, we interviewed some workers with the questionnaire to be used during the whole research. In this particular case, observational information was very valuable.

Session observation, second case: The strategy followed in the second case was different. Sessions were observed and codified for several groups. These results were in some cases not included because the groups were not directly related to technology diffusion, such as in the case of the "Protección Personal" group; this gave us a feeling of the arena where discussion

took place.

Interviews, second case: Some participants in the groups observed were interviewed, according to their disposition to give information.

Discovery of additional sources of Information : This proved to be one of the lucky strikes in this reseach. Abundant evidence, in the form of session minutes, was found in the archives of the firm. This information proved very valuable, since it gave a time structure to our research; furthermore, it allowed us to analyze events about which people had already forgotten, such as the very early PIEs. This discovery also had the effect of modifying our research strategy.

Analysis of memoranda information: As a result of the discovery of the archival information, the interviewing activities were interrupted and we proceeded to analyze the documents. We tried to obtain the maximum amount of evidence to analyze the propositions. In some cases, this source provided enough evidence to support propositions.

Additional information gathering in sessions and memoranda: Once the documentary information was analyzed, we proceeded to obtain information for those issues not clearly supported and for those issues where no information was found; for instance, the structure of the groups could not be derived from the analysis of the documents.

Refinement of propositions and development of models and preliminary results: Almost simultaneously to the analysis of documents, we derived some preliminary conclusions. One of the models developed during this stage is the activity model presented in figure 13. This helped us as guiding tools for further inquiry. These tentative conclusions required additional information which was obtained through interviews and additional analysis of evidence.

Additional literature review: The models presented required additional literature reviews.

Development of questionnaires, second case: As a result of the analysis of evidence performed until now, additional evidence was required, and additional questionnaires developed, such as the one for the Geniecillos Brillantes group, presented in Appendix I.

Additional inteviews, second case: Additional interviews were made to obtain the required evidence.

Analysis of evidence and development of conclusions: As a final stage, the whole body of evidence was analyzed and conclusions derived. At this time, more evidence could be obtained and other results tested, but this was not the purpose of this research, developing instead questions for further research.

This non-linearity is now an accepted path in some areas of research in management. While some studies do follow a linear development, many are reported in this linear fashion even though a series of rearrangements, additions and other departures from linearity took place (Golden-Biddle & Locke, 1993). As stated by Checkland when speaking about intervention in organizations:

> [W]hen the phenomena under study are social interactions the researcher will find it almost impossible to stay outside them. If he accepts wholeheartedly that he cannot remain aloof [...] then he may express his research aims as hopes but cannot with certainty design them into his experiments. He has to be prepared to react to whatever happens in the research situation (Checkland, 1981: 153).

As described above, the use of a case study approach to research allowed us to modify the path of research in the light of unanticipated sources of evidence. Initially we thought that our major source of evidence would be interviews, but in Eaton we found a great deal of information in the form of memoranda and minutes. This led us to consider the flexibility of the sources of evidence, so that the scheme presented in figure 4 for the research method is presented in figure 12 with the corresponding enhancements.

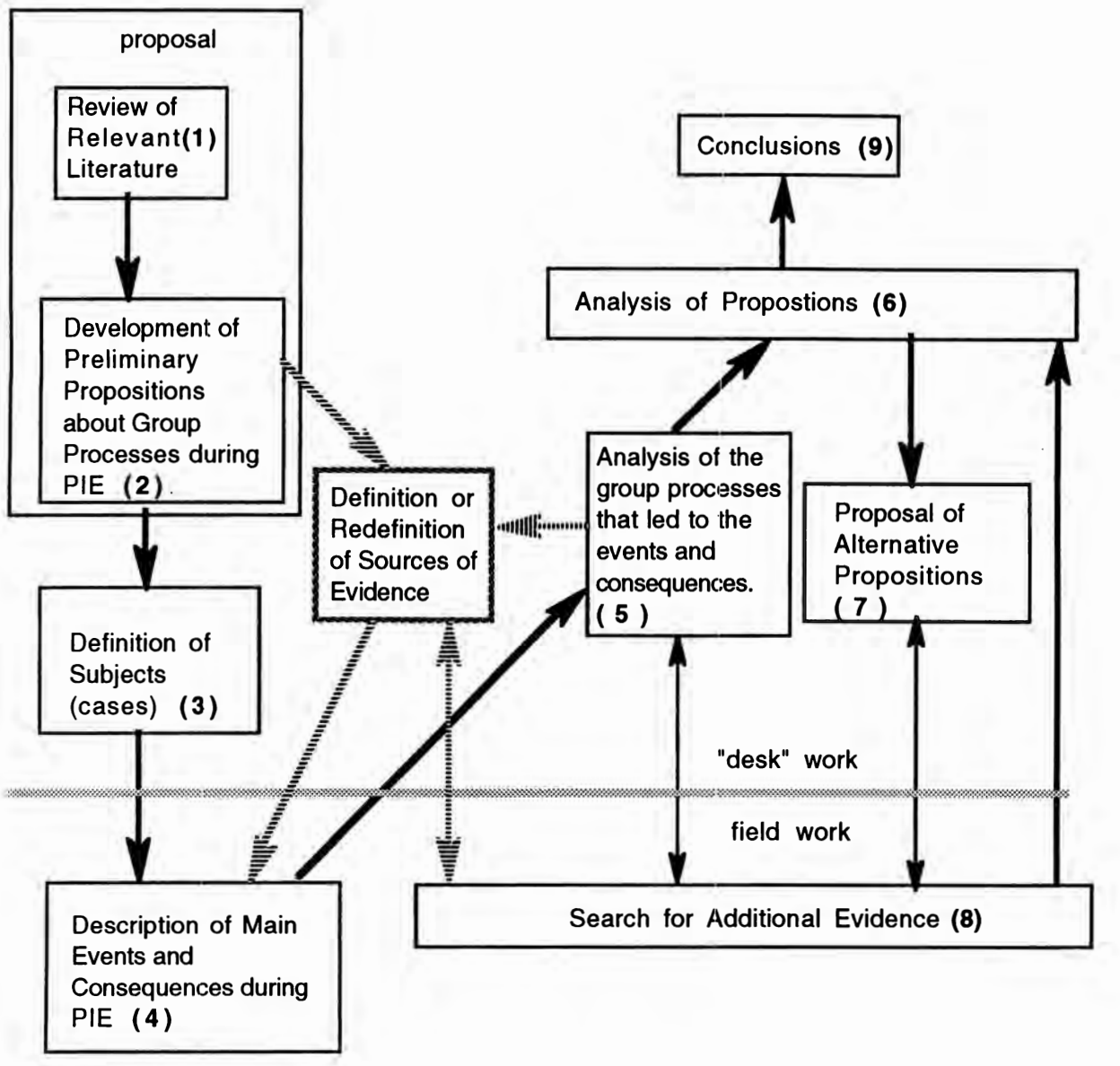


Figure 12 : Enhanced Research Method

6.2 Conclusions About the Propositions Themselves. The conclusions for each particular proposition and the importance of the sources of evidence are presented in table 5 (Sutton & Callahan, 1987); the details of the evidence can be found in the case descriptions given in chapters 4 and 5.

Table 5

Conclusions about Technology Diffusion by Work Groups in PIE

firm	CNH			EATON			
group	MGMT	SUP	WU	IMPUL	SOL	GB	ALBAT
p1	s/i,o	s/I,O*	s/I,O	S/I	s/i	S/M,I,C	S/M
p2	s/i,o	S/I	S/I	S/M	S/M	S/M,C	S/M
p3	N/o	N/I	N/I	N/I,M	N/I,M	N/c,M	N/m
p4	N/o	N/i	N/I	S/I,M	S/I,M	S/M	s/M
p5	N/i	S/I	S/I	s/c,m	s/c,m	s/c,m	s/m
p6	S/I	S/I	S/I	S/I,C	S/I	S/I	s/m
p7	s/o	s/I	s/I	S/M	S/M	s/m	s/m
p8	s/o	S/I,O	S/I,O	S/I,M	S/I,M	S/I,M	S/M
p9	s/o	S/I,O	S/I,O	S/I,M	S/I,M	S/I,M	S/M
p10	S/I,O	S/I	S/I	S/C,M	S/M	S/M	S/M

* In this table there are several instances of weak support for a proposition with strong evidence; this usually happens when there is strong evidence in favor and strong evidence against the proposition at the same time.

Table 5 (continued)
Conclusions about Technology Diffusion by Work Groups in PIE

Legend:

S	Proposition Supported
s	Proposition Supported to Some Extent
N	Proposition Not-supported
O	Strong Evidence from Observation
o	Modest Evidence from Observation
M	Strong Evidence from Minutes
m	Modest Evidence from Minutes
I	Strong Evidence from Interviews
i	Modest Evidence from Interviews
C	Strong Evidence from Session Codings
c	Modest Evidence from Session Codings
MGMT	Managerial Group in CNH
SUP	Supervisory Group in CNH
WU	Work Units in CNH
IMPUL	Impulsivos Group in Eaton
SOL	Safety, Order and Cleanliness Group in Eaton
GB	Geniecillos Brillantes Group in Eaton
ALBAT	Albatros Group in Eaton

p1. The perception of a group's performance by other groups affects the work of the first group as change agent.

p2. The expectations of the group depend on past performance in PIEs.

p3. When an imported technology differs from the group's previous technology under use, the group will resist this technology or will try to adapt it so that it resembles its previously used technology.

p4. During reinvention, groups may have considerable discretion in technology difussion; this may not be the case in "packaged" PIE, where the group must conform to specifications and cannot use its network freely.

p5. When searching for technical information about tasks, groups will use first their homophilous relations, and if these are unsuccesfull, they will use heterophilous relations.

p6. When undergoing PIE, group members obtain information from sources that are not the same in essence or frequency as those sources used when the group is not under PIE.

p7. The behavioral criteria for considering a PIE complete do not depend on the type of PIE in question; the technical criteria for considering a PIE complete depend on the type of PIE in question.

p8. As workgroups evolve, efficiency and effectiveness in technology difussion increase.

p9. Effective workgroups have structural characteristics appropriate to their level of technological uncertainty; less effective units have a "mismatch" between technological uncertainty and structure.

p10. Workgroups create norms to determine what information, from what source, under what circumstances is adequate.

6.3 Knowledge Kinds. Another result that could be obtained thanks to the case-study method is that the technology a group uses involves several kinds of knowledge (Hackman, 1987). In all groups and firms studied, there were several forms of knowledge used in the different PIEs; for instance, in the Albatros group it was found that while the group had relatively low *technical* knowledge about the equipment they had relatively high *use* knowledge, and this later kind of knowledge determined the moment when the technology was ready for diffusion (Levi & Mainstone, 1987). The kinds of knowledge found during our inquiry, and the persons in which they reside are the following:

Technical : this kind of knowledge is related to engineering principles, technical data and design information. It is usually handled by engineers or non-engineers with considerable expertise in the area. One characteristic of this kind of knowledge is that it is incomprehensible for those people that lack the necessary training; this kind of knowldge may become a source of power in the organization, since those who cannot access it are in disadvantage when proposing improvements.

Use: this kind of knowledge refers to the collection of details and operating procedures required to get the process going. This kind of knowledge is obtained through the repeated operation of the process, so that people that have been involved with the process for a long time have more of this knowledge than the newcomers; on the other hand, this kind of knowledge seems easy to obtain, so that it is not very highly valued. This kind of knowledge usually resides in workers and supervisors.

Layout: this kind of knowledge refers to the location of machines and auxiliary tools on the shopfloor, and the problems associated with the different possible layouts and the material movement. A good layout leads to reduced inventories and transportation times. This kind of knowledge is usually obtained through the repeated operation of the process, so that people that have been involved with the process for a long time have more of this knowledge than the newcomers; however, this kind of knowledge can also be obtained through the solution to optimization models, which are the domain of engineers. In the first case, this kind of knowledge seems easy to obtain, so that it is not very highly valued. This kind of knowledge usually resides in workers and supervisors.

Workspace & Containers: this kind of knowledge is related to the location of tools and parts for assembly around the worker, and the size of the inventories required. This kind of knowledge can lead to the reduction of operations and movements that do not add value, or that lead to excessive inventories. This kind of knowledge is the typical domain of industrial engineers, but

some details cannot be forecast and this is where the experience of the workers comes in. This kind of knowledge resides in workers.

Identification: this kind of knowledge refers to the identification codes used by workers to classify tools or subassemblies. Since several of the products share some parts but not others, it is important that containers of subassemblies or parts for each product be correctly identified; otherwise, defective parts will result. This kind of knowldge resides in workers, who are the ones *who* know how many different products they are working with, and what are the most usual mistakes in assembly.

Analytical Tools: this kind of knowledge refers to the statistical or graphical tools available to diagnose a problem. These include Ishikawa and Pareto diagrams, histograms, control charts, etc. Some of these have some arithmetical complexities which would make their use difficult for workers, but others can be readily usable by them. This is a form of soft technology.

Organizational: this kind of knowledge is not directly related to technology, but it was found that it is an important form of knowledge for work groups that want to be successful. This kind of knowledge involves sources of information, persons with resource control, power relations, etc.

Some of these forms of knowledge seem to have a higher value in the firms studied. For example, "location" and "containers" do not seem to be very valuable when compared to "technical", since the PIEs that involve the first two kinds of knowledge are usually not given immediate attention. However, it could also be the case that support groups allocate more resources to those PIEs which they feel are under their responsibility, and this responsibility is coincidentally related to the kind of knowledge they manage; in other words, support groups have the power to assign resources to the kinds of knowledge they hold and restrict resources to the PIEs that work groups manage, which involve other kinds of knowledge. This became evident when one of our informants said that they recognize that they are not as knowledgable as the supervisors ("OK, we are stupid, but...") but they expected that the supervisors to help the group achieve its goals. We do not have enough evidence to clarify this issue nor to say that this is an intentional tactic, so we leave it as a question for further research.

These results can be related to organizational memory, which is where knowledge is stored in the orgnization; while this is the same function for any kind of memory, the difference is that organizational knowledge can reside in people, in organizational objects, like procedures and

charts, and in organizational cultures and myths: "Members come and go, and leadership changes, but organizations´ memories preserve certain behaviors, mental maps, norms and values over time" (Hedberg, 1981).

A further elaboration of the organizational memory concept is given by Stein (1991), who argues that organizational memory can be justified as a subject of study because (1) it is a metaphor useful in addressing organizationa theory issues, and (2) it is relevant to management practice. The author relates organziational memory to the dialectics of "learning verses unleraning; flexibility verses stability; storage verses retrieval; human resources verses information technologies; structure verses process; theory verses practice". In other words, organizational memory is a necessary component when trying to understand the dynamic issues of learning: learning usually results in a modified memory.

This learning and unlearning are important issues when an organization wants to improve its manufacturing processes by modifying its technology since in some ocassions the obstacle to improvement may be the organization's inability to unlearn.The organizational memory issues are set into the context of organizational learning by Huber (1991).

6.4 Existing Gap Between Supervisory and Work Units. The evidence in all cases indicates that a gap exists between supervisory/managerial units and worker units: this gap is due to differences in the type of knowledge managed and in power to allocate resources. While the existence of the gap is expected in most organizations, the way this gap is managed is detrimental for the operation of the firms: those in managerial/supervisory positions tend to act more as obstacles than as facilitators of the diffusion process, and this in turn leads to workers being unable to improve their performance.

Even in the no-group situation of CNH, management's role was not the best in order to promote process improvements, since the supervisory's group alliances tended to oscillate between the managerial and worker groups.

Furthermore, when comparing results of these support groups with the Albatros and Geniecillos Brillantes groups, we find that one of the criteria for determining whether a group is considered a change agent (being capable of obtaining resources) is not applicable here, since the participants in the SOL and Impulsivos groups have the control over resources: it is not a measure of their success as change agents the capacity to assign resources that are already under their control.

Our conclusion about this issue is that the relation between management/supervisory groups and worker is not in line with Total Quality prescriptions (Luthans & Thompson, 1987; Pacheco, 1994). We do not have enough evidence to say that this is an intentional or even pervasive behavior, but we feel that this issue deserves further exploration, since the ones capable of changing this situation are the managerial/supervisory groups and they may not be aware of it.

6.5 Concept of Process Improvement. The concept of process improvement is not clearly understood in CNH and somewhat unclear in other firms. This concept has a very clear definition in the literature reviewed: productivity increase by reduction of common causes more than reduction of special causes; special causes are related to identifiable events, such as machinery failure, new operators, power failures, etc. Common causes are characteristics that the manufacturing process has: for instance, bad design of containers, bad location of equipment etc (Levi & Mainstone, 1987).

It is interesting to note that in CNH, the concept and activities related to process improvement are clearly *special* causes, as can be obtained from interviews with the "Milling" unit; on the other extreme, groups such as SOL and Impulsivos have a concept of process improvement more aligned with the usual definition; work groups such as Albatros and Geniecillos Brillantes have a concept of process improvement that sometimes focuses on special causes and sometimes on common causes.

6.6 Concept of Technology. The concept of technology held by most people interviewed is that of "machinery". This, however does not preclude the analysis of technological issues from the broader perspective given by the definition used in this work. This was very useful in analysing minutes, since the broader definition of technology allowed us to identify several issues related to technology that were not considered as such by the informants.

As work groups evolve, they begin recognizing the importance of the soft part of technology. In the no-group situation, the hard part of technology is seen as external and the soft part is not seen; as work groups evolve, they understand that technology is the combination of machines, the hard part, with a soft part, often called know-how and which resides in people; thus the concept of technology is enriched, becoming a place where man and machines can coexist. This was evident in the use of analytic tools by the most advanced groups, such as Impulsivos.

We consider that it is very important for groups to understand that technology has a soft part, so that they can focus on problems in this area. In the present state of things, this soft part is seen as intuitive or easy, any of which conceptions precludes its serious analysis. The success in technology management resides in optimizing the relation between the soft and the hard parts in a given context, not in yielding to the hard part.

6.7 Modified Definition for a "Process Improvement Effort". According to Larroyo (1973), concepts in science are evolving entities, whose meaning is usually refined as more evidence is obtained. One of the interesting results from the analysis of the cases in this research is that the concept of PIE had to be extended. Particular sequences of events, such as the one obtained from the files of the Albatros and Geniecillos Brillantes groups, led us to recognize that our original definition of PIE was limited, since a great deal of the group's energy is spent in pushing their proposals through the company, asking for support and waiting for an answer; the modified definition for a "Process Improvement Effort", which was used in the analysis of propositions, is as follows:

> *A Process Improvement Effort (PIE) is a series of nonroutine activities that an individual or workgroup identifies as unitary, and undertakes in order to improve the performance of a task which is part of a manufacturing process. A PIE also includes those activities that are not technical but that are necessary to have the proposed improvement accepted and implemented within the organization.*

where "unitary" means that the activities included in a particular PIE are those considered necessary and sufficient to undertake it (Dutton & Ashford, 1993). This result is in line with the concept of "seducing the elites" proposed by Kelley (1976) when dealing with Research & Development projects. While the specifics of the projects are different in Research & Development and in Process Improvement Efforts, it seems that considerable effort must be invested in having a new idea accepted and implemented.

6.8 Activities in Process Improvement. We propose two activities model presented in figures 13 and 14 for Process Improvement Efforts. It is worth noticing that not all of the activities that are performed are value adding activities, thus lowering the efficiency of the workgroup.

