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# The Work Process Setting and Situational Contexts Based on Socially Distributed Cognition: An Interactive, Cognitive and Social Proposal of Analysis

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ABSTRACT

To carry out an ethnographic study on the work process in the sterilization unit of a hospital in Catalonia (Spain), we found the socially distributed cognition approaches of Hutchins and Kirsh useful. However, these approaches lack sufficient explanation on three important issues: (a) the pragmatic criteria for identifying and delimiting a relevant unit of analysis and therefore the setting and contexts of the work process, (b) the mechanisms and results of reciprocal influences between these levels of analysis; and (c) the relation between these levels. Therefore, we added several new elements to these approaches, in addition to Layder's model of contexts with some important modifications, with the aim of offering an interactive, cognitive and social proposal of analysis that clarifies these three issues, allowing a more exhaustive and broader empirical analysis that captures better the 'social' dimension embedded in the work processes.

Keywords: Distributed Cognition; Unit of Analysis; Contexts; Edwin Hutchins; David Kirsh

## INTRODUCTION

This article aims to offer a proposal of analysis for examining the work process and other areas from the socially distributed cognition (SDC) perspective, based on the approaches of Hutchins (1991; 1995a; 1995b; 2001; 2006; 2014) and Kirsh (1999; 2001). The theoretical and methodological bases of SDC were established in the seminal works of Hutchins (1991; 1995a), who, as Cicourel (2006, p.61) points out, understands culture as "an information economy and cultural evolution as distributed systems of learning", which derives from both Robert's (1964) structural view of culture as an information economy of cognitive processes of information reception, adaptation, uses and transmission, and D'Andrade's (1989) view of culture as distributed systems of learning and practice.

This conception of culture, continues Cicourel (2006, p.61), suggests "a structural view that presupposes but does not address the role of social interaction and affect during collaborative activities" and "alludes to, but seldom describes and analyzes emergent, affective, temporally-driven, observable activities and communication". Hutchins, however, solves this limited view of culture by empirically examining the role of social interaction in cooperative work activities. In work environments characterized by a division of labor, there is the requirement of a distributed cognition that allows the coordination of work activities of participants. Therefore, as Cicourel (2006, p.61) remarks, Hutchins is showing the observable distributed "cognitive labor" that any cooperative work activity needs and that, as Hutchins (1995a, p.176) maintains, involves two types of cognitive labor: "the cognition that is the task and the cognition that governs the coordination of the elements of the task".

Hutchins' conception of cognition follows the claims of *embodied cognition* that argue that mental cognitive activity must be understood "in situation" and that "the environment is part of the cognitive system" (Wilson, 2002; p. 625). These claims go against the traditional cognitive science view of cognition based on a mind "as an abstract information processor" (Spackman and Yanchar, 2013, p.46). Thus, the central idea of Hutchins's SDC perspective is that cognition is not a possession which exists only in the mind of the individual (Hutchins, 1995a; 1995b; Hutchins and Klausen,

1996). Cognition encompasses notional systems and external representations and is created in the interaction between agents and instruments (Pea, 1993). The whole is made up of a system and a cognitive and interactive process, which together lead to the emergence of cognition. The cognitive system is composed of agents, artifacts and internal (mental/brain constructs, i.e., memory or experience) and external representations (e.g. designs, graphs, drawings) (Rogers, 2006, p.2731). According to Hutchins (2014, p.36), wherever we find cognition, it will be possible to investigate how the cognitive process "*emerges* from the *interactions* among elements in some system"; specifically regarding the way representations function in the cognitive process, Osbeck and Nersessian (2005) maintain that internal representations do not simply 'interact' with external representations, but they 'couple' with them (what is stronger than 'interact'). Boundaries of the cognitive system are analytically enlarged to the levels of local and cultural organization and cognition is extended to or shared across agents and environments (Osbeck and Nersessian, 2014, p.83). In short, the SDC perspective aims to understand the complex interdependencies between agents and artifacts in their work activities (Rogers, 2006, p.2733), so Hollan et al. (2000) think it is especially well prepared to analyse the networked world of information and computer-mediated interactions.

