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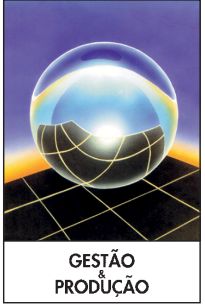

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Economic approach to cognition (AEC) in work safety

Abordagem econômica da cognição (AEC) em segurança do trabalho

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Abstract: This article presents a new approach on human cognition in work activity: an economic approach to cognition (EAC). Workers share a common world in which they understand and act in tune. This common world is called Umwelt or genus. An external observer does not have the same vision and the same understanding of the workers in his Umwelt. This explains the lack of understanding of an accident at work. Another point addressed was the three-level model of behavior (knowledge, rules and skills) proposed by Rasmussen. We affirm that this model is incorrect because the action occurs with the simultaneous presence of the three levels, horizontally, and not the hierarchical form proposed by this author.

Keywords: Workplace safety; Action; Cognition; Rasmussen.

Resumo: *Este artigo apresenta uma nova abordagem sobre a cognição humana em atividade de trabalho: abordagem econômica da cognição (AEC). Os trabalhadores compartilham um mundo comum no qual se compreendem e agem em sintonia. Esse mundo comum recebe o nome de Umwelt ou gênero. Um observador externo não tem a mesma visão e a mesma compreensão dos trabalhadores em seu Umwelt. Isso explica a falta de compreensão de um acidente de trabalho. Outro ponto abordado foi o modelo de três níveis do comportamento (conhecimentos, regras e habilidades) proposto por Rasmussen. Afirmamos que este modelo está incorreto porque a ação ocorre com a presença simultânea dos três níveis, de forma horizontal, e não da forma hierarquizada proposta por este autor.*

Palavras-chave: *Segurança do trabalho; Ação; Cognição; Rasmussen.*

1 Introduction

Human cognition does not have unlimited resources to perform regulation and operative strategies, articulating results, objectives, means and operative modes (Guérin et al., 2001) in the work activity. Most of the work accidents occur due to tasks that go beyond the operator's cognitive ability to manage risks in a given situation (Amalberti, 2004). This research did not need to be supported by empirical data because it is a theoretical investigation that can undoubtedly support other empirical research that wants to validate the proposed model. This was built on the basis of research carried out by contemporary cognitive sciences. For example, the notion of intentionality (Searle, 1983) contradicts the idea of a model that fragments consciousness into three levels of action control: skills, rules and knowledge. It should be noted that the cases described in the literature on occupational accidents corroborate the approach proposed here. A good mechanism of scientific validation of the present model is to confront, not only the real yet to investigate, but especially the situations already investigated, with the modeling (Curie, 2004) of the "*embodied encative cognition*".

On the other hand, it is no longer correct to distribute the action hierarchically, in levels, between behaviors based: 1) in knowledge; 2) in rules; 3) in sensorimotor skills, as in the representationalist model of Rasmussen (1986) (Figure 1).

In reality, as we propose here, the three "levels" are distributed horizontally (Figure 1), in a model in which the action employs all of them simultaneously; in other words, when acting, the operator employs sensorimotor skills, rules and knowledges. The notion of intentionality does not allow hierarchization of these levels and distinguish them, since they are simultaneously present in the composition of behavior and action in an integral and present moment of the work situation, guided by intentional acts (Searle, 1983). The more the action in activity requires of a certain item (among the three), the less space will be

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available for the others, in a true Economic Approach to Cognition (EAC) proposed here.

The role of sensorimotor behavior in the relationship between cognitive control and what is commonly referred to as "human error" was addressed by some authors in the field of work accidents (Rasmussen, 1986, 1988; Reason, 1988) and engineering of cognitive systems (Rasmussen et al., 1994). However, these approaches still remain tied to Jerry Fodor's cognitivism and representationalism (for which the mind obeys a syntactic formalism, physical processing of symbols, as a computer program (Smith, 1999, p. 102)). They hierarchize the human control of action, so that the manipulation of symbols is considered the highest level, or level of "knowledge", of elaboration of an abstract mental model in the form of internal representation of external information. A major representative of cognitivism in the definition of human error is Rasmussen's (1986, p. 101) model of representation, which is widespread in work safety in Brazil. On page 152 in the last paragraph and beginning of page 153, the author of the work that bears the name "information processing ..." states that people make mistakes for lack of knowledge:

> […] people may commit errors in reasoning because of, for instance, slips of memory, lack of knowledge, or to high workload-it may be difficult by unsupported, linear reasoning to deal with the complex causal net of the real world (Rasmussen, 1986, p. 152-153).
>
> A typical closeness to cognitivism, physicalism, and symbolic representationalism (by J. Fodor) of information processing (Smith, 1999).