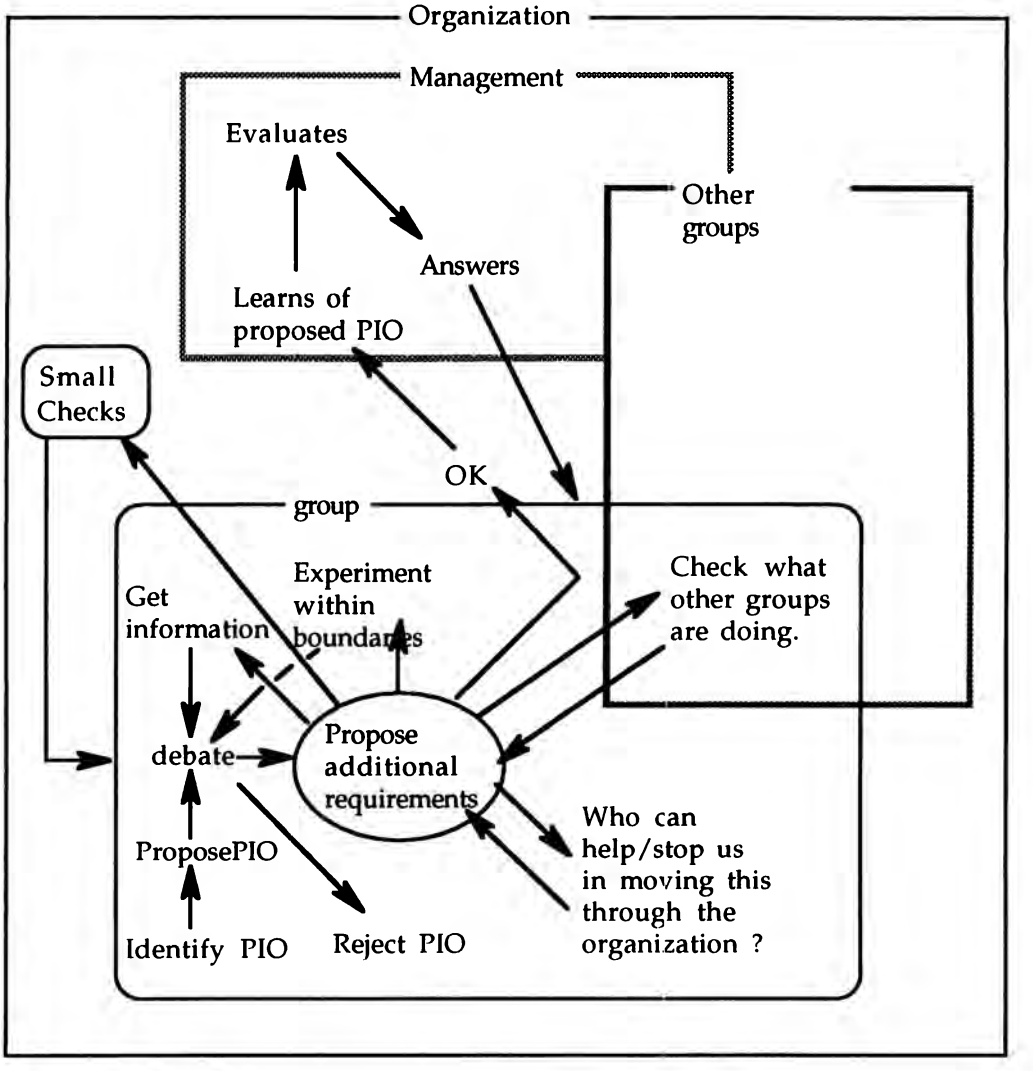


Figure 13: A Model of Diffusion of Ideas by Work Groups

The additional resources assigned to groups may not be the result of successful performance, but from an intense selling activity. Since these activities are part of PIE under the modified definition, we can consider that success in PIE may be in the technical activities or in the selling activities. This may lead to inefficient assignment of resources, since a group may develop

expertise in selling improvement ideas and not in improving the process; in other words, we may get unwanted learning by the group and a shift in their expectations, as explained below. The final result is that the group becomes inefficient, since resources are allocated to activities that do not add value.

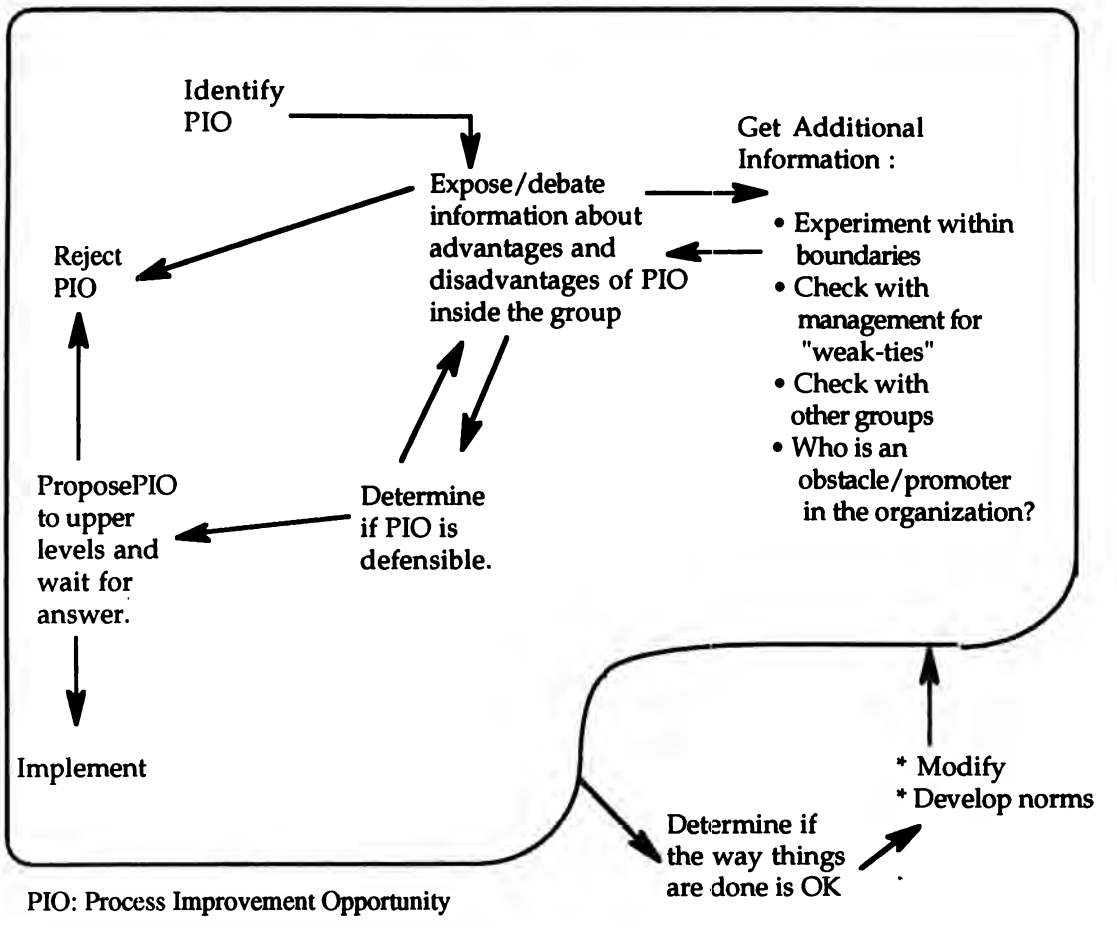


Figure 14: An Activities Model of Diffusion of Ideas by Work Groups

6.9 About boundaries. The definition of *boundaries* between PIEs may be an important issue to consider. Since a workgroup may be involved in several PIEs at the same time, they may have difficulty determining when one PIE ends and another begins. Further, since the new definition of PIE includes organizational selling of issues to management, this may be a common activity to all PIEs the group is involved in, helping to blur the difference between them.

The events that we identify as completeness criteria or partial completeness criteria, whether behavioral or technical, may help defining the boundaries between PIEs. We conclude that the behavioral criteria for considering a PIE complete are related to the degree of control the group has on the new technology. Another way to look at this is to say that the behavioral criterion for considering a PIE complete is when knowledge about how to control the underlying technology is enough as to say that the PIE is no longer innovative, but rather routine.

An interesting issue related to this conclusion is that worker groups may need concrete objective milestones, in contrast with supervisory or managerial groups, which can handle unachievable goals, such as "excellence" and "continuous improvement". This is also related to the type of knowledge involved in the PIE, as explained elsewhere.

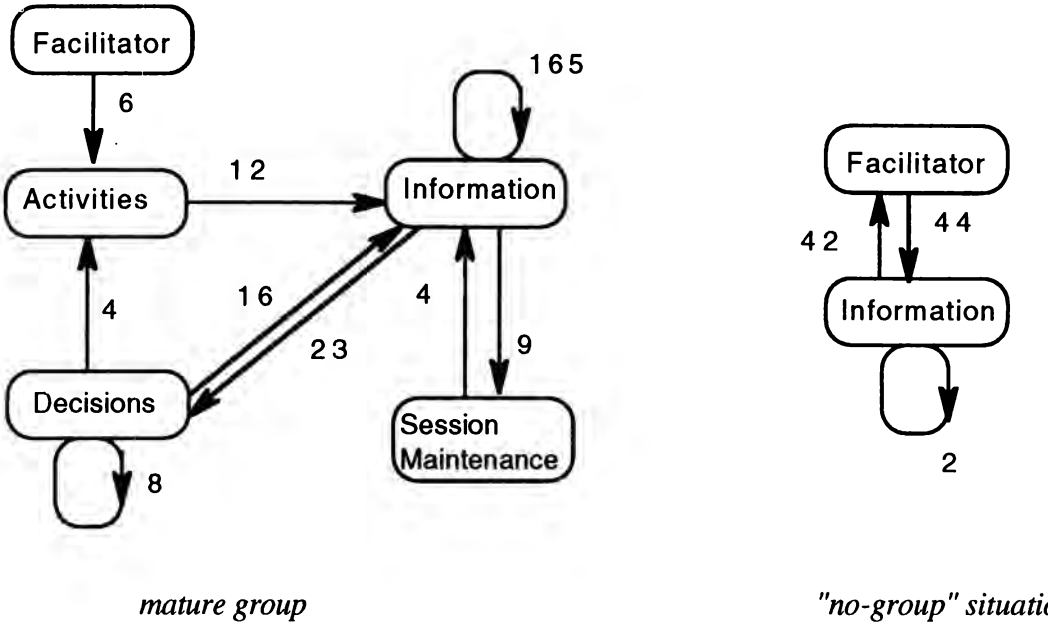
There may be several technical criteria to assess the progress of a PIE. These partial criteria are milestones where the group must change their tactics in order to achieve success; for instance, after a design is completed, the tactics are no longer "design", but "resource acquisition", and when acquisition of resources is complete, the tactics can be labeled "realization".

A sequence of events that was found to occur in the groups studied is the following:

i) A proposal for improvement is communicated to a support group.
ii) A promise to analyze proposal is made by the support group.
iii) The proposal is analyzed and an answer is given.
iv) A promise to allocate resources is given .
v) Resources are allocated.
vi) The improvement is delivered.

when event (iv) occurred, the group was usually satisfied since uncertainty about the result of the PIE was reduced in the part they cannot control; that is, resource allocation. The groups usually felt that their part was done since the delivered that part of the PIE which they could control.

6.10 Meeting Dynamics. There are several state-transition structures of how the groups go about integrating information during meetings. Two such structures are presented in figure 15, for a relatively mature group and for a "no-group" situation; the numbers appearing on each arrow indicate the frequency with which each transition takes place. This structures correspond to the Impulsivos group meeting of 28/10/93 and to the Packaging group meeting of 15/06/1993. The concepts marked in the nodes correspond to the general categories described in the coding form (Appendix V).



mature group *"no-group" situation*

Figure 15: Transition Structures of Two Meetings

The importance of this model is that depending on how mature a group we are handling, we will know which are the transitions we must take care of, whether to avoid or to promote them. For instance, it is clear that for the more mature groups the interventions by the facilitator are relatively few, while for no-group situations the intervention of the facilitator is very frequent; also, it is seen that mature groups spend most of their interactions in the "information" or "decision" blocks, while in the no-group situation the interactions are usually of the "question-answer" type.

This kind of structure comparison lends itself well for some form of network analysis, but the purpose of this work was not to study them. As further research, we think it would be important to study the relation between the maturity of the group and the kind of structure it

presents during meetings. This kind of research has been done extensively (Auster, 1990; Bales, 1978, Hartman & Johnson, 1990), but we feel that for the particular case of technology diffusion, some contributions can still be made.

6.11 Technological Uncertainty. One result of technology diffusion into work groups is an increase in the technological uncertainty for that group. This may seem paradoxical, but the fact is that as the work group evolves, it is expected from the group to have better knowledge about the manufacturing process, and thus has more responsibility about its performance; that is, the group is expected to handle more types of knowledge (Adler, 1989). When the work group or unit, as was the case in CNH, is not expected to have significant knowledge about the process, their technological uncertainty is very low, since they need only know how to perform a series of predetermined tasks; in other words, if work groups or units are not expected to think but only to obey, the technological uncertainty burden is on the shoulders of he who gives the orders.

Thus, simultaneously to a diffusion of technology, there is a diffusion of uncertainty.

6.12 About Proposition #3. There was no evidence found to support Proposition 3, which read as follows:

> *When an imported technology differs from the group's previous technology under use, the group will resist this technology or will try to adapt it so that it resembles its previously used technology.*

Even in non-group situations, like Compañía Nacional de Harinas, where new technology was creating a great deal of trouble, the new technology was accepted.

Our reasoning for this is as follows. First, according to the model above, groups detect process improvement opportunities and perform a series of activities to implement these opportunities; that is, the diffusion of technology is more a result of a work group "pull" than an organizational "push". As a consequence, it is not likely that the work group will resist diffusion of such technology. This may be so because groups perceive a wider gap between "hard" and "soft" technologies than between different vintages of "hard" technology.

Second, the technologies that the groups identified as having arrived into the organizations

studied were hard, packaged technologies that do not allow for significant modification. However, soft technologies, such as statistical tools, arrived but were not used extensively.

A significant proportion of the work groups studied do not seem to use special techniques to make their work more effective or efficient. For instance, quality control tools, such as Ishikawa (fishbone) or Paretto diagrams, or group norms, such as termination rules during sessions, were expected but not frequently found (Redmon & Dickinson, 1987; Steel & Lloyd, 1988; Levi & Mainstone, 1987). We found that these are used by supervisory groups but not by worker groups, which may help confirm our proposition of the "ownership" of the different kinds of knowledge by different entities in the firms studied. It may be the case that the groups may not have an ability to modify their work procedures or there could exist a cultural inhibition to modify; however, we feel these issues are open for further research, since we do not have enough detail of the vlaues involved in adopting a "soft" technological innovation.

6.13 About Proposition #5. Proposition #5 asserts that homophilous relations are preferred to heterophilous relations. This proposition reads as follows:

> **p5:***When searching for technical information about tasks, groups will use first their homophilous relations, and if these are unsuccesfull, they will use heterophilous relations.*

However, the evidence in support for this proposition obtained from interviews and other sources is not clear. When this proposition was analyzed using the evidence of interviews, only in some occasions did the work groups behave this way; even more, there didn't seem to exist an intention to behave this way, since the few occasions where this occurred, it was because someone in the group already had a hint on what the problem was.

However, an analysis of the archival information indicates that information is usually obtained first from heterophilous relations when the information sought are *technical data.* When other forms of information were needed, such as tactics to tackle a problem, the homophilous relations were used first. The apparent contradiction seems to stem from the concept of technology and information held by most of the people inteviewed.

The counterproposition, which we could state as:

p5a: *When searching for technical information about tasks, groups are likely to obtain it from knowledgeable sources, rather than from homophilous relations.*

was found to be intentionally followed by groups in many situations when the information sought was *technical knowledge.* When asked why, the informants found the question strange, since they found logical to obtain missing information from knowledgeable sources, rather than from colleagues, who couldn't provide any additional information beyond what the group already knew.

This conclusion is in line with the "strength of weak ties" theory of Granovetter (1973), where relevant information is obtained from sources which are not in frequent contact with us. This result may seem paradoxical, but it must be noted that the use of paradoxical results is recommended (Poole & Van de Ven, 1989) as a way to gain insights into weaknesses or gaps in theories.

Having this in mind, we hypothetized that communication took place in the way stated in the original form of the proposition only where the work group perceived their heterophilous counterparts as too distant, or when the group felt that arriving to a solution was a challenge, such as in the SOL group. Thus, we could refine proposition #5 even further, to read:

p5b: *When searching for technical information about tasks, groups are likely to obtain it from knowledgeable sources which often are heterophilous, rather than from homophilous relations; the exceptions are when the heterophilous relations are perceived as too distant or when solving the problem becomes in itself a challenge or when the information sought is not technical data but other forms of technical information.*

6.14 Efficiency and Effectiveness of Technology Diffusion. Technology diffusion in no-group situations may be very efficient, since only the necessary information is transferred and only to the direct users. However, effectiveness may not be very good in this situation, since minor but frequent improvements to the process, that are usually suggested by workers in other contexts, are silenced in the top-down approach to technology diffusion common in the no-group situation.

6.15 Effect of Evolution of Work Groups. As discussed earlier, the groups in CNH were not very effective in technology diffusion. By contrast, the groups in Eaton seemed to be more able in devising or obtaining technological bits that could help their respective organizations reach its goals. Since the organizational setting in CNH (determined in part by the contracts informally accepted between groups) is not new, and the organizational setting in Eaton is relatively young, we can conclude that the evolution of work groups in itself (measured in time) does not lead to increased efficiency and effectiveness. There must be other variables that help determine whether a group will become effective or not, or else, the evolution of work groups should be measured in units other than time since the formation of the group.

We also found earlier that structure and technological uncertainty alignment is a necessary but not sufficient condition for group effectiveness, so that we must conclude that the determinants of group effectiveness in technology diffusion are several and interrelated; this is supported by the results found in section 6.7.

6.16 Initiation of PIE. The first signs of diffusional issues in several PIEs are seen when the group gathers the required intelligence to define the problem and propose solutions. This initial effort was seldom the result of a formal analysis, but rather of an experience sharing process: far from using an analytical tool, groups frequently gathered and dumped ideas and objections about a proposal; as a result the proposal began taking shape. This issue may be worth considering in further research, since, first, the sessions where ideas are generated are relatively rare and may take place as conversations outside the session; and second, because effective groups behaved this way which in some sense contradicts some prescriptions in Total Quality approaches (Cole, 1991; Nemoto, 1987).

6.17 Expectations about Success and Effort in Process Improvement. We believe that the way expectations are shaped in group work, taking into account the definition of PIE, is captured by an "expectation shift model", depicted in figure 16. This model stresses the importance of accumulated frustration and the availability of resources, leading to a shift in the way time and effort are allocated between "promotional activities" and "technical activities". This is directly related with the efficiency of the work groups, since promotional activities reduce their efficiency by demanding extra effort and time in selling suggestions to supervisors and managers(Marks et al, 1986). A particularly important link in this model is the one marked with shaded arrows; if this link does not exist (that is, if work groups perceive their effort is not conducive to quality results), a withdrawal situation may occur (Gresov, Drasin & Van de Ven, 1988; Steel & Lloyd, 1986).

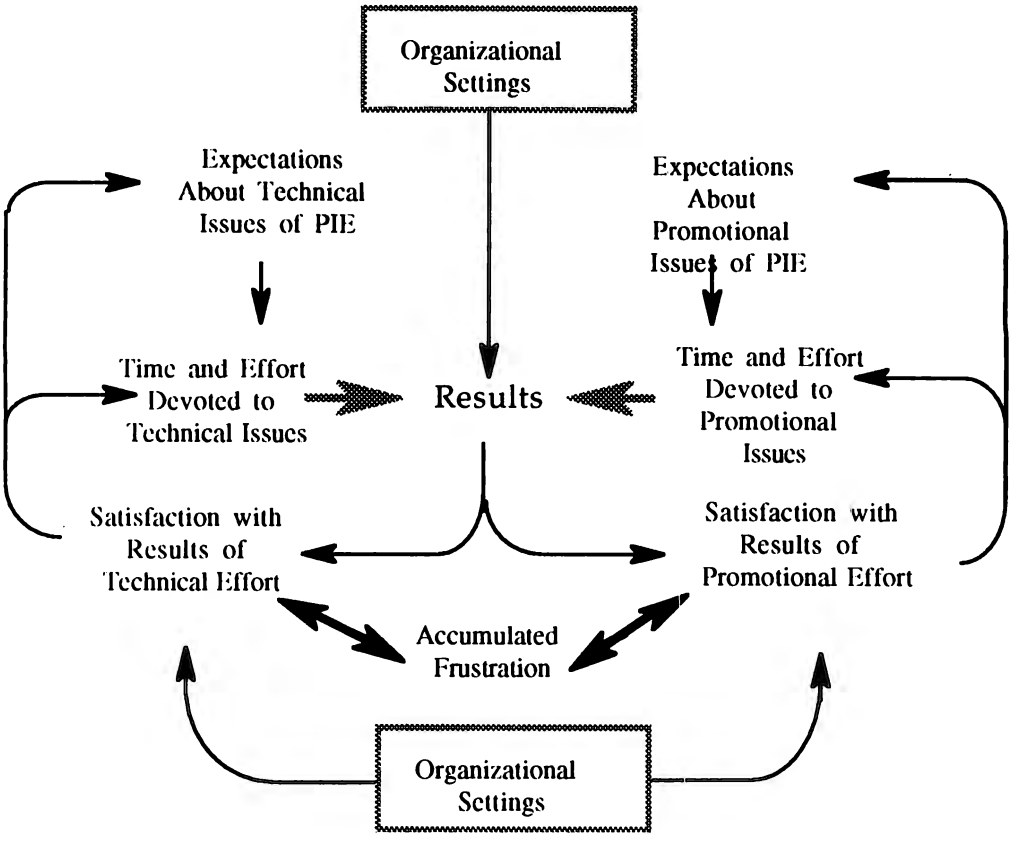


Figure 16 : Expectation and Effort Shift Model

6.18 Issue Selling. As is clear from the above discussion, issue selling is an important activity in the proposed models. According to our analysis, *production* is an issue with higher priority than *improvement* in the agendas of managers in CNH and Eaton; as an example, we can mention the "end-of-the-month" syndrome, where the highest priority is given to issues related to fulfilling the monthly production goals, leaving aside activities related to improvement of the process. This may be contradictory, since the problems at the end of the month may be the result of a lack of improvements in the process.

This reduces the commitment of workers and managers towards working in groups (Dutton & Ashford, 1993; Dutton, Dukerich & Harquail, 1994). Evidence found in the firms studied can be analyzed in the light of Dutton and Ashford's model. Related to the "organizational-instrumental" dimension of the model, production issues, which are firmly rooted in the agenda of the firms studied, become an obstacle to organizational adaptation to a more innovative

environment; this inability to adapt may lead to the creation of particular meanings for events, such as the widespread feeling that group activities are not considered really important by management, and that what is proposed there is never taken into account; further, there is a decrease in self-esteem, as expressed during worker meetings.