To study this cognitive system, the unit of analysis must be broad enough to include the whole set of coordinated agents and artifacts (Arnau et al., 2014, p.4). However, in Hutchins's SDC perspective, the unit of analysis is not fixed in advance: it depends on the scale of the system under study and its boundaries and centres become empirical questions (Hutchins, 2014, pp.36-37).

The SDC perspective has been applied to study several settings of work and/or for a better understanding of the role of some elements of the cognitive system, such us cockpits (Hutchins and Klausen, 1996), the memory systems of telephone hotline groups (Ackerman and Halverson, 2004), research laboratories (Nersessian et al., 2003), scientific practice (Giere and Moffat, 2003), the genesis and use of a work artifact in air traffic control (Halverson and Ackerman, 2008), the communicative patterns between doctors and nurses (Muntanyola-Saura, 2008), the use of the body as a communicative tool in dance (Muntanyola-Saura and Kirsh, 2010), how external representations enhance cognitive power (Kirsh 2010), the complexity and opacity of administrative work and sterilization work in a hospital (Lozares at. al., 2013), the types of cognitive artifacts (Heersmink, 2013), expert and creative teamwork of a choreographer and a dance group (Muntanyola-Saura, 2014), and the importance of chance and interactivity in the creative method of the choreographer (Kirsh, 2014). Especially relevant to the purposes of this article is Kirsh's (1999; 2001) contribution to work contexts. Kirsh (1999; 2001) complements the SDC perspective with a concept of 'environment' that allows a treatment of work contexts that goes beyond classical solutions that refer to 'who is acting, where and when'.[1] Although he does not deny these, he extends the study to other contexts such as the state of resources, people's concepts, the state of the job in hand, social relations and work culture.

These contributions for studying and understanding cognition in work processes and other areas are of unquestionable value. However, the micro-perspective normally used by most SDC theorists and their focus on the cognitive dimension may not sufficiently highlight the social relevance when examining and interpreting the reality.[2] As a consequence, SDC approaches lack sufficient explanation on three important issues: a) the pragmatic criteria for identifying and delimiting the unit of analysis, and the setting and contexts of the process; b) the mechanisms and results of reciprocal influence between these levels; and c) manners of extending, relating, bringing into play

and mutually relating the unit of analysis, the work process setting and the contexts. Clarifying these three issues will allow the empirical analysis carried out using these approaches to be more exhaustive and broader in scope and to better capture the 'social' dimension embedded in the work processes. Therefore, this article aims to offer a proposal of analysis for clarifying these three elements in the study of work processes and other areas from the SDC perspective. By adding several new elements to the approaches to SDC of Hutchins (1991; 1995a; 1995b; 2001; 2006; 2014) and Kirsh (1999; 2001), in addition to the model of contexts of Layder (1990; 1994) with some important modifications, we will offer what we call the Interactive, Cognitive and Social (ICS) proposal of analysis.

Below we present this proposal and apply it to a work process carried out in the sterilization unit of a hospital. Each step of the work process is described and documented by reference to the data obtained, which were collected by informal observation, direct and detailed visual observation, notes, video-clips and narrative semi-directed interview.

The article is structured as follows. We begin presenting the research framework from which our ICS proposal comes and the work process carried out in the sterilization unit of a hospital. We then show the main shortcomings of the SDC and present our ICS proposal of analysis for examining the work process, its environment and its contexts. We continue presenting the methodological characteristics of the fieldwork we carried out. To exemplify the usefulness of our proposal, we analyze the process of 'doing boxes', which is part of the work carried out in the sterilization unit. We then establish a typology of agents in the work process setting and of external co-text and contexts. Finally we present the conclusions.

