An Integrated Framework for Office Information Systems Design and Management

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ABSTRACT

Information Technologies are complex and this is true even in the smallest piece of equipment. But this kind of complexity is nothing compared with the one that arises when this technology interact with society. Office Automation has been traditionally considered as a technical field but there is no way to find solutions from a technical point of view when the problems are primarily social in their origin. Technology management has to change its focus from a pure technical perspective to a sociotechnical point of view.

To facilitate this change, we propose a model that allows a better understanding between the managerial and the technical world, offering a coherent, complete and integrated perspective of both. The base for this model is an unfolding of the complexity found in Information Technologies and a matching of these complexities with several levels considered within the Office, Office Automation and Human Factors dimensions. Each one of these domains is studied trough a set of distinctions that create a new and powerful understanding of its reality. Using this model we build up a map of Office Automation to be used not only by managers but also by technicians because the primary advantage of such a framework is that it allows a comprehensive evaluation of technology without requiring extensive technical knowledge. Thus, the model can be seen as principle for design and diagnosis of Office Automation and as a common reference for managers and specialists avoiding the severe limitations arising from the language used by the last.

1. Introduction

In the past few years, Office Automation has become one of the most important application areas of technology. There are several reasons for this, which have been studied in considerable depth by many authors, among others [2], [4], [13]; so we will not review them in detail. At the same time, however, we would like to emphasize the key role which the office plays in the development, evolution, competitiveness, and economy of an enterprise. The growing complexity of organizational environments; the trend towards an international market; the strength of regional differences; the need for a strong corporate identity; the capabilities required in order to survive in today's economy; these are only some of the factors which make Office Automation a basic strategic tool.

These factors alone are not "big news"; the advantages and disadvantages of technology have been discussed at length; however, as regards Office Automation, there is still something fuzzy -- unclear -- which prevents things from working as they should. Many managers are already aware of this fact, and it gives them good reason for fearing technology. Office Automation is necessary; there are sound reasons to see it as a solution to many problems in private and public organizations. Why, then, is it so difficult to implement technology in work environments; and so difficult as well to achieve an overall acceptance of the equipment? These and similar questions run counter to the traditional point of view concerning technology, in which it is portrayed as the solution to all ills; nonetheless, they are questions frequently posed by many managers, and they have no easy answer.

This is so because problems having a social and human component can not be solved from a strictly technical point of view. But to adopt a strictly social perspective is also a mistake, since Office Automation is an applied field of Information Technologies. Office Automation, as a field of study, requires the use of a conceptual framework as the starting point for technological and organizational design; a framework embracing both social and technical aspects, establishing between them the appropriate relations, and giving a global perspective of Office Automation and its reality. This is the goal of the present study: to develop a conceptual framework for managers, to allow both users and producers to work with a common and integrated understanding of what Office Automation is and what it implies.

2. What the manager needs is a powerful set of distinctions

If there is any application that can be considered to be a synthesis of Information Technologies, it is Office Automation. There is no better field for showing the need for a multidisciplinary, non-specialized and mainly generalist approach. The polyhedric and extremely complex character of Office Automation is obvious. And this character is the reason traditional technological and managerial methods alone are not sufficient.

Our proposal is to deal with Office Automation through a set of distinctions made within this domain. To make a distinction means to create our own domain of action and meaning, establishing our own bases for understanding that domain. Within Office

Automation many different aspects coexist which we will try to identify by means of these distinctions. At the same time, the perspective given by each distinction must be focused and related to the whole, in order to allow a richer and deeper picture of reality to surface. The proper management of Office Automation begins with the recognition of its many facets and of their projections over the organization where it is going to be implemented.

The set of distinctions is intended to be the skeleton of a new approach to Office Automation. It is neither a methodology nor an implementation system, but rather a conceptual framework for action and interpretation. Each one of the proposed distinctions will deal with a different facet, showing a new and integrated vision that can be considered as a part of a higher order distinction whose origin can be found in the questions posed at the beginning of this article. The reader's task, merely suggested, is to consider each of them and try to relate its meaning, of necessity abstract, to his own reality, developing in this way his own set of distinctions which, in the end, will be the one to use.

3. Understand complexity to understand technology

The are many reasons for considering technology a complex object. But, those reasons do not concern us here; what we are going to deal with is complexity itself. Any manager who keeps in touch with technology is aware of the facts: chaotic, ever changing and disorganized offers in the marketplace; incompatible equipment; lack of standards; inadequate systems for personnel needs; lack of human resources to deal with that technology; changes in the organization's structure due to the new technologies; lack of motivation among personnel to use the new equipment; and so forth.

All these facts make it very difficult to take full advantage of technology. And given that technology doesn't offer any help in solving those problems, it is the user -- especially the manager -- who has to choose a critical approach for discerning what is relevant to his needs. In most cases, technology models the user's needs and not the other way around, as it should be. This is so because there is no real understanding of what technological complexity is and what it implies. The manager lacks the conceptual tools to evaluate technology, its potential and its subjective value, established according to his needs. Here is where we propose the first distinction: a hierarchy of levels of complexity.

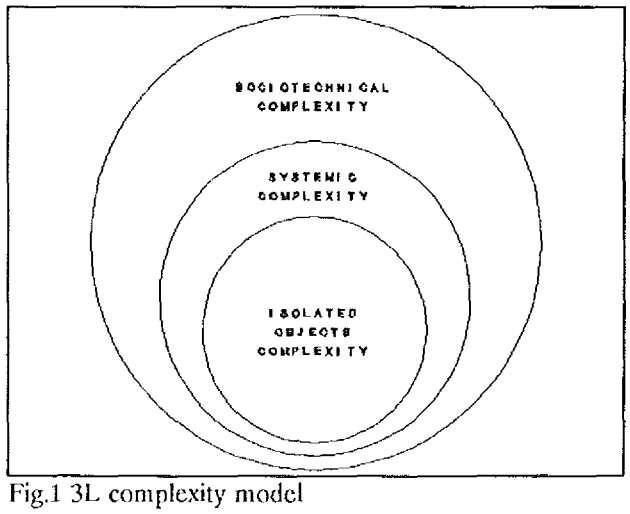

Fig.1 3L complexity model

Technology has a first level; that which deals with isolated objects. Considered separately, programs and computers, oriented to a narrow application such as text

processors, calculators, electronic agendas or electronic sheets, demonstrate a complexity level that we consider to be first level complexity. As far as the manager is concerned, these are applications with well defined goals and without any further complication. But this is not the only complexity level in technology; there are still two more, and these are of great interest to the manager.

