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PROPOSAL OF A THREE LEVEL COMPLEXITY MODEL FOR OFFICE AUTOMATION

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Abstract: Office automation is one of the fields where the complexity related with technologies and working environments can be best shown. This is the starting point we have chosen to build up a theoretical model that shows us a scene quite different from the one traditionally considered. Through the development of the model, the levels of complexity associated with office automation and office environments have been identified, establishing a relationship between them. Thus, the model allows to state a general principle for sociotechnical design of office automation systems, comprising the ontological distinctions needed to properly evaluate each particular technology and its virtual contribution to office automation. From this fact comes the model's taxonomic ability to draw a global perspective of the state-of-art in office automation technologies.

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Brief review of Office Automation Technologies

As a general rule, anyone of us has an intuitive idea, usually rather clear, about what is an office and the kind of tasks involved in it. Other thing is when each observer assumes a specific point of view and center his interest in some particular aspect of the office. As a matter of fact, the office can be seen, for example, as a set of information transfer processes, regardless of the media used, as a somehow special productive system processing information, or as an organization trying to provide services to another organization with a bigger scope [Hirschheim, 1985]. These ways of understanding the office have a point in common, the object they deal with is **information**, to process it or to communicate it through the office's environment.

From here, we distinguish three basic activities in the office, and their related types of technologies: **Information Processing, Communication and Coordination and Decision Taking.** Information Processing are all those activities performed to transform, store and retrieve information, and for this kind of activities several technologies exist, e.g., text processing, spread sheets or data bases. On the other hand, Communication are all those activities performed to move information from one place to another, regardless of the media used. And for these activities the technology offers solutions such as networks, telephones, fax, electronic-mails ...etc.

Coordination and Decision Taking give rise to a somehow different dimension of the problem. The origin of these activities is the fact that the office is embedded in a bigger organization that imposes to the office its effectiveness criteria and corporate goals, demanding to coordinate information processing and communications to assure that the right information reaches the right place at the right moment to feed the decision taking process inside the organization. It is obvious that this set of tasks does not affect in the same degree to all the individuals in the organization, but it affects, mainly and particularly, to the managers. For this set of activities, technology provides coordination tools and decision-support systems.

To be successfully applied in office automation, the three mentioned types of information technologies need to be 'encapsulated' in some kind of convivial device. This can be seen as a fourth type of information technology that does not deal with any specific activity but with the psicosocial problems related with Man-Machine interface in all activities, that is, the **Humanization / Conviavility** dimension.

Three level complexity model

The base of our study is the complexity model proposed by Sáez Vacas [1983], initially to be applied in the computer systems field. This model establishes three levels of complexity, starting at the lowest level with the complexity related with isolated objects. In the computer field this is the complexity found in circuits, algorithms or even programs. This

level is recognized by all specialists.

However, in the computers field, when the different circuits, algorithms and programs are combined to build up systems, a new kind of complexity results, **systemic complexity.** This is the case of a computer, an operating system or an information system.