2 Exploring action, cognition and sensoriomotricity at work

The present proposal also aims to demonstrate the role of the sensorimotor aspect in the management of risks, without the control of the action/situation necessarily passing through the elaboration of internal mental representations by the operators. As discussed by Amalberti (2004), this risk management involves prevention, recovery and mitigation actions. All connected to the sensorimotor. Recovery, for example, allows you to stop the development of an incident scenario before it becomes an accident. The cognitive activity of the operator works in a way to manage contradictory aspects of the situation (time, quality, quantity, safety, etc.) and can not be fully prescribed, since the action against this complexity is created cognitively, by the cognition of the operator, in a commitment and "[…] cognitive control of the situation" (Amalberti, 2004, p. 293).

Here, as a contribution, it is important to demonstrate that this cognitive management of risks is at least partially affected by the notions of sensorimotor, motor intentionality, kinesthesia and sensorimotor coupling between agent and situation (in its environment of action or Umwelt). Perhaps a cognitive management of risks based on the body's motor action.

In the cognitive sciences, it has long been argued that the sensorimotor can not be seen as the lowest level of action (in an incorrectly hierarchical approach), but rather as the essence of cognition, to the extent that it can be said that the body is in the mind, that is, the mind is the body in motion (Johnson, 1987).

The contribution of this article comes in the sense of offering a theoretical knowledge, or model, that guides, in part, the practice of the professionals of work safety of the Brazilian companies, especially the engineers. It is not a question of offering a ready formula for safety and production engineers, but of pointing to a new point of view, a more theoretically correct model, which can be useful if considered in occupational safety and health management programs or systems.

In other words, we propose to discuss that mechanisms for blocking errors, prevention devices, tools to combat failures and malfunctions, resources for risk management, anticipation, prevention or recovery (concepts taken from Amalberti, 2004) should we will explain what will be explained later as the sensorimotor coupling between the agent (operator, worker) and the situation (including the environment). We believe that this thesis, and its premises, function as an explanatory model in different situations, not only in those that served as the basis for this research, but also for accidents described in the literature and even in the great press. However, as must be done in the practice of science, here we offer the scientific model (Figure 1), and invite researchers and professionals in the field of work safety and production engineering to test their validity in their reality practice. Let us leave with them the opinion about what we offer as contribution to the field.

Behavior, which is the prime cause of all stimuli, is divided into horizontal and non-hierarchical knowledges, rules, and skills (Figure 1). This implies that if an operator exercises an activity where apparently the sensorimotor abilities predominate, as a background of behavior we have, in full operation, simultaneously the components of knowledge and rules integrating their action. In an economic approach to cognition (EAC), the overload of the component of sensorimotor abilities makes the portions of rules and knowledge proportionally less used, but does not imply that they are absent at a given moment. It is the cognitive economy in action. That is why the novice operators are more supported in rules and knowledge, compromising the almost "automatic" fluidity of the sensorimotor gestures in the action, verified in the operators with expertise.

A typical and exemplary situation of the EAC (Economic Approach to Cognition) in work safety can be observed in the case of a civil construction site operator (worker) who died because he "did not remember" closing the makeshift elevator door on the spot. The case of the accident in a construction site lift is reported by Almeida & Binder (2004, p. 1374-1375), and illustrates well the hypothesis in question. Let us see what the authors say:

> [...] This is an accident occurred when the injured person, called to solve a problem related to the repairs executed in the water tank of a building, when leaving the elevator that had taken him to the floor in which the box, did not close the elevator door (default). When it was opened to give access to the place of work, the door protruded out on a platform on which the workers walked to the water box. Opening and closing the door were manual and the lift had no locking device to move if the door was open. As he left the elevator to the platform, the worker did not close the door, walking toward the water box. At that moment, the elevator began to descend and the open door collided with the platform, knocking it over. The worker suffered a 40-meter fall and died [...].

Further, although the authors do not allude to the EAC theory, they correctly exemplify this hypothesis, which we are proposing here, which can be verified by any research subject who so desires. In this sense, we see other affirmations of great importance of the authors:

> [...] Walking is one of the examples of skillbased human performance, in which automatic control predominates, allowing the individual to perform a certain sequence of operations without having to mobilize attention to them. In this accident, it was observed that the omission occurred during the displacement (walking) of the accident to the place of origin of the demand and in the proximity of it, which, due to the characteristics of the psychic functioning of human beings at work, tends to mobilize the attention of the for the activity to be performed. And the closing of the door has no relation to its main objective, with a greater capacity to capture its attention [...] (Almeida & Binder, 2004, p. 1366).

And the operator was still found guilty of the accident that killed him.

