Influences of aging and work experience: an ergonomic approach in the workgroup in an assembly line

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Abstract
Analyze the influences of aging on work activity to identify the strategies adopted by workers in an assembly line with workgroup. This study has hypothesized that workers develop a collaborative tacit knowledge between young and experienced workers.

Key-words: Aging, expertise, work, ergonomics, competence

Introduction
Questions about the relationship between aging and work have been explored by the most diverse areas of knowledge. The interest in studying these questions comes from the paradox presently faced by industries in regards to age and technical knowledge of their employees. If, on one hand there are young people that are highly educated entering the labor market, on the other hand it is observed a large number of older, lower-education workers, but with great experience in the execution of their work.

According to (Welford, 1986) studies on issues related to aging and work began in the 1920s with the researches of Miles and Stanford, California. Since then, the approaches of the studies were modified according to the age and social changes observed in the post war period which triggered new paradigms. It has been observed that over the years, studies on aging have lost their essentially biological characteristic, turning toward cognitive aspects. Likewise, there has been a change in the study of performances for strategies study (Ramos & Lacomblez, 2005). The table below provides a brief summary about the temporal changes in the conduct of studies on aging:

Table 1- Chronology of studies on aging, cognition and work in the 1920 century (Adapted from Ramos & Lacomblez, 2005).

<table>
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<tr>
<th>Chronology</th>
<th>Characteristics</th>
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<tbody>
<tr>
<td>Decade of 1920</td>
<td>Miles and Standford, California conducted studies with an emphasis on motor performances and apprenticeship in industrial sectors (Welford, 1986).</td>
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<td>Decade of 1940</td>
<td>Studies motivated by the lack of manpower in the postwar period. The beginning of contributions of psychology (Teiger, 1995). Studies of human performances emerge in Cambridge: with</td>
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<td>Decade of 1950</td>
<td>the purpose of defining the most appropriate work for this population (Welford, 1986).</td>
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<td></td>
<td>Focus on empirical tests in the U.S. (Lacomblez, 1986).</td>
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<td></td>
<td>Period of aversion to applied research due to military connotation of the studies conducted in the post-war. Use of psychometric tests, comparative age questionnaires and longitudinal studies (Welford, 1986).</td>
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<td></td>
<td>Aging theories favored biological aspects (Welford, 1986; Teiger, 1995).</td>
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<td></td>
<td>Compensation concept: older ones compensate loss of performance with increased precision (Welford, 1986).</td>
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<tr>
<td>Decade of 1970</td>
<td>Emergence of a new aging paradigm. Change in industrial sectors and industrial age pyramids. Companies rejuvenate and face loss of experience, culture and know-how (Teiger, 1995).</td>
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<td></td>
<td>Integration of cognitive aspects among them: compensation, regulation and vicariance (Teiger, 1995).</td>
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<tr>
<td></td>
<td>Later the notion of strategy as part of performance arises (Welford, 1986).</td>
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<tr>
<td></td>
<td>Emerging paradigm of psychology, guiding to cognitive dimension (Teiger, 1995).</td>
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</tbody>
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It has been observed that in the studies reported above, the aging process is always approached in extreme ages, usually in ages starting at 50 years old to the detriment of intermediate periods (Ramos & Lacomblez, 2005).

The aim of the present study seeks to study not only the aging process, but the relationship between the increases of experience in a work situation that accompanies this process.

**Relationship between working time and experience**

The increase in working time in performing a task generates an increase in the worker’s experience to develop it. This increase in experience is often related to the competence that can be classified according to two theoretical currents:

- Competence measured by way of results: Represented mainly by French authors such as Le Bonterf, 1997 and Zariffan, 1999, associates competence not to a set of attributes of an individual, but to its achievements in a particular context, in other words to what the individual produces or performs at work (Dutra, 2004).
- Competence translated into knowledge: Represented by American authors such as Boyatzis, 1982 and McClelland, 1973, for example. This current understands the competence as a set of qualifications or characteristics underlying to the individual that allow it to perform a certain work or deal with a given situation.
There is a third aspect that has been highlighted in recent years, to the extent that adopts an integrative perspective, aiming to define the competence from the juncture of conceptions of such mentioned currents. This position is defended by (Gonczi, 1999) for whom competence has the character of associating personal attributes to the context in which they are used, i.e., to the environment and work that a person carries out.