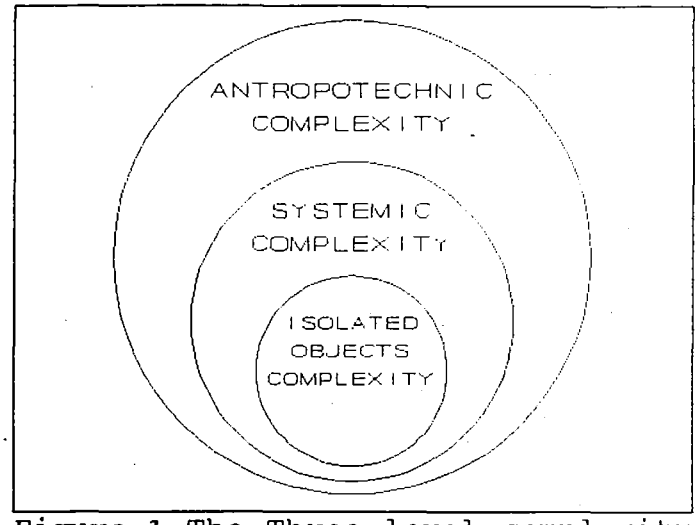

Figure 1 The Three level complexity model

When these systems reach society they give rise to the upper level's complexity, the one that we call **antropotechnic complexity.** This kind of complexity requires a different approach than the used to face the complexity found in the lower two levels, due to the social origin, instead of technical, of antropotechnic systems. We believe that this complexity can be matched with the one that Flood has named, more recently, complexity in the Homo Sapiens line [Flood, 1987].

With the appropriate change in the observer's point of view, this three levels can provide a good taxonomy of complexity in the office automation field, whose main purpose is to face the variety generated in the working environment where technology is applied.

Office and Office Automation Complexity. A new perspective

The proposed model had its origin when, while studying office automation, we realized that there are a considerable amount of perspectives that could be assumed. Most of the researchers center their view of office automation partially and, in some cases, falling in contradiction with other interpretations. We needed a model to locate the different approaches and, thus, develop a more comprehensive view of office automation.

To solve this problem, Hirschheim [1985], has identified two different theoretical perspectives of the office: analytical and interpretivist, the former paying attention to the manifest behavior in the office environment, and to the social aspects of the office, the later. Inside the analytical perspective there are three major approaches: office activities, office semantics and office functions. The interpretivist perspective can be divided in four major subsets: work views, decision taking, transactional and language action. All these seven groups reflect in a comprehensive way the developments in the field but without any connection among them. This diversity is, one more sign of the complexity related with office automation, but even being this so, we believe that these perspectives can be included in a hierarchy that

not only classifies them but map them perfectly in the office structure.

To accomplish this task we use our three level complexity model, through a logic translation from a more technical perspective to an user-observer's view, who, instead of programs and circuits or other technical devices, 'sees' an information system and several utilities. Watching the second level of the model applied to the computers field, we find that information systems are a specially wide example of an object from this level.

We can 'zoom' on it and develop a detailed view in three levels of complexity both for the office environments and for office automation. Now, the isolated objects of the first level are the basic tools such as text processing or spread sheets. This is the first level of complexity in office automation, the one we call **Tool Box.** Its counterpart in the office is the office activities view, the **Individual Processes** level.

In the same way systemic complexity arises when studying the office semantics and the office functions, because to try to understand the reasons behind the activities and organize them to form functions with a greater operational effectiveness is to face the office as a system. This is the complexity level that we call **Systemic Processes.** The technology used to support Systemic Processes faces also the systemic complexity, given place to the second level in our model of office automation, the **Office Technological System.**

Finally, the social aspects related with the interpretivist perspective immediately move us to associate it with the level of antropotechnic complexity. When the system reaches the office environment's microsociety then it gives rise to the work roles, decision taking, transactional and language actions views. This is the level called **Global Process.** Its technological counterpart is the **Office Automation System.**