In terms of the propositions presented by Dutton and Ashford (1993), proposition #14a was clearly supported in the sequence of events where the Albatros group met with the Excellence group and presented a bundle of PIEs for analysis. Also, proposition # 5 of Dutton and Ashford's work is related to the lack of support given to work groups by management and thus the difficulty in selling issues to them.

On a larger scale, further research on issue selling in this setting may reveal why the issue of improvement has not gained enough currency among middle managers in the firms studied, while the issue of production is still in their agendas.

6.19 Concluding Remarks. As a general conclusion, we may state that there are organizational settings that reduce the effectiveness of technology diffusion. In the firms studied, the characteristics of the relation between managerial and work groups do not allow work groups to obtain resources in the required time and quantity from the managerial groups. This leads to frequent organizational problems which include the lack of clear indicators of knowledge diffusion, conflicts about the use of different types of knowledge, superstitious selection of information sources, and frustration about the improvement effort. As a consequence, overall performance in technology diffusion never reaches its full potential.

The organizational arrangementes made to enhance the diffusion of technology within the firms create a need for a different organizational structure; a symptom of this need is the struggle of special substructures, such as work groups, for a place within the organization. The accomodation of these special substructures within the organizational structure is not an easy task, requiring the redefinition of functions, roles, performance measures, communication links, priorities and agendas, but the commonly held belief that the new substructures can simply be appended to the present organizational structure without any major organizational change only complicates the situation.

APPENDIX I: QUESTIONAIRE

This is the initial questionaire used. After the answers to some of the questions and the analysis of other sources of evidence, other questions were developed but these were contingent on the group and other issues. The numbers in parentheses indicate the propositions to which each question may be related.

cuestionario

version 131193

parte A

conceptos:

roles:

1. ¿Con qué frecuencia ha ud. hecho o intentado algo para mejorar el proceso?

[ ] Nunca [ ] Ocasionalmente [ ] A menudo [ ] Muy frecuentemente

2. ¿Qué ha hecho o intentado ud. o su grupo? En que fecha se realizó esto? Qué comentarios tiene? (2,8)

2a. Cuando se encontraba ud. realizando las mejoras anteriores,

Cuales fueron las actividades iniciales ?
Cuales fueron las últimas actividades ?
Qué resultados esperaba ?
Porqué dió por terminado el proyecto ?
Considera que se alcanzó el resultado ? (2,5,7,8)

5. ¿Qué nuevas tecnologías han llegado a su lugar de trabajo? ¿Han sufrido adaptaciones estas tecnologías ? (3,4,10)

6. ¿ Qué tanta libertad para adaptar ha tenido? ¿La libertad para adaptar siempre ha sido así ? (3,4,10)

7. ¿Ha habido cambios en la forma de realizar su trabajo que no incluyan maquinaria? Cuales ? (3,4)

8. ¿Cuando necesita ud. ayuda o información técnica acerca del proceso:

¿A quien pregunta ?

¿Por qué?

¿Alguien le dijo que así lo hiciera?

¿Siempre ha sido así?

¿Si esa persona no sabe, a quién recurre? (2,5,6,8)

10. ¿Cuánto tiempo tiene ud aquí? _____ años (5,10)

11. ¿Quién es la gente que considera ud cercana a ud (amigos)? (5)

12. ¿A quién pide o de quien recibe ud información acerca de sus labores diarias (como metas de producción, etcétera)?

¿A quien pregunta ?

¿Por qué?

¿Alguien le dijo que así lo hiciera?

¿Siempre ha sido así? (2,5,6,10)

13. ¿Quienes considera que son los grupos o las personas que mas saben acerca del proceso? Qué puesto ocupan ? Qué antigüedad tienen ? Qué estudios tienen ? (1,2,5,9)

14 ¿Cuanto tiempo fué capacitado para su trabajo? ¿Quién lo capacitó? (5)

15 ¿Quienes son las personas con quien realiza ud. su trabajo? (5)

16 En caso de que detectara que es necesario o posible hacer una mejora al proceso, como procedería? (10)

17 ¿Ha habido cambios en la composición del grupo? ¿Han sido importantes?¿Porqué? (2,9)

19 ¿Qué eventos o cosas importantes han ocurrido en esta empresa desde que ud. está aquí? ¿Cuales han sido las consecuencias? (eventos)

20 ¿Existe alguna persona o grupo que consistentemente guie el cambio ?¿ Cómo lo hace ? (1,9)

21 ¿ Qué papel desempeñas sus compañeros dentro del grupo ?(por nombres, quien es p.ej., "experto", "policia", etc.) (5,6,7,9,10)

22 ¿Estos papeles son los mismos en todas las circunstancias ? ¿ Como es que empezaron a jugar este papel ? (5,6,7,9,10)

23 ¿Todos en el grupo hacen o algunos sólo proponen y sugieren mientras que otros hacen?¿Porqué es así ? (5,6,7,9,10)

24 ¿Diría ud. que su grupo es ahora mas eficiente para manejar información técnica? ¿Cómo lo mide? (8)

25 Acerca de herramientas de Calidad(Pareto, Ishikawa,etc.), ¿cuales manejan ?¿Cuando? ¿Porque?

parte B

1. ¿Piensa ud. que las actividades de mejora en las que actualmente está involucrado tendrán resultados positivos ?

2. ¿Qué resultado espera ud. de estas actividades ?

3. ¿Qué tan experto o preparado se considera ud. para el problema ?

Additional Questions for Albatros/Eaton

Homero Cruz
Heladio vazquez
Carlos Alberto Medina
Justino Mendoza
Aurelio Legorreta
Faustino Monroy
Pedro Hernández
Jose Rico
A. Avalos.

1. Aurelio Legorreta,Faustino Monroy, Pedro Hernández, Jose Rico y A. Avalos se integraron al equipo en 200593. ¿ A que se debió esto ?¿ Se les llamó a ingresar al grupo o ellos lo pidieron ? ¿Tienen alguna habilidad especial ?

2. Porqué desapareció el grupo ?

3. ¿ Para qué fué la junta con Excelencia ? Después de esta junta con Excelencia se empezaron a notar resultados. ¿A qué cree que se deba esto ?

4. En diversas ocasiones ustedes recibieron promesas de resultados (por ejemplo, los polipastos). ¿ Se cumplieron estas promesas ? Si no fué así ¿qué opina usted de esto?

5. Cuales son los PIEs mas importantes de la siguiente lista ? Porqué empezaron con los marcados ?

   llaves de impacto **
   dispositivos **
   martillos
   racks
   engrasadora
   polipastos
   calibre p/altura de portadiferencial
   probadora de cabezas

6. ¿Ustedes prefieren buscar una solución primero entre ustedes, o prefieren recurrir primero a alguien que sepa mas del problema ?

7. Algunos de los cambios que ustedes desarrollaron se han usado en otros departamentos ? ¿De qué manera se han comunicado estos avances ?

Additional Questions for Geniecillos Brillantes/Eaton

Leobardo López
Concepción Gonzalez
Juan Vázquez
Lucas Nava
Oscar Montes de Oca
A. Avalos (Supervisor)
Antonio Hidalgo
Rafael Gonzalez

1. Antonio Hidalgo y Rafael González se integraron al equipo en 5/Mar/93 (El grupo se inició en 31/Ago/93). ¿ A que se debió esto ?¿ Se les llamó a ingresar al grupo o ellos lo pidieron ? ¿Tienen alguna habilidad especial ?

2. Al iniciar los cambios en montacargas, se suspendieron los otros esfuerzos o ya se habían terminado ?

4. En diversas ocasiones ustedes recibieron promesas de resultados (por ejemplo, los contenedores de baleros). ¿ Se cumplieron estas promesas ? Si no fué así ¿qué opina usted de esto?

5. Cuales son los procesos de mejora mas importantes de la siguiente lista ? Por qué empezaron con los marcados ?

    Contenedor de Baleros **
    Engrasadora **
    Máquina de Aceite
    Carros para material de ensamble
    Montacargas
    Identificación de Gavetas

6. ¿Ustedes prefieren buscar una solución primero entre ustedes, o prefieren recurrir primero a alguien que sepa mas del problema ?

7. Algunos de los cambios que ustedes desarrollaron se han usado en otros departamentos ? ¿De qué manera se han comunicado estos avances ?

APPENDIX II: CODING SCHEME

The following is the coding scheme used to record group interaction during PIE. This scheme is intended to be simple enough to be used during group interaction and is oriented towards technology diffusion interaction: during group sessions, several types of behavior may take place, but only those related to technology will be recorded, the rest being labeled as non-relevant behavior.

This coding scheme is an extension of the one proposed by Bales (1978). The reason for not using Bale´s scheme is that we are interested in more specific information about tasks and less specific information about social roles.

The categories involved in this coding scheme are explained below, along with the subcategories and examples.

norms: statements related to prevailing norms, accepted by the firm or not. These may not be made explicit, in which cases a comment must be included for further exploration.

reminds: the participant reminds the rest of the group that some norm exist about subject matter.

"Let me remind you that our firm´s policy for technological update doesn´t allow us to..."
"We have been checking the information comming from department X since Y left"

asks about: The participant asks if there is a norm in that would allow a decision to be made concerning technology or process improvement.

"Have newcommers been allowed to decide on this before ?"
"How can we know if a problem has been solved satisfactorily ?"

shares: The participant suggest a norm to simplify interaction in the future.

"Why don´t we avoid these too frequent and nonsense argumentations by stopping them in the first interchanges ?"

"Shouldn't newer groups present their suggestions to other groups for evaluation ?"

decision: in almost every session a decision or set of decision is taken. Several important issues appear around decisions.

suggests: the participant suggests an alternative for the problem at hand.

"Why don´t you change thetype of lubricant ?"

asks for consensus: the participant asks for the decision to be taken by the whole group.

"Why don't we vote?"
"Let's give everyone the opportunity to choose an alternative."

decides: The participant chooses an alternative. This implies that this participant has the power to decide about some issue.

"OK, we will do X"
"I'll have this information ready next Wednesday."

accepts: the participant publicly accepts a decision taken.

"That's fine with me; I'll get the information for tomorrow."
"OK, we will change that gear."

regects: the participant rejets an alternative or some terms contained in it.

"No, I will not go in there again"
"I did not have this in my agenda"

activities A great deal of interaction in workgroups revolves around activities perfomed or suggested for process improvement.

reports: The participant reports the activities he performed during the previous period.

"The bearing in machine # 3 has not been replaced because..."

commits to: the participant accepts an activity as his responsibility

"OK, I'll replace the lever tomorrow"

offers help: the participant considers he can help others with their tasks.

"I can help you in developing that computer program"

information Information exchange is one of the most frequent behaviors during PIE sessions and the predominant way to diffuse technology within the group.

offers: the participant provides information by his free will or upon request. This information must be new or meaningful to some or all participants in order to belong to this category.

"The Toads have developed a new way to insert the die and all we have to do is ask them"
"Other firms are using this kind of steel but for other purposes"

asks for: the participant asks for some piece of information he needs.

"Do you know how can we reduce this scrap?"
"Is there someone in this plant who has tried this before ?"

complements: the participant gives additional information to the information given by another participant or by himself.

"I must add that this new product is cheaper"
"Besides, our firm has a serious pollution problem"

contrasts: the participant finds some missing or contradictory issues in the information given.

"Well, I don't think this will work because I remember an ocassion when..."
"That right but you are not considering the effect of temperature."

group maintainance Some time is always alloted in every session to activities that will allow the group to keep functioning as a group. These are activities that address issues that occured in the between-sessions period.

makes notice: the participant makes the group aware of something he considers may be harmful for the functioning of the group.

"Some of us have been late for our weekly meetings"
"We should work as a group, so lets help Michael"

solves conflict: the participant suggest a solution for the conflicting parties.

"Let's forget that missunderstanding and think about our jobs here"

facilitator/coordinator In the early stages of group interaction a facilitator is usually brought in to direct interaction to productive activities and to signal behaviors that may be harmful. Other groups have a coordinator, either permanent or shifting, who conducts the session.

asks for report: the coordinator asks the participants to report on their activities during the previous period.

"OK, George, how did you fare last week ?"

coordinates time: the facilitator controls time in order for the group to reach some conclusion or decision in the available time.

"We should not spend so much time dealing with personal issues"

asks: the facilitator ask for information or opinion to participants he knows can make a significant contribution but who do not confident enough to speak.

"Who can suggest something ?"

session maintainance A symptom of a mature group is its ability to manage an agenda in the available time. This implies hurrying when necessary, bringing discussion back to the subject, ending a subject and begingin another, etc.

tension release: the tension between conflicting parties or stressed relations is released by jokes or some other form.

hurries: the participant indicates that the time available is not being used properly.

"OK, what's next in the agenda ?"

returns to subject: the participant redirects discussion because he feels that the present discussion is not related to the subject.

"Let's get back to our polishing problem.We can handle this latter".

ends: the participant considers the subject has been sufficiently explored and suggest a move to a new subject.

"OK, that's all about foundry"

expression of failure: the participant expresses his dissatisfaction with the results obtained in the session.

"We have gone nowhere today"
"We are still waiting for your results, Bob"

expression of success: the participant expresses his satisfaction with the results obtained in the session.

non-relevant behavior All behaviors that are performed by the group but do not relate to PIE. Care should be taken not to interpret **maintainance** behavior as **non-relevant behavior.**

non-relevant statements: statements that do not deal with the issue at hand.

"The wage increases were lower than we expected, weren't they ?"
"The game last night was really bad !"

signs of absence: the participant shows by his behavior that he is not involved in the session. Some behavior may be interpreted as this but the person may be really participating.

APPENDIX III: INTERVIEW TRANSCRIPTIONS

In this appendix we present a sample of the transcriptions of the interviews done to the personnel of the firms studied.

Company: Compañía Nacional de Harinas (CNH)
Group: Packaging
Participants: COB, TOMASA, MARIBEL, HORACIO, CSA (assistant), CLAUDIA (assistant)
Date: May 93

COB: Lo que quisieramos saber mas que nada es ¿cuales son las medidas de calidad que ven uds. ahí en lo que sería "Empaque"?.
HORACIO: Bueno, una de las medidas sería mas que nada la limpieza, que vaya libre de cualquier impureza el producto. Que vaya bien hecho, que lleve bien su forma.
COB: ¿"Bien Hecho" es que lleve bien su forma?
HORACIO: Exacto, si. (silence) Y... este (silence) esas serían, no?, las mas indicadas, que vaya limpio el producto.
COB: En cuanto al peso y eso, ¿manejan algo?
HORACIO: Exacto, también. De hecho tenemos una basculita, estamos checando constantemente el peso, si le falta se le aumenta. Hay veces que la harina está un poco humeda y eso nos perjudica un poco. No baja como debería, ¿no?, muchas veces varia el peso, unos salen con mas otros con menos, pero eso solamete cuando llega a estar humeda. (silence).
COB:Donde miden la humedad o como la miden?
HORACIO: Nosotros acá no tenemos aparatos para medirla. Sólo en los molinos, o sea en los departamentos de molienda.
COB: Mhhm!
GROUP: (Silence).
COB: OK, entonces vamos viendo. Tenemos, por un lado que limpieza es una de las cosas en que uds se fijan, que esté bien hecho el paquete,...
HORACIO: (Afirmación)
COB: ...el peso, eh, que la humedad les afecta en cuanto a esto...
HORACIO: Si.
COB: OK, qué mas nos podrían decir?
HORACIO: Eh...(Silence)... Bueno, hay veces que el envase viene un poco defectuoso, no?, el envase.
COB: ¿Qué significa que venga un poco mal?
HORACIO: Bueno que no tiene correctas sus medidas. Hay veces que viene mas corta la bolsa o mas grande. O sea, un grupo de bolsas tiene diferentes medidas.
COB: ¿ Trae diferentes dimensiones ?
HORACIO: Ahá... (silence)
COB: Que otra cosa verían por ahí ?
GROUP: (silence)
HORACIO: Pues, este, alguna falla que tenga la máquina. Claro que cuando se detecta, pues inmediatamente, no?, se repara.
COB: Qué tipo de fallas son lo mas común?
HORACIO: Pues algún desajuste en algun pistón...
COB: Para qué son los pistones ?
HORACIO: Para mover los paquetes.
COB: Ah, OK.
HORACIO: Si...(silence)... Tenemos tambien fallas en la barra selladora, que es la que sella el

empaque, si?, por arriba.
COB: Hmm.
CSA: La que lo sella?
HORACIO: Si, esa. Se llega a ensuciar bastante del mismo pegamento y hay que estarla limpiando constantemente. Esa barra es de aluminio, tiene una especie de Teflon, algo así, para que no se pegue el pegamento, se va desgastando y se llega a caer y es necesario aplicar nuevamente el esmalte. Qué mas? Este... (silence)
COB: Con qué frecuencia fallan las máquinas ?
HORACIO: Mmm, pues, mira, ahora tenemos un problema con el vibrador de la máquina. El vibrador sirve para nivelar la harina y entonces el doblez quede parejo. Si no se asienta sale chueco el doblez. Ese vibrador ahorita se venció el soporte...
COB: Mmmm..
HORACIO: ..nada mas que el señor de mantenimiento está muy ocupado y no pudo resolver el problema. Bueno, es mínimo, el problema.
CSA: Y cuando hay un problema se busca al jefe de mantenimiento ?
HORACIO: Exacto. Bueno, si uno no puede resolver, si.
CSA: (interrupts) ...pero primero si tu puedes lo resuelves.
HORACIO: ... y es que ahorita como tienen montajes y eso pues no tienen tiempo, pero espero que se resuelva pronto. Este, otra cosa sería la pistola de pegamento, se tapa constantemente porque llega un momento en que se carboniza.
COB: Porque se carboniza?
HORACIO: Es que nosotros usamos el pegamento diluido y a una tempreatura de 300 grados aproximadamente, entonces en el momento en que se queda en el fondo se está quemando, o sea, no todo fluye, se quema eso, llega un momento en que se carboniza y se tapa. Pero afortunadamente tenemos los medios para destaparlo.
COB: ¿La máquina debería funcionar así, con tantos, este, o sea es normal lo que le pasa ?
HORACIO: O sea es que mire, esa máquina salió un tanto defectuosa. Ahora prácticamente le conocemos sus mañas.
CSA: (interrupts) ¿Cuánto tienen con ella?
HORACIO: Se adquirió aproximadamente hace como dos años; año y medio, más o menos. Yo tengo apenas un año, como año y medio aproximadamente con ella, y este...
CSA: (interrupts) ...estaba casi nueva cuando llegaste.
HORACIO: ...casi nueva sí, entonces desde ese momento a la fecha ya sabemos cuales son sus fallas, claro que como la máquina es importada y todo eso y es muy complicada pues no es fácil sacarle las fallas, o sea aunque uno ya sepa la falla siempre cuesta un poco de trabajo.
COB: Entonces ustedes lo que hacen es tratar con la máquina hasta "jugar" digamos.
HORACIO: Si.
COB: Permiten eso, digamos, lo que dijiste ahorita de a jugar con ella.
HORACIO: Bueno si, en mi caso pues si, porque yo como operador tengo que estar observando y pues de plano aprenderme todas las fallas que tenga para en un dado caso que el de mantenimiento no pueda tratar de resolver uno el problema.
CSA: ¿Fuera de ti no hay otro operador?
HORACIO: Si. Bueno tengo otro muchacho que me ayuda, lo que pasa es que él me ayuda con la otra máquina, entonces casi no la conoce, de hecho ahorita apenas empiezo a capacitarlo, por decirlo asi para que en dado momento que yo tampoco pueda pues él me eche la mano.
COB: Muy bien. ¿Qué ajustes tiene la máquina? ¿Tiene algún ajuste por hay que ustedes puedan jugar, no sé, para mayor temperatura, alguna cosa así, para las bolsas?
HORACIO: Si, tiene sus este, para la temperatura tiene sus pirómetros nosotros podemos aumentar o reducir la temperatura; para el peso de la harina también tiene su regulador, tiene este (silence) orificios para los pistones también hay que, si la bolsa viene más pequeña hay que bajar el nivel del portabolsas y se le puede dar el nivel que desee uno.
COB: Muy bien. ¿La velocidad de la máquina la puede regular ustedes?
HORACIO: Si la podemos regular.
CSA: En caso de requerir repuestos ¿si existen aquí? al ser máquina importada. ¿Tienen

refacciones?
HORACIO: No. Bueno, este cuando mandaron esa máquina mandaron algunas piezas se puede decir que las más importantes pero de hecho aquí no se consiguen hay que mandarlas traer; o en todo caso mandarlas reconstruir , hacer aquí; ya varias piezas las hemos mandado hacer porque te imaginas que sea algo así de la computadora, algo de la parte electrónica, algunas partes si las hay aquí, claro no son igual pero sirven.
COB: Volviendo a lo que seria la harina que les llega a ustedes, lo que más les afecta de ahí qué es ¿la humedad?
HORACIO: La humedad sí, sería la humedad lo que nos afecta, sí porque es lo que más nos ha dado problemas sobre todo en el peso, varía un poco.
COB: Lo más grave es que afecta el peso ¿Sería el único problema que tendrían? La humedad.
HORACIO: Si, sería el único.
COB: Las bolsas, por ejmplo serían otro problema?
HORACIO: Si, pero eso ya es mínimo, eso lo resolvemos nosotros rápidamente, de hecho si la bolsa sale mal completamente se cambia por otra
COB: ¿Llegan a tener problemas con un lote completo de bolsas?
HORACIO: No nada más, vamos por decir de un lote sale por decir media caja o algo así, la caja aproximadamente trae 2000 mil bolsas, vamos a decir un 10% que salgan defectuosas.
COB: ¿Esas bolsas vienen también de una empresa del grupo?
HORACIO: No, son aparte, la empresa que nos distribuye el envase es de Guadalajara. Se llama me parece que MODISAN.
COB: ¿Con el pegamento no han tenido problemas nunca?
HORACIO: No, del pegamento no, afortunadamente nos ha salido bueno, el aparato trabaja bien, a reserva de lo que le vuelvo a repetir, se carboniza el pegamento y se tapa, pero tenemos la solución para eso, constantemente se le da mantenimiento para evitar los problemas.
COB: OK. Les voy a leer las fallas que tengo apuntadas, serían: pistón de la barra, el vibrador, la pistola del pegamento, ¿serían las fallas principales?
HORACIO: Si, las fallas principales, de hecho la máquina casi en su totalidad se compone de puros pistones, todos los aparatos trabajan a base de pistones y lógico si falla un pistón ya no trabaja la parte, la pieza.
COB: ¿Del sistema neumático nunca tienen problemas?
HORACIO: No. de hecho lo único que le hemos cambiado son las ventosas, son una gomitas, son las que más se desgastan y constantemente se las cambiamos.
CLAUDIA: Acerca del mantenimiento que dijeron que le daban constantemente para evitar desperfectos, ¿si lo tienen ya establecido cada cuando tiempo se va a hacer?
HORACIO: Bueno no, de hecho este se le debería dar mantenimiento aproximadamente cada mes mínimo pero hay veces que la producción no lo permite, tenemos bastante trabajo, entonces yo creo que sería hasta cada dos meses aproximadamente el mantenimiento que se le da a la máquina.
CSA: ¿Se lo dan ustedes mismos o es gente de afuera?
HORACIO: No, se lo damos, ya sea el personal de mantenimiento o nosotros.
COB: Habían mencionado la característica de que "esté bien hecho", ¿a que se refiere?
HORACIO: Bueno, me refiero al empaque, nosotros utilizamos un plástico que es encojible,para eso es el horno pero hay veces que viene un poco más delgado como es mucha la temperatura se rompe o sale disparejo; todo eso también hay que cuidarlo.
CSA: ¿Ese plástico se desperdicia?
HORACIO: Si, porque ya sale, pues, o sea ya no podemos utilizarlo otra vez.
COB: ¿Viene por rollo el plástico?
HORACIO: Si, viene por rollo.
COB: Y si viene muy delgado, ¿desechan todo el rollo?
HORACIO: No, bueno de hecho se regresa a la compañía y nos lo reponen.
CSA: O sea que necesita un grosor epecial?
HORACIO: Exacto.
CSA: ¿Con ese horno no a tenido problemas? El del plástico.