When those isolated objects are joined together to build up a system, a set whose goal is not just text processing, for example, but to give support to some organization's functions, then what we define as systemic complexity arises. At this second level, we are dealing not with isolated objects and actions, but with a great number of technical connections and group activities and with the implications of facing those aspects. One example would be a set of computers running first level applications connected through a local network. They could be thought of as constituting a technological system. The last level stems from the interaction between technological systems and society. We refer to it as the sociotechnical complexity level. It is mainly at this level that the manager works, and it shows some characteristics that differ radically from those of the previous two. Here, all the fuzziness, lack of definition, incongruence and irrationality introduced by the human factor appear. Although strictly sociological in its origin, it must be taken into account that this is the highest level and that it includes the other two. These three levels represent three different kinds of complexity.

This model, which we call the 3-L model of complexity (three level model), was initially proposed in [13]. A brief study of its application to Office Automation can be found in [17] and a deeper one in [1] and [18]. We will use this model systematically in the remainder of this article.

3.1 Understand your own office ...

A basic step towards Office Automation is to have a clear idea about what kind of office tasks are going to be technologically supported. It is not the same to automate purely administrative tasks -- text processing, for example -- as to apply technology to decision-making; but surprisingly, both are Office Automation. Technology can only be correctly applied if there is a thorough knowledge of what you want to do and of what needs to be done, and this knowledge can only be achieved by knowing what it is in fact done in the office. Even if it sounds naive, this is one of the initial mistakes of many implementations: to buy technology and then to try to find out what to do with it.

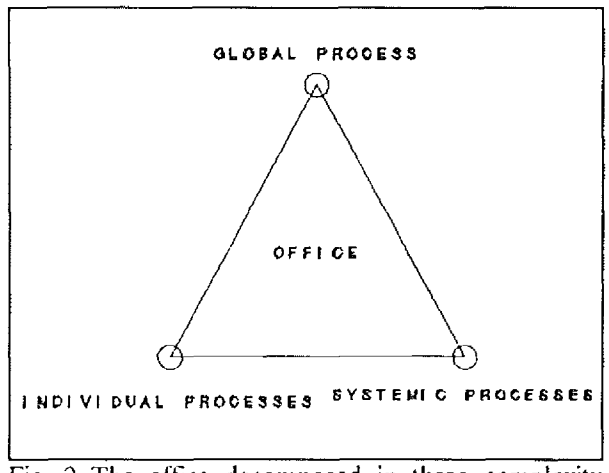

Fig. 2 The office decomposed in three complexity levels

There are many studies analyzing office tasks, with all kinds of detail: reading,

writing, making simple calculations, telephoning, mailing, meeting, filing and retrieving of information, and so on. Nevertheless, the office is more; much more. When offices are conceived only in terms of their manifest behaviour, shown by the above mentioned activities, there immediately arises a dissonance between technology and reality because the latter is much richer and has much more variety than the former.

Those activities are only the office's lowest level. They are part of what we call Individual Processes; tasks carried out in an isolated way and without any significant meaning in terms of the organization. No enterprise defines its activity in terms of reading and writing tasks, filing and retrieving, meeting and so on; why, then, does technology do so? Managers must of course be aware of these manifest activities, but their goals are set much higher.

Above these first level activities is something giving them meaning and coherence, which establishes goals through office functions. These are known as Systemic Processes, which are composed of several individual activities, communicating with each other, and connected to build up a process with meaning within the organization. It is not a matter of reading and writing, but of processing purchase orders, patents and financial reports, etc. To someone not familiar with office, the first things he notices are first level activities. As soon as he understands better "what is really going on" he starts to consider Systemic Processes. Managers deal only with Systemic Processes, not with Individual Processes, because their concern are the objectives to be met.

And there is yet another level, which encompasses the previous two. All those Systemic Processes must be coordinated to fulfill corporate requirements which affect the organization as a whole but not groups or individuals. It is the manager's task to translate these objectives into appropriate instructions for the Systemic Processes. Corporative requirements define a higher level activity that concerns the third level we distinguish in the office: the Global Process. This last level determines which Systemic Processes are to be used and how they are to be carried out; just as Systemic Processes define the Individual Processes to be undertaken. This view of the office is our second distinction, depicted in figure 2 and with the same hierarchical meaning of figure 1.

3.2 ... and then apply technology

The title should read "and then, and only then, apply technology". Only with a thorough understanding of the way each office works can technology be correctly applied. Each work environment has unique characteristics. There are, of course, several points in common among them all, but each case is special and "as individual as fingerprints" [20].

Office work is a product of the organization and it reflects its unique characteristics. Implemented technology must mirror, as far as possible, the environment's personality. Our third distinction has its origin in the previous one. Once the office is interpreted as a hierarchy of complexity levels, Office Automation can be seen as having a similar structure.

Despite the obvious existence of the levels described above, Office Automation

practice seems to recognize only the lowest level and, only recently has it become aware of the second one. There are many tools devoted to individual activities: text processors, electronic sheets, electronic agendas, graphic programs, laser printers, calculators, and so forth. All this technology is what we call the Tool Box, an accurate term given the situation. In the same way as a craftsman's tool box, the office Tool Box deals with very narrow problems; it is devoted to Individual Processes, and it is the user's task to integrate all these activities and supporting technologies to build up higher order functions. And, in the same way as the craftsman, the user sees technology as a partial solution to unrelated problems. The point is that much of current Office Automation is nothing more than a big tool box.