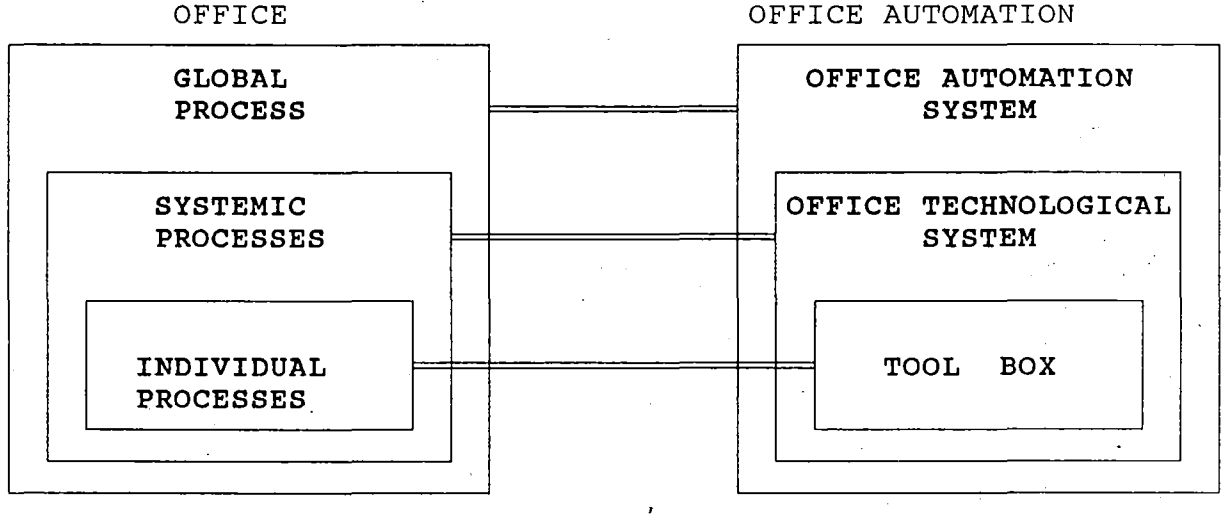

Figure 2 The Office and Office Automation models.

Hence, we have defined the Office Automation System concept as a purposeful device embracing all complexity levels. As a result of this, it must be designed as the system corresponding to the Global Process. Through this concept, what we call Office Automation System becomes a goal and a design principle that shows us how in nowadays practice most of the office automation implementations have been built considering only the first level of complexity, the Tool Box.

In this model the different complexity levels are gathered together considering them as a whole. To work with the model it is important to have in mind that each level comprises all the lower levels, this fact appears very clearly when applying technology, given that there is a relationship between the model and the four 'types' of technology in the office mentioned before, Information Processing, Communication, Coordination and Decision Taking, and Humanization / Conviviality. Each one of them can be found in the different levels of the model but prevailing in a particular level, except in the case of Humanization/Conviviality.

So, the technology found in the Tool Box level is mainly related with Information Processing, given the characteristics of the activities that we have called Individual Processes. In the same way, Communication is the central axis of the Office Technological System, given that the Systemic Processes' main objective is the organization of the Individual Processes to form functions performed in an environment endowed with spatial distribution and limited resources.

In the last level, technology must solve the issues related with Coordination and Decision Taking, but this is not enough. The Humanization dimension states clearly problems related with the third level, although they can be operatively decomposed in different degrees and characteristics related with technologies and methodologies in each particular level. In every level there is interaction between Man and technology, but it not always in the same way. In the first two levels, specially in the Tool Box, the main issues are interfacing and ergonomics. The third level tries to fit the office in the human social system, where the parameters of conviavility are quite different from those of the individual or the group.

Applying the model to the Evaluation of technologies and to Systems Design: Integration and Automation

Our belief is that the proposed model can be interpreted as a general and dynamic principle for sociotechnical design. It is a principle for sociotechnical design because the last levels defined, Global Process and Office Automation System, come out from the antropotechnic complexity resulting from the interaction between technology and society. And this level comprises the lower two, in such a way that the Office Automation System embraces the three mentioned levels. Methodologies for sociotechnical design must be tuned with the model, both in the interpretation of the office and in the integration

of technologies in each one of the three levels.

Terms such as Integrated Office Automation only produce noise and misconceptions, preventing even the cost effective use of existing solutions. The reasons to establish parallel levels of complexity in office environments and office automation is that we need to separate the model and the state-of-art of technology (on which tools and methodologies depend), and this can only be accomplished through an appropriate understanding of automation and integration concepts.

The office **automation degree** grows along three major axes: a) **intra-level integration** of technologies, b) **inter-level integration** of technologies, c) **human integration**, that is, the enhancement of conviavility or third level technologies and methodologies.