## A STUDY OF THE WORK PROCESS OF THE STERILIZATION UNIT AND THE SITUATIONAL WORK PROCESS SETTING OF 'DOING BOXES'

The origin of our ICS proposal of analysis is an ethnographic study on the work process in the sterilization unit of a hospital in Catalonia (north-east Spain). The main objective of this study was to determine the extent to which the changes that have taken place in work processes affect their interactive cognitive systems, although these changes are not dealt with herein.[3] In this article we focus on the identification and analysis of the work process setting and the influence that contexts have on the work process in the sterilization unit of the hospital. In outline, this whole work process of sterilization is composed of a) pre-washing/washing of surgical instruments and tools, b) preparing the instruments for sterilization or 'doing boxes', c) preparing of fabrics and gauze, called 'folding cloths', d) autoclave sterilization, e) sterilization of instruments and fabrics, and e) external distribution of instruments and fabrics (see Figures 1 and 4). The working team involved in this process is made up of six assistant nurses and a coordinator. The work is carried out by pairs who change tasks every week. For reasons of space, in this article we will only apply our ICS proposal to the work process setting of preparing the instruments for sterilization or 'doing boxes'.

The work of 'doing boxes' is carried out at the end of the sterilization room, in a small space on a table. The incoming products which undergo transformation are the surgical instruments placed on metal trays which come from the machine wash. There are seven trays, three of which come from the pre-washing and four from the washing. The action is carried out on two tables side by side, on which the trays of instruments are delivered and on which the workers classify and supervise the instruments. At the

end of the table, each worker works individually with its box(es) that they prepare for sterilization in the autoclave. A cloth, several materials and instruction guides related to each sterilization box are placed on the table. The instruments that belong to the operating theatre are placed in these boxes in preparation for sterilization in the autoclave. There are also registration and marker papers to indicate entries and identification.

Insert Figure 1 about here

## THE ICS PROPOSAL OF ANALYSIS FOR EXAMINING THE WORK PROCESS, ITS ENVIRONMENT AND ITS CONTEXTS

In this section, after discussing the limited introduction of the social dimension in SDC, we propose our way of analyzing the work process in two steps. Firstly, we will establish a work process setting model, which will then be complemented by taking into account different kinds and levels of contextual agents. Because of the components of our proposal, we call it the Interactive, Cognitive and Social proposal of analysis.

### The Social Relevance of Work Processes and Its Limited Introduction in SDC

The social relevance of a work process appears, develops and is spread as a result of several instances. The first is the interaction between human agents and/or mechanical artifacts as an ontological and methodological unit of analysis. Individuals and their behavior are social insofar as they move in the direction of (or result from) the interaction. The micro-perspective normally used by SDC approaches may not sufficiently highlight this social relevance in examining and interpreting the reality. It is not a matter of lack of recognition, which is assumed, but rather a consequence of operating in the micro-perspective. SDC's focus on the cognitive dimension of internal and external representations and on instrumental components (mechanical or smart) as an object of study does not clearly reveal the importance of the social component. In addition, SDC examines work processes by considering states, transitions and flows through a dynamic model with social agents, which is another reason to give more importance to the social component, as suggested by the name SDC. This article highlights this social importance following the logic of SDC.

There are three important issues that the SDC model does not show. Firstly, all the *states*, *transitional phases* (whether they are intermediate or end point) and *results*, are not just interactive and cognitive but also social insofar as they are appropriated and distributed by agents. Secondly, there is a clear distinction between agents' resources and what actually happens in the process and result phases. We believe that results are socially relevant if they acquire identity and autonomy to act as agents or if they are resources and can be assimilated or appropriated by the agents. Finally, according to the SDC approach, the results of a preceding phase are *entry points* for the current stage. These results create new states, conditions, settings or contexts. We believe that these initial states (resulting from actions, the work process setting and contexts) are not mere entry points, simple initial conditions or means by which to interpret the said processes, but rather acting agents in work processes.

## A Reduced Model of the Work Process: The Units and the Contexts of Reference for the Analysis

With a view to highlighting and analyzing social relevance in work processes, as pointed out by the SDC in concepts such as *functional interactivity*, *cognition* and *dissemination of information*, it would seem important to previously establish, at least practically, an ontological and methodological identification and choice of the referential unit of analysis, that is, the work process setting and its contexts.