In his sensorimotor coupling with the environment, the worker does not elaborate mental representation, he moves, he acts, guided by motor intentionality (Pachoud, 1999; Barbaras, 1999), in a flow or transparency (Varela, 1999). He just walks. There is no reflection in the activity (and no time for this in the face of the high temporal pressure of this), as if the worker were executing an algorithm of the type: "I-I'm going to open the door; 2-now I'm going to leave; 3-Now I'm going to close the door". He does not elaborate this kind of mental representation, and the accident was the undesirable proof of it. It simply, in its motor intentionality (Pachoud, 1999; Barbaras, 1999) acts according to the context. That is, in his embodied act, which integrates mind and body, he walks out when the door is open. And just.

The operator was basically linked to sensorimotor (walking) behavior, as well as behavior based on rules and knowledge (the objectives to be achieved, the time available, the means employed, the type of repair to be performed on the scene of the accident, etc.), and it was not possible to say that the action was guided only by a certain "level" of behavior (Figure 1) in the specific situation. The overload caused by the task has surpassed the cognitive capacity of the operator in all three fields of behavior and action (knowledge, rules and skills).

In this case of the construction elevator, it should not be necessary for the worker to remember to close the door (or act this). A mechanism, sensorimotor (that reached the sensorimotor coupling between worker and environment), of the "affordance" type, should be employed to block the automatic behavior of leaving without closing the door. An "affordance" that would guide the action of the worker, every time he went out, hitching up the act of coming out at the act of closing the door. This is because, in the case in question, the implementation of an automatic door might not be feasible. The use of affordance would then be a safe option.

Moreover, other empirical data, obtained by other authors, go in the same direction is being defended in this article, as in the complex case of collision between a Gol Boeing and a Legacy jet (Carvalho, 2011), in which the sensorimotor demands of the action, at any level of analysis, were not met "[…] there is a message in white and small letters indicating TCAS OFF [...]" (Carvalho, 2011, p. 1492). The message that warned, or should have warned, the pilot that the TCAS was off was invisible to him, in the context of the situation investigated by the author. The mind was taken by two components of behavior, overshadowing the level based on which rules to use in the situation.

Perception in work activity does not occur passively, as if the operator were picking up stimuli from a predetermined outer world and processing them in the same way as receiving them. Perception is an active process, which depends on the behavior of the operator, his knowledge, the rules he is following and his sensorimotor behavior. It also depends on the available regulations regarding the results and objectives to be achieved, the time available, the means at its disposal and the operative modes (Guérin et al., 2001, p. 66). This means that there is no universal stimulus, captured from a world independent of the operator's action. Operator and world are coupled so that it is not possible to separate the first from the second so that it captures a stimulus from an

unbiased world without interacting with it as if it were an information processor. World and operator are mutually specified, it is not possible to "leave" the world to elaborate an exempt representation. The subject makes his mark on what is perceived from the real world.

The way of perceiving a stimulus from the world of production depends on the mode of interaction with this world. And this interaction is affected by the ergonomic aspects of the activity, such as the time available; the permitted space of regulation; the operative strategies for achieving the objectives, goals and the treatment with the variability; the operative modes that are possible to be elaborated.

3 Common world, Umwelt or genre

Operators who work together in the same activity create a real common world among themselves (Pastré, 2005). In their common world, they share language, perceptions, and tacit knowledge that are difficult to understand for outsiders: observers. As observers we can classify the managers and other professionals who do not share the activity of the operators. This is a cause of the difficulties of mutual understanding in language when any incident or work accident occurs. Observers fail to understand the point of view of operators in their common world. The common world in philosophy is called Umwelt (Merleau-Ponty, 2006).

A common cognitive environment, or a common operational reference in the world of work: a gender (Clot, 2006). An interface between the world of the "in-itself" and the world of "for-itself". A universe of clipping (derived from behavior) constructed by the agent's acting (living being). A unit of analysis that breaks with the objectivist idea of mental representation of the world as a mirroring of the external environment by the mind. The world of work is internally experienced by the worker. These phrases enable an initial sketch of Umwelt's notion in Merleau-Ponty (2006). The Umwelt is a kind of common world (Pastré, 2005) shared by those who carry out the same work activity. This is part of the reality that is commonly experienced. It is a symbolic interface placed between the subject and the object and the other agents of the same activity, which regulates the individual action based on the repertoire of rules, perceptions and knowledge of the collective. It supports and guides individual activity based on the repertoire of possible collective work.