HORACIO: No, creo que es el único que no nos ha dado problemas.
COB: Yo he visto algunas bolsas con un hoyito encima, a la hora que las apachurran por arriba sale aire...
HORACIO: Ah sí, es que esas son de la otra máquina.
COB: ¿Usted se hace cargo de la otra máquina?
HORACIO: Si, ese hoyito se le hace para sacarle el aire al paquete para poderlo sellar, se le hace un doblez a la bolsa y se sella con etiquetas para que quede unido el paquete.
COB: Entonces es intencional el hoyito.
HORACIO: Sí, debe de llevarlo.
COB: ¿En la otra máquina no han tenido problemas?
TOMASA: (uncomprehensible)
COB: En la otra máquina medirían lo mismo, limpieza, que esté bien hecho, igual tendrían problema con la humedad en la otra máquina?
HORACIO: Pues si, la ventaja de acá de la otra máquina es que el sistema de alimentación, vamos por decir, el tubo es un poco más amplio, entonces tiene mayor facilidad de caer la harina y pues si varia un poquito el peso pero es mínimo, varia por decirlo así de 10 a 20 gramos más o menos.
COB: ¿Checan el peso de cada paquete o es por muestreo, o como le hacen?
HORACIO: No, por cada paquete.
CSA: ¿ En las dos máquinas?
HORACIO: En las dos.
COB: ¿ Qué más habrá por ahí?
HORACIO: Bueno ahorita también tenemos algunas fugas en las tolvas de almacenamiento como la harina nos la mandan a presión entonces llega el momento en que se bota de alguna parte la tapa y llega a haber una fuga y siempre el polvito que cae es molesto.
CSA: ¿A esas tolvas también se les da mantenimiento?
HORACIO: Si, también.
CSA: ¿Como a que hora dejan de trabajar las máquinas?
HORACIO: Las máquinas, bueno yo las paro media hora antes de la salida; por decir si salimos a las tres yo las paro a las dos y media para poder hacer limpieza y dejar limpio el departamento.
CSA: Entonces en el turno de la tarde, ¿ya no hay empaquetamiento?
HORACIO: No, ya no; de hecho nada más es un turno.
CSA: Es un turno, ¿de siete a tres?
HORACIO: Si, de siete a tres, si llega a haber bastante demanda de producción nos quedamos tiempo extra nada más.
CSA: ¿Ustedes mismos?
HORACIO: Sí, nosotros mismos.
COB: ¿Ustedes que hacen?
TOMASA: Pues nosotros nada más estamos ahí ayudándole, si sale un paquete roto pues lo vaciamos; es que luego se atoran y los rompe, es lo que hacemos nosotras y limpieza.
COB: ¿ Ustedes están directamente en la de empaque de papel?
HORACIO: Bueno, de eso nada más ella es la que me ayuda.
MARIBEL: Yo estoy en la otra.
COB: ¿Entonces no ven ustedes parte de lo que ya hemos visto aqui?
MARIBEL y TOMASA: Pues no.
HORACIO: No sean mentirosas. No fíjese que si hay veces que me dan "tips", bueno o sea, me ayudan a observar y si me han ayudado a sacar fallas.
COB Por ejemplo, ¿como cual?
HORACIO: Eh, pues casi en todas.
MARIBEL Yo casi no, pero ella es la que, como es la que le sabe más porque esta en esa máquina, es la que luego le dice a él las fallas.
TOMASA: O sea algun ruido que no es el de la máquina luego ya le dijo.
COB: ¿O sea por el ruido se conoce la falla?
TOMASA: O sea porque es un ruido extraño le dijo.

MARIBEL Y yo como estoy en la otra casi no le sé a esa.
COB: ¿Y la otra no tiene ruidos?
MARIBEL: Pues como estoy hasta aca en la mesa de trabajo y la máquina hasta allá pues la verdad no oigo.
CSA: ¿ Tú no estas en la máquina ?
MARIBEL: No.
CSA: ¿Tú empaquetas?
MARIBEL: Ajá.
HORACIO: Sí, es que en la máquina que esta alla es manual y en la que estamos acá nosotros es más rápida, todo lo hace la máquina.
COB: Bueno, creo que sería todo por ahora, si tenemos alguna preguntan pues los iremos a ver y les agradecemos mucho que hayan venido con nosotros. Yo creo que nosotros vamos a hacer un reporte y se los vamos a presentar a ustedes para que vean que como aportaron ustedes su experiencia a este proyecto.

Company: Compañía Nacional de Harinas
Group: Molienda
Participants: COB, JUAN CARLOS (JC), BENITO, PABLO, HECTOR(assistant)
Date: May 93

COB: ¿Ustedes trabajan en el área de limpieza y molienda?
GROUP: Si.
COB: Cuando les llega la harina que sale de ahí, ¿cuáles creen ustedes que son los parámetros importantes de la calidad, que es lo que se le ve a la harina en cuanto a calidad, a la harina que sale ya lista?
JC: La calidad, o sea lo blanco que tiene la harina. Primero la blancura, lo blanco, que no esté manchada ni nada de eso.
COB: ¿Ha que se refiere manchada?
JC: A que vaya, por ejemplo en el área de cernido, que vaya a haber una tela rota que se pase de un producto a otro o sea del salvadillo a la harina y eso no debe de pasar.
COB: ¿Qué otra cosa puede ser manchar? Nada más eso que vaya...
JC: Si a un producto revuelto o que se combine con otro.
COB: Muy bien. Por un lado es lo blanco. ¿Qué otra característica hay? Fineza me decían, ¿o qué más?
JC: Si.
COB: Esa, ¿como la perciben ustedes?
JC: Saliendo del banco ahí se agarra y se ve, luego se ve si falta más apretar, o no sé, en los bancos.
COB A ver, a ver, explíqueme eso porque no sé qué es eso de los bancos.
JC: La máquina es donde pasa primero el trigo, donde se muele bien, bien el trigo. Hay unas palancas y se aprieta abajo y es donde se ve la harina, a ver si esta bien o le falta más apretado o está demasiado.
COB: Esto es igual para sémola y para la harina.
JC: Si.
COB: Este control ustedes lo tienen fijo en algo o lo van cambiando.
JC: Está fijo, si cada banco tiene un, como un perímetro, una palanquita siempre está así, casi nunca se mueve.
COB: Eso sería en cuanto fineza, verdad en la harina? Que más le ven. La fineza de la harina la ven así al tacto?
JC: Si, si; luego, luego se siente.
COB: ¿Tardan mucho ustedes en aprender la fineza de la harina, que debe tener ?
JC: Si tarda.
COB: ¿Que otra cosa checan ustedes en la harina, o que es importante en la harina que sale ?
JC: Lo más importante es eso, que no esté manchada, todos los días hay que estarla revisando, porque una tela en cualquier ratito se puede romper, y son toneladas que van de harina.
COB: Ustedes detectan ahí mismo que se rompió una tela?
JC: Si.
COB: Y ¿ Qué hacen cuando se rompe la tela? ¿Paran el proceso?
JC: Paran, si hay que parar, checar donde está saliendo mal el producto, y ahí es donde hay que ir a destapar y parar todo, y revisar todo... Desde la primer tela hasta la última y hay que fijarse donde esté rota y si esta rota cambiarla por otra nueva.
COB: Eso es OK. Entonces serían estas dos principalmente, verdad? Blancura y fineza. Dentro de lo que es la maquinaria, que son las palancas o cosas que ustedes mueven dentro del proceso? ya hablaban ahorita de apretar los bancos y cambiar las telas. ¿Qué otra cosa hacen?
JC: Eso si se puede mover casi todo. Un botoncito dentro del banco hay que abrirle por si se sube. Es un botoncito que hay que abrirlo para que baje más rápido el producto y no se suba.
COB: ¿Sería para la verificación del producto?

JC: Se llama alimentador. Es un botoncito que lleva en medio. Para cuando quiera abrir, se sube y se abre ahí para que baje rápido o si está muy vacio, cerrar un poquito para que complete bien de los dos lados.
COB: Muy bien. OK.
JC: Eso si hay que estar todos los días moviendo.
COB: ¿Qué otra cosa hay por ahí. El botoncito este les afecta en algo en el producto? Si se llena demasiado rápido, ¿tienen que parar o algo?
JC: No. Nada más si se llena hay que abrirle un poco. Hay que abrirle tantito para que baje. O si esta muy vacio hay que cerrarle un poco.
COB: ¿No afecta la fineza?
JC: No, eso si no. No eso nomás es porque no vaya demasiado a caer.
COB: ¿Qué más, que otra cosa le mueves por ahí?
JC: Es una palanca que lleva a un lado. Pero esa es nada más para cuando se para el molino. Cuando se para tiene un botón a un lado y se aprieta para que se bote, se bota y se para, y a la hora de echarla andar otra vez arranca el motor y se jala la palanca. Es nada más cuando se para. Esa no se mueve. Es nada más para arrancar, cuando se para el molino y empieza a arrancar.
COB: Hasta ahorita lo que estamos viendo es molienda verdad? Lo que les llega a ustedes a molienda ¿qué características debe tener? Digamos el trigo ya que viene de limpieza.
JC: Que esté húmedo.
COB: ¿Cómo saben que la humedad está bien o está mal?
JC: Antes de llegar a molienda, se agarra un poquito, y cuando va a llegar a la tolva, cuando pasa por la primera lavada, se agarra para ver si esta bien o le falta agua o le sobra agua, hay se ve, si le falta agua le pongo más agua o si le sobra le quito un poco de agua.
COB: OK ¿También es al tacto?
JC: Si también así. Se toma el trigo y se ve luego, luego, si le falta o le sobra agua.
COB: Esto es, ¿para cualquier tipo de trigo duro o blando?
JC: Mhhm! Creo que ahorita lleva más agua el de sémola que el de harina. Casi no es la misma agua porque el trigo de acá lleva más trigo que el trigo de allá, es poco menos el que viene para sémola que el de harina.
COB: ¿ Qué otra característica hay aparte de la humedad que les interese medir?
JC: Las cenizas y la basura y todo eso.
COB: OK. ¿Cenizas, incluye basura y todo?
JC: Se le quita todo; hay una maquinaria que hace todo eso.
COB: ¿ Si a ustedes les llega ya sucio, ya no pueden hacer nada, ya se sigue o tienen que cambiar algo?
JC: No.
BENITO: Se tiene que limpiar porque arriba se tapa y hay que quitarle la carga y destaparlo.
COB: OK entonces ¿Si viene mal, ustedes tienen que parar lo que es molienda?
BENITO: No, pura limpieza es lo que hay que parar.
JC: No se puede parar todo, nada más se para una sola cosa y lo demás sigue trabajando.
COB: OK. Muy bien, entonces si viene con cenizas o pajillas o lo que sea el trigo a moliendsa ya no le pueden hacer nada, se sigue.
JC: Ya, ya no.
COB: Y ¿Sale mal la harina?
BENITO: No porque lo que es la basura va a la sema y al salvado y la harina va aparte.
COB: OK Muy bien. Bueno, entonces tenemos humedad, cenizas, y ¿qué más hay por ahí? ¿qué otra cosa puede haber, que traiga el trigo de limpieza?
JC y BENITO: Nada más.
BENITO: O sea lo que viene de limpieza es que trae paja, piedras y trae diferentes piedras, grandes, chicas; y ya después ahí ya es donde se escoge; ya baja limpio, luego vuelve a subir allá arriba; se moja y caé en las tolvas, la duración del trigo ahí es de cuatro horas, luego vuelve a pasar a la segunda limpieza y es donde se vuelve a mojar el trigo y ya limpio se va a la molienda.

COB: OK, entonces en lo que es limpieza de salida digamos, tienen ustedes cierta humedad, ciertas cenizas, al salir de limpieza. ¿Cómo regulan ustedes eso, como lo manejan, o que le hacen?
BENITO: O sea lo del agua del trigo es por el ciento que lleva, claro que si lleva un 70% u 80% ya es de quinientos o cuatrocientos de agua; ya no más se ve lo que es la humedad.
COB: Y ¿les dicen a ustedes ese número de la humedad?
BENITO: Si.
COB: OK Entonces ustedes ya le dicen lleva tanto por ciento y hay que echarle tanto de agua. Para todo lo que es quitar la pajilla y todo eso ¿cómo le hacen o que pasa?
JC: Hay una máquina.
BENITO: Hay una maquinaria para que se separe...
COB: ¿Tiene unas como agujitas, no?, de por...
JC: No, eso es una máquina que lleva tela adentro.
BENITO: Es un separador, lleva una tela, separa lo que es la paja, el polvo del trigo y el trigo.
COB: Y ustedes no le pueden dar a esa máquina....
JC: Nada, tiene su medidor, para regular el aire y todo.
COB: Muy bien, entonces aquí no mueven nada. ¿verdad? OK, el trigo que entra a limpieza, ¿les afecta como venga, si trae mucha paja o poca paja, o piedras o todo eso?
BENITO: Hay veces que si afecta, porque hay veces que se tapa y hay que tener que parar.
COB: Oye, ¿Por qué se tapa, eh?
BENITO: Porque hay veces que lleva mucha paja y lo de la caida del separador no esta muy ancha.
COB: Ah! OK. Muy bien. Entonces, si trae mucha paja se tapa ahí en el separador. Muy bien ¿Pero no les afecta en la calidad del producto?
JC: No.
BENITO: No, eso casi no afecta.
COB: ¿Qué otra cosa tendra el trigo que viene hacia limpieza que les pueda afectar, o que les cause problemas?
BENITO: No, pos nada más lo de la paja.
COB: ¿Qué problema tienen normalmente ahí en el proceso?, en los dos, limpieza y molienda.
BENITO: O sea que el molino ya cuando se para muy seguido así como el joven fue la vez pasada se habían arrancado unas bandas y fue cuando se paró. También cuando se tapan los cernidores se vuelve a tapar...
JC: Si se para, no más de dos días, ya es mucho tiempo dos días, de que se queda parado todo y a la hora de arrancar se queda pegada la harina a los tubos... bueno casi nunca pasa.
HECTOR: Me dijeron que tenia dos días el trigo, y que traian el trigo de la otra... ¿de donde traían el trigo?
JC: de los silos.
HECTOR: De los silos, ah!
JC: Todo el trigo que viene por ahí es de los silos.
COB: ¿No tienen problemas con el transportador, que se atore o algo asi?
JC: En un elevador de los silos, ya esta muy viejo, por eso. Pero ahorita ya lo compusieron , ya está nuevo, ya no. Es el único.
COB: De ahí, de su área, digamos con el aire y cosas así, ¿no hay problemas?
BENITO: No, de eso casi no hay problemas.
JC: También tiene medidores.
COB: Que más, jovenes, alguna cosa que quieran platicar del proceso.
HECTOR: En una visita que realizamos vimos en los tubos de los bancos creo habia unas palomitas, ¿esas cómo llegan ahí?
JC: Se hacen, cuando pasa mucho tiempo se hacen un montón, cuando vemos que está mucho tiempo la harina dentro se hacen ahí.
COB: Y ¿fumigan para eso?
JC: Si.
COB: ¿Cada cuanto?
BENITO: Cada año ¿no?
JC: No, cada medio año.

COB: ¿Y sí es efectiva la fumigación ?
JC: Si.
BENITO: Bien rápido.
COB: ¿Es en los dos procesos la fumigación?
JC: Si, igual.
HECTOR: ¿No creen que debería ser más seguido la fumigación?
JC: Si, claro.
BENITO: Crecen rápido.
COB: ¿Cuánto tiempo?
BENITO: Casi, o sea que fumigando, a los dos o tres meses ya vuelven a nacer.
JC: El problema es que siempre se está trabajando y nunca se paran.
COB: Ah, para fumigar tienen que parar?
JC: Si todo. Son muy fuertes las sustancias que ponen y marean luego luego.
COB: Y ¿a la harina no le pasa nada?
JC: No, todo se vacia y hasta que hagan eso se limpia el tubo bien, bien de adentro todo, hasta que no quede nada.
HECTOR: ¿Cuánto tiempo tardan entre equipar y volver a arrancar?
BENITO: La operación es de dos días.
JC: Todo cerrado, ventanas, puertas.
COB: ¿Ustedes cada cuando le dan mantenimiento?
JC: Todos los días eso sí.
COB: Usted joven platiquenos algo; de su experiencia.
PABLO: Lo que pasa es que tengo poco tiempo de haber entrado aquí.
COB: ¿Tienen más ustedes?
JC: Si.
COB: ¿Cuánto tiempo?
BENITO: Yo cumplo un año.
JC: Ya tengo tres años.
CESAR: Ustedes como trabajadores de ahí, ya con un poco de tiempo qué procesos, o qué consideran que podrían ustedes cambiar, o mejorar algo que hayan visto mal.
JC: Si. Por ejemplo él y yo que ya tenemos tiempo podemos hacer cosas ya no necesitamos que vengan; por ejemplo ese día que se rompieron las bandas ya nomás lo estabamos haciendo él y yo. Ya sabemos que hacer no necesitamos que venga el jefe de turno, ya tenemos que hacer. Como le decia al joven cuando uno tiene problemas pues esta ahí, pero sólo no importa lo que hagas. Si uno quiere se junta y si se puede aprender.
COB: ¿Ustedes trabajando juntos se apoyan unos a otros?
JC: Si.
COB: ¿Se llevan bien entre ustedes?
JC: Si.
BENITO: Casi, casi nadie tiene peleas.
COB: Porque hay otro lugares donde siempre hay gente que tiene problemas. Es que son pocos, poca gente, ¿no?
JC: Si somos nada más cuatro.
COB: ¿En cada molino?
JC: Si.
COB: ¿Ustedes estan cada uno en un piso o todos en el mismo?
BENITO: O sea que dos allá abajo y dos hasta alla arriba, en el último piso.