To do so, we need to take into consideration three particular aspects of work processes, some of which have not been fully taken into account by SDC models in general or by those of Hutchins (1991; 1995a; 1995b; 2001; 2006; 2014) in particular. Firstly, as SDC does, we will consider the nature, volume and dynamics of the elements involved in the work process, such as agents (people and/or instruments), resources, interactions, representations and objects. In the SDC model, limits are set by everything that is relevant to the study of the work process—everything that is present in each moment of the process. Secondly, we should consider how the process extends over time: its beginning, evolution and end as a diachronic unit. Here we find the result or end state of the process, which is decisive for establishing its boundaries. Although this temporal dimension is latently present in the SDC because precisely one of its concerns is to account for the propagation of representations, it is not sufficiently explained by it. Thirdly, we should pay attention to different forms of significant relevance, some of which are highlighted more than others in the SDC approach. These are a) the objectified contents of 'what is happening' and the changes and interactions in relation to a technical-functional relevance; b) cognitive contents and propagation; c) the distribution and, above all, appropriation of produced states, transitions and flows, which give the process its social nature; and d) the relations of union and mutual emergence that bring about the processes of interaction between the three preceding forms of social relevance and between the work process setting levels and contexts.

We have described above what we identify as the unit of reference in the analysis or as the work process setting. This can be expressed as 'everything that is present' in or acts on the process, the expansion in time of the sequence, the distribution and appropriation of the results by and between agents and the emerging nature of the results, given the multiple forms of relevance and the mutual actions and reactions between the levels. Thereby, although this article is based on the theory of SDC in general, and more specifically on the approaches of Hutchins and Kirsh, the consideration of the above elements allows us to make our specific contribution to the analysis of work processes. First, it enables us to establish a model that takes into account not only the cognitive dimension but also its relationship with instrumental and social functions. Second, it allows us to highlight the forms of appropriation of the results of the interaction by the social partners (at the micro-, meso- and macro-social levels).

### *A situational work process setting model*

Taking the model of Kirsh (1999; 2001) as a reference, we will establish a work process setting model as a unit of reference for analysis. As equivalents to the unit of analysis of the work process and core focal points of the observation, Kirsh established 'analytical concepts' made up of *entry points, activity landscapes* and *mechanisms and structures of coordination.* The *entry points* represent the invitation to begin a task. The *activity landscape* (part mental, part physical construct) is the 'space', form and content

constructed by users and is different from the initial stage or entry points. Finally, the *mechanisms and structures of coordination* include machines, the calendar, clocks and the papers, which help the user to carry out complex tasks. These mechanisms may be agents or resources. Kirsh seems to find the ontological equivalent of these analytical concepts in the fact that they equate to 'what there is' and 'what is happening', both in the initial state and initial resources of interactions and in the transition phases and results. Moreover, Kirsh identifies the methodological level as levels of visibility of the work process.

On the whole, our proposal is identical to that of Kirsh except in specific additions to his four axes. In the first axis we specify in greater deal the development in time in the phases (a process may have several phases), which frame the time limits of the work process setting. In the second axis, the one of contents, we specify its three components in greater detail. Finally, in the third axis, which Kirsh refers to as mechanisms, we will define its content in greater detail. This modeling and addition of dimension will allow us to reveal the content and structure of the work process setting model and how it operates. The first three axes of the model constitute the ontology of the work process setting model or unit of analysis, while the fourth axis is methodological.

The first axis (the horizontal axis in Figure 2), which is diachronic, shows the direction of development of the phases of the process. In Figure 2, we differentiate between a) the entry points or conditions of entry, origin and initial state; b) the landscape of activity in its intermediate state and transition phases; and c) the final landscape or result of the process, although it is understood that Kirsh deals with this in (b). This time-based axis also gives us a criterion for identifying and delimiting the work process setting. This delimitation of the unit of analysis as a work process setting is a given from the entry point and extends until the result of the process acquires a certain level of stability. At some point, an important change in the nature of the state of the product takes place. This allows us to claim that there is at least a relative maximum level of stability in the final state, such as the actions of closing and identifying a box or completing the washing of surgical instruments in a machine in our study of the sterilization work. It is a reliable and pragmatic criterion which operates at the three levels, given that cognitive and social aspects interrelate and self-generate each other in the functional interactivity. As this relative stability is clearly a question of degrees, in order to identify the work process setting or unit of analysis, it is important to decide initially, albeit in general, the number of phases and the nature of the process, as well as the starting conditions, the 'entry points' and the final state phase. This will give us the 'socio-time extension' of the process.