The world of distinctions and the constitution of the reality of an absolute (external) observer is radically different from the world lived by the agent within his Umwelt of acting (Maturana & Varela, 2002). Therefore, a manager or member of the hierarchical leadership of the organization of work have difficulty understanding the viewpoint of the workers located in his Umwelt. As in the works of these Chilean researchers, anti-objectivism and anti-representationalism (of representative realism) emerge in Merleau-Ponty (2006, p. 271) texts:

> Umwelt marks the difference between the world as it exists in itself and the world as a world of such or such a living being. It is an intermediate reality between the world as it exists for an absolute observer and a purely subjective domain. [...] It is the environment of behavior "opposite the geographical environment", to use Koffka's words. Uexküll anticipates the notion of behavior. When it comes to Umwelt, there is no psychological speculation, he argues.

The Umwelt (genre, common world, world of action or constitutive ontology) is preponderant about the notion of consciousness, embracing it as a world of embodied action that can not be isolated purely as the fruit of a mental representation. The action of the operator (agent) occurs inside his Umwelt, which also functions as a symbolic interplay between the agent and the work tool and the other subjects. The agent is coupled to his world of action according to the designation of intentional arc (Thompson, 2005): "This behavior oriented towards an Umwelt begins long before the invention of consciousness" (Merleau-Ponty, 2006, 271).

The idea of mental representation is affiliated with both objectivism and representative realism. It can also be seen as pertaining to idealism. This criticism is clear in the Merleaupontian terms: "Uexküll denounces the Cartesian dichotomy, which combines an extremely mechanistic way of thinking with an extremely subjective way of thinking" (Merleau-Ponty, 2006, p. 272).

Merleau-Ponty's point of view is anti-cognitivist and anti-representationalist, which is clear in his explanations of the Umwelt in consonance with Uexküll. Cognitive production events are shaped according to the Umwelt or gender (Clot, 2006) of operator ownership. "[...] Uexküll presents Umwelt as a type of which organization, consciousness and machine are mere variants" (Merleau-Ponty, 2006, p. 272).

In the world of work activity, the operators who perform the same activity are inserted (incorporated), acting in the same Umwelt and share perceptions and language. An actuation Umwelt (incorporation) very close to what Clot (2006, p. 38) calls gender:

> Action medium for each one, gender is also group history and impersonal memory of a workplace. Sometimes we say simply genre, for short. But it will always be about activities linked to a situation, the ways of "apprehending" things and people in a given environment. In this capacity, as a social instrument of action, gender preserves history. It is constitutive, from this perspective, of the personal

> activity that is realized through him. [...] From our perspective, a group is not a collection of individuals but an unfinished community whose history also defines collective cognitive functioning. [...] There are social instruments of action that pre-organize it in the form of impersonal rules of use and exchange. These instruments constitute the "generic" dimension of individual activity.

Whether or not a member of the Umwelt type explains the difficulties of mutual understanding in language between agents outside the Umwelt (eg managers and consultants) and workers (agents within their gender). This occurs in cases of breaches or accidents at work, or even in incidents. No one understands.

It is within each Umwelt, or genre, that the sharing of a small portion of the experiences occurs: those linked to the cognitive acts performed on the production process - the instrumental activity. It is also within an Umwelt that intercomprehension occurs between the agents of production and communion in a common language.

The Umwelt is a social, historical, collective construct that will serve as support for each individual's action, as well as Clot's (2006) notion of genre. The Umwelt becomes a common embedded basis in which agents are inserted, and which provides them with a set of common perceptions and similar interpretations of reality. It is a repertoire of actions for individual action. It saves the cognition of agents by allowing them to act without having to recreate at all times a roadmap for individual action. It is enough to appropriate a portion of the genre, or of the genre itself, to act effectively and in tune with the other actors (agents) coupled thereto (Clot, 2006). The Umwelt or genre (common world, world of action, constitutive ontology) is a construct engendered in the social and historical sharing of agents. It allows the construction of common points of view and presents itself as strange to another actor situated outside their domains. The outer world is recreated in the interiority of an Umwelt, throwing aside the idea of mental representation:

> In the stage of the higher animals, the Umwelt ceases to be closure to be aperture. The world is possessed by the animal. The outer world is "distilled" by the animal which, by differentiating the sensory data, can respond to them by final actions, and these differing reactions are only possible because the nervous system assembles itself as a replica of the outer world (Gegenwelt). In this perspective, the disposition of the external world, the objective universe, now plays the role of sign rather than of cause (Merleau-Ponty, 2006, p. 276-277).