Company: Compañía Nacional de Harinas
Group: Producto Terminado
Participants: COB, ARACELI(assistant), ALEJANDRA (assistant), VIDAL (worker), EUSEBIO (worker),
Date: May 93

COB: Quisiera empezar por preguntarles, ¿cuáles son las características de calidad que tiene el producto cuando sale para que ustedes ya lo empaquen?¿Cuáles son las cosas en que se fijan ustedes?
EUSEBIO: Primero que nada el tipo de molienda que lleva.
COB: ¿Tipo de molienda, eso que quiere decir?
EUSEBIO: O sea cada producto lleva diferente tipo de molienda, diferente tipo se puede decir de terminado.
COB: Ajá, ¿Es la fineza?
EUSEBIO: Es la fineza, o bien el tipo de cascarilla que se le pone al producto.
COB: Ah! OK.
EUSEBIO: Y dentro del molino ahí puedes ver texturas.
COB: Si viene mal, ¿ustedes que hacen o que pasa?
EUSEBIO: O sea si está mal la molienda, nosotros lo reportamos con los jefes de molienda.
COB: OK. ¿Qué otra cosa ven ustedes, aparte de la fineza?
EUSEBIO: El tipo de mojado, la humedad que trae o que tanto hay que mojarlo.
COB: Y esa como es, ¿cómo es esa relación, o sea si viene más húmedo es más esponjado, o como es la cosa?
EUSEBIO: Si, o sea si viene más húmedo es más poco.
VIDAL: O sea mientras más líquido traiga se puede apelmasar o hacer más compacto.
COB: Y para ustedes eso les beneficia o les perjudica que venga muy húmedo?
EUSEBIO: Bueno nos beneficia en que el empacado es más rápido y es más compacto pero no, ¿cómo decirle?... nos perjudica también que ya después, en determinado tipo de almacenamiento, hay varios que no pesan es por eso que nosotros hacemos el muestreo de los distintos pesos y vemos la diferencia de lo que merma cuando empacan.
COB: Y ¿cómo cuanto es la diferencia?
EUSEBIO: 100 gramos.
COB: Entonces tenemos aquí humedad, tenemos el tipo de molienda, la textura todo eso ¿algo más?
EUSEBIO: Nada más en el empacado, que vaya correctamente. El peso correcto.
COB: ¿El peso lo ven en los costales?
EUSEBIO: Si por eso hacemos el muestreo, porque mucha gente antes empacaba mal.Más o menos de cada cien sacamos uno y vemos si no esta en el peso sacamos otro.
COB: Dentro del proceso, ustedes lo que hacen es tomarlo de los silos y meterlo a los costales, ¿qué problemas o que cosas han visto en este proceso?
EUSEBIO: El problema que tenemos es de que muchas veces los tubos, los conductos se llegan a tapar y hay muchos que son muy dificultosos para destapar.
ARACELI: ¿Por qué se tapan? ¿ por la humedad?
EUSEBIO: Por la humedad, se apelmazan y es como si se pusiera yeso con agua y se compacta.
ALEJANDRA: ¿Tarda mucho en destaparse?
EUSEBIO: Si, porque necesitamos localizar primero la falla y después necesitamos buscar la herramienta y tenerla lista para desarmar , armar y destapar.
ARACELI: ¿No se podría hacer algo para evitar eso?
EUSEBIO: Las tolvas tienen básculas automáticas, las del molino dos, pero muchas veces depende, le digo de la humedad y no es culpa ni de nosotros ni es culpa de los empacadores, hay varias fallas por lo que los costales que salen de 100gms. menos, 50 gms menos hasta 100 gms más.
ALEJANDRA: Pero eso es por la humedad; y eso ¿no lo pueden controlar ustedes?
EUSEBIO: Pues lo podemos controlar poniendo peso exacto en las básculas nosotros mientras esté

saliendo asi, pero cuando ya vuelve a salir bien entonces hay que volver a ajustar la máquina y no tendría caso, entonces lo que hacemos es un variante de almacenamiento nada más para no estar ni moviendo ni desajustando las máquinas; en eso nos basamos nosotros. Y hacemos el reporte igual, si a tales horas el producto salió con más humedad, para no tener problemas.

COB: Ahí trabajan con aire, verdad. ¿tiene problemas con el aire o algo asi?

EUSEBIO: No es muy raro cuando hay problemas de aire.

VIDAL: Con lo que tenemos problemas es con la luz. Hay muchos apagones.

ARACELI: Tarda mucho en prender la maquinita, o sea, regresa la luz y luego luego enciende la máquina?

EUSEBIO: No, no, es que cuando se va la luz el molino tiene sistema de protección, entonces nosotros tenemos que ver a los jefes de molienda para que ellos lo restablezcan en la estación que está abajo, y luego lo restablecen y ya podemos trabajar aunque el molino este parado.

ARACELI: Y, ¿eso es mucho tiempo, lleva mucho tiempo mientras que...?

EUSEBIO: No, no es mucho tiempo, digamos que en cada apagón perdemos cinco o diez minutos, mientras buscamos al jefe de turno y lo restablecen.

ALEJANDRA: ¿Pero sí son seguidos?

EUSEBIO: No, no muy seguidos, pero si últimamente si han causado problemas.

COB: ¿Ustedes controlan la presión del vacio, y todo eso?

EUSEBIO: En los empacadores del molino uno es por peso igual, a parte de eso se checa el peso al empacarlo; los empacadores a la hora de que sale de la tolva lo vuelven a meter a la báscula para ahorrarnos problemas, luego venian gentes y nos reclamaban.

COB: Entonces el problema principal que tienen ustedes es la humedad. Algo más que nos quieran comentar?

EUSEBIO: Pues lo que nos comentaba la señorita; de cada cuanto se hacia la limpieza de los silos; y se hacen cada treinta máximo cada cuarenta días dependiendo el tipo de harina que se esté trabajando y el tipo de molienda que se esté utilizando.

ALEJANDRA: ¿Usted está en los dos almacenes; en el de trigo y el de empacado?

EUSEBIO: No. Estoy en las empacadoras. Antes trabajaba en Conasupo.

ALEJANDRA: ¿Qué mejoras o diferencias ves entre esta empresa y donde estuviste antes trabajando?

EUSEBIO: Las mejoras que ví, es que aquí esta mejor la carga para el camión. El envasado también es muy diferente aquí.

ARACELI: Usted que ya tiene tres años, ve que las cosas han mejorado en lo que ustedes hacen; usted que ha visto,ha mejorado o sigue igual?

VIDAL: Ha mejorado; yo cuando llegue este, estaban más feos los molinos, ya los han ido reparando más.

COB: Y esas reparaciones ustedes sugieren algunas modificaciones? o quienes las coordinan?

EUSEBIO: No; esas las coordinan los mecánicos.

COB: Si tienen algún problema en el proceso acuden a los de mantenimiento, o lo resuelven ustedes?

EUSEBIO: No, hay que acudir a los de mantenimiento.

ALEJANDRA: ¿Ustedes consideran que en el almacen hay suficientes empleados y trabajadores?

EUSEBIO: Estando la gente completa no hay problema.

ALEJANDRA: ¿Faltan mucho?

EUSEBIO: Si están completos, lo que pasa es que dieron de baja a muchos, o se fueron a otro trabajo, entonces hay que enseñar a los nuevos.

ARACELI: ¿Se tardan mucho en enseñar a la gente nueva que llega?

EUSEBIO: Bueno casi no, y no es muy pesada su tarea; o sea no es muy laboriosa en cuanto a que tengan que aprender muchas cosas; además los muchachos les enseñan.

ARACELI: ¿Y por que se van, los tratan mal?

EUSEBIO: No, es que muchas veces el trabajo es un poco pesado. Es que hay gente que ya tiene experiencia, entonces es más rápido, no hay que revisarlo tanto en cambio una persona nueva hay que enseñarle tiene más errores.

COB: ¿Qué tipo de errores?

EUSEBIO: Puede ser que como no están acostumbrados y con tal de querer avanzar no lo pesen corréctamente; otro error puede ser que como hay que hacer las estivas más o menos altas, si no saben hacerlas se caen. Por eso se les da trabajos más ligeros, más fáciles de hacer y enseñarles poco a poco y así cuando la gente de experiencia no pueda venir ya se sustituye, lo que hacemos es poner una gente nueva y una que ya tenga experiencia, para que los ayuden. Así nos ahorramos tiempo.
ALEJANDRA: ¿Qué medidas propondrían para los problemas que ustedes ven?
EUSEBIO: Yo pienso que lo único que podemos hacer es tratar de exigirle un poco más a la gente en cuanto ha que tengan un poco más de responsabilidades al hacer las cosas, porque muchas veces no es de la máquina sino de ellos.
ALEJANDRA: ¿Ha habido cargas o entregas que se regresen por el mal peso?
EUSEBIO: Algunas veces en los que salen de harina.
ALEJANDRA: ¿Y los vuelven a llenar?
EUSEBIO: Se vuelven a abrir, se checa el peso y se llenan.
COB: ¿Ustedes de quien reciben el programa de producción?
EUSEBIO: Tenemos un jefe inmediato, nosotros dependemos directamente de él y a parte tenemos un jefe de almacén y el jefe de ventas o bien nos dice a nosotros o al jefe de almacen lo que va hacer en cuanto a carga. Pasamos todos los reportes con el jefe de almacen y él da el visto bueno.
ARACELI: ¿Usted cree que si los motivaran con algo mejorarían?
EUSEBIO: En algunas fábricas la motivación para el empleado es muy importante; si estaría bien que nos motivaran un poco más.
ARACELI: Eso haría que no se fueran de aquí, que no faltaran...
EUSEBIO: Exactamente. Una de las cosas sería en cuanto a puntualidad o a asistencia que le llaman; en algunas fábricas hay premios por puntualidad...
ARACELI: ¿Y a ustedes les gustaria tener eso?
EUSEBIO: Bueno a quien no le gustaria, a quien le dan pan que llore. Pienso que todos vienen por ganar dinero o por una necesidad que tenemos todos, sino no estariamos aquí. Entonces, por decir algo, si me dieran un premio por venir toda la semana sin faltar yo por ganar el premio vengo toda la semana, de todos modos tengo que venir y si hay premios por llegar temprano pues con mucho más razón. Son tipos de motivaciones que muchas veces sí resultan otras veces no resultan.
ALEJANDRA: ¿Ustedes creen que puede aumentar la rapidez en la productividad?
EUSEBIO: Puede aumentar, pero si es más la molienda necesitamos también un poco más de personal y calcular los tipos de envase que vaya a ser.
ALEJANDRA: Sí, pero por ejemplo la gente que trabaja ahí puede dar un poco más de sí y aumentando un poquito más dependiendo si la molienda ...
EUSEBIO: Si, o sea durante un tiempo lo van a hacer, y van a estar conscientes de que lo tienen que hacer pero tampoco les vamos a exigir más de lo que es posible que nos den. Por ejemplo si nosotros les estamos exigiendo 700 piezas no creo que de la noche a la mañana nos vayan a sacar 1000 piezas que es lo que tiene que ir.
ARACELI: ¿Las máquinas tienen capacidad para producir más, o sea no es nada de la máquina?
EUSEBIO: No, o sea, la maquinaria esta bien lo que hariamos es meter más gente en el empaque, digamos tenemos dos gentes meter tres para repartir más el trabajo entre los tres; sería más rápido, más producción, dependiendo del tipo de molienda también. Si porque también dejarlos en un solo lugar, creo que a nadie le gusta estar en un solo lugar.
ARACELI: ¿No le gustaria que lo capacitaran, que viniera gente ha enseñarle más cosas?
EUSEBIO: Pues si estaría bien, en cuanto a referencias al mismo molino porque si no volvemos a lo mismo, no tendría caso capacitarlos y que se fueran a otro lado, sería ahora si un gasto en balde para todos. Pero si estaría bien que hicieran cursos de capacitación.
ARACELI: ¿A usted que le gustaria que le enseñaran?
EUSEBIO: A mi me gustaría aprender lo de molienda.
ARACELI: ¿Y a usted qué?
COB: ¿Siempre han estado dentro de la misma área?

VIDAL: No, he estado de cargador en el patio, de cargador en el almacén y ahorita también.
COB: ¿Hace cuanto que esta ahí?
VIDAL: Ya voy para el año.

Company: Eaton
Group: Impulsivos
Participants: COB, Silverio Cedillo
Date: 211093

1. How frequently have you done or tried to do something to imporve the process? Desde que se inciaron los grupos de trabajo se está tratando de mejorar constantemente.

2. *What have you or your group done or tried?* Modificar modelos, Mejorar las Impresiones de los Previos y Marcar Referencias Visuales; todos en el primer semestre de 1993. LAs referencias visuales eran necesarias porque de lo contrario se dependia de la habilidad del trabajador.

2a. *Cuando se encontraba ud. realizando las mejoras anteriores, que actividades realizó que resultados esperaba, porqué dió por terminado el proyecto ?* Primero se hizo un diagrama de pescado y se encontró la causa. Después se implemento la solución. Una vez resuelto el problema se procedió a analizar otros problemas. Se dió por teminado el proyecto una vez que se notó una reducción significativa en el porcentaje de defectos. Satisfecho con los resultados.

5. ¿Qué nuevas tecnologías han llegado a su lugar de trabajo? Afirma que ha habido pocos cambios. Principalmente se ha limitado a mejorar mantenimiento y habilitar maquinaria.

6. ¿La libertad para adaptar siempre ha sido así ? No se mencionó el concepto de adaptación.

7. ¿Ha habido cambios en la forma de realizar su trabajo que no incluyan maquinaria? Cuales ? Esencialemente mantenimiento. Antes no se realizaba y ahora si. El mantenimiento consiste en programar el mantenimiento en función del programa de producción.

8. ¿Cuando necesita ud. ayuda o información técnica acerca del proceso, que hace ? Si la información requerida es en relación a maquinaria, se llama al proveedor de equipo; si es un problema de diseño o moldes, se llama a la gente de ingeniería industrial o de ingeniería de planta o a Servicio de Manufactura; y si no se encuentra respuesta, se procede a una reunión con los departamentos adecuados para obtener la información adecuada.

10. ¿Cuánto tiempo tiene ud aquí? 14 *años*

11. ¿Quién es la gente que considera ud cercana a ud (amigos)? Los amigos son los de la infancia; aquí es solamente relación laboral. Se hace una junta semanal con los "muchachos" en la cual a veces se dan chascarrillos para romper el hielo. Si se requiere de alguien para un problema se le convoca por minuta.

12. ¿A quién pide o de quien recibe ud información acerca de sus labores diarias (como metas de producción, etcétera)? De acuerdo al programa de producción se procura tener el herramental a tiempo. Otras ordenes se reciben directamente del jefe.

13. ¿Quienes considera que son los grupos o las personas que mas saben acerca del proceso? Considera que todos los que están en los Impulsivos son los que mas saben acerca del proceso para el problema particular. El grupo se forma tomando en cuenta los conocimientos de cada persona para un mejor desempeño.

14 ¿Cuanto tiempo fué capacitado para su trabajo? ¿Quién lo capacitó? Menciona que él trabajó en IUSA durante varios años donde lo capacitaron en aspectos técnicos, "casi de la mano";

ahí trabajó como tornero durante un tiempo. Después se fué a Monterrey, donde trabajó varios años. Regresó a Toluca y en Eaton ha recibido mayor capacitación. Consiera que la capacitación fundamental la recibió en IUSA y que después se actualizó en EATON. Actualmente se capacita leyendo manuales.

Actualemente el capacita en lo básico a los trabajadores nuevos; después se pasan un mes trabajando con trabajadores expertos y finalmente se "graduan".

15 *¿Quienes son las personas con quien realiza ud. su trabajo?* Los Impulsivos, otros grupos de trabajo, "los muchachos".

16 *En caso de que detectara que es necesario o posible hacer una mejora al proceso, como procedería?* Haría un estudio de la situación y propondría una sugerencia, que sería llevada a manufactura o al departamento que corresponda, para hacer un análisis conjunto; después se implantaría y una vez implantado se buscaría una nueva oportunidad de mejora. Los impulsivos intervendrían en parte en esto.

17 *¿Ha habido cambios en la composición del grupo? ¿Han sido importantes?¿Porqué?* Afirma qué prácticamente no ha habido cambios.

19 *¿Qué eventos o cosas importantes han ocurrido en esta empresa desde que ud. está aquí? ¿Cuales han sido las consecuencias?* La perspectiva del TLC ha dado lugar a cursos, de manera que la gente piensa de manera distinta. Esta perspectiva también ha ocasionado un aumento en la eficiencia, reducción de personal y mejora en la calidad.

20 *¿Existe alguna persona o grupo que consistentemente guie el cambio ?¿ Cómo lo hace ?* Afirma que se trabaja en conjunto, por lo que sería difícil señalar un grupo o persona; tal vez el director general pueda tomar ese papel: si el no quiere que se hagan las cosas, no se hacen.

21 *Comentarios adicionales.* No ofrece comentarios adicionales. Mencionó al incio que el objetivo del grupo es la reducción del scrap.

Company: Eaton
Group: Impulsivos
Participants: COB, Gustavo Escamilla
Date: 211093

conceptos: *adaptación* el concepto de adaptación se refiere no tanto a cambios al paquete tecnológico, sino a cambios físicos en el lugar donde se va a instalar la tecnología.

1. ¿Con qué frecuencia ha ud. hecho o intentado algo para mejorar el proceso? Constantemente se está pensando en mejoras.

2. ¿Qué ha hecho o intentado ud. o su grupo? (i) Reducción del exceso de calientamiento en una viga. Mediante un registro de temperatura en billets se reducen piezas quemadas. Agosto de 92. (ii) Pliegues en el producto. Se capacitó al operador y se pusieron unos topes; esto redujo el número de defectos.

2a. Cuando se encontraba ud. realizando las mejoras anteriores, que actividades realizó que resultados esperaba, porqué dió por terminado el proyecto ? Primero se obtuvo información estadística, se realizo un diagrama de Pareto y se encontró que el problema principal era la viga. Los resultados esperados eran positivos, ya que se cuenta con grupos integrados por personal de distintos departamentos. Se dió por terminado porque encontramos la causa del problema. Está satisfecho con los resultados.

5. ¿Qué nuevas tecnologías han llegado a su lugar de trabajo? Un lubricador automático. Es un robot que elimina personal. Se requirió una modificación que fué una cimentación adecuada.

6. ¿La libertad para adaptar siempre ha sido así ? Se tiene autoridad para adaptar porque el gerente de ingeniería de planta se encuentra en el equipo de trabajo. Siempre se ha tenido la libertad para adaptar.

7. ¿Ha habido cambios en la forma de realizar su trabajo que no incluyan maquinaria? Cuales ? Grupos de Trabajo.

8. ¿Cuando necesita ud. ayuda o información técnica acerca del proceso, que hace ? Desde hace dos años acude a Servicios de Manufactura, que se encarga de proyectos nuevos y modificaciones. Ellos tienen la información documentada. Si ellos no pueden proporcionar la información, lo que no ha sucedido hasta ahora, tiene confianza en que los Impulsivos le ayudaran a resolver el problema.

10. ¿Cuánto tiempo tiene ud aquí? 15 *años*

11. ¿Quién es la gente que considera ud cercana a ud (amigos)? Para efectos de trabajo, no considera que existan amistades. En caso de problemas se recurre al departamento responsable.

12. ¿A quién pide o de quien recibe ud información acerca de sus labores diarias (como metas de producción, etcétera)? De la gerencia de planta, de la cual se reciben objetivos mensuales.

13. ¿Quienes considera que son los grupos o las personas que mas saben acerca del proceso? La gente de Manufactua, Gustavo Escamilla. "Si llevo aquí 15 años es por algo."

14 ¿Cuanto tiempo fué capacitado para su trabajo? ¿Quién lo capacitó? Ha recibido capacitación

constante desde que entró. Si requiere capacitación en algo específico, la puede solicitar.

15 *¿Quienes son las personas con quien realiza ud. su trabajo?* Especialmente con los Impulsivos.

16 *En caso de que detectara que es necesario o posible hacer una mejora al proceso, como procedería?* Buscaría Información al respecto; la compartiría con el grupo junto con alguna sugerencia y esperaría retroalimentación del grupo.

17 *¿Ha habido cambios en la composición del grupo? ¿Han sido importantes? ¿Porqué?* Algunas personas salieron de la compañía; otros no quisieron "jalar". Estos últimos alegaban que tenían demasiado trabajo. Considera los cambios como benéficos, pues los que quedaron tuvieron que esforzarse para demostrar que realmente son los Impulsivos.

19 *¿Qué eventos o cosas importantes han ocurrido en esta empresa desde que ud. está aquí? ¿Cuales han sido las consecuencias?* No se preguntó

20 *¿Existe alguna persona o grupo que consistentemente guie el cambio ?¿ Cómo lo hace ?* Delta-Forge, mediante ayudas visuales y mejoras; Impulsivos, mediante información estadística; Corona-Piñón.

21 *Comentarios adicionales.* Mencionó espontaneamente que el objetivo del grupo es la reducción de scrap. El objetivo para diciembre es tener un porcentaje de scrap de 1.5%; actualmente está en 1.58% y cuando empezaron estaba en 2.4%.

La información de las mejoras al proceso está bien documentada y es accesible a los trabajadores.

En caso de problemas, suele llamarse a los trabajadores para oir su opinión.

Los grupos de trabajo son positivos. Se aprecia una considerable mejora respecto al periodo anterior. Los grupos de trabajo de distintos departamentos implican experiencia compartida.

Hubo algunos problemas con grupos de trabajodores; por ejemplo, el grupo Hércules II presentó problemas de participación, tal vez porque no hubo una decuada inducción. Sin embargo, Jasso resolvió este problema.

Las decisiones se guian en este grupo por la posibilidad de reducir el "scrap", sin descuidar la seguridad.

Company: Eaton
Group: SOL
Participants: COB, Arturo Villaseñor
Date: 261093

conceptos: *base* nucleo esencial del grupo/ *saber vs hacer*

1. ¿Con qué frecuencia ha ud. hecho o intentado algo para mejorar el proceso? Constantemente.(Se deduce de la lista de mejoras realizadas)

2. ¿Qué ha hecho o intentado ud. o su grupo? Los proyectos que se consideran mas interesantes son: Sistema de Alumbrado de Emergencia; Orden y Limpieza en la planta; Control de la Contaminación; Cambio de Actitud en cuanto a Seguridad.

