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ERGONOMICS AEROMEDICAL TRANSPORT ANALYSIS

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This article presents the Ergonomics Action Methodology applied to an aeromedical transport company in Rio de Janeiro, Brazil, studying the interactions among pilots, mechanics, physicians and nurses during the flight operation. Some ergonomics aspects were issued, affecting the appropriate performance in their interfaces, considering 2 types of helicopters: BK 117 C1 and Esquirrel AS 350 B2. As results, it was proposed some ergonomics suggestions and recommendations, aiming at providing improvements and minimizing the risks levels of accident occurrence.

Introduction

The general purpose of this study was to assist the company in the analysis of some demands about work situations involving a group of professionals, so that the main difficulties of a determined activity could be identified and ways to manage them could be indicated, contemplating the safety of the aeromedical transport. To implement the study, it was adopted the Ergonomics Action Methodology with the following techniques: Oriented Interactions (VIDAL, 2001a) and Work Collective Analysis (FERREIRA, 1993).

Context

The study was developed during twenty months (from October of 2001 to June of 2003), by a team of interdisciplinary professionals: a psychologist, a physiologist and a group of engineers. The company has the mission to realize the aeromedical transport of patients, from the accident place to the hospital, using 2 modalities of services: ground rescue, with ambulances; and air rescue, with helicopters. The choice for this study was based on some Preliminary Demands (I), initially originated and then clarified by a Global Analysis (II), which prioritized the air rescue, specifically, in both Sectors: Flight Operation, composed by 9 professionals (7 pilots and 2 mechanics); and Rescue, composed by 57 professionals (24 physicians, 18 nurses, 9 ambulance drivers and 6 administrative agents). Figure 1 shows the Social Construction Structure of the Ergonomic Action Methodology (VIDAL, 2001b): Support Group (1), composed by the decision-making manager of the aeromedical transport, who asked for the study an to whom we reported during the whole period; Follow-up Group (2), composed by the managers of both Sectors (Flight Operation and Rescue); and Workers Groups, composed by pilots (3), mechanics (4), physicians (5) and nurses (6).

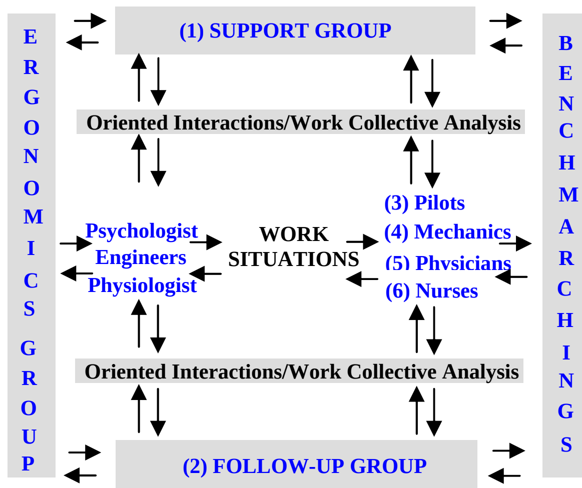

Figure 1. Social Construction Structure of Ergonomics Action Methodology (VIDAL, 2001b).

Methodology

The Ergonomics Action Methodology (VIDAL, 2001b) has 7 different phases, as shown in Figure 2:

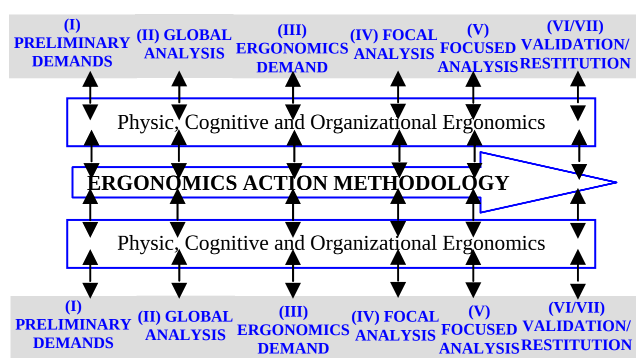

Figure 2. Ergonomics Action Methodology (VIDAL, 2001b).