The Umwelt performs a sign function, as a product of the actuation of the agents incorporated in it. They share a common language and common perceptions, since the Umwelt is a common world created by the social and historical belonging of its agents. So there are no universal stimuli to be picked up by incorporated agent. The stimulus will be reformulated by the Umwelt or gender, acquiring only the meanings that are allowed by this. The representationist idea of capturing an input for the emission of a universal output is false. An input does not cause a behavior, but only triggers a response that fits the Umwelt or genre of the agent therein. There is only one form of external disturbance compensated by the autopoiesis of the cognitive agent, in its operational closure, in its structural coupling to its working world, or Umwelt (Maturana & Varela, 2002). The Umwelt produces meaning rather than being a cause of an outward objective world; so it is in accordance with the notion of gender:

> A body intermediate between the subjects, a social interposition situated between them, on the one hand, and between them and the object of work, on the other. In fact, a gender always links those who participate in the situation, as co-authors who know, understand and evaluate this situation in the same way (Clot, 2006, p. 41).

The Umwelt is, in reality, an environment (historical and social) that the agent conquers for himself, as Merleau-Ponty says to the higher animals:

> The higher animal therefore constructs an Umwelt which has a Gegenwelt, a replica in its nervous system. In his 1934 work Uexküll needs this notion of Gegenwelt. Distinguish Welt: it is the objective world; the Umwelt: it is the environment that the animal conquers for itself, and the Gegenwelt, which is the Umwelt of the higher animals. [...] Uexküll shows that human space is composed of three imbricating spaces: visual space, tactile space and space of action (Merleau-Ponty, 2006, p. 279-280).

The visual, tactile and action dimensions are in continuous interaction in the understanding of reality, as well demonstrated in Husserl's work (Pacherie, 1999). These dimensions situate the agent within the Umwelt, providing understandings and perceptions common to the agents situated therein.

The Umwelt singularizes the physical environment before purely objective. It gives meaning and meaning to experiences mistakenly held to belong to this objective and decontextualized world. Workers located inside their Umwelt form a collective that provides support, support for individual actions, as well affirmed in the notion of gender (Clot, 2006). The Umwelt is this collective sharing in which the phenomenon of reciprocal understanding in language occurs and even the sharing of some perceptions that are absolutely unknown to the agent outside Umwelt. This becomes serious in situations of failure or accidents at work, in which outside agents (managers,

hierarchical superiors) do not understand the point of view of those who experienced the event of the interior of their Umwelt. The difficulties of common understanding and of sharing in language between different agents then occur. The experiences inside and outside are absolutely distinct and incompatible. The genre or Umwelt offers a repertoire of modes of action to the operators, saving the cognition in causing that the action flows in a coherent flow - transparency (Varela, 1999), without the need of a planning of each moment that occurs, that is, without, also, the occurrence of a mental representation.

4 The model proposed in counterpoint to the conventional Rasmussen (1986, p. 101) model

Consciousness, in its specificities of intentionality (Searle, 1983), unity, globality and non-fragmentation, can not be divided into three hierarchical states as Rasmussen (1986, p. 101) does, Figure 1. There is no higher level, based on mental representation, as the author states. In addition, the action situated and contextualized by the work activity, involves all aspects on the same horizontal level: sensorimotor skills, rules and knowledges. A cognitive commitment that allows the operator to make the necessary adjustments to meet the objectives of production - quantity, quality, safety and self-preservation - involves unified cognitive ingredients based on skills, rules and knowledge. The operative strategies needed to manage conflicting aspects require the elaboration of regulations between means and objectives, in order to achieve the predefined results, by varying the operative modes, so as to ensure the internal state of the organism, as explained by Guérin et al. (2001, p. 66). These regulations do not involve hierarchical levels of a representationalist action, but rather an embodied action that encompasses all three aspects (skills, rules and knowledge) in a unified and horizontal way.

Knowledges, rules and abilities make up an incorporated action in a model of consciousness without fragmentation. This is an indispensable premise for the ergonomic cognitive aspects that enable the operative strategies in managing the dynamic work situation. The operator acts within his Umwelt, which also encompasses the work activity, allowing the variations of operating modes and the regulations necessary to obtain the results stipulated by the production. In the elaboration of operative strategies and operative modes, there is no simultaneous elaboration of mental representation, there being no symbolic planning of action, but rather a situated action, incorporated in flux, as in the notion of transparency by Varela (1999).

The operative modes result from an incorporated cognitive compromise, which encompasses all three components in a homogeneous way, or as affirmed by Guérin et al. (2001, p. 65-66):

> Operational modes adopted by operators are therefore the result of a compromise that takes into account: - the required objectives; - the means of work; - the results produced or at least the information available to the worker; - its internal state. In situations without constraints, alertness indexes related to their internal state ("fatigue") lead the operator to modify the goals or the means of work to avoid aggression to his health. [...] Conversely, in a situation subject to constraints, it is not possible to act on the objectives or the working methods. At first, the required results are attained at the cost of changes in the internal state, which may eventually lead to health aggressions.