2a. Cuando se encontraba ud. realizando las mejoras anteriores, que actividades realizó que resultados esperaba, porqué dió por terminado el proyecto ? Se raliza una reunión donde se ve qué problemas existen y se generan ideas; se nombran responsables de acuerdo a capacidad de acción; se consiguen recursos y se da seguimiento. Los cambios implantados nunca se dan por terminados, pues siempre son suceptibles de mejora. Solamente en el caso de eliminación de condiciones inseguras, como instalación de una escalera, se consideran terminadas una vez implantadas.

5. ¿Qué nuevas tecnologías han llegado a su lugar de trabajo? Una de las nuevas tecnologías que están llegando son las "salchichas" para recolectar líquidos como aceite y que se usan en la industria petrolera; por ahora están a prueba para sustituir trapos y aserrín.

También se han adaptado algunos filtros en máquinas; estos se usan directamente aunque cuando ha habido necesidad de adaptar, se han hecho las adaptaciones sin ningún problema.

6. ¿La libertad para adaptar siempre ha sido así ? En Eaton siempre ha habido esta posibilidad de hacer cambios y ha aumentado un poco desde que hay grupos de trabajo.

7. ¿Ha habido cambios en la forma de realizar su trabajo que no incluyan maquinaria? Cuales ?

8. ¿Cuando necesita ud. ayuda o información técnica acerca del proceso, que hace ? Se trata de resolver el problema internamente (en la empresa); si no es posible, se va a los catalogos, manuales, folletos, conferencias, etc; si aun así no se puede obtener la información necesaria, se recurre a los vendedores o expertos.

10. ¿Cuánto tiempo tiene ud aquí? 9.5 años

11. ¿Quién es la gente que considera ud cercana a ud (amigos)? Los muchachos, es decir, los subordinados. (Contestó inmediatamente, sin titubeos)

12. ¿A quién pide o de quien recibe ud información acerca de sus labores diarias (como metas de producción, etcétera)? Programa preventivo de mantenimiento; del jefe.

13. ¿Quienes considera que son los grupos o las personas que mas saben acerca del proceso? Como personas, el ingeniero de seguridad (Miguel Angel), Rocha y Fausino. Aclara que el hecho de que sean los que mas saben no signifca que sean los que mas hacen.

Considera que SOL es el grupo mas sólido en Eaton; reconoce que no conoce otros grupos y que el que sabe de eso es Jasso.

14 *¿Cuanto tiempo fué capacitado para su trabajo? ¿Quién lo capacitó?* Para efectos de su área de especialidad recibió capacitación en la escuela y después en Eaton. Como grupo, recibió Sicapacitación en Eaton en integración de grupos, métodos, etc, de acuerdo a los grupos SOL brasileños.

15 *¿Quienes son las personas con quien realiza ud. su trabajo?* Los muchachos realizan las tareas; el recibe información diaria de su jefe.

16 *En caso de que detectara que es necesario o posible hacer una mejora al proceso, como procedería?* Si la acción cae dentro de su area de decisión, actuaría individualmente, de inmediato, generando una orden de trabajo que ejecutarían los muchachos.

Si es un proyecto que implica inversión fuerte de dinero, se trataría de hacer una justificación, luego se buscaría la autorización; enseguida se buscarían los proveedores, se implantaría y se daría seguimiento. (Se le preguntó acerca del grupo SOL) El grupo SOL intervendría en la etapa de análisis, de donde surgirían los responsables, uno de los cuales puede ser el entrevistado.

17 *¿Ha habido cambios en la composición del grupo? ¿Han sido importantes?¿Porqué?* Si ha habido cambios pero han sido mínimos y no han afectado el desempeño del grupo. La **base** sigue siendo Gcias de planta, Gcias de Miniplanta, el médico, el ing de seguridad, etc.

19 *¿Qué eventos o cosas importantes han ocurrido en esta empresa desde que ud. está aquí? ¿Cuales han sido las consecuencias?* La legislación ecológica, que afecta directamente a este grupo; (se le preguntó si la implantación de grupos de trabajo había tenido algun efecto) contestó que si pero no precisó en que forma.

20 *¿Existe alguna persona o grupo que consistentemente guie el cambio ?¿ Cómo lo hace ?* El grupo SOL y cree que algunos grupos en Eje Trasero.

21 *Comentarios adicionales.* Es bueno trabajar en equipo. "Me gusta el futbol y voy a hacer una analogía: un futbolista puede ser bueno pero si además sabe trabajar en grupo, el equipo resultante es invencible."

Company: Eaton
Group: Geniecillos Brillantes
Participants: COB, Concepción, Roberto, Narciso y Antonio
Date: 220394

comments: This interview was held with the group during one of their sessions; the questions used were intended only as a guide to explore the issue. The members of the group, according to minutes are the following: Leobardo López, Concepción Gonzalez, Juan Vázquez, Lucas Nava, Oscar Montes de Oca, A. Avalos (Supervisor), Antonio Hidalgo and Rafael Gonzalez; they were not all present in the meeting because some were in the night shift. The respondents tended to drift from one subject to another, making it difficult to follow the questions in the order proposed. Since our intention was to gain confidence from the workers, we didn't interrupt them when they began drifting to other subjects; rather, we wrote down their answers and later edited them to match the corresponding questions.

Some of the anwers may not seem relevant to the issue of this work, but we left them there in order to have a taste of the context where technology diffusion is taking place. In some instances, the names of the respondents are given in parentheses.

1. ¿Con qué frecuencia ha ud. hecho o intentado algo para mejorar el proceso?

The respondents told us that they had had no time to meet regularly for some time now. They say that in one ocassion, a supervisor told them to stop meeting regularly, since there was no budget to support improvements.

comment: The respondents took some time to answer the question. This answer leads us to beleive that the concept of process improvement held by this group is associated with meetings and not really with PIEs.

2a. Cuando se encontraba ud. realizando las mejoras anteriores,

The respondents say that some objectives have not been met completely. In the case of the parts containers, they are not used properly; the suggestions about the amount to put in each container are not respected. In the case of the forklift scheduling, there has been considerable improvement. An in the case of the greasing machine, the respondents feel that the problem was not location but the machine itself, which has multiple leaks.

The respondents told us that they expected their results to be implemented in the firm; they feel that their part was done satisfactorily but that there was lack of support during implementation; for this reason, several PIEs have been abandoned. They agree that their ultimate objectives have not been meet.

As an example, they mention the subassembly carts, that are filled with the wrong parts and that parts that should be in the carts are not there; the ones that determine what material goes where are the supervisors or "chiefs".

comment: In the case of the greasing machine, the definition of the problem was not correct, which means that the group is not effective in that sense.

5. ¿Qué nuevas tecnologías han llegado a su lugar de trabajo? ¿Han sufrido adaptaciones estas tecnologías ?

comment: This question has already been explored in the minutes from the group.

6. ¿ Qué tanta libertad para adaptar ha tenido? ¿La libertad para adaptar siempre ha sido así ?

There is no freedom to adapt (Antonio).

There is a person that makes changes to his own benefit, but doesn't get close to the worker. We are never taken seriously, with facts. We don't talk because of fear: many of our supervisors take an authoritative stance and if we make comments they are not well taken. I believe that if I am making a mistake, the group is there to help me. If things go on this way, there will never be changes, in spite of the existence of groups (Narciso).

7. ¿Ha habido cambios en la forma de realizar su trabajo que no incluyan maquinaria?

comment: From the minutes of this group we concluded that the main change is the introduction of work groups.

8. ¿Cuando necesita ud. ayuda o información técnica acerca del proceso:
¿A quien pregunta ?
¿Por qué?
¿Alguien le dijo que así lo hiciera?
¿Siempre ha sido así?
¿Si esa persona no sabe, a quién recurre?

The respondents report that their main source in this respect is one of their fellow workers, Justino Menoza; he is their coordinator. Also their supervisor and the people from quality control are helpful.

10. ¿Cuánto tiempo tiene ud aquí?

Concepción, Roberto and Narciso have been in this firm for 3 years; Antonio has been here for 15 years.

11. ¿Quién es la gente que considera ud cercana a ud (amigos)?

comment: This question was not asked.

12. ¿A quién pide o de quien recibe ud información acerca de sus labores diarias (como metas de producción, etcétera)?¿A quien pregunta ?¿Por qué? ¿Alguien le dijo que así lo hiciera?¿Siempre ha sido así?

Our respondents told us that the main source of information for daily tasks is their supervisor; often, they already know what they have to do and do not need to ask him.

13. ¿Quienes considera que son los grupos o las personas que mas saben acerca del proceso? Qué puesto ocupan ?

commentt: As explained before, they consider that Justino Menoza, their coordinator, is the one who knows more about the process.

15 *¿Quienes son las personas con quien realiza ud. su trabajo diario?*

The persons with whom the resondents perform their daily tasks are the ones in the rear-axle assembly line; some of these belong to the group, other left after some time and the rest have never been in the group.

16 *En caso de que detectara que es necesario o posible hacer una mejora al proceso, como procedería?*

Our resondents feel that problems in the "group stuff" is so complex that there is no point in devising strategies for attacking problems. They think that the best would be that the "chiefs" would show up on a Saturday, to see how the workers are suggesting improvements could be made. There should be more open talks. The work group should be reinforced with new participants and instead of sending minutes, action should be taken.

17 *¿Ha habido cambios en la composición del grupo? ¿Han sido importantes?¿Porqué?*

The changes have occured for two reasons: first, some of the participants have quit because they did not like the environment of the group; second, some participants have been called in to acquire expertise in certain areas.

comments: This is further explored in question #1 of part C.

19 *¿Qué eventos o cosas importantes han ocurrido en esta empresa desde que ud. está aquí? ¿Cuales han sido las consecuencias? (eventos)*

comment: This question has already been explored in the minutes from the group.

20 *¿Existe alguna persona o grupo que consistentemente guie el cambio ?¿ Cómo lo hace ?*

Our respondents report that the industrial engineering department has been promoting change in some ways; this group proposed some changes.

21 *¿ Qué papel desempeñan sus compañeros dentro del grupo ?(por nombres, quien es p.ej., "experto", "policia", etc.)*

Since there have been a lot of changes in the group, and the sessions have been interrupted several times, there has been no opportunity for roles to form. There is no communication among the memebers of the group; we are not "in".

22 *¿Estos papeles son los mismos en todas las circunstancias ? ¿ Como es que empezaron a jugar este papel ?*

Since there have been a lot of changes in the group, and the sessions have been interrupted several times, there has been no opportunity for roles to form.

23 *¿Todos en el grupo hacen o algunos sólo proponen y sugieren mientras que otros hacen?¿Porqué es así ?*

Since there have been a lot of changes in the group, and the sessions have been interrupted several times, there has been no opportunity for roles to form.

24 ¿Diría ud. que su grupo es ahora mas eficiente para manejar inforamción técnica? ¿Cómo lo mide?

Due to the changes in the group, the persons interviewed were not present in earlier times and have no reference in this respect.

25 ¿Acerca de herramientas de calidad (Pareto, Ishikawa, etc.) ¿cuales manejan? ¿Cuando?¿ porqué?

Three of our respondents told us that they didn´t use the tools; the fourth told us that in the begining, the fishbone diagram was used; he says that it is a very usefull tool, easy to use.

part B

1. ¿Piensa ud. que las actividades de mejora en las que actualmente está involucrado tendrán resultados positivos ?

Our respondents say that often they know some improvement will not work, but since the "chief" proposed it, they have to live with it; they do not feel confident enough to say "no" to some suggestions, since there may not be wage increases for them. "If there were more compensations for workers everything would be O.K. If we are told something one day and the opposite later, there is no case in making improvements."

2. ¿Qué resultado espera ud. de estas actividades ?

In general, our respondents felt that the goals of several PIEs have not been met, so that they did not feel that improvement is possible. They mentioned that a lack of interest and the "end-of-the-month" syndrome lead to a further decrease in interest and finally people begin blaming each other for lack of progress; there is no cooperation between the participants.

3. ¿Qué tan experto o preparado se considera ud. para el problema ?

Our respondents felt that they could propose suggestions for improvement within certain limits.

Part C: additional questions for the Geniecillos Brillantes Group

1. Antonio Hidalgo y Rafael González se integraron al equipo en 5/Mar/93 (El grupo se inició en 31/Ago/93). ¿ A que se debió esto ?¿ Se les llamó a ingresar al grupo o ellos lo pidieron ? ¿Tienen alguna habilidad especial ?

Our respondents told us that they were interested in having them in the group so that they realized that their demands to them were not exagerated and that there was no "politics" going on (Narciso).

A point was being explored outside this group about supply and forklift service. A new group was about to be formed but it was never formed and we were integrated to Geniecillos Brillantes without knowing why (Antonio).

2. *Al iniciar los cambios en montacargas, se suspendieron los otros esfuerzos o ya se habían terminado ?*

In general, our respondents felt that the goals of several PIEs have not been met, so that they did not feel that improvement is possible. They mentioned that a lack of interest and the "end-of-the-month" syndrome lead to a further decrease in interest and finally people begin blaming each other for lack of progress; there is no cooperation between the participants.

The respondents report that there is a lack of suport of supervision of what people are doing in terms of PIEs. They felt that workers do not count in this firm; supervisors and engineers should see the changes by themselves, not only on minutes.

comment: this answer leads us to believe that it is likely that the other PIEs were abandoned or simply were lying in a dormant state.

4. *En diversas ocasiones ustedes recibieron promesas de resultados (por ejemplo, los contenedores de baleros). ¿ Se cumplieron estas promesas ? Si no fué así ¿qué opina usted de esto?*

In several instances, our respondents said, "we would be satisfied not with promises but simply if the supervisors or managers would take time to answer our memoranda; often our messages are not even answered".

As an example, the respondents mention a plastic curtain that was promised for two months ago and nothing has happened; they feel that the responsible is not giving the adequate follow through to the acquisition process.

5. *Cuales son los procesos de mejora mas importantes de la siguiente lista ? Por qué empezaron con los marcados ?*

Contenedor de Baleros **
Engrasadora **
Máquina de Aceite
Carros para material de ensamble
Montacargas
Identificación de Gavetas

According to our informants, all of these are equally important.

6. *¿Ustedes prefieren buscar una solución primero entre ustedes, o prefieren recurrir primero a alguien que sepa mas del problema ?*

Normaly, the solutions come from the group; however, there is usually a lack of support for implementation.

7. *Algunos de los cambios que ustedes desarrollaron se han usado en otros departamentos ? ¿De qué manera se han comunicado estos avances ?*

Our respondents told us that they don't know; they never get a chance to see what other groups are doing.

APPENDIX IV: CODIFIED SESSION OF IMPULSIVOS (OCTOBER 7,1993)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1																																		
2	**Codified Session of Impulsivos, October 7th., 1993**																																	
3																																		
4			**norms**																															
5			reminds	1																									4	1				
6			asks																															
7	**participant**		shares																															
8			**decisions**																															
9			suggests																												2a			
10			asks f consensus																															
11			decides																															
12			accepts																			1										5		
13			rejects																															
14			**activities**																															
15			reports		4		4		4		4												4		4	2								
16			commits to																															
17			offers help																															
18			**information**																															
19			offers													3								2a										
20			asks for			2		3		2																								
21			complements									1		1			4		4		4													
22			contrasts										4					1		1														
23			**group maintenance**																															
24	**group**		makes notice																															
25	Impulsivos		solves conflict																															
26	**firm**		**facilitator/coord**																															
27	Eaton		asks for report																															
28			coordinates time																															
29	**date**		asks																															
30	Oct 7/93		**session maintenance**																															
31	**page**		tension release																															
32	1 of 5		hurries																								1							
33	| initiates		returns to subject												2																			
34	* interrupts		ends																															
35	- silence		expresses failure																															
36			expresses success																															
37			**nonrelevant behavior**																									4						
38			non-related statements																															
39			signs of absense																															
40			other																															
41			**comments**																															

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
42			**norms**																															
43			reminds																															
44			asks																															
45	**participant**		shares																															
46			**decisions**																															
47			suggests																				4											
48			asks f consensus																															
49			decides																															
50			accepts																					3										
51			regects																															
52			**activities**																															
53			reports	4																								4	4					
54			commits to																															
55			offers help																															
56			**information**																															
57			offers		2a		2a	-	2a			2																						
58			asks for			2				2	2a		3	2a	3		3								2a				2a				
59			complements																	2						4	3			1	4		
60			contrasts													2		4	3		3	4											
61			**group maintenance**																															
62	**group**		makes notice																															
63	Impulsivos		solves conflict																															
64	**firm**		**facilitator/coord**																															
65	Eaton		asks for report																															
66			coordinates time																															
67	**date**		asks																															
68	Oct 7/93		**session maintenance**																															
69	**page**		tension release																															
70	2 of 5		hurries																															
71	| initiates		returns to subject																															
72	* interrupts		ends																															
73	- silence		expresses failure																															
74			expresses success																															
75			**nonrelevant behavior**																															
76			non-related statements																															
77			signs of absense																															
78			other																															
79			**comments**																															

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
80			**norms**																														
81			reminds																														
82			asks																														
83	**participant**		shares																														
84			**decisions**																														
85			suggests				2a		1				2a											2a									
86			asks f consensus																														
87			decides																														
88			accepts														2a					4	4											
89			regects																														
90			**activities**																														
91			reports																														
92			commits to																														
93			offers help																														
94			**information**																														
95			offers		4			4																				1	2a				
96			asks for	2a		2a				1	4															2a						
97			complements									1		2a	1			1	1	2a	1					4					2a		
98			contrasts													1									4				4				
99			**group maintenance**																														
100	**group**		makes notice																														
101	Impulsivos		solves conflict																														
102	**firm**		**facilitator/coord**																														
103	Eaton		asks for report																														
104			coordinates time																														
105	**date**		asks																														
106	Oct 7/93		**session maintenance**																														
107	**page**		tension release																														
108	3 of 5		hurries																														
109	¡ initiates		returns to subject																														
110	* interrupts		ends																														
111	- silence		expresses failure																														
112			expresses success																														
113			**nonrelevant behavior**																														
114			non-related statements																														
115			signs of absense																														
116			other																														
117			**comments**																														

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
118			**norms**																															
119			reminds																															
120			asks																															
121	**participant**		shares																															
122			**decisions**																															
123			suggests											4											4									
124			asks f consensus																															
125			decides																															
126			accepts												2a								G											
127			regects																															
128			**activities**																															
129			reports														4												4	4	4	4		
130			commits to																															
131			offers help																															
132			**information**																															
133			offers		2a		3		3	3e						2a			4		4	3		2a		4								
134			asks for	1		1						1						2a		2a							2a							
135			complements																									4						
136			contrasts					3			1		2																					
137			**group maintenance**																															
138	**group**		makes notice																															
139	Impulsivos		solves conflict																															
140	**firm**		**facilitator/coord**																															
141	Eaton		asks for report																															
142			coordinates time																															
143	**date**		asks																															
144	Oct 7/93		**session maintenance**																															
145	**page**		tension release																															
146	4 of 5		hurries																															
147	| initiates		returns to subject																															
148	* interrupts		ends																															
149	- silence		expresses failure																															
150			expresses success																				T											
151			**nonrelevant behavior**																															
152			non-related statements																															
153			signs of absense																															
154			other																															
155			**comments**																															
156																																		

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
157			**norms**																														
158			reminds																														
159			asks																														
160	parts:		shares																							4							
161			**decisions**																														
162			suggests										2								1												
163			asks f consensus																														
164			decides																														
165			accepts																														
166			regects							3																							
167			**activities**																														
168			reports		3						4																						
169			commits to																														
170			offers help																														
171			**information**																														
172			offers									2																					
173			asks for			2a								3				3															
174			complements												2	2	3		3	4		2	4		4								
175			contrasts																					2									
176			**group maintainance**																														
177	group		makes notice																														
178			solves conflict																														
179	firm		**facilitator/coord**																														
180			asks for report						4																								
181			coordinates time																														
182	date		asks																														
183			**session maintnance**																														
184	page		tension release				T																					1					
185	5 of 5		hurries					4																									
186	| initiates		returns to subject																														
187	* interrupts		ends																								1						
188	- silence		expresses failure																														
189			expresses success																														
190			**nonrelevant beh**																														
191			non-related statements																														
192			signs of absense																														
193			other																														
194			signs of absense																														
195			other	1																													
196			**comments**																														

Note for cell A8:
1. Cedillo
2. Marco
3. Jorge
4. Enrique
2a. Jasso

Note for cell W36:
About procedures for tools; a step by step procedure is required before auditing.