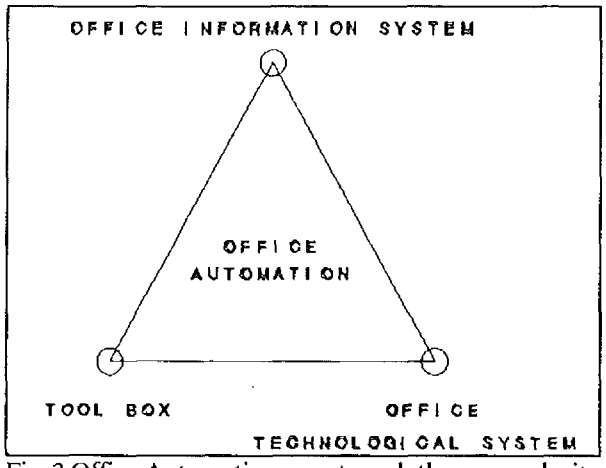

Fig. 3 Office Automation seen trough three complexity levels

If one accepts the highest activity levels considered above, one must admit that Office Automation should be much more than a Tool Box. The next level is related to Systemic Processes; to the relevant processes and functions found in an office. At this level, technology must offer Office Technological System, which means solutions in which different activities can be grouped together into a meaningful process.

And, for the same reasons, there should be a level in Office Automation for dealing with the Global Process. Nowadays, this is just wishful thinking; we are far from achieving this -- not only in technological terms but also in the organization's ability to understand this concept. We call this level Office Information Systems, and it is our intention to denote with it only those technologies taking into consideration the existence of all aforementioned levels and dealing with them in an appropriate way.

3.3 New Distinctions in Information Technologies

Information Technologies are the basis of Office Automation. Everything works as technology does, or so it seems, and moves to the rhythm of technology. Technology is not independent of the demands created by the user's needs, but it is also true that technology creates its own demands and applications. It is quite common to find technologies in search of applications.

To put it succinctly, technology is anything but neutral. It originates an uncontrolled dynamic of evolution which, if not correctly channeled, can be a source of real trouble to the organization. Very often it goes far beyond the users actual needs [7] and it is not uncommon to find inefficient, unworkable process hidden under the "provisions for the future" chapter.

Again, we have technology in search of applications, which means an excess of

power, low return on investment, lack of adaptation, unjustified difficulty of use and meager benefits from what technology has to offer.

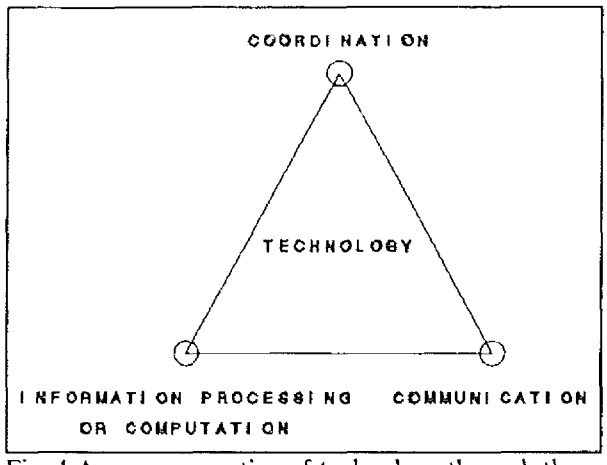

Fig. 4 A new perspective of technology through three complexity levels: the three C's

It can be argued that the idea that technology can answer our every need is utopian. And this would be true. But it is also true that, too often, technology either "overflows" the user's needs or doesn't fill them; probably because that user does not know how to pose his problems properly.

It is possible to classify technology into three groups and to relate these groups to the previously defined levels in Office and Office Automation. At the lowest level, which is devoted to Individual Processes and their technological counterpart, the Tool Box, we have Information Processing, which includes the storage, retrieval and management of information. This kind of technology can be generally found in Personal Computers and it is oriented towards individual applications.

At the second level we find Communication. When Individual Processes are combined to form Systemic Processes the need immediately arises for sufficient communication capability so as to allow individual activities to interchange information and integrate into a larger process. Thus, Communication is the basic component of Office Technological Systems and it becomes clear that the office is, mainly, a communication problem. Examples of this type of technology are Local Area Networks and Micro-Mainframe Links.

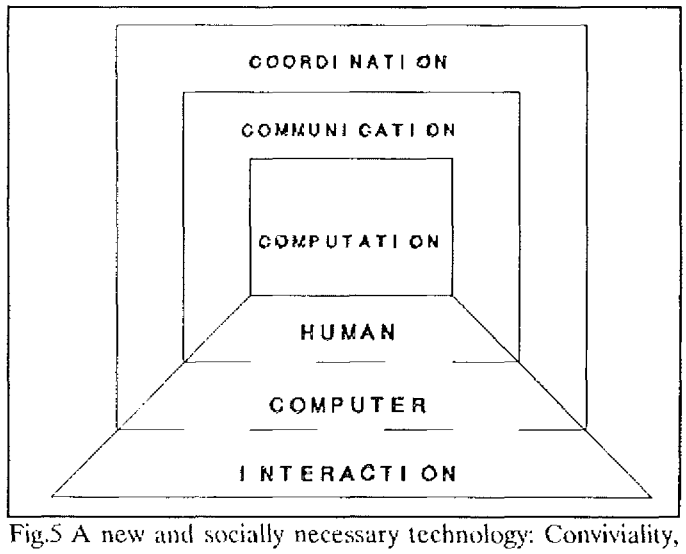

Fig.5 A new and socially necessary technology: Conviviality, the fourth C.

Coordination must be considered as belonging to the third level. Seen as a form of metacommunication, and given that its function is to organize the Systemic Processes to build the Global Process, the Office Information System, third level in Office Automation, must provide coordination facilities for orchestrating the two lower levels. The Office Information System is thus the global system (it encompasses all other levels) as is coordination technology, which encompasses any other technology from lower levels. And there is yet a fourth type of technology; one which makes the other three types usable and then viable. It is Humanization/Conviviality Technology -also known as Human Computer Interaction- and it deals with the human factor and with sociotechnical

complexity. It must provide ways to integrate machines with individuals and individuals within groups and organizations -- this is the reason it appears at all levels - these last considered in their social aspect and bearing in mind all the problems derived from human activities systems. This technology does not belong exclusively to any level.

From a more general point of view, we can consider these four types of technology as they relate to abstract information processors, such as T processors (information changing with time), F (changes in format) and S (changes in space) [8]. But in addition we must define two new processors in order to include human and social dimensions: M processors (changes in Meaning) and H processors (human processing of information). As we see it, all Man-Machines interfaces work as H processors. Figure 6, adapted from [18], illustrates this last point.