The Preliminary Demands (I), concerned about the interactions among pilots (3), mechanics (4), physicians (5) and nurses (6) involved in the aeromedical transport operation, pointed out, mainly, to 3 work situations: (a) the pilots rest place, where they used to study and relax together, while waiting for the rescue flights; (b) the helicopters hangar, where the mechanics worked in their routine maintenance; (c) the helicopters interior, with their variety of devices and situations of interactions among the agents involved in the aeromedical transport. In the 3 work situations, there were related Collective Activities (ROUGNIN & PAVARD, 1996), of higher and lower relevance, some of them indicating critical aspects that could influence the effectiveness of Air Safety. The Global Analysis (II) made these work situations more evident, but the Ergonomics Demand (III) elected by all groups was the last one: (c) the helicopters interior, with their variety of devices and situations of interactions among the agents involved in the aeromedical transport. This specific work situation chosen (c) as the Ergonomics Demand (III) was justified, considering the necessity to support the company with technical information for modernization or reposition of helicopters, which represented a high cost decision that required this research. Continuing the study, the Focal Analysis (IV) configured a pre-diagnoses, determined by critical aspects which showed the necessity of a more detailed study of Organizational Culture (DEJOURS, 1987), Collective Activities (ROUGNIN & PAVARD, 1996) and Cognitive Ergonomics (VIDAL, 2001b), considering the Complexity (LEPLAT, 1992) of aviation environment, aiming at getting a better interaction among the operators on the rescue flight and contributing to minimize operational collective problems in their performance.

Emphasis in Organizational Culture (DEJOURS, 1987) is observed when pilots are concerned about the safety operation of the helicopters, focused to a safety culture, and, in the other hand, the aeromedical groups are concerned about the patient survival, focused to an attenuating culture.

Also, Collective Activities (ROUGNIN & PAVARD, 1996) and their Complexity (LEPLAT, 1992) could be evident when: the aeromedical groups try to help the pilots when landing the helicopter, by paying attention to all kinds of obstacles (mainly birds), in order to make a more safety flight; the aeromedical groups help the pilots team to search a referential point to land, signalized by the waiting people. Still, some "regulations" (FAVERGE, 1980) seemed to be created by the operators during their Collective Activities (ROUGNIN & PAVARD, 1996), in order to manage some apparent problems, not prescribed in manuals, affecting their perception, concentration, attention, memory etc. These "regulations" (FAVERGE, 1980) about inappropriate ways to manage the equipments represent a factor of risk for the aeromedical activity.

The reliability of the Collective Activities (ROUGNIN & PAVARD, 1996) among pilots (3), mechanics (4), physicians (5) and nurses (6) during the flight can be understood through the Cognitive Ergonomics (VIDAL, 2001b), to succeed on dealing with handling information all around.

The final diagnosis, presented in the Focused Analysis (V), pointed out to some characteristics actions (A, B, C and D), which, in Validation (VI), were recognized by the agents, allowing to present the conclusions, in Restitution (VII).

The Study

In the Focal Analysis (IV), the chosen Ergonomics Demand (III) concerning (c) the helicopters interior, with their variety of devices and situations of interactions among all agents involved in the aeromedical transport, brought some critical aspects which were related by all Workers Groups (3, 4, 5, and 6), such as: the returning flights during the sunrise in places not homologated by the Brazilian Civil Aviation Authority; postural pains apparently caused by inappropriate seats, and audition disturb apparently caused by trepidation and noise, during the flights; monotony during administrative tasks needed for the flights (alertness state and vigilance while waiting for a call to rescue flights, daily check of documents, post-flight reports etc.); etc. The Focused Analysis (V) brought a final diagnosis, constituted by the selection of the main characteristic actions studied, such as: (A) Watching the control panel; (B) Processing the communication among the pilots and the aeromedical groups (physicians and nurses); (C) Handling with devices and materials in helicopters; and (D) Dealing with comfort context in helicopters.

At this moment, it is important to emphasize that the differences between both helicopters, during take off, flight and landing moments, permitted comparisons which were taken account for the study: Esquirrel is more appropriate to day flights, in places of difficult landing and taking-off, because it has only 1 engine, is more light and has visual operation; BK is more appropriate to night and long distance flights, in places of easy landing and taking-off, because it has instrument operation and, also, 2 engines, what makes it heavier. These differences are described in Table 1:

Table 1. Differences between Esquirrel and BK

ITEMS	HELICOPTERS	
	***ESQUIRREL* AS 350 B2**	***BK* 117 C1**
MANUFACTURE	Eurocopter	
ENGINES	1	2
SEATS	1 pilot, 1 physician, 1 nurse and 1 patient	2 pilots, 1 physician, 1 nurse, 1 patient and 1 patient familiar
AUTONOMY	730 km	540 km

Oriented Interactions (VIDAL, 2001a) and Work Collective Analysis (FERREIRA, 1993), based on job descriptions, interviews, direct observations and workers reports, were used as techniques to conduct all the phases of the study. The analysis about the Collective Activities (ROUGNIN & PAVARD, 1996) of the Workers Groups (3, 4, 5 and 6) permitted the classification, in the Focused Analysis (V), of the characteristics actions plotted, according to their intensity, in order to compare, quantitatively and qualitatively, the behavior of the agents in both helicopters, during take off, flight and landing moments. From here on, these characteristics actions will be commented to better understand the analysis.