In order to execute the necessary adjustments in the work activity, the operator needs to elaborate a cognitive commitment that encompasses the action in its three aspects: knowledge, rules and skills, according to a horizontal model (Figure 1). This is counter to the idea of mental representation, through the notion of an action incorporated in the work situation, with its constraints and possibilities of regulation (Guérin et al., 2001).

The operator does not vary the operative modes based on a mental representation. It does so in accordance with what it perceives and feels in a way incorporated into the context of the work situation, within a flow of action that involves the cognitive experience of the situation itself (Varela, 1999):

> In fact, the adopted operative modes are the result of a set of commitments coming from different levels. [...] The concept of "workload", in our view, can be interpreted by understanding the margin of maneuver available to an operator at a given moment in order to elaborate the operative modes, with a view to achieve the required objectives, without unfavorable effects on their own state. A moderate "workload" corresponds to a situation where it is possible to design operative modes that meet these criteria and to change the ways of working. The increase in "workload" translates into a decrease in the number of possible operative modes: the number of possible ways of organizing is becoming smaller (Guérin et al., 2001, p. 67).

The regulation of the workload occurs through the incorporated variation of the operative modes, without there being anything like a mental representation. The operator does not have, for himself, a planning of the action of modifying the operative modes. This only occurs as an effect of incorporation into the work activity. In it, he feels, perceives, thinks, and acts interdependently, employing, in a unified and horizontal (non-hierarchical) way, the cognitive

ingredients based on sensorimotor skills, rules and knowledges.

The operative modes adopted are the result of a set of cognitive commitments adopted, integrating different aspects of the situated action. The objectives and results required, the means of work and the internal state of the organism (Guérin et al., 2001) are articulated in a way that involves the components of action based on skills, rules and knowledge in an integral way, to carry out the activity or actual work. Consciousness can not be fragmented at hierarchical levels in activity, nor can it operate on the basis of mental representation, since action occurs on the basis of the embodied cognition of the operators (agents), in their Umwelt or gender (Clot, 2006), in the which there is an interdependence between feeling, thinking, acting and acting. It is not possible to go beyond oneself to elaborate a planning of action (representation) independent of the structures of the subject itself and of its action/performance in the work process. Absolute knowledge of the objective world of production is not possible.

In fact, the sensorimotor activity acts as a support to the other ingredients of the action, as presented in the proposed model (Figure 1). This sensorimotor activity has the function of allowing a cognitive economy in the use of the other components of the action. This is clear in the behavior of experienced operators (expertise). Their action relies on the sensorimotor level in order to save the simultaneous use of skills, rules and knowledge (economic approach). The rules of the trade and the knowledge of the work process are there present, together, in the unified consciousness that is directed to the world of embodied action.

Therefore, it is impossible for only one of the "levels" to be alone in the control of the operator's action. This encompasses the three levels (skills, rules, knowledges), unified, in the accomplishment of the work activity. There is no presence of a single "level" in charge of the situation, but rather an action that merges, unified, skills, rules and knowledges. If the operator (agent) is primarily using skills-based behaviors, the presence of behavior based on rules and knowledges is verified. These ingredients are situated horizontally (not hierarchical) as demonstrated in the proposed model of Figure 1. They integrate the consciousness of the action, about the situation, together, globalized, without fragmentation. For example, when preparing for takeoff or landing, a pilot is acting on sensorimotor components, but without losing sight of the rules to follow in the landing or take-off procedure and, in particular, by putting into practice, at the same time, their deeper knowledge.

The notion of intentionality (Searle, 1983) does not allow the fragmentation of consciousness into three hierarchical levels of action: skills, rules and knowledge. Distinguishing a level just as the one who commands action is a baseless representationalist question for contemporary cognitive sciences. In an economic approach to cognition (EAC) it is possible to criticize occupational health and safety management systems, because they tend to overload the working memory of the operators with rules and standards to follow, safety at work. They should ensure that all three components function systemically to ensure the safety of operators and facilities. "Classroom" training, within the proposed EAC approach, is risky for safety.

The problem of treating the operator as an "information processor" is serious and risky. The Rasmussen (1986, p. 101) model, which still supports many accident analysis and prevention practices, remains a dangerously hierarchical model at three levels, based on this idea of mental representation (as opposed to the proposed model presented in Figure 1). In a synthetic way, it implies adopting more "use knowledge ..." prescription; "Apply such and such rules ..."; "Follow such and such rules and instructions ..."; "Thus processes such and such secure information ...", which is an anti-economic bias in cognition - the human mind does not have an unlimited capacity for "processing" - and therefore tends to overload working memory increase the risk of accidents.