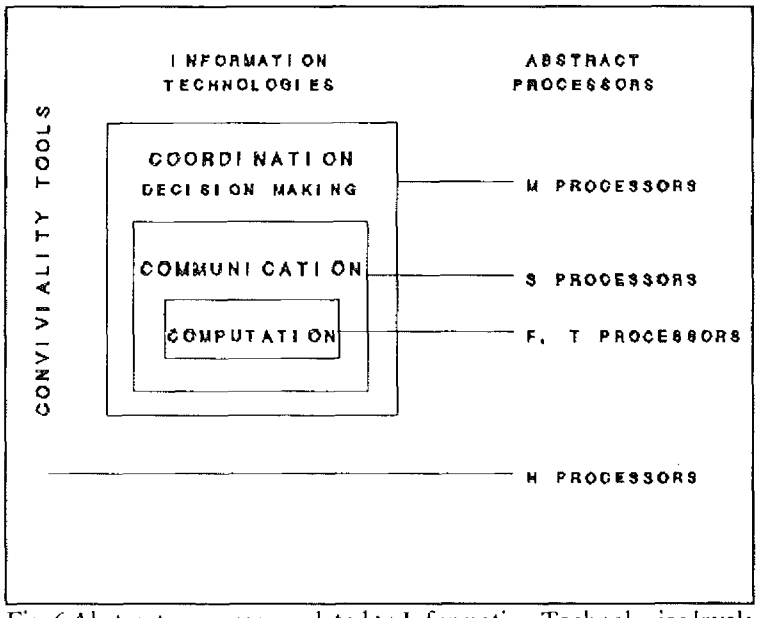

Fig. 6 Abstract processors related to Information Technologies levels

4. Linking distinctions: is your office a system ?

Currently, Office Automation ranks as one of the better resources for enhancing competitiveness in organizations. The famous 'technological innovation' is, in large part, based on Office Automation. But true Office Automation is much more than Kbytes of memory, KHz of processing speed or Mbits of transmission rates. While the technical side is vital, we shouldn't forget that computers don't work by themselves; that networks carry meaningful messages and not just bit strings; and that memories, with all their growing capacity, may contain useless information. And these problems are not going to be solved by your "nearest dealer". It can be seen that one of the key responsibilities of the manager is organizing Office Automation -- in this case Office Technology -- according to his organization's needs and peculiar culture.

There are no methods or methodologies for designing "ad hoc" or "prêt à porter" Office Automation. The proposed distinctions, ranging from complexity, office structure, and technology applications to technology, are intented to be the starting point of a conceptual framework used as a general principle for design and diagnosis of Office Automation. The goal is to give the managers a tool for bridging the gap between their interests and knowledge on the one hand and pure technology on the other, providing them with capabilities for evaluating, comparing and choosing the right thing, and having

a precise idea about offers and needs and getting, certainly, a bigger return on their investment. In order to achieve these goals, these dimensions or distinctions have to be considered as a whole and understood in terms of the appropriate links among them.

4.1 Three levels along four dimensions

The model we will follow from here is shown in figure 7, which integrates figures 2, 3 and 4. Human factors constitute a fourth dimension and they will always be placed in the highest vertex. At the base of the figure are the levels considered in Office, Office Automation and Technology.

As we have seen, the office encompasses three levels of complexity: individual processes, systemic processes and the global process. The lowest level, individual processes, is the most generic and even the most obvious one; some authors call this level "manifest aspects". Apart from some minimal details, individual processes are all the same for any organization, defining the basic framework of office work. This characteristic of generic and isolated activities caused us to consider the Tool Box as the technological counterpart of this level.

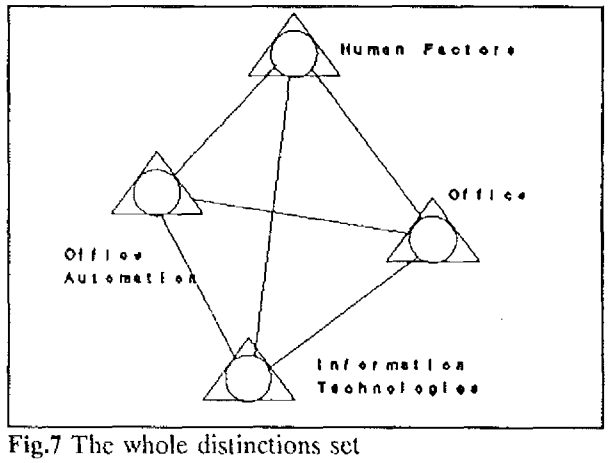

Fig.7 The whole distinctions set

The Tool Box consists of applications designed to work independently of other tasks -- a growing trend since the appearance of the Personal Computer -- and to support very specific activities (figure 8). Unfortunately, many organizations confuse the Tool Box with Office Automation and too many producers make their offers only in terms of this level.

This is the meaning of the question: is your office a system?. Every system is composed by simpler objects working together. In Office Automation, one must first surpass the Tool Box level in order to be able to deal with problems at the Systemic Processes and Office Technological System levels. Systemic Processes, as stated before, are the functions performed in the office, resulting from the integration of several individual activities into a higher order task. The number of lines written each day or the improvements achieved in the

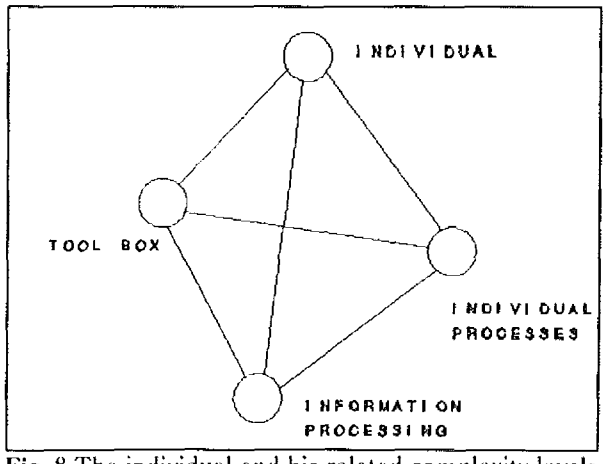

Fig. 8 The individual and his related complexity levels

quality of graphics is of little importance here. What really counts is in the number of valid reports produced; the number of patents processed; the speed in answering purchase or sales orders; that is, the overall system. This was originally -- is it still so today?-- the goal of operations research.