A) Watching the control panel (Figure 3):

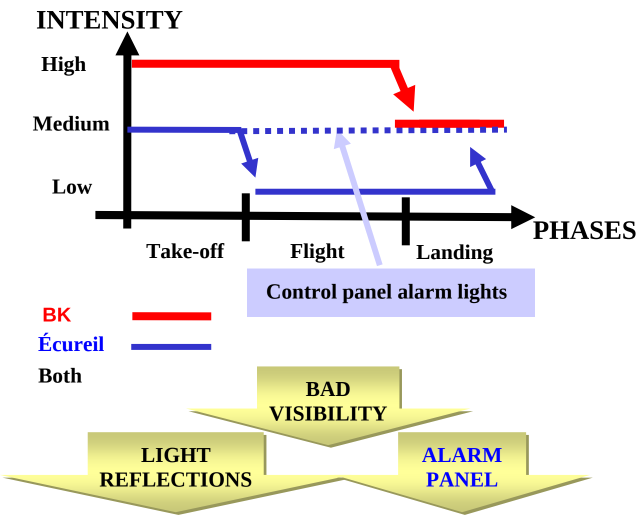

Figure 3. Characteristic Action A) Watching the control panel.

Helicopters are very fragile equipments which require the development of attention by pilots during flight operation, mainly because of the continuously external pressure, as in case of the aeromedical transport. That is why it becomes necessary, for cognitive support, the aid of all senses, mainly: tactile, vision and audition. Specifically, the vision sense will be emphasized when talking about the characteristic action of "watching the control panel" (A).

During BK take-off, which operates by instrument controls, "watching the control panel" reveals to be an action of high intensity, because pilots are required to realize the take-off checklist, verifying if all items related to the equipment are in favorable conditions for the flight (oil, temperature etc.).

During Esquirrel take-off, "watching the control" panel reveals to be an action of lower intensity, compared to BK, but higher related to the flight and landing moments, because of the take-off checklist. For these reasons, it would be correct to consider Esquirrel take-off of medium intensity on this action.

During BK flight, the intensity of "watching the control panel" is of high intensity, such as during take-off, for the same reason, because it is, mainly, an equipment which operates by instrument controls.

During Esquirrel flight, the intensity of "watching the control" is considered low, once this equipment operates, mainly, in visual conditions, which requires more attention of the pilot to the external stimulus (birds, high tension wire, radio and television aerial feelers etc.). More than that, this equipment is configured for only one pilot, which requires a high level of cooperation, communication and tasks division between him and the aeromedical groups, mainly, during flight and landing moments, for the success of the mission. Exception is made when, during the flight and, also, landing moments, the control panel alarm lights gets, automatically, on, leading the pilot to look at it, which increases, again, the characteristic action of "watching to the panel" to medium intensity, as in take-off, aiming at verifying the irregularity detected.

During BK landing, the intensity of "watching the control panel becomes medium, mainly, for these reasons: external requirements for landing, frequently, in places of difficult access; restrict vision of the back of the equipment, which requires the help of the aeromedical groups (physicians and nurses); necessity to maximize the seat level to increase the external vision; the eventual change of functions between both pilots, when the wind position requires; higher intensity of tasks division between both pilots.
During Esquirrel landing, it maintains a low intensity of "watching the control panel", for the same reason

of being a visual equipment, which requires: more attention to external requirements for landing, frequently, in places of difficult access; the help of aeromedical groups (physicians and nurses), because of the restrict vision of the back of the equipment.

This characteristic action of "watching the control panel" (A) contemplates the main problem of bad visibility, which involves 2 critical situations: internal and external light reflections in both equipments; and inadequate localization of the control panel alarm in Esquirrel.