Note for cell AC36:
About report of last week activities

Note for cell D41:
Reminds that participants in groups should not be aggresive

Note for cell E41:
Discussion about water based lubricant begins

Note for cell A46:
1. Cedillo
2. Marco
3. Jorge
4. Enrique
2a. Jasso

Note for cell D79:
About smoking lubricants

Note for cell G79:
Coment about a dangerous operation

Note for cell A84:
1. Cedillo
2. Marco
3. Jorge
4. Enrique
2a. Jasso

Note for cell I117:
I will intervene here. ("Aqui meto mi cuchara")

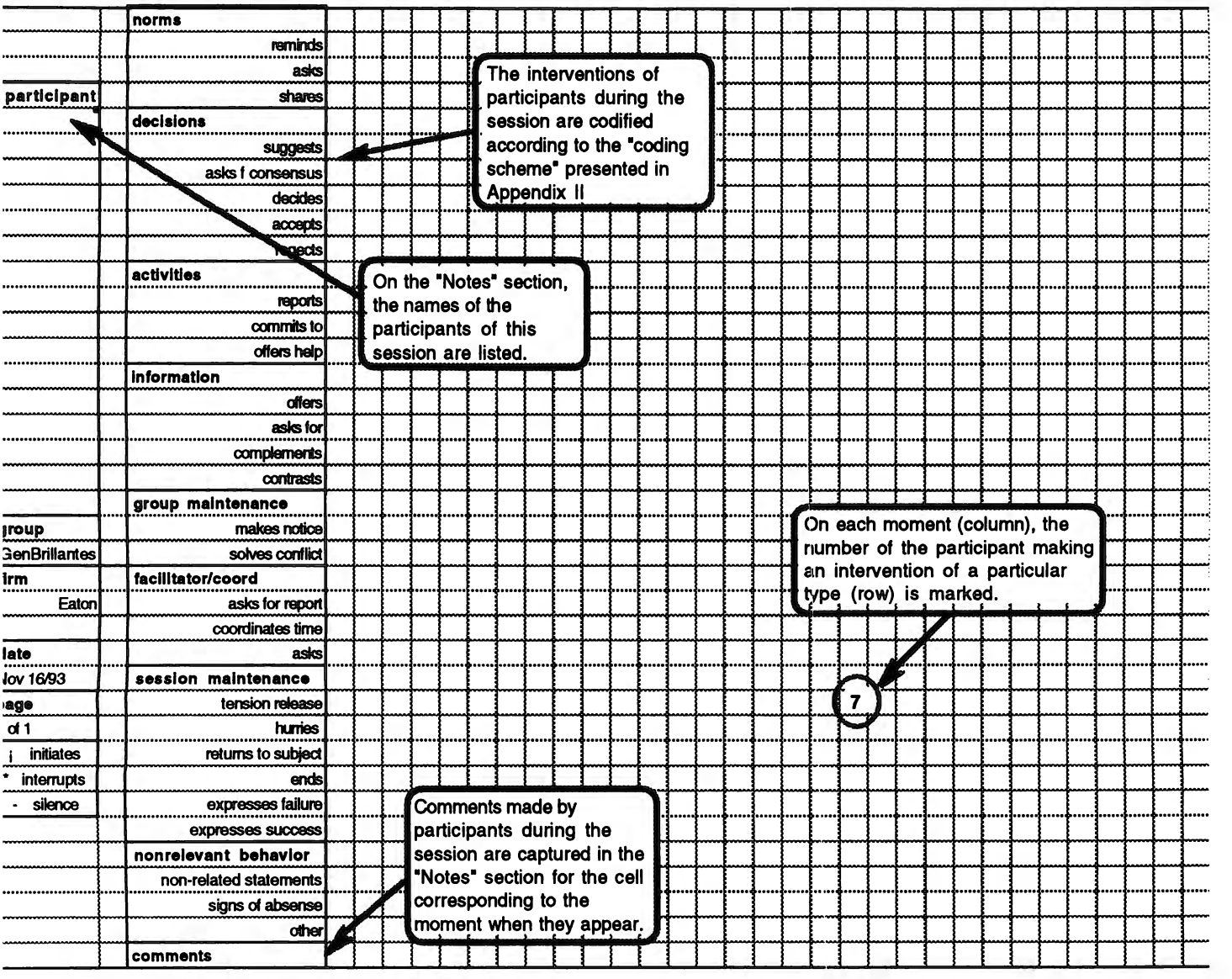
Note for cell K117:
About foundations for a machine

Note for cell A122:
1. Cedillo
2. Marco
3. Jorge
4. Enrique
2a. Jasso

Note for cell Z196:
About timeliness

Note for cell AB196:
About work schedule

APPENDIX V: MEETING OBSERVATION FORM EXPLANATION



APPENDIX VI: EVENT SEQUENCES FOR THE ALBATROS GROUP

Appendix VI: Events Sequence for the Albatros Group.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Event Sequences											
2	group: ALBATROS											
3	date	PIE1	PIE2	PIE3	PIE4	PIE5	PIE6	PIE7	PIE8	PIE9	PIE10	
4												
5	11192											
6	81192											
7	91192											
8	191192											
9	241192											
10	241192											
11	261192											
12	271192											
13	150193											
14	190193											
15	220193											
16	40293											
17	120293											
18	300493											
19	70593											
20	140593											
21	200593											
22	210593											
23	50693											
24	110693											
25	180693											
26	20793											

Note for cell B3:
PIE 1
Impact Wrenches
Llaves de Impacto

Note for cell C3:
PIE 2
Safety Devices
Dispositivos de Seguridad

Note for cell D3:
PIE 3
Impact Hammers
Martillos de Impacto

Note for cell E3:
PIE 4
Racks for Subassemblies
Racks para Subensambles

Note for cell F3:
PIE 5
Greasing Machine
Engrasadora

Note for cell G3:
PIE 6
Polipastos
POLIPASTOS

Note for cell H3:
PIE 7
Differential-Holder Height Caliber
Calibre para altura en portadiferencial

Note for cell I3:
PIE 8
Pinion Gear Holder
Brida Piñón

Note for cell J3:
PIE 9
Head Tester
Probadora de Cabezas

Note for cell K3:
PIE 10
Pneumatic Riveting Machine
Remachadora Neumatica

Note for cell B5:
1/Nov/92

Straighten Impact Wrenches

Enderezar llaves de impacto

Note for cell C5:
1/Nov/92
Investigate what issues related to safety devices with the responsibles.

Investigar lo relacionado a dispositivos con las personas responsables

Note for cell B6:
8/Nov/92
Memorandum to Jesus Rocha, asking for the instalation of a quick change line for the pneumatic equipment en all air supply valves, in order to reduce change time. Standarization of impact wrenches.
- - -
MEMO --> Jesus Rocha
Instalación de linea de cambios rápidos para equipo neumático en todas las tomas de arie, para reducir tiempo en cambio de llaves de impacto.

Estandarización de las llaves de impacto

Mantenimiento periódico de las llaves de impacto

Note for cell A7:
9/Nov/93
A talk about Impact tools for workers is Communicated

Aviso sobre platica de herramientas de impacto

Note for cell A8:
19/Nov/92
An organization chart will be obtained to know who are the area responsibles and whom the demands should be made to.

Se solicitará un organigrama de los responsables del area así como de los WG para saber a quien dirigirse para solicitudes.

Note for cell C8:
19/Nov/92
A comment about device 88912 was made; its shape is not adequate because time is lost.

The press located in the subassemblies area lack a device. It was removed for fixing it, but it hasn't arrived yet.

Additional investigation of support devices is suggested.

Proposal to send a memorandum about devices.
- - - - -
Se comentó acerca del dispositivo 88912 cuya forma no es adecuada porque se pierde tiempo.

Prensa ubicada en el area de subensamble de coronas sin dispositivo. La quitaron para arreglarlo pero no ha llegado.

Se propone seguir investigando dispositivos de apoyo.

Se propone enviar memo para dispositivos.

Note for cell D8:
19/Nov/92
The hammers used are not the right ones; these break down constantly.

A memorandum demanding a solution will be sent.
- - -
Martillos no son adecuados; se dañan constantemente.

Se enviará memo para solicitar solución.

Note for cell F8:
19/Nov/92
An investigation will be made about the problem that the greasing machine causes (this is a "field research" done by members fo the group, in this case, Ladis and Jorge).

Se investigará problema que causa engrasadora. (esta suele ser una investigación de campo por alguno de los miembros de grupo, en este caso Ladis y Jorge)

Note for cell D9:
24/Nov/92
A memorandum is sent to G.Dominguez (manufacturing engineering mgr.) about the hammers

MEMO --> G.Dominguez (ingeniería de manufactura) acerca de Martillos

Note for cell D10:
24/Nov/92
A memorandum is sent to A.Manzano (manufacturing engineer) asking urgently for a change of hammers.

MEMO --> A.Manzano donde Albatros solicita urgentemente el cambio de Martillos.

Note for cell D11:
26/11/92
A memorandum from A.Manzano informing that the 32 lb. hammers will arrive in January 1993 is received .

-->MEMO de A.Manzano (ing. de manufactura) donde informa que los martillos de 32 libras llegarán en Enero de 1993.

Note for cell A12:
27/11/92
There is no minute for this date.

No hay minuta

Note for cell A13:
15/Jan/93
A.Palma , from the Excelencia (support) group joins the meeting. He was called by the group to communicate him the demands of the group. He accepted to give support.

Asiste a la junta A.Palma, del grupo excelencia (apoyo eje trasero) que fué llamado para comunicarle peticiones. Acordó apoyar.

Note for cell A14:
19/Jan/93
A memorandum is sent to the Excelencia support group, where several issues are pointed out. The Albatros work group says it has been working, receiving an answer only in one of them; the rest are "frozen" for lack of support of those responsible.

MEMO --> Excelencia. Se señalan asuntos varios. El WG dice que se ha trabajado en algunos puntos obteniendo respuesta sólo en uno de ellos, quedando los demás estancados por falta de colaboración de los responsables.

Note for cell B14:
19/Jan/93
A note is made, specifying that impact wrenches are out of order.

Se hace mención de que las llaves de impacto están en mal estado.

Note for cell D14:
19/Jan/93
A note is made, specifying that impact hammers are out of order.

Se hace mención de que los martillos son inadecuados.

Note for cell E14:
19/Jan/93
A note is made, specifying that subassembly reacks are inadequate.

Racks Inadecuados

Note for cell F14:
19/Jan/93
A note is made, specifying that the greasing machine is out of order; the injection fails frequently.

Engrasadora en mal estado; falla la inyección.

Note for cell G14:
19/Jan/93
A note is made, specifying that polipastos are out of order.

Polipastos en mal estado.

Note for cell H14:
19/Jan/93
A note is made, specifying that a special caliber is needed for the differential holder.

Se requiere un calibre para determinar altura en portadiferencial.

Note for cell I14:
19/Jan/93
A note is made, specifying that the pinion holder fitting is unsafe.

Falta seguridad en la colocación de la brida del piñón.

Note for cell A15:
22/Jan/93
There is no minute for this date

No hay Minuta

Note for cell A16:
4/Feb/93
A monthly evaluation is made, yielding diverse observations. The group agrees to keep studying opportunity areas.

Se realiza una evaluación mensual, que arroja diversas observaciones. Se acuerda seguir estudiando areas de oportunidad.

Note for cell B16:
4/Feb/93
The instalation for quick changes in neumatic impact wrenches is ready. They will be in a trial period.

Holding rings for impact wrenches in the pinion gear and head are in place.
- - -
Se colocaron instalaciones de cambios rápidos en sistemas neumáticos de llaves de impacto. Están a prueba.

Se colocaron aros para sostén de llaves de impacto en el area de piñón y cabeza.

Note for cell C16:
4/Feb/93
Waiting for the crown subassembly press. Safety device is missing.

The analysis by the group of the assembly holders' safety devices is pending; some models will be modified.
- - -
En espera de prensa de subensamble de coronas. Falta dispositivo.

Pendiente estudio por parte de equipo a los dispositivos de ensamble de bridas para modificar algunos modelos.

Note for cell D16:
4/Feb/93
Waiting for the hammers.

En espera de Martillos

Note for cell E16:
4/Feb/93
The answer about racks is obtained; it is postponed for lack of funds.

Se obtuvo respuesta a la petición de racks. Pospuesta por alto costo.

Note for cell F16:
4/Feb/93
The greasing machine is put to work on trial.

Se pusieron a funcionar engrasadoras, quedando a prueba.

Note for cell J16:
4/Feb/93
The study about the probles that the head tester represents is pending.

Queda pendiente el estudio de los problemas que representa la probadora para su posible uso.

Note for cell A17:
12/Feb/94
There is no minute for this date.

No hubo minuta

Note for cell B18:
30/Apr/93
Failutes for lack of maintenance are detected in impact wrenches. Agreement to send a memorandum.

Se detectó que las fallas en las pistolas de impacto es por falta de mantenimiento. Se acordó enviar memo.

Note for cell C18:
30/Apr/94
The tooling table for the crown press must be of the sliding type, which is not the present design.

Para la prensa de coronas la mesa de dispositivos debe ser corrediza, lo que no sucede.

Note for cell F18:
30/APR/93
Studying the posibility of removing the greasing machine from the line and locate it in a dedicated area.

Se estudia la posibilidad de sacar la engrasadora de la linea para ponerla en un area exclusiva.

Note for cell J18:
30/Apr/93
Analyising the possibility of relocation to increase free space.

Se estudia la posibilidad de reubicarla para aumentar el espacio en el área.

Note for cell K18:
30/Apr/93
A larger rivet is desired

Se busca que el remache sea mayor.

Note for cell A19:
No hay Minuta

Note for cell A20:
14/May/93
The assembly line will receive maintenance next week.

El mantenimiento a la liena será la próxima semana.

Note for cell B20:
14/May/93
The standarization of impact keys was demanded.

The Industrial Engineering and Maintenance departments will analyze the best quick change tool for the task ivolved.

FMonroy will prepare an impact wrench to test it.
- - -
Se solicitó estandarización de llaves de impacto.

IngInd y Mnto estudiarán el tipo de cambio rápido mas adecuado para el trabajo a realizar.

FMonroy preparará una pistola para probar su funcionamiento.

Note for cell G20:
14/May/93
Answer is obtained about the polipastos bags.

Se obtuvo respuesta a las bolsas de polipastos.

Note for cell J20:
14/May/93
PHernandez and JMaya will study the way to design the tooling required in the head tester.

PHernandez y JMaya estudiarán la forma de diseñar un aditamento requerido en la probadoras de cabezas.

Note for cell K20:
14/May/93
The pneumatic riveting machine issue still pending.

Asunto de la remachadora neumática pendiente.

Note for cell A21:
20/May/93
A memmorandum is sent to Jasso, informing that the following persons are entering the group:
A.Legorreta, F.Monroy, P.Hernandez, J.Rico, A.Avalos.

MEMO-->Jasso. Se integran al equipo Aurelio Lgorreta, Faustino Monroy, Pedro Hernandez, Jose Rico, A. Avalos.

Note for cell A22:
21/May/93
There is no minute for this date.

No Hay Minuta

Note for cell A23:
5/Jun/93
A demand will be sent to the maintenance department, in order to have a person dedictated to this area.

Se hablará con mantenimiento para que mande una persona exclusiva a este depto.

Note for cell B23:
5/Jun/93
A comment is made about the quick change that is on trial; good results have been obtained, so that an agreement is reached to use these on every department that uses impact wrenches.

Se comentó sobre el cambio rápido que está a prueba, dando buenos resultados, quedando de acuerdo el *uso de* este cambio rápido en los deptos que usan pistolas neumaticas.

Note for cell C23:
5/Jun/93
Analysis of the possibility to increase the length of the crane in the crown area to make operations easier.

Se analizará la posibilidad de alargar el polipasto en el area de corona para facilitar operación

Note for cell G23:
5/Jun/93
A Legorreta will put a metalic bag as test in the crane used to lower the axles to the shopflooor.

ALegorreta mandará colocar una bolsa metalica como prueba en el polipasto con que bajan ejes.

Note for cell A24:
11/Jun/93
Failures in the manufacturing line will be observed; comments will be made during next session.

Se observarán fallas en la linea para comentar la siguiente sesión.

Note for cell B24:
11/Jun/93
Answer about quick changes received; A Legorreta informed that they will be installed in a few days.

Respuesta sobre cambios rápidos; ALegorreta informó que en pocos dias se instalarán.

Note for cell C24:
11/Jun/93
A quotation for cost for the increase in length in the crane for the crown area will be received next week .

La próxima semana se traerá cotización en respuesta al polipasto que se alargará en el área de coronas.

Note for cell G24:
11/Jun/93
A Legorreta informed that a suplier will bring a sample metalic bag for trial in the line.

ALegorreta informó que vendrá proveedor con una muestra de una bolsa metalica para ver su funcionamiento dentro de la linea.

Note for cell K24:
11/Jun/93
Next Friday the pneumatic riveting machine will be ready.

Sobre el funcionamiento de la Remachadora neumatica, el viernes quedará lista.

Note for cell A25:
18/Jun/93
There is no minute for this date

No hay minuta

Note for cell A26:
2/Jul/93
The talk with the Excelencia group was commented; in that talk the group exposed the need for more support.

Se comentó acerca de la plática que se tuvo con el grupo excelencia, donde se planteó necesidad de que se brinde mayor apoyo.

Note for cell G26:
2/Jul/93
A Legorreta made a commitment to change the crane bags for metalic bags, changing two bags per week until finished.

ALegorreta se comprometió a cambiar bolsas de polipastos por bolsas metalicas, cambiando 2 bolsas por semana hasta terminar.

APPENDIX VII: EVENT SEQUENCES FOR "GENIECILLOS BRILLANTES"

	A	B	C	D	E	F	G	H	I	J	K	L
1	GenBrill											
2	fecha	PIE1	PIE2	PIE3	PIE4	PIE5	PIE7	PIE9	PIE10	PIE11	PIE12	PIE13
3												
4	290193											
5	30293											
6	40293											
7	90293											
8	160293											
9	230293											
10	20393											
11	90393											
12	160393											
13	230393											
14	300393											
15	20493											
16	60493											
17	130493											
18	200493											
19	270493											
20	40593											
21	110593											
22	180593											
23	250593											
24	10693											
25	80693											
26	150693											
27	160693											
28	220693											
29	290693											
30	300693											
31	60793											
32	130793											
33	200793											
34	270793											
35	30893											
36	100893											
37	170893											
38	240893											
39	310893											
40	70993											
41	140993											
42	210993											
43	280993											
44	51093											
45	151093											

Note for cell B2:
Modificación al Contenedor de Baleros

Note for cell C2:
ALARGAR RIEL DE BALANCINES Y PISTOLAS PARA APRETAR EL ULTIMO EJE Y EL PRIMERO PARA REDUCIR ESFUERZO.

Note for cell D2:
NUT AND BOLT CONTAINER DESIGN

Note for cell E2:
PIE4 LOCALIZACION de ENGRASADORAS

Note for cell F2:
DESPLAZAMIENTO DEL FRESADO DE ALOJAMIENTO DE HORQUILLA

Note for cell G2:
DISPOSITIVO DE LLENADO DE ACEITE

Note for cell H2:
MATERIAL CONTAINER CARTS

Note for cell I2:
AIR HOSE CONNECTION FOR IMPACT WRENCH

Note for cell J2:
DELIMITATION OF AREAS FOR MATERIAL TEMPORARY STORAGE

Note for cell K2:
FORKLIFT OPERATION

Note for cell L2:
SPARE PART DRAWER IDENTIFICATION

Note for cell B4:
290193/1 Se sugiere la modificación al contenedor de baleros

Note for cell C4:
290193/2 Se sugiere hacer modificación.

Note for cell D4:
290193/3 Contenedor para tuercas, igual al de espaciadores y arandelas.

Note for cell B5:
030293/1 MEMO -> Gerardo Dominguez donde se pide apoyo para la modificacion. El Wg hizo un contenedor a prueba y es funcional, pero se requiren otros 7 y no tienen material ni tiempo.

Note for cell E5:
030293/6 MEMO-->Gerardo Dominguez se solicita area para engrasar baleros y evitar desperdicio de grasa.

Note for cell E6:
040293/4 Se elaboró croquis del anaquel.

Idea: Fabricar un anaquel para colocar subensamble de piñón de ataque.

Note for cell B12:
160393/1 Queda pendiente petición de contenedor tipo cigarrero para rodameintos de masa hasta tener resultados de engrasado en un area.

Note for cell E12:
160393/4 Se acuerda mover engrasadores para tener un solo lugar de engrasado y observar mejoras propuestas(temproal). Esto no afecta producción ni calidad.

Note for cell B13:
230393/1 En la próxima junta se dará respuesta a la fabricación de contenedores.

Note for cell E13:
230393/4 Resultados positivos con engrasadora en un solo lugar.
Reunión para comunicar de una sola engrasadora a montacarguistas/almacén/producción.

Note for cell F13:
230393/5 Se analizará el esplazamiento del fresado de alojamiento de horquilla.

Note for cell G13:
230393/7 Estudiar forma de acondicionar bancos de coronas.

Note for cell B14:
300393/1 En espera de respuesta de contenedores de rodamiento.

Note for cell F14:
300393/6 Dispositivo de llenado de aceite a ejes restringe espacios.

Note for cell G15:
020493/7 MEMO> Gerardo Domínguez.
Solicita información sobre dispositivo de llenado de aceite que restringe espacio porque se cruzan las operaciones.

Note for cell H15:
20493 Solicitud de mas carros para material DINA; se tienen con material Mercedes-Benz y produce equivocaciones.

Note for cell B17:
130493/1 Se hablará con A Cisneros acerca de los contenedores de rodamientos.

Note for cell G17:
130493/7 Solicitarán informes a Gerardo Domínguez acerca de máquina llenadora de aceite.

Note for cell H17:
130493/9 Respuesta más carros Dina.

Note for cell I17:
020493/10 Conectar manguera para llave de impacto en el techo (Tropezones).