It becomes obvious that The Tool Box makes individual work easier, but it is not necessarily true that by improving the Tool Box the whole system will thereby improve. This second level can only be improved through the proper technology; through what we call the Office Technological System. The development of Integrated Software was a first step in this direction. Since then, several more applications have appeared which recognize the existence of this second level in the office and which provide methods for connecting individual tasks, addressing the true structure of Systemic Processes: Group Work (figure 9).

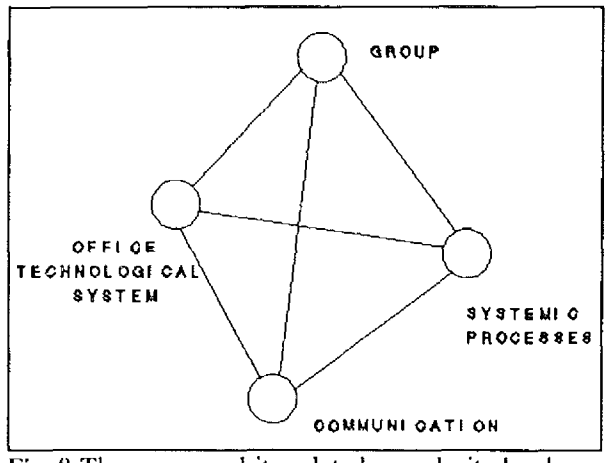

Fig. 9 The group and its related complexity levels

In 1986, in Austin, Texas, the first international conference dealing with what was then called Computer Supported Cooperative Work took place. This event can be considered as the starting point in an important trend in technology; the trend towards group work. The goal was to devise a technology capable of supporting groups; not just individuals. This means a radical change in how applications and computers are conceptualized. Even the growing demand for connectivity, compatibility and standardization can be interpreted in terms of this trend. Personal Computers, conceived as individual tools, require only some compatibility. When we became aware of the fact that we don't work alone is when connectivity and standards adquire all their meaning. From the organizational's point of view, it is irrelevant for individuals to have very powerful text processing tools, for example, if the appropriate processes for integrating individual jobs into group functions are not conveniently orchestrated. What is needed is a technology capable of supporting groups as a whole, with common goals, thereby improving the function performed (already relevant to the organization). Today, there are some commercial products designed and developed with this idea in mind, but further research and study is still needed.

In his search for appropriate technology, the manager should look for global solutions -- those designed to support Systemic Processes as a whole -- rather than merely seeking a set of individual tasks. On the technological side, the key is communications. Tool Box applications have to be connected through several systems and communications networks which, as stated before, introduce a new level of complexity into the four dimensions considered so far.

4.2 Is your office just a system?

But Office Automation doesn't end here. The proposed model shows us a third level, Global Process, the one which defines true Office Automation. All functions included within Systemic Processes have a meaning that goes beyond their results or how they work; over and above any other consideration, the office is a Human Activities System [3], with all that term implies. While it is wrong to consider only Individual Processes, it is no less an error to focus only on Systemic Processes, because they take place within a given environment, inside a precise organization, and are contingent on the specific policies, shared constraints, behaviour patterns, idosyncracies etc. that make up a specific corporate identity.

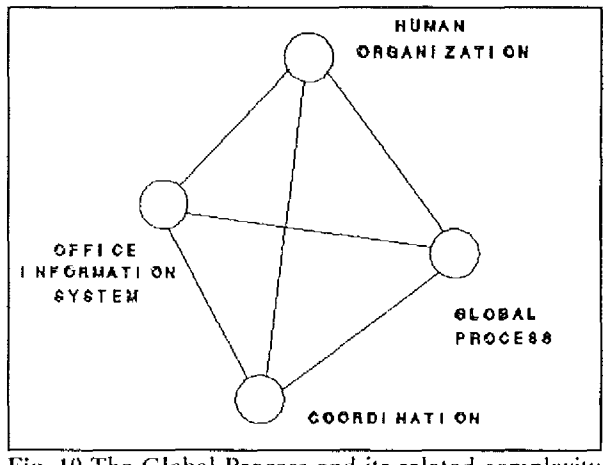

Fig. 10 The Global Process and its related complexity levels

The meaning of Global Process may appear to be obvious, but it is not as easy as it appears to apply these to Office Automation, however natural and necessary this may seem. Over and above classical measures of performance, which are no more than performance measures of man-machine teams, there are other considerations which are much more relevant for the manager: changes in organizational structure -generally towards increasing decentralization-, retraining of personnel, reinvestment of time, job satisfaction, acceptance of technology, evolution and growth of equipment along with the organization, etc. Finally, a human organization is more than a single system; it is in fact a set of systems according to the different organization's images from the different agents [10]. This makes it more difficult to create a sociotechnical system and provides us with an idea of the kind of complexity encountered at level three (figure 10).

All these points are related to the problem of corporate identity, currently one of the hottest issues in organizational development, about which technology has a lot to say. For logical cost reasons, hardware and software are clearly on the path of increasing standardization. Technology thus becomes a very strong factor in the trend towards homogenization, against the equally strong trend towards self identity. In this way, we find a type of technology which, while implemented to improve the organization, ends up producing, as a side effect, a weaker organizational identity, an effect which is intensified when the Tool Box is used as if it were Office Automation.

This is not a proposal against standards and normalization. Not at all; in fact, we consider compatibility to be a highly desirable feature; much more so than is usually recognized. But this is not our point. Our point is that, in the same way as there is a Global Process, there must be a customization of equipment in order to provide true Office Automation, capable of answering not only data processing/communication needs but a type of O.A. which also adapts itself to the organization's structure; one which eases the task of coordination; reflects the organization's unique and individual character

and is capable of evolving along with it.

5. The Human Side: Conviviality, as a condition for technological innovation

All the distinctions made up to now, together with some conclusions we have arrived at, can be synthesized by the diagram shown in figure 11.