B) Processing communication between the pilots and the aeromedical groups (Figure 4):

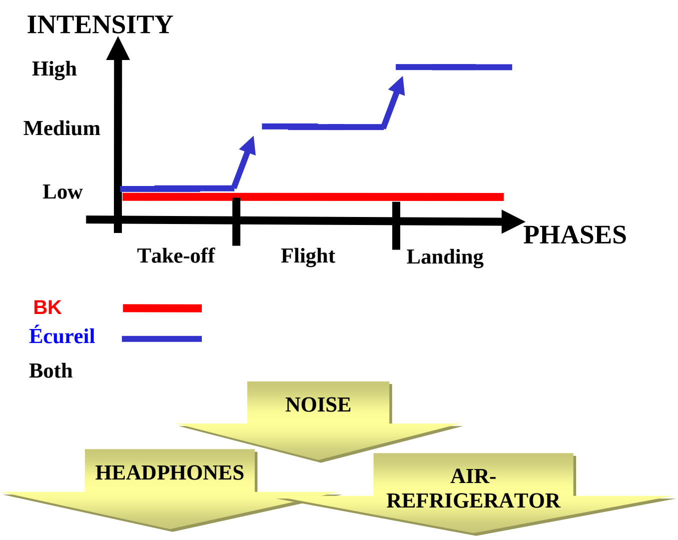

Figure 4. Characteristic Action B) Processing communication between the pilots and the aeormedical groups.

One of the serious problems detected as aeronautic accident causes is the concentration of the pilot only on a specific situation, forgetting to flight the equipment. That is why is so important the tasks division, either in BK, which operates by instruments controls, or in Esquirrel, which operates, mainly, in visual conditions.

Again, here, it becomes necessary, for cognitive support, the aid of all senses, mainly: tactile, vision and audition. Specifically, the audition sense will be emphasized when talking about the characteristic action of "processing communication between the pilots and the aeromedical groups" (B).

During take-off, the communication in both equipments is low, because of the take-off checklist.
During BK flight, the communication among the groups, related to Collective Activities (ROUGNIN & PAVARD, 1996), remains low, because of the characteristic of its instruments controls.

During Esquirrel flight, the communication becomes from low to medium intensity, because of the requirement of cooperation between pilot and the aeromedical groups, based on its characteristic of being, typically, an equipment of visual conditions. Furthermore, the patient localization just beside the pilot seat reinforce the need of the aeromedical groups help. There is only 1 pilot, which demands cooperation, communication and tasks division, although there is no air-refrigerator in the helicopter, which affects the communication because of the noise of the opened windows to soften the temperature.

During BK landing, the communication between the pilots and the aeromedical groups remains low, because there are 2 pilots, who interact themselves for tasks division involving the control of the helicopter, related to inside and external stimulus. At this moment, just like during the take-off, it may be a change of functions between the pilots, if the wind position requires. The cooperation between pilots reveals to be more relevant in this moment than between the pilots and the aeromedical groups.

During Esquirrel landing, in spite of this equipment be more light and, because of it, more capable to land in places of difficult access, there is only 1 pilot, which points out to the necessity of a high intensity of communication between both, pilots and the aeromedical groups, and, still, of more cooperation and Collective Activities ((ROUGNIN & PAVARD, 1996).

This characteristic action of "processing communication between the pilots and the aeromedical groups" (B) brings the main problem of noise, interfering in communication between both groups, because, mainly, of: the lack of maintenance of the headphones in both equipments; and the lack of air-refrigerator in Esquirrel, which requires to open the windows, increasing the noise and affecting the communication.

C) Handling with devices and materials in helicopters (Figure 5):

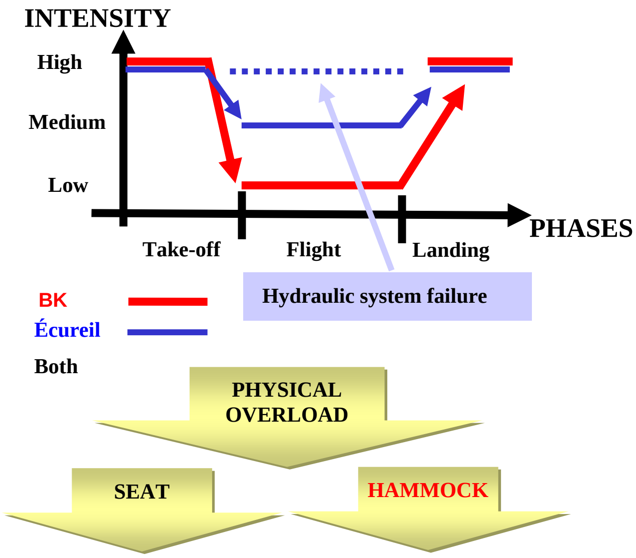

Figure 5. Characteristic Action C) Handling with devices and materials in helicopters.