A serious misconception in work safety management programs or systems is implicitly underpinning their practices, a model that assumes the operator (agent) as a receiver and processor of symbols, information and rules or rules which are supposed to result in appropriate, safe, behavior. This tends to saturate the working memory of the operators with rules to follow, leaving less space for the use of skills and knowledge. It is an amplification of risks, not safety. It is the situation that demands of the operator a full action based on knowledge, rules and skills. The situation does not tolerate Rasmussen's fragmentation.

The information unrelated to the sensorimotor (Thompson, 2005) makes no sense to the agent / operator. The sense of action is, in reality, a sensorimotor sense. The "motor intentionality" (Pachoud, 1999; Thompson, 2005) is the opening or directing of consciousness, towards the objects aimed at, structured by the motor potentiality of the body; as a pre-objective and pre-reflective layer that precedes one's own reflection or awareness (Thompson, 2005). This is the "brute being" already addressed by the phenomenology of Maurice Merleau-Ponty (Chauí, 2008, p. 47-50). On the other hand, it is a construct of sense (in the constructivist sense) of the Umwelt type. That is, Umwelt, from Uexküll, addressed in Merleau-Ponty's phenomenology as a constructed sense, which emerges from the sensorimotor movements of regulation of the situation (Merleau-Ponty, 2006, p. 284-292) understood and applied technologically in Cybernetics, Computer Engineering, Information

Sciences, Microelectronic Automation, Bioinformatics and Artificial Intelligence.

In cases of accidents at work, the agent (operator) was generally guided, without fault, without intention, by the "Transparency" of the action (Varela, 1999, p. 298), or Umsicht (Heidegger, 2005, p. 232), usually under temporal pressure or temporal embarrassment. In the case of an accident, motor intentionality (without intention or guilt) was mobilized, which mobilizes an incorporated sensorimotor type of knowledge, as the base that guides (supports) the safe action (Figure 1, proposed model) of dynamic situations (Hoc, 2004). Under temporary pressure (constraint), the operator has neither space nor time to reflect on his behavior. Cognition declines to a precarious state. He does not have it clear as a mental representation, of the verbal, declarative, propositional type, or as a translucent and fully conscious reflection prior to action. His consciousness is all situated in the sensorimotor act, in its gross merleaupontian being (ie, not representative, that is to say, far from the realism representative of pure abstract virtuality). Its space is lived and incorporated space (Thompson, 2005), not abstract virtual space.

Avoiding an accident requires guiding (through supporting devices) the sensorimotor behavior (in the agent-situation / environment coupling), whose absence (of support mechanisms ...) surely contributes to the accident without going through a mental representation.

Or, on the other hand, to induce another sensorimotor behavior that is safe, in the Umwelt sense (Merleau-Ponty, 2006, p. 276-323), which is invariably constructed by motor intentionality (Thompson, 2005) of the proposed model, that is, it emerges from the concrete movements on the surrounding environment.

Or, to facilitate the cognitive control of the situation by granting autonomy for the active sensorimotor exploration of the environment (Figure 1, proposed model) and kinesthesia, in the sense of Embodied Enactive Cognition, indispensable for the perception and management of risks. This autonomy, as well known in ergonomics, also implies not imposing constraints on the variability needs of the operating modes in the work activity, which would generate impediments in the sensorimotor, in the sensorimotor exploration of the environment, obfuscating the perception and cognition demanded to combat the " mistakes "and failures, detect malfunctions, assess risks and avoid accidents and incidents. Perception and language, necessary for risk management (Amalberti, 2004), occur inside the operator's Umwelt.

Therefore, when it comes to work safety, prescriptions based only on the provision of information, rules and symbolic chains, unrelated to the lived space - Umwelt - sensorimotor of the worker, are generally not very effective. These symbolic procedures end up making no sense to the agent, because they are located in a virtual externality, that is, outside the lived space or Umwelt of sensorimotor activity of the agent / operator. Therefore, they do not activate their perception of risks and do not act as barriers against accidents. In order to activate the perception of risk, to increase voluntary attention - teleologically directed to a specific purpose - by the worker in a dangerous situation, and to help the action to be safe, it is necessary to create devices that focus on the sensorimotor coupling between subject and environment. As Thompson (2005) says, "intentional arc".