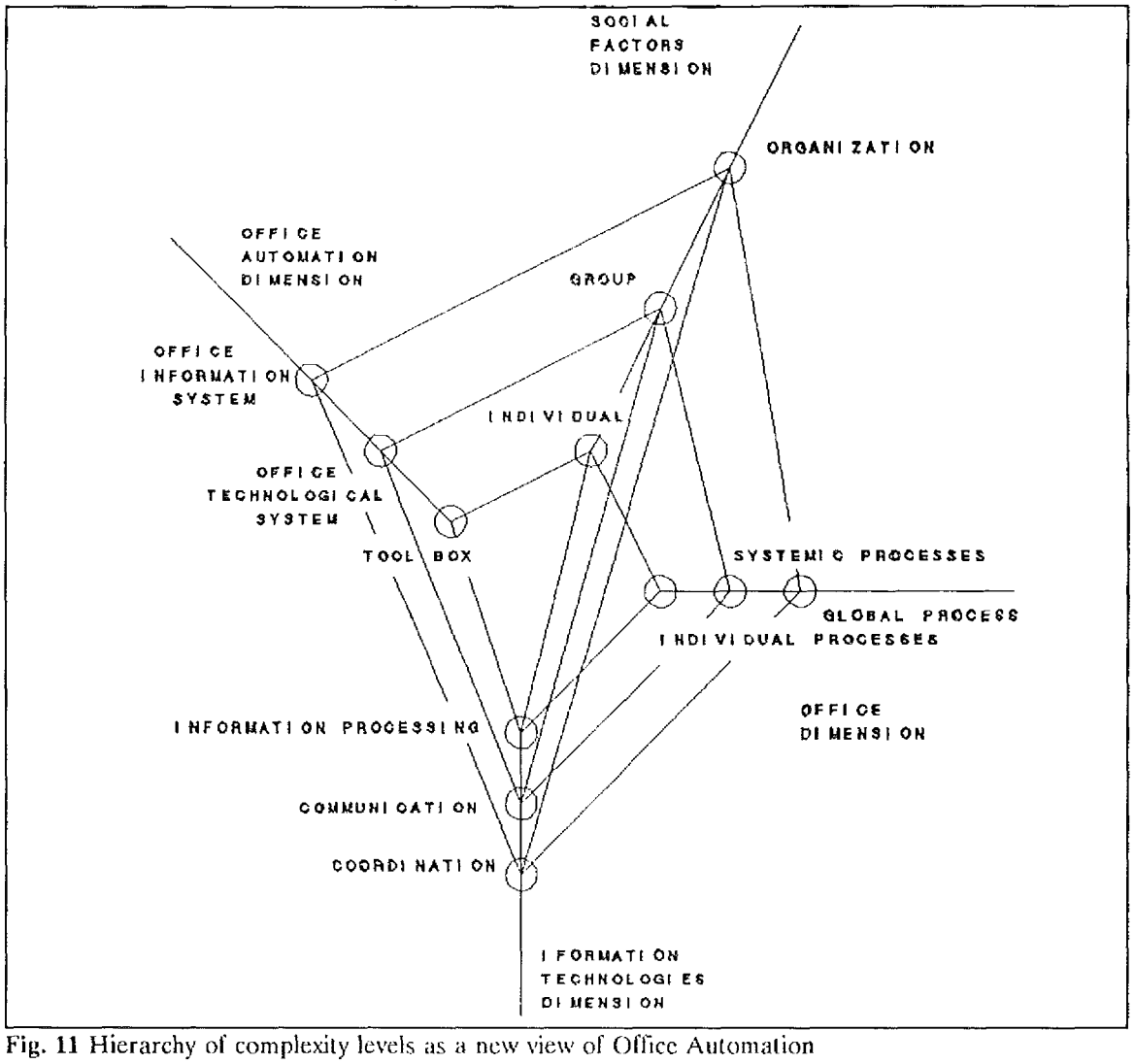

Fig. 11 Hierarchy of complexity levels as a new view of Office Automation

This figure provides an ordered and complete image of Office Automation and related factors. Although the diagram may seem rather complicated, it is in no way arbitrary. Within this diagram, one can recognize the different tetrahedrons previously built (with their corresponding distinctions). The reason for situating them one within the other is that this format reflects the essentially hierarchical nature of the object we want to describe. When examined in further detail, the diagram shows the aligned vertex forming the different distinctions we mentioned previously, which fall within the domain of the Office, the Office Automation and Information Technologies, but with the addition of a fourth dimension -- human and social factors -- which in turn encompasses

three different levels: individual, group and organization, each placed at the top vertex of its tetrahedron.

At the beginning of the 1970's, Ivan Illich was the first to use the term Conviviality [6]. According to his ideas, there are three requirements any tool must meet in order to be considered convivial: It must be efficient without diminishing personal autonomy; refrain from creating masters and slaves; and expand the radius of our personal actions. There is no other more appropriate term for what we wish to say: Office Automation must be convivial.

The third level of complexity (as shown by the 3L model with its corresponding degree of sociotechnical complexity) arises with the development of what are called, in Figure 11, 'social factors', and is thus a consequence of the complex mesh among humans, office processes and technology in the Office Automation Axis. From here stems the notion of conviviality as a requirement for evolution of this kind of systems (and to meet the cibernetic law of Required Variety, here applied to complexity). In these three principles of conviviality no advice is found concerning productivity, applications, organizational structures or management methods. The principles only point out what the relationship should be between the user and the tool, whoever, and whatever, those may be.

As regards this level, many ideas related to complexity have been taken from previous studies in which complexity is explored in relation to several technological fields, aside from office technology [1], [14], [15], [16], [17], [18].

We propose to apply these rules, or principles, to every level we have distinguished in Office Automation. The O.A., as any other tool, must be at the person's service and not the other way around. In order to achieve this, we normally need to know what we want to do, how it will be done, and who is going
to do it. Some of these questions have been answered through the distinctions made; Figure 11 shows us how to structure our knowledge about Office Automation, technology and organizations. But this would be just a mere conceptual exercise if we do not try to go further. That is our reason for introducing a new understanding of these distinctions through the complexity/conviviality pair.

With a hierarchy such as the one here proposed, we can be sure that the right balance among all levels is established while, at the same time, it becomes easier to identify the levels in which complexity must be considered. The first level is the individual one, which perhaps is the best known and also the one in which many people are working, given that many consider only this level. It is more interesting to focus
on group work, a fact which has been recognized only very recently. Not very long ago, groups worked with individual tools, and it was the individual who had to struggle with the complexity generated by the lack of balance. It disrupted not only his own work but also the group as a whole.