Leplat, 1991 identifies four main features of competences: I) they are constructed and developed in order to perform a specific task (and thus are not general competences), II) they are learned in the course of the activity, III) they are organized to achieve a goal, and IV) they are abstract and hypothetical notions, since only the result of their use can be observed. It is through these competences that operators are able to perform their tasks, and especially anticipate possible errors and malfunctioning besides improving its procedure in the situation (Montmollin, 1986). The development of competences characterizes the development of intra-individual variability allowing the operator to handle complications occurred during the work process.

Thus, the concept of competence articulates with the regulation one, which consists of the balance between what should be done, the conditions available for its execution and the internal state of the individual. The regulation occurs through procedures adopted by individuals to perform the activity. These procedures result, among other factors, from the possibilities of interpretation of information from the work environment and the evocation of knowledge and experiences contained in the memory of the worker (Guérin, 2001).

**The role of knowledge in the competences training**

Knowledge is related to the ability that an operator has to perform his work. This concept refers to an individual characteristic that includes relevant work factors built through the balance between personal resources and work demands. The skill can be represented in levels, these are: I) the lowest level, based on health and physical, psychological and social capacities, where the responsible ones are the operators themselves II) the subsequent level comprises professional knowledge and competence, III) the third level composed of values, attitudes and factors affecting motivation at work and, IV) the fourth level comprises work and the rest of factors related to it, this is the responsibility of supervisors and for being the largest and heaviest, it exerts pressure on the others, as shown in Fig.1 (Ilmarien, 2010)

According to Davenport & Prusak, 1998, "Knowledge is a fluid mix of condensed experiences, values, contextual information and acquainted insight, which provides a framework to evaluate and incorporate new experiences and information. It originates and is applied in the minds of the informed. In organizations, it is often embedded not only in documents or repositories but also in routines, processes, practices and organizational standards.”

It is observed that knowledge is understood in the second level correlating with the formation of competences.
Relationship between age and experience

Another process that occurs concomitantly with the increase in working hours is the age increase of workers. This process generates the evolution of competences through transformations resulting from the effect of age (Falzon, 2007) bringing physical and psychological changes (Rhodes, 1993), but also generates an increase in gained experience (Falzon, 2007) mainly arising from the conversion of explicit knowledge into tacit knowledge (Aranha, 1997).

According to (Oddone, 2007) three types of experience can be characterized:

<table>
<thead>
<tr>
<th>Type</th>
<th>Definition</th>
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<tr>
<td>Raw Experience</td>
<td>Related to the manner of producing. Assumes only usable form of knowledge to perform the work. This experience places to the researcher the problem of how to make it transferable to others.</td>
</tr>
<tr>
<td>Manner of producing Experience</td>
<td>This type of experience can accelerate and enrich the process of production of its own work experience. Determines the know-how of the company.</td>
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</table>
Experience related to the influence of working conditions on health

Often with negative connotations. Little value: is not given proper interest to the value of experience of the worker in finding solution to occupational diseases that pertain to a given work station.

It is possible to correlate the types of experience with the level of knowledge shown by the operators, since the knowledge relating to the technical process generates raw experience, as to the product knowledge gained through enhanced use of technical process generates experience in the way of producing. Finally, the experience related to the influence of working conditions on the health is related to the partial use of the social process and product.

The increase of experience resulting from aging in the work situation has been touted as one of the positive aspects of this relationship and may even influence the performance of the worker (Ilmarien, 2005) as it can be seen in Fig. 2.

![Diagram](chart.png)

*Figure 2-Interrelation between age, experience and work performance (Ilmarien, 2005)*

It is noteworthy that old age does not always characterize greater experience in performing an activity as it can be observed in profiles of three different operators. These are:

- **Apprentice Operator:** Who is often young, has low technical knowledge and high level of formal training. This worker is usually getting the first contacts with the practice since the courses offered cover high theoretical loads.
- **The adult operator:** This operator, in addition to training, also has some practice performing the activity, but not specific to the product that he is producing. It is worth
remembering that knowledge is situational, in other words, practice in conducting a similar activity does not guarantee experience in producing a new product.

- The experienced operator: This operator may or may not have formal training, but the practice in carrying out the activity ensured the accumulation of experience making him an expert in the activity.

The benefits of intergenerational relationships

The experience and competences acquisition can ensure competitive advantage to expert operators when compared to novice operators.

Several companies have used intergenerational relationships and mentoring activities as a strategic resource (Hilsen & Ennals, 2005), because the ability of technological innovation of a company depends on the level of tacit knowledge sharing, arising from experience (Zhi-guo & Cui-jian, 2012).