Once more, it becomes necessary, for cognitive support, the aid of all senses, mainly: tactile, vision and audition. Specifically, the tactile sense will be emphasized when talking about the characteristic action of "handling with devices and materials in helicopters" (C).

During the take-off and landing of both equipments, the physical effort of the pilots and the aeromedical groups is of high intensity (handling with hammock, bags, documents, medicaments, monitors etc.).

During the BK flight, the physical effort is of low intensity, because the instruments are, mostly, automated. In spite of this, it is profitable to mention that the manual electrocardiogram does not have a definitive locate to be placed, being carried by the aeromedical groups, mainly in BK.

During the Esquirrel flight, the physical effort is of medium intensity, because its seat is not comfortable enough for both, the pilots and the aeromedical groups (bad seat cushion angle, lack of head support and lack of seat vertical regulation). Furthermore, the materials, as monitors, for example, are fixed in BK, but not in Esquirrel, being carried by the aeromedical groups and tending to fall during the flight. Exception is made when, in Esquirrel, there is an hydraulic system failure, which demands to maximize the pilot physical effort, from medium to high intensity.

Considering this characteristic action of "handling with devices and materials in helicopters" (C), the main problem is physical overload, derived of 2 critical situations: uncomfortable seat, in both equipments; and manual hammock of BK.

D) Dealing with comfort context in helicopters (Figure 6):

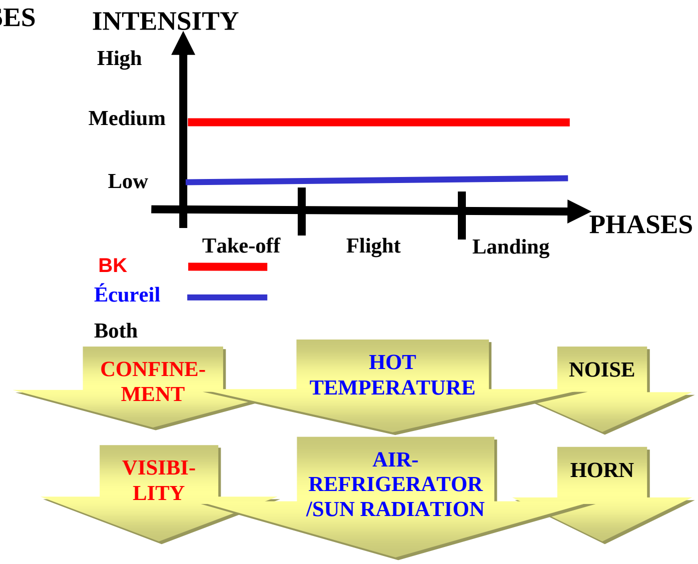

Figure 6. Characteristic Action D) Dealing with comfort context in helicopters.

During BK take-off, flight and landing moments, there is an environment discomfort for the pilots and the aeromedical groups, by the sensation of confinement, from the lack of external visibility, because the windows are obstructed by medical equipments. Specifically during the flight, there is the problem of nausea, for the same reason.

During Esquirrel take-off, flight and landing moments, there is, also, an environment discomfort for the pilots and the aeromedical groups, but because of the hot temperature, as there is no air-refrigerator in the helicopter, and of the noise, as they open the windows to try to compensate this situation.

In both equipments, during the flight, there is an environment discomfort because of the horn noise.

This characteristic action of "dealing with comfort context in helicopters" (D) points out to the following problems: confinement because of the lack of visibility in BK; hot temperature and noise because of the lack of air-refrigerator and sun irradiation in Esquirrel; and noise from the horn in both equipments.