Note for cell B18:
200493/1 Se cotizarán contenedores tipo cigarrero con un nuevo diseño que ahorre espacio y albergue 20-30 rodamientos al alcance del ensamblador de masas.

Note for cell E18:
200493/6 Analizar posibilidad de sacar engrasadora de la línea de ensamble y siguiente conexión que está en el suelo de ensable cabezas.

Note for cell H18:
200493/9 Acuerdo acerca del acondicionamiento de carros y contenedores de mat. en ensamble eje trasero.
Se cotizarán contenedores de rodamientos tipo cigarreras/.

Note for cell J18:
200493/11 Necesidad de delimitar áreas donde se acomodan rectas de los diferentes tipos de cabezas para facilitar acero.

Note for cell K23:
250593/12 Analizar mal servicio de almacén, montecarga, no hay coordinación en uso de equipo.

Note for cell K25:
080693/12 Surgió la idea de que el personal que trabaja en almacén debe saber la cantidad de material con que cuenta esa área.
Que haya 3 montecargas p/trabajo dividido sin presiones.
No hay coordinación del equipo.
Ausentismo montecarga por servicio a otro lugar o depto. y no queda guardia.
Solicitar a O. García que los insp. C.C. chequen los ejes al 100% estando en el transportador -cuando bajen los ejes ya están librados- mejor servicio del montecarguista pues se evitan movimientos innecesarios.
Montecarguista debe tener su base de manera que domine visualizando toda el área.
Se pedirá punto de vista a montecarguista.
Memo a J. Rocha pidiendo comprar metro preventivo a montecarga.

Note for cell K26:
150693/12 se solicitó a O. García colaboración para que hable con insp. C.C.
Se solicitará a todo el personal de prod. coordinarse con almacenistas para mejorar surtimiento, sobre todo en cambios repentinos.
F. morales (responsable almacén) acuerdo en estar en la línea para visualizar deficiencias en servicio de montacargas.
Se probará sugerencia surgida del wa para que un montacarga, ajuste, haga movimientos generales a la línea y otro los de la línea.
Montacarga hará recorridos cada determinado tiempo en el área de máquina para dar servicio requerido.
Mover hacia la pared la lámina de procesos de ensamble, porque estorba a los montacargas.

Note for cell K27:
160693/12 wa-> Jesús Rocha. Ingeniería de planta.
Solicitud para mejorar servicio de montacargas.

Note for cell K28:
220693/12 O. García habló de libración de ejes. Causas de no libración:
- Falla de materiales proveedores externos.
- Deficiencia enfundas.
El servicio de montacarguistas sigue deficiente, se le pide colaboración.

Note for cell K30:
300693/12 compromiso de A. Paz para programa de producción.
Libración de ejes es ahora mas eficiente pero falta mejorar.
A. Paz concientizando almacenista y montacarguista.

A. Paz y F. Morales estarán en la línea observando montacargas (A. Paz Conmits).
A. Paz informa que el montacarga se dedica a cabezas, traerá a la línea el material de proveedores internos y externos, de esta manera el otro montacargas estará siempre en la línea. *** de frenos y masas la hará otra persona.

Note for cell K31:
060793/12 El 03 de cada mes se entragará un programa calendarizado. -> B. R. hará un programa diario. -> almacén lo conocerá un día antes-> almacén prepara material.
B.R. plática con almacenista y montacarguista.
B.R propone stoch de aproximadamente 10 cabezas.

Note for cell L35:
030893/13 Se propone identificar de color diferente la gabeta de tuerca eje s-22; que es el mismo color que s-17.
ESTRUCTURA: Para dar mayor participación a los integrantes, se contratará coordinador y secretaria que se irán cambiando cada 2 ó 3 meses.
ORGANIZACION: Wa platicará con F. Pacheco/A. Avalos/A. Legorreta/F. Morales
Solicitan tiempo para añadir a sesión y como sustituirán a los que van a las juntas de sus áreas.

Note for cell K36:
100893/12 Cambios repentinos -< acumulación de materiales, se hablará con F. Morales para que lo recojan.

Note for cell L36:
100893-> Se sustituirá al personal cuando asista a la junta.
Identificación de gavetas.

Note for cell L38:
240893/13 ***
No se ha identificado gaveta.
Contratiempos en ensamble de piñones sugerencia: canastilla con stock para cambios repentinos. Se espera autorización por parte de ingeniería de procesos.

Note for cell L45:
151093/13 Anticipación en la programación a los diferentes ejes para ensamblar, facilita surtimiento 85% efectiva.
Identificación de gavetas pendiente <- cambios Eaton.

APPENDIX VIII: EVENT SEQUENCES FOR THE SOL GROUP

	A	B	C	D	E	F	G	H	I
1	SOL								
2	fecha	PIE1	PIE2	PIE4	PIE5	PIE6	PIE7	PIE9	PIE10
3									
4	80492								
5	140492								
6	210492								
7	280492								
8	50592								
9	70592								
10	120592								
11	140592								
12	190592								
13	260592								
14	20692								
15	90692								
16	160692								
17	230692								
18	300692								
19	70792								
20	140792								
21	210792								
22	280792								
23	40892								
24	110892								
25	180892								
26	250892								
27	10992								
28	80992								
29	150992								
30	220992								
31	290992								
32	61092								
33	131092								
34	201092								
35	271092								
36	31192								
37	101192								
38	171192								
39	241192								
40	11292								
41	81292								
42	151292								
43	221292								
44	291292								
45	50193								

	A	B	C	D	E	F	G	H	I
46	90193								
47	120193								
48	190193								
49	260193								
50	20293								
51	90293								
52	160293								
53	220293								
54	230293								
55	20393								
56	90393								
57	160393								
58	230393								
59	300393								
60	60493								
61	130493								
62	200493								
63	270493								
64	300493								
65	40593								
66	110593								
67	180593								
68	250593								
69	10693								
70	80693								
71	150693								
72	220693								
73	290693								
74	60793								
75	130793								
76	200793								
77	270793								
78	30893								
79	100893								
80	170893								
81	240893								
82	280893								
83	310893								
84	51093								
85	191093								
86	261093								

Note for cell B2:
Process Improvement Procedure Development

Note for cell C2:
Unsafe Condition Reduction

Note for cell D2:
Forklift Scheduling Improvement

Note for cell E2:
Polishing Machines

Note for cell F2:
Non-Smoking Lubricant

Note for cell G2:
Air Extractors

Note for cell I2:
Non-Poiting Products

Note for cell B9:
070592/1 Importancia del seguimiento a gráficas SOL.

070592/3 Seguridad presentará estadísticas de accidentes para su revisión e ir eliminando las causas.

Note for cell B10:
120592/1 Se llevará un pizarrón con áreas evaluadas para llevar control.

Note for cell B12:
190592/1 No hay minuta ni información acuerdo de la junta.

Note for cell B15:
090692/3 En la próxima junta serán analizadas las causas de accidentes y gráficos de siniestralidad.

090692/3 En la próxima junta serán analizadas las causas de accidentes y gráficos de siniestralidad.

Note for cell C15:
090692/2 Comité de seguimiento a condiciones inseguras dio un método que van a utilizar para evaluar; el avance se dará en la próxima junta.

Note for cell B16:
160692/1 Presentaron modificaciones a la hoja de auditoria SOL y fueron aprobadas.

160692/3
- Se solicitó al departamento de seguridad que incluya estadísticas de accidentes y las causas en que lo originaron, para la próxima junta.
- El departamento médico entregará hoja de accidentes a los supervisores para ser llenadas cuando ocurra un accidente y una vez llenas serán entregadas al departamento médico para tener estadísticas y causas.

Note for cell C16:
160692/2 El Comité de seguimiento a condiciones inseguras prometió entregar la siguiente junta el

método de evaluación.

Note for cell D16:
160692/4
-Relación en montacargas y condiciones de su operación.
- Relación de personal autorizado para operar montacargas.
- Identificación con licencia interna para los autorizados para operar montacargas.

Note for cell E16:
160692/5
- Establecer procedimiento para revisar discos abrasivos antes de montarlos en las pulidoras.
- Solicitar a mantenimiento que cuando revise una pulidora, haga constar que fueron checadas las revoluciones y que son las adecuadas para esos discos.
- Coordinar para que el proveedor de esos discos venga a EATON a dar una plática sobre el uso adecuado y normas de seguridad para el personal que los opera diariamente.
- Solicitar al supervisor que verifique revisiones con tacómetro al iniciar turno, utilicen pulidoras con guardia y que no las azoten en el piso.

Note for cell F16:
160692/6 El fabricante será cambiado por uno que no produzca mucho humo. La próxima semana llegará uno aprobado.

Note for cell G16:
160692/7 Los extractores no funcionan, se presume que se debe a los filtrol. Se checará próxima junta avance.

Note for cell D17:
230692/4
- Se presentará programa con G. Gantt con acciones para montacargas.
- Se averiguará si existe procedimiento para montacarguistas.

Note for cell E17:
230692/5 Pulidoras y discos abrasivos: 24 de junio darán capa los proveedores y se demostrará procedimiento de revisión y montaje. El procedimiento quedará a la vista.

Note for cell F17:
230692/6 El fabricante menor no ha llegado.

Note for cell G17:
2303692/7 Extractors: se sellarán campanas y se harán pruebas entre semana.

Note for cell B19:
070792/1
- Se decide que la junta se lleve a cabo según: 30min. minuta anterior/ 30 min discusión de causas.
- Se aprobó hoja de auditoria.
070792/12 Jesús Rocha ofrece llevar en la próxima junta un ejemplo para trabajar con la espina ISHIKAWA.

Note for cell B21:
210792/1
- Solicitud de asistencia.
- Se explicó procedimiento de auditoria.

Note for cell B22:
280792/1
- Impuntualidad -> no se leyó minuta.
- Reprogramación de fechas de avances.
- Se anunciaron auditorias.

Note for cell B23:
040892/1 De acuerdo con las estadísticas presentadas SOL deberá duplicar esfuerzos en las auditorias ¿Qué resultado se esperaba de auditoria?

040892/12 De acuerdo con las estadísticas presentadas SOL deberá duplicar esfuerzos en las auditorias ¿Qué resultado se esperaba de auditoria?

Note for cell B24:
110892/1 Se realizó auditoria a las áreas.

Note for cell B25:
180892/1 Se solicitó mayor aplicación al programa de avance.

Note for cell G28:
080992/9
- Se propone visitar empresas como Chrysler, dina, etc.
- Se mencionó los relacionado al problema de dados.

Note for cell H28:
080992/9
- Se propone visitar empresas como Chrysler, dina, etc.
- Se mencionó los relacionado al problema de dados.

Note for cell B30:
220992/1 Joel Alvarado solicita orden en manejo de materiales porque en auditoria de clientes ha ahbido problemas.

220992/3 Se nombran 3 elementos para que busquen causas SOL (formación de un subgrupo).

Note for cell G30:
220992/9
- F. Domínguez/Villaseñor están cotizando extractores para solucionar área de dados (humo).
- En próxima junta programa de visitas.

Note for cell H30:
220992/9
- F. Domínguez/Villaseñor están cotizando extractores para solucionar área de dados (humo).
- En próxima junta programa de visitas.

Note for cell B31:
290992/1
- C. Figueroa exhortó al grupo a manejar estadísticas como herramienta de TQ.
- Próxima junta: estadísticas.
- Revisión de programa.

Note for cell B32:
061092/12
- Se invita a Saúl Acosta para que provea información y seguir trabajando en estadísticas.

- Solicitar información estadística en accidentes de acuerdo al grado de semestralidad.
- Checar lista por área que se entregará a supervisor para que involucre operarios.

Note for cell B33:
131092/12
- En la próxima junta se hará una autoevaluación al equipo en cuento al número de integrantes para determinar si continua igual o se hacen modificaciones.
- Se presentaron estadísticas.

Note for cell B34:
201092/12
- La autoevaluación del desempeño del grupo en cuanto al alcance de objetivos -> satisfactoria.
- En estadísticas integrar accidentes IMSS e internos para plantear objetivos más ambiciosos.

Note for cell B35:
271092/1 Las auditorias serán realizadas por los equipos de trabajos ya formados.

Note for cell B37:
101192/1 Dos equipos de tres no han entregado auditoria.

101192/12
- Se aclara que no hubo minuta.
- Presentación de estadísticas.

Note for cell D37:
101192/4 Se presentará un video de los daños causados por los montacargas al material.

Note for cell C38:
171192/2 Se presenta un procedimiento para reportar actos peligrosos. En el un departamento de seguridad, tiene facultad de detener procesos, sí después de 3 notificaciones, el proceso no ha pasado a un estado seguro.

Note for cell D38:
171192/4
- Medidas resultado del resumen gráfico.
  - Colocar unidad móvil junto a la prensa.
  - Análisis de estibas en scrap.
- Programa de prevención a elaborar para montacargas.

Note for cell B39:
241192/1 Auditorias entregadas.

Note for cell D39:
241192/4
- Se creará programa de montacargas.

Note for cell B40:
011292/1 Solicitud de que se lleven hojas de auditoria diario.

ESTADOS	a nov 92
No. de accidentes	88
No. de días perdidos	2298
Población promedio	941
Incapacidades por dem.	0

011292/12 Se presentan estadísticas.

Note for cell B41:
081292/1
- Se solicitan auditorias
- Arizmendi dará un curso sobre el uso de bióxido de carbono al personal de Forja.

Note for cell B46:
090193/3 Se presenta forma para seguimiento al plan de acción que se aplicará a las causas de accidente en 1993.

Note for cell B47:
120193/12 Se presentaron estadísticas de 1993 y se logró objetivo -> reservado entusiasmo.

Note for cell B49:
260193/1
- Saúl Acosta exhortó al equipo SOL a que se dé difusión a las actividades y logros del equipo en '92.
- Dar más aplicación a gráficas o retirarlas.

Note for cell B50:
020293/1 Se realizarán gráficas de SOL, serán sustituidas por manta.
- Los resultados de las auditorias deberán mandarse antes del viernes.

Note for cell B52:
160293/3 Se presenta estudio de causa de accidentes.

Note for cell I53:
220293/10 Se envió memo a comedor solicitando uso de detergentes biodegradantes y evitar tirar desperdicio al drenaje.

Note for cell B55:
020393/1 Se solicitan resultados de la auditoria.

020393/12 se presentan estadísticas.

Note for cell C55:
020393/2 Se solicitan avances sobre acciones correctivas en prevención de accidentes.

Note for cell B59:
300393/1 Faltan grupos de entregar auditorias.

300393/12 Estadísticas de accidente.

Note for cell B61:
130493/3 Análisis de accidentes.

Note for cell B64:
300493/12 Estadísticas.

Note for cell B66:
A program for continuous improvement feedback is suggested; it is proposed to bring groups to SOL meetings to make people aware of the problems: people must get involved in solutions.

Note for cell B68:
250594/1 Ya se está llevando a cabo la retroalimentación en tableros.

Note for cell B72:
220693/12 Se ha notado un incremento en accidentes en los últimos 2 meses. Se exhorta a jefes de miniplanta a mejor control.

220693/3 Se ha notado un incremento en accidentes en los últimos 2 meses. Se exhorta a jefes de miniplanta a mejor control.

Note for cell B77:
270793/12 Estadísticas.

Note for cell D77:
200793/4
- Se pide apresurar manual de movimiento de materiales.
- Se mandarán fotos de análisis en movimiento de materiales.

Note for cell B78:
030893/3 Analizarán de Plan de Acción para corregir causa de accidentes.

Note for cell D78:
030893/4 Manual en mes y medio.

Note for cell B82:
280893/12
- SOL se vuelve a reunir semanalmente.
- Estadísticas.

Note for cell I82:
280893/10 Ampliamente en ecología (exposición de puntos Ara).

Note for cell I84:
051093/10
- Productos de los proveedores no deben contaminar (se solicitó).
- Se habló de responsabilidad de evitar la contaminación.
- Se conseguirán folletos alusivos a Ecología.

Note for cell B86:
261093/12 Estadísticas.

APPENDIX IX: GROUPS AT EATON

grp	name	type	reg. dat	purpose	dept.	plant	place
1	Impulsivos	APOYO	06/25/92	Reducción del índice de scrap	Varios	Forja	Capacitación
2	Competitivo	TRABAJO	'02/04/9	Incrementar productividad	Vigas	Ejes II	Eje delantero
3	Seguimiento Q-1	GERENCIA	10/30/92	Lograr procesos estables y hábiles	Producción	Ejes 1/2	Gcia. Planta
4	Impulsores 93	TRABAJO	08/27/92	Reducción scrap M16000	Martillos	Forja	Taller dados
5	Protección personal	APOYO	11/26/92	Disminuir consumo de E.P.P.	Varios	Ambas	Capacitación
6	Eje integral	APOYO	10/30/92	Eficientar línea puntas	Puntas	Ejes II	Eje delantero
7	Semiejes	TRABAJO	05/27/93	Procesos hábiles	Semiejes	Eje I	Eje trasero
8	Savings	APOYO	05/28/92	Reducción de costos	Varios	Ambas	Capacitación
9	Ases correctivos	TRABAJO	'02/04/9	Incrementar productividad	Vigas	Ejes II	Eje delantero
10	Ambiente sano	HIGIENE	04/28/93	No fumar en Eaton	Varios	Eaton	Dirección
11	Resucitadores	APOYO	'06/04/9	Reconstrucción maquinaria	Varios	Ejes 1y2	Capacitación
12	Fundas-htales.	APOYO	'04/06/9	Habilitar herramentales	Varios	Ejes II	Fundas
13	En busca del objet.	TRABAJO	'04/06/9	Incrementar productividad	Ens. E.D.	Ejes II	Fundas
14	Proyecto de frenos	APOYO	08/30/93	Seguim. proyecto de frenos	Varios	Ejes	Dirección
15	Cast iron	TRABAJO	02/22/93	Eliminar procesos rojos	Fundición	Ejes I	Eje trasero
16	Mensaje eaton	APOYO	10/30/92	Excelencia en Eaton	Varios	Ambas	Rec. Humanos
17	Fuerza positiva	TRABAJO	'08/04/9	S.O.L. en martillos	Martillos	Forja	Taller dados
18	Fundas 2000	TRABAJO	04/15/93	Lograr procesos hábiles	Fundas	Ejes II	Fundas
19	Geniecillos Brillan.	TRABAJO	08/31/92	S.O.L. ensamble eje tras.	Ens. Eje T	Eje I	Eje trasero
20	Unión puntas	TRABAJO	'02/04/9	S.O.L.	Puntas	Ejes II	Eje delantero
21	Deming	APOYO	'02/04/9	Implantar 100% C.E.P. en forja	Varios	Forja	Taller dados
22	Tratamientos T.	TRABAJO	'06/04/9	Incrementar productividad	Trat. Term.	Ejes I	Eje trasero
23	Hércules II	TRABAJO	'08/20/9	Reducción scrap M13000	Martillos	Forja	Taller dados
24	Asistencia perfecta	APOYO	05/28/92	Reducción ausentismo	Varios	Ambas	Rec. Humanos
25	Compañeros unidos	TRABAJO	'02/04/9	S.O.L.	Puntas	Ejes II	Eje delantero
26	Portadiferencial	TRABAJO	04/20/93	Optimización de procesos	Portadifer	Ejes I	Eje trasero
27	S.O.L.	APOYO	05/28/92	seguridad, orden y limpieza	Varios	Ambas	Capacitación
28	Exito	APOYO	'06/04/9	Eficientar soldadora por fricción	Varios	Fundas	Fundas
29	Apolo	APOYO	04/21/93	Actualización de diseños	Varios	Forja/Ej	Capacitación
30	Corona-Pinon	TRABAJO	11/23/92	Cumplir 100% programa	Corona-Piñ	Ejes	Eje trasero
31	Grupo unión	TRABAJO	09/25/92	S.O.L.	Lapeado	Ejes I	Eje trasero
32	Pioneros	TRABAJO	10/21/92	Cumplir 100% programa	Acabado	Forja	Taller dados
33	Fuerza de avance	TRABAJO	'02/04/9	Disminuir rechazo escareado cónico	Brazos	Ejes II	Eje delantero
34	Nóminas	APOYO	07/20/92	Prevenir errores en nómina	Varios	Ambas	Capacitación
35	Excelencia	APOYO	05/28/92	Eficientar ensamble eje trasero	Varios	Ejes	Capacitación
36	Fuerza 2000	TRABAJO	08/26/92	Reducción scrap línea de brazos	Línea Braz	Ejes II	Eje delantero
37	Unión y fuerza	TRABAJO	08/25/92	Reducción scrap vigas	Línea Viga	Ejes II	Eje delantero
38	Albatros	TRABAJO	08/24/92	Eficiencia ensamble eje trasero	Ens. Eje T	Ejes I	Eje trasero
39	Martillo 16000	TRABAJO	07/28/92	S.O.L. en martillos	Martillos	Forja	Taller dados
40	Delta forge	APOYO	06/26/92	Incrementar eficiencia	Varios	Forja	Capacitación
41	Muestras iniciales	APOYO	04/23/93	Implementar 100% muestras iniciale	Varios	Forja	Taller dados
42	Small gears	TRABAJO	02/22/93	Optimizar procesos	Engranes P	Ejes I	Eje trasero
43	Pace	APOYO	05/28/92	Planeación avanzada de calidad	Varios	Ejes	Capacitación

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