In addition, to this, the interaction between more and less experienced workers is important even in social aspects, as it is recognized the difficulty of entering into a team already with techniques, materials, and forms of well-defined cooperation saving gestures and words (Prot, 2009).

Perspectives for the development of the study

The ergonomic work analysis (AET) refers to the observation and reflection of activity in confrontation with other elements of the work, for that considering the personal dimension. The strategies used by operators to accomplish the task by managing the distance between prescribed work and real work establish the distinction between task and activity, important concepts in the use of this method (Guérin, 2001).

In addition to these concepts, there are two definitions also important during the analysis of an activity. These are: variability and operating mode. The variability is related to unforeseen situations that lead to a gap between the obtained and planned results. This factor may be linked to the individual, to the technical or organizational device (Grupo-Ergo&Ação, 2003). Now the operating mode can be understood as the strategies adopted by the operator to handle the activity considering the available resources and the possibility of regulation (Guérin, 2001). A greater experience in performing an activity often leads to the adjustment of the operative modes adopted to ensure the obtained results and preservation of the operator’s health. According to (Guérin, 2001), AET is a method that allows to understand and explain the relationship between working conditions and the health of workers besides covering important insights in designing occupational situations.

AET is presented as an effective method of evidencing the relationship between age and work experience through the analysis of observable behaviors of experienced operators before variabilities, especially when compared to operational modes adopted by apprentice operators in a sector of structural assembly.

The activity of structural assembly platers is characterized as non-repetitive and with high physical and cognitive demand (Secchin, 2007). This activity is present in the small scale automobile industry, navy shipbuilding industry and in the aviation industry, whereas the latter
still presents characteristic of handcraft character, thus benefiting from the expertise of operators that develop them.

The structural assembly of aircraft wings is divided into a series of stages in which parts and components of the product go through different delimited sectors in the manufacturing environment, until joining all in one template of final assembly. In each sector there are workstations dedicated to specific assembly operations. The process of structural assembly in the aviation industry is characterized by the cyclical execution of basic procedures of assembly parts, drilling, reaming, adjustments and crimping with long work cycles and diversity of tasks inside the cycles (Secchin, 2007).

The wing assembly operations begin with the receiving of pieces that will shape the product delivered by the staff responsible for the logistics. These pieces may have been received from external suppliers or been manufactured within the company. Upon the receiving of all necessary parts for assembling, the positioning of them is held in the assembly jigs (metal structures fixed on the ground with the docking positions determined for positioning of the main structures).

The parts that will be joined together to form the product have in some places of its length, holes made by the suppliers during the manufacturing process in order to be used as starting points of attachment. Through these holes the pieces are joined together using fasteners denominated glecos. In some cases are also used straps made of nylon or other resistant materials to ensure proper junction, alignment of parts and avoid backlash. The next step of structural mounting process is the hole drilling.

The drilling may be defined as a machining process in which the cutting motion is circular and the tool advance occurs only at its axis of rotation, which maintains its position in relation to the machined part. The drilling operation is followed by the reaming operation which consists of removing the material from the top or bottom region of the hole to enable the allocation of the rivet head or bolt to be installed (Castillo, 2005).

Subsequently, the adjustment of the parts is performed. These are made by removing the work piece material by sanding the same until it reaches the required measures in design/project without exceeding the specified permitted levels. These adjustments are provided for by the product design, however, when it becomes necessary to make an unscheduled adjustment, the product engineering is queried to ensure there will be no implications affecting the quality and safety should the adjustment be made.

After being drilled, reamed and adjusted the pieces are nailed to each other in order to shape the projected wing and guarantee fixation of the structural elements when they are subjected to great strains during the flight. For the crimping, studs and in some cases bolts, are used. Depending on the access to the region where the rivets are installed two different crimping procedures may be used. To install the rivets in holes close to the parts edges, it is possible to use a type of manual pneumatic press. When the crimping region does not allow access to this type of tools, two operators act together to crimp, one of whom hits the rivet head with a pneumatic hammer and the other pushes the rivet on the other side, into the opposite direction, with a riveting bar (solid metal device), until the rivet be conformed and assemble the pieces.

The main objective of this study is to apply the AET method in a structural assembly sector to understand the influences of aging (age versus experience), in the work activity, more specifically in the operational modes, identify the strategies adopted more frequently by operators and; check
if there is influence of the operational modes from the most experienced operators into the operational modes of the younger ones.

**Bibliography**