Individual tools, used in a group environment, do not enhance efficiency; nor do they respect personal autonomy. It is therefore necessary to think in terms of an Office Technological System as the tool for the work group. For the same reason, the use of

individual tools devoted to information processing by the work group, where the primary need is actually communication, creates an undesirable dependency on the elements that provide that communication. The solution is, again, the Office Technological System, whose main goal, after all, is supporting work group communications.

The third rule, that of expanding the personal radius of action, can only be met if the tool works at the appropriate level. The radius of action of the work group is very different from that of the individual. If individual tools are used within the context of the work group, it will be at the individual level -- the lowest -- where they will have an impact, but they will not modify the group's radius of action. It can even happen that, rather than expanding, this radius actually diminishes, due to the mismatch between what is expected and what is finally obtained.

From this point of view, the need for a second level in Office Automation can be better understood. And these reasons apply equally to the third level.

Conviviality is the key to technological innovation itself, as well as to the success of technology implementation in work environments. We pointed out this need previously, in the discussion of Human Factors/Conviviality tools as a support technology. Two very well known aspects of conviviality are user- friendly interfaces and ergonomics. They are certainly important but, as we have just shown, Human Factors play a much richer role than the one normally assigned them -- people do not work only as isolated individuals; they work also in groups and organizations. Even the concept of "user-friendly" must enlarge its meaning to encompass groups and organizations; something the manager should bear in mind when trying to reap the benefits of technology.

6. The many faces of the global process: third level complexity.

And now, and just for a while, let's concentrate on the third level. The third complexity level we will consider is that of sociotechnical complexity, which arises from the interaction between society and technology. It introduces a new domain completely different from the ones traditionally considered. Strassmann [20] states that between 1960 and 1985 approximately 95 % of the references about Office Automation dealt only with its technological side. Hirschheim's book [4] was an interesting change in focus and a good example of the remaining 5%. This kind of complexity can be seen as intrinsic to "human activity systems" , as Checkland defined them [3].

The evolution towards an Office Information System, technologically and socially advanced, implies a coherent evolution in all the dimensions depicted in figure 11. This implies, among other things, a problem of mutual adaptation between social factors and technology; a matching of complexities.

There is still much research to be done in the field of Global Processes, because that term conceals very different problems which, at first glance, can be grouped together under a new set of subdomains which serve to define the complexity of this level: a) complexity of technology in itself, b) complexity of matching technology with organizations and c) complexity of matching technology with humans. We represent these

three subdomains by the triangular schema depicted in figure 12. Its intention is to show not a hierarchy -- as in previous figures-- but the dialectic among these three subdomains.

The latter two subdomains, especially the complexity of matching technology with organization, affect mainly the manager; however, the three subdomains must be understood as a whole set. Commonly there has been a tacit gap among those three fields, but this gap is no longer valid. Technology has reached an evolutionary stage where it can, and in fact does, deeply transform organizational structures and seriously affect human factors in work environments. The relation between human factors and organization is well known and we will not go into further discussion about this point.

The growing interest in what has been called Human/Computer Interaction proves once again how important the human factor really is. From a purely technical point of view, the subject of Human Factors poses significant challenges but, from the manager's point of view, it is a "must" in the process of integrating any type of technology into his organization.

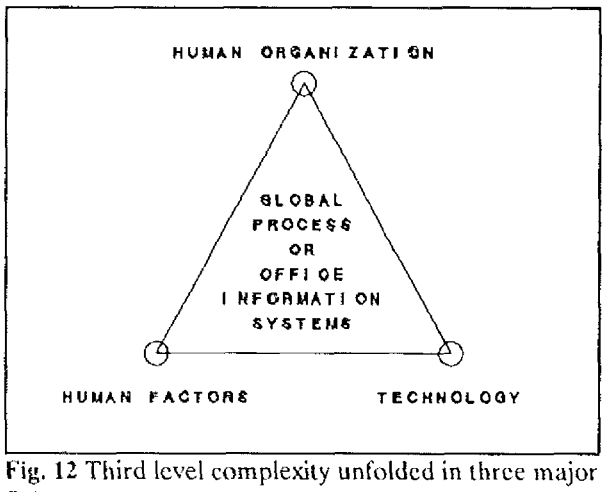

Fig. 12 Third level complexity unfolded in three major fields

Top managers tend to see their organizations from a global perspective, in which human factors play only a minor role. This point of view, within the traditional organizational structure, wouldn't necessarily have serious consequences -- to have a global picture is something extremly appreciated in managers -- but technology provides both individuals and work groups with a degree of power that makes the Human Factors concept a very critical factor to contend with. This increased processing and communication power wielded by individuals and work groups represents, in fact, a major change within the organization.

However, there are many barriers which must be overcome before the potential power that organizational complexity represents can become a reality. Among them, an important example is psyhcological resistance on the part of human beings toward changing personal work habits; and the fact that many technological tools are still unnecessarily complicated. The existence of these barriers requires a thorough study of tool usability, in order to create a truly workable individual-tool interface. A possible conclusion to be drawn is that the organization's process of technological innovation is constituted, in large part, by a set of innovation microprocesses.

As concerns the complexity arising from the interaction between technology and organization, it can be stated that it is the most obvious aspect of this new distinction. When an organized entity faces/incorporates technology, many important changes are produced, and they must be confronted in order to really reap the benefits of technological innovation. In the face of this complexity, many possible postures can be adopted. Usually, if the manager lacks experience with technology, an initial prejudice

can appear, and it may prove to be a major handicap in the organization's technological development. But managers with some or even much experience with technology have a problem as well; a failure to take non-technical factors into account.

7. Users and Producers, Managers and Leaders

One of the main problems technology poses is the inevitable gap it creates between users and producers. Such a gap is natural when one considers the different approaches toward the use and understanding of technology; to the user it is merely a tool, but to the producer it represents a goal. However, such a gap ceases to be natural when it creates a pathological situation, as happens most of the time in organizations. In Office Automation this problem is exacerbated because upon the logical division between users and producers is superimposed the even wider gap between specialist and non-specialist.

Users are perfectly aware of the environment in which they work; their needs; their particular circumstances; their goals and objectives and their limitations. But, as general rule, they are not able to translate this knowledge into parameters related to technological innovation. In other words, they are not aware of the true dimensions of technology; its complexity and its advantages, as well as its disadvantages.