We state that the model is dynamic because the structure it shows assumes technological evolution and it is somehow independent of it. The model serves also as a framework to analyze technology according to the three axes of integration. Let's see first some examples of intra-level organization.

At the Tool Box level, the prevailing technology is Information Processing through Hw/Sw applications such as text processing, spread sheets, note books, electronic publishing, data bases ...etc. In many cases these tools are considered to be the 'information system' in the office, misconception due to understand office automation only by means of the automation degree reached. Progressively, technological integration allows to put together several tools (as an example we can mention wellknown software packages such as Open Access or Symphony), being this an example of intra-level integration that, in the case of the Tool Box level, it can be stated that it produces multifunctional tools, that is, more automated resources. The same happens with the integration between different information media that produces the trend towards multimedia tools.

At the level of Office Technological System, parallel to the development of Hw/Sw technology (local networks, connections PC-mainframe, ISDN, terminal simulation) is the automation degree's growth of Systemic Processes, mainly through the intra-level integration, in which the ISDN effort is a major example. At the third level, intra-level integration has produced important advances in some technologies related with CSCW (Computer Supported Cooperative Work).

An example of inter-level integration, among many others, may be a spread sheet running in a PC linked to a mainframe where resides the data base. A more general example is the fact that all levels must consider Humanization issues.