Conclusion

The main characteristic actions (A, B, C, and D), presented and analysed before, which contemplates the final diagnosis of the Focused Analysis (V), were confirmed in Validation (VI) by the Workers Groups of pilots (3), mechanics (4), physicians (5) and nurses (6), in order to enhance the safety of the aeromedical transport. Afterwards, in Restitution, (VII), the results were consolidated after presented to them (Workers Groups 3, 4, 5 and 6), the managers of Flight Operation and Rescue Sectors (Follow-up Group - 2) and the decision-making manager of the aeromedical transport (Support Group - 1). The synthesis of the study report is found in Table 2:

Table 2. Validation (VI) and Restitution (VII)

Characte-ristics Actions	**Possible Causes**	**Effects**		**Proposed Suggestions/Recom-mendations (Possible Solutions)**	
		Esquirrel	**BK**	**Esquirrel**	**BK**
(A) Watching the control panel	Light reflections	Visibility harmed by looking to the control panel		*Insulfilm* on the lateral windows and the superior watch (I)	
				-	Directional illumina-tion with a special lantern (I)
				Increase of the advance panel (II)	-
(A) Watching the control panel (Cont.)	Limited vision angle of the pilot	Visibility harmed by looking to the control panel	-	Master alarm (II)	-
				Height seat regulation (II)	
(B) Processing the communi-cation among pilots and the aerome-dical group	Communi-cation noise between pilot and the aerome-dical group	Lack of efficiency of the acoustic phones isolation used		Silicon headphones with electronic noise attenuator (I)	
				Phones conservation (III)	
		Opened windows increase the sound pressure	-	Air-refrigera-tor (II)	-
(C) Handling with the devices and materials in the helicopters	Difficulty to reach of the control panel	Physical		Back support seat regulation (II)	
				Head support (II)	
				Height seat regulation (II)	-
	Difficult hammock movement	overweight		Better angle of the seat cushion (I)	-
				-	Pantogra-phic hammock (II / III)
(D) Dealing with the comfort context in the helicopters	Inadequate horn	Noise	-	Adequate horn with *gong* (II)	-
	Lack of air-conditioned	Hot temperat ure	-	Air-refrigerator (II)	-
	Sun irradiation			*Insulfilm* on the lateral windows and the superior watch (I)	-
	Low external visibility	-	Confi-nement	-	Higher external visibility for crew (IV)

Legend: (I) Small modification [1]; (II) Big modification [1]; (III) Training; (IV) New acquisition.

Aiming at a safer aeromedical rescue in the company, the report of the complete work was sent to the decision-making manager of the aeromedical transport (Support Group - 1); and the Flight Operation and the Rescue Sectors managers (Follow-up Group - 2). Worried about using relevant data for prevention in the context of aeromedical aviation, it was sent, either, to the Aviation Authority, the helicopter manufacturer and some research institutions, as an attempt to improve this kind of operation.

This research entends to attempt the general purpose of assistimg the company in the analysis of some of its demands in the work situation studied: (c) the helicopters interior, with their variety of devices and situations of interactions among the agents involved in the aeromedical transport; and to contribute for better Air Safety conditions of the helicopters Esquirrel AS 350 B2 and BK 117 C1, in aspects related to Collective Activities (ROUGNIN et PAVARD, 1996), Organizacional Culture (DEJOURS, 1987), Cognitive Ergonomics (VIDAL, 2001b) and Complexity (LEPLAT, 1991).

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1 BRASIL, 2002: Big modification (not listed in technical specification approved for the aircraft, engine or propeller, affecting consubstantiality its weight, balance, structural resilience, flight characteristics of maneuver, or airworthiness); small modification (does not have the definition of big modification); and IAC 3134-0799 (Public Air Transport of Patients).

References

DÉJOURS, Christophe. (1987) – A Loucura do Trabalho [Madness of work]. Oboé. São Paulo.

FAVERGE, J.M. (1980). L'analyse du travail em termes de regulation. *Bouletin de psycologie*, XXIII, 5, pp.14-26.

FERREIRA, L.L. (1993). Análise Coletiva do Trabalho [Collective work analysis]. *Revista Brasileira de Saúde Ocupacional*, n. 78, vol. 21, abril/junho, p.7-19.

LEPLAT, J. (1992). Quelques aspects de la complexité en ergonomie. In : DANIELLOU, F. *L`ergonomie en quête de ses príncipes*. Octaresed. Toulouse.

ROGNIN, L. et PAVARD, B. (1996). Pluri-addressed messages and coordination: impact of the intercom on the human cooperation. In: *Second International Conference on the Design of the Cooperative Systems* (COOP'96). Juan-les-Pins.

VIDAL, M. C. R. (2001a). Interações Orientadas. [Oriented Interactions]. In: Revista Ação Ergonômica. Ed. Virtual Cientifica, Rio de Janeiro.

VIDAL, M.C.R. (2001b). Ergonomia na Empresa: útil, prática e aplicada. [The organizational ergonomics: useful, practice and applied]. Ed. Virtual Cientifica, Rio de Janeiro.