The accident literature recommends many procedures that still presuppose a subject model as a symbolic information processor, and we do not

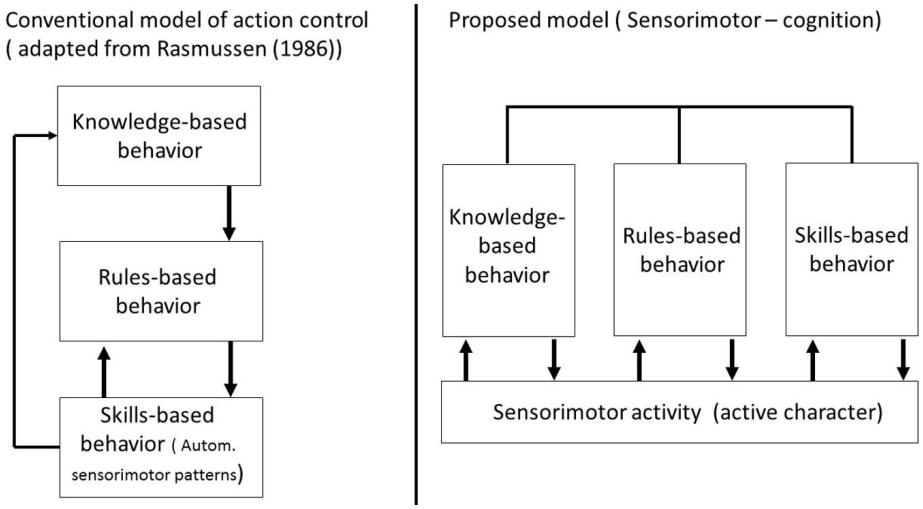

Figure 1. Conventional model of Rasmussen (1986, p. 101) × Proposed model.

find yet any bibliographical references that discuss the present issue of sensoriomotricity in work safety, simultaneously, in the threefold sense of: a) Umwelt (Merleau-Ponty, 2006); b) Umsicht (Varela, 1999, p. 298) or "transparency"; and c) intentional arc (Thompson, 2005). If ontologically the accident cases have their bases in the motor behavior, linked to the cognitive activity (including the perception), it is necessary to put the question of the safety also in terms ontologically pertinent to guarantee the life and health of the worker: action, perception, cognition, movement, motor activity (Figure 1) and intentionality.

There is, therefore, an incorrect assumption about the subject of action (on work safety), or agent / operator. This subject of action, or agent, is not clear to himself, during the action, the reasons and motives of his behavior. He does not enjoy reflective transparency on the plane of consciousness, which allows him to mentally represent, in a clear, propositional, verbal or declarative way, his own cognitive processes involved in a decision. He acts in the gross mode of being merleaupontyano (Chauí, 2008), ie pre-reflective. In other words, without elaborating cognitive, objectivist, and physicalistic mental representation, the operator only experiences his world of action, and acts in unison with him, in his coupling, in the mode of operation of an intentional arc (Thompson, 2005). Or, it acts in a real lived space and not in a virtual space, according to this author, since the virtual is non-existent, and the real only acquires meaning by the sensorimotor movement against the environment (Thompson, 2005, ref. real (lived) and virtual space).

In an economic approach to cognition, or embodied cognition, it does not operate according to a hierarchical model oscillating between skill-based behaviors for rules-based and ultimately knowledge-based ones. It works on the basis of all three, at one and the same time, in an integral, horizontalized and non-vertically integrated manner (Figure 1). The action can be understood as a result of the three components acting simultaneously, in harmony. No one acts based only on knowledge (level 3) or rules (level 2), but rather on the basis of sensorimotor skills linked to the rules of the craft and the knowledge mobilized in the work activity.

5 Final considerations

A more coherent approach to cognition and action in work activity, supported by both the cognitive sciences and phenomenology. The economic approach to cognition (EAC) states that cognition does not have unlimited capacity in the production processes. Understanding this is vital to work safety.

The Umwelt or gender is a cognitive environment shared by the operators that mate with it, and in which it is possible to intercomprehension and support for actions in accordance with productive situations.

For the external observer (managers, engineers, administrators) the perceptions are different from those obtained by the operator incorporated in his world of performance or Umwelt. Due to this, when an accident at work occurs, it is difficult to obtain consensus on the causes of the accident. While belonging to different genres, the agents have different perceptions and different understandings for the same facts of the productive system.

It should also be stated that the hierarchical model of Rasmussen (1986) is not compatible with the real cognition of the operators. This involves three components horizontally situated and in simultaneous operation (skills, rules and knowledges).

Although this article specifically does not have empirical data, the theoretical construction here was based not only on theories of action and phenomenology, but also on the vast realization of empirical studies presented in other more elementary articles, already published in other periodicals. In the first place, it is a theoretical research, supported by the epistemology of the contemporary cognitive sciences and the phenomenology of Husserl and Merleau-Ponty.

The basis of the new theory presented here is a set of empirical studies, presented in other texts, as well as the current theories of the field of cognitive sciences and phenomenology. It was possible to construct an alternative model under the protection of these sciences. It was decided not to use empirical data since this has already been done in other studies and also for the sake of space. Moreover, the construction of the theory proposed here has been made, as already mentioned, on the basis of other theories already consolidated in the field of cognitive sciences and phenomenology.

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