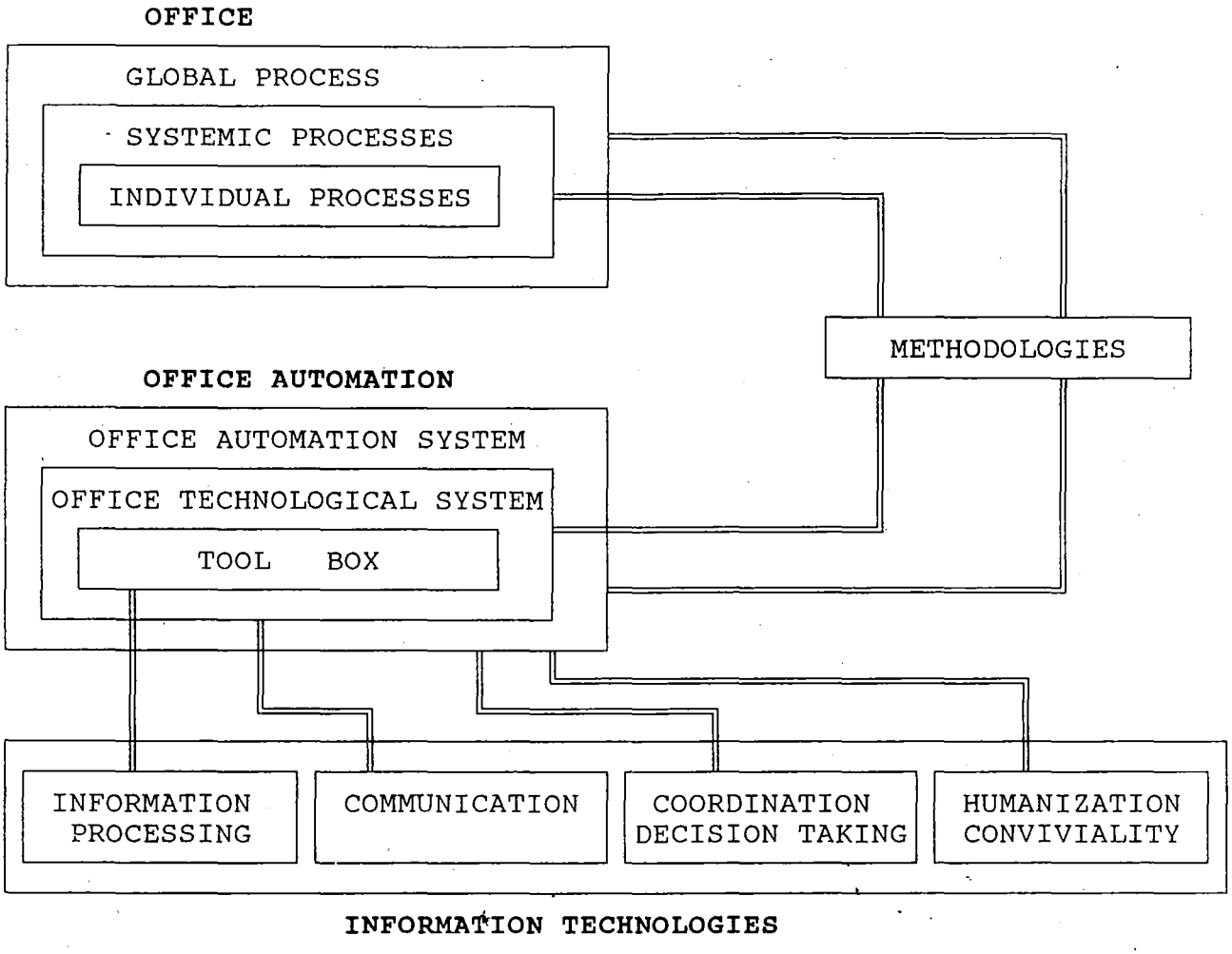

Figure 3 The model and its relation with technologies and methodologies

Third level Technologies and Methodologies: A Field for Future Research

In the Office Automation System level, we find several issues, belonging to antropotechnic complexity, that require a completely different approach. Technological tools are needed, but conceptual frameworks for design considering both the technical and the social side of the problem are more necessary. Techniques, technologies and methods to manage this level must undertake Hw/Sw applications for coordination, such as The Coordinator (Action Technologies) or the University of Milan's CHAOS project, based both in the Speech Act Theory, and, in general, all kinds of technologies to enhance tool's conviavility (human interfaces) and methodologies to manage organizational complexity, but only if they are **soft-methodologies** able to deal with human activities systems.

Related with this last point, we are doing some research with the Viable System Model proposed by Beer [1985] and its points in common with our model. The Viable System seemed to be very suitable to be compared with our complexity model and a certain parallelism can be established between the VSM and the levels of complexity of our model. The Policy Function and the Intelligence and Control filters, according to the terminology proposed by Espejo [1988], can be compared with the level of antropotechnical complexity (Global Process), while the Implementation function is the second level (Systemic Processes) and the viable subsystems are related with the lowest level (Individual Processes).

But we have encountered some difficulties due to the fact, we think, that cybernetics models, like VSM, assume an order paradigm in clear conflict with the disorganized complexity of an antropotechnical system. Our current interest is in the application of Checkland's Soft Systems Methodology [Checkland, 1981], combined with the VSM, to the design of office automation systems.

References

Beer, S. (1985) **Diagnosing the System for Organization**, John Wiley & Sons, Chichester.

Checkland, P. (1981) **System Thinking, System Practice**, John Wiley & Sons, Avon.

Espejo, R. (1987) Cybernetic Method To Study Organizations, **XXXI Annual Meeting of the International Society for General Systems Research,** Budapest (Hungary), 1-5 June.

Flood, R.L. (1987) Complexity: a Definition by Construction of a Conceptual Framework, **Systems Research**, v.4, N.3, pp.177-185.

Hirschheim, R.A. (1985) **Office Automation, A Social and Organizational Perspective**, John Wiley & Sons, Chichester.

Sáez Vacas, F. (1983) Facing Informatics via Three Level Complexity Views, **X International Congress on Cybernetics,** Namur (Belgium) August 22-27.

Sáez Vacas, F. (1987) Towards a conceptual remodeling of information technologies based on a broad consideration of complexity, **XXXI Annual Meeting of the International Society for General Systems Research,** Budapest (Hungary), 1-5 June.