Producers, those who create, produce, sell and maintain technology, are familiar with it and its applications, opportunities and advantages. They have worked long enough with technology to, at least, recognize that it poses some problems. But producers know nothing about the work environment where this technology is going to be applied; they do not have access to the particular details of organizational functioning and, thus, they can only offer generic products adapted to meet a global demand. The growing success of technological consulting is evidence of this last point.

It could be argued that this gap is not a major problem. Applications such as text processors are general and sufficiently widespread to avoid the need for customization. We agree there. But text processors are, as we have seen, merely a component of the lowest level: the Tool Box. At this level there is enough generality to enable users and producers to more or less coincide in supply and demand.

7.1 Top down / Bottom up

In reality, however, this coincidence is merely an illusion. To the user, what matters is the Global Process, much more than the Individual Process. If the user were capable of translating his needs into the corresponding technology, he would ask for an Office Information System, in the sense we are proposing, or, if not available, Office Technological Systems, not just a Tool Box. To him the hierarchy is top/down, with almost no relevance at the lowest levels.

To the producers it is just the other way round. Due to technological and market

constraints, the producer gears his offer towards the Tool Box concept by means of generic applications having no technical or conceptual difficulties, in this way guaranteeing a wider market. Upper levels require a much more refined product; more knowledge about user needs is necessary, and the potential market is much narrower (the upper extreme would be custom design). The hierarchy as the producer perceives it is bottom/up, with Individual Processes as a first goal.

This is an indisputable reality. But the proposed model for the office and Office Automation in effect moves these two perspectives to closer together. With this model, the user can establish his technological needs with specific reference to his particular activity, while the producer can recognize the existence of upper levels in the demand and react accordingly. And both can thereby have a shared understanding, a common language to facilitate actions.

7.2 Managing complexity

Many methodologies used to implement technology underscore the role played by the leader of technological innovation. While the ultimate success of technology and future user satisfaction depend largely on the efforts of this person, he seldom has the resources necessary for achieving these goals. An implementation methodology can offer a more or less effective way to introduce technology in work environments; plan the organization's evolution or even take into account more advanced problems such as productivity measures or cost justification. But no methodology can say whether technology is applied in tha appropiate levels; if it is applied to the right tasks and processes; or if it respects the established structure. This is the gap our proposal attempts to fill.

Managers interested in technology can read many books and articles and find a lot of "solutions" to almost any kind of problem and, to a lesser extent, methodologies for implementing those "solutions". But in spite of that, he will lack the required reference point to be able to locate the performance of a given piece of equipment, not just focusing on generalities, but based in his own needs and according to the characteristics of the organization where it will be employed. With the proposed model, the manager has a very powerful conceptual framework for completing a sociotechnical design of his own technological innovation, as well a reference model upon which to map it. To managers, managing Office Automation is the same as managing third level complexity. In general, we think that technological innovation management is the same as complexity management.

Today's managers have become Information Systems Managers [5] and they must think in terms of this new role. Models such as the one proposed here facilitate this task by allowing a better understanding between the managerial and the technical world, offering a coherent, complete and integrated perspective of both.

8. Conclusions

We have proposed a conceptual model for Office Information Systems, a model

that evolves through three types of complexity to form a hierarchy. The model integrates four domains: information technologies, office processes, social factors and office systems. The result is a new and complete framework for the design and management of O.I.S.

The model has been presented in the form of a group of distinctions, at once powerful and easy to remember. To accentuate its dialectic character we have used as many graphic representations as possible. These figures can be summarized by Figure 11.

In [1] and [18] it has been shown that this conceptual model reflects the various possible perspectives of the office, as synthetized in [4]. In [18] the model has been analyzed as a tool for developing, in conjunction with cibernetics, a new vision of technological innovation in organizations through office automation.

8.1 A non-technical language for managers

The primary advantage of such a framework is that it allows a comprehensive evaluation of technology without requiring extensive technical knowledge. In other words, it provides a new and accurate language for expressing any kind of technological need posed by the organization, while avoiding the severe limitations arising from the language used by specialists.

By using the model, the manager can easily identify in which levels technology is to be applied, and always has at hand the references which make evolution possible; not only with technology but also coherently with corporate objectives. These three levels (Individual Processes, Systemic Processes and Global Process) constitute a step-by-step approach to Office Automation as well as a non-traumatic way for assimilating technology into work environments. At the same time, it permits managers to identify the most appropriate technology for each level, and to be guided by what it is actually done in the office, instead of what technology has to offer.

In this way, managers have a very powerful methodology for planning their technological strategies without having to face solely technical issues. As concerns technology, the model points out a very clear path for innovation and research. Once the first level (The Tool Box) is overcome, technology should concentrate on solving cooperation issues, integrating first level tools into full solutions to Systemic Process problems. This trend has already begun, as shown by the growing interest in Computer Supported Cooperative Work. But the fields where major research is still needed are basically Office Information Systems; the approach of technology to corporate activities; understanding the organization as a whole, and the study of implied factors (social, job satisfaction, organizational changes, corporate goals, evolution, competitiveness, etc.).

We would like to underscore the potential the model shows for serving as a common reference for the two major participants in Office Automation, users and producers, integrating both perspectives, top-down for the first, bottom-up for the latter, and opening new domains for action.

8.2 Opening new perspectives

A very important aspect of our study has been its focus on Office Automation from the point of view of complexity; in fact a very uncommon perspective in the fields of technological research and application. Unfortunately, studies about complexity, from the pioneer works of Simon [19] to the works of Morin [11] and Le Moigne [8] among others, are essentially unknown to managers.

We can feel justifiably hopeful about this last point, if books such as Pagels' [12], who recently passed away, can be seen as representing a new trend in the recognition of the complexity issue. In his study, he proclaims the computer to be the basic instrument of the science of complexity: "the great unexplored frontier is complexity" (p. 12); "I am convinced that the nations and people who master the new sciences of complexity will become the economic, cultural, and political superpowers of the next century" (p. 15).

We believe that, nowadays, the sciences of the artificial [19] are being replaced by the sciences of complexity, particularly when they include the human factor, as is underscored by the focus of the first conference dealing with critical issues, to be held in November 1990, by the Association for Computing Machinery (ACM). There are two central subjects to debate: Managing Complexity and Modelling Reality. These two principles have guided our paper.

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