The second axis (the vertical axis in Figure 2), which is synchronic in nature for each phase of the work process setting, contains the components of the interactive, functional, cognitive and social system. Here, we differentiate between three basic aspects that are fundamental in SDC: a) what happens, or the interactivity of the process, which is more technical-functional in nature; b) the representation-information base of cognitive content; and c) the social relevance conferred by the distribution and appropriation of states, transitions and flows produced in the work process and by relation to contexts. Knowledge of what occurs in each stage is essential to determining the work process setting as a fundamental entity and unit of analysis.

The third axis (diagonal in Figure 2), the one of mechanisms or authorship, refers to the agents, resources or mechanisms of interaction and coordination. Kirsh situates in it his 'analytical concepts'. It is taken for granted that the agents (individual subjects-instruments), as fundamental elements of coordination and interaction, are to

be found among the mechanisms. Although it can be said that everything may potentially influence everything, we believe that it is correct and informative to differentiate this axis from the others as a relevant criterion for identifying and establishing the work process setting as a fundamental entity and unit of analysis, and therefore for differentiating it from its contexts. A change of agents or mechanisms of action is accompanied by important modifications in the work process. However, it must be stressed that the dynamics of the changes of state and contents of the work process (the first and second axes) also modify the resources available to the agents and mechanisms, therefore acting on the execution of the process.

Insert figure 2 about here

In line with Kirsh, we will also consider the methodological component of the process that figures on the fourth axis (not represented in Figure 2). We may focus on various levels of ranging depth and take various sequences of ranging length in order to decide on the perspective taken in observation and analysis. The first level would refer to what is directly seen: we have here the work process setting seen directly, that of appearances. Another level, a sequenced one, would be a prolonged exercise of remembering the past and present history of the ICS system. Finally, a deeper level, or latent one, would focus on the dynamics or on 'that which is taken for granted' and/or the invisibility of certain interactions in the mechanisms of coordination of the processes. Ideally, it would be better to consider all levels with their appropriate methods of observation and analysis.

*Mechanisms or authorship*

Let us return to the mechanisms of interaction in the work process setting. Although Kirsh is reluctant to present this question using the classical 'what, where, when', we still need to refer to this question when showing a 'route' to identify and delimit these mechanisms.

The mechanisms-agents are not immediately obvious. Consequently, we need to take into account four distinctions or clarifications in order to identify them. Firstly, we need to consider the distinction between agents and resources. We need to clarify whether the objects and/or symbols, machines, representations or people are resources or agents. Secondly, we need to determine the distinction and connection between agents and transformed reality. It is important to know whether the transformed reality in each phase and in any of the components of the work process setting is the result of interaction between agents. This reality would be a resource to be appropriated by some agents or a coming into being of a new agent. Thirdly, we need to distinguish**,** in the interaction and its phases, between the externalized or functional and internalized representations. Finally, we also need to consider the nature and difference between the work process setting and its contexts.

Various issues are relevant to the above reasoning. First, we will look at the nature of the agents. Agents may be individual people and/or mechanisms, but there is no reason why they should not refer to entities such as the normative system of a process, a community of practice, a cooperative group, the management of a company, etc. These entities exercise different degrees of power, dynamics of action, statuses and roles, objectives, cultures and modes of operating that give them the status of agents. In no way do we claim that all these agents are epistemic agents: rather, what is interesting now is their pragmatic activity and autonomy and their power to influence processes.

An agent in a work process setting is such to the extent that it is involved in and influences the situational setting, in interaction with other agents and with a sufficient degree of autonomy (not entirely determined), and it uses some of the possible resources (cognitive, functional and social) in such a way as to play a part in modifying or maintaining, distributing and appropriating the state of the ICS system of the process.

Second, we will consider the difference and connection between the agents, the work process setting and its contexts. Kirsh generically talks about settings and recognizes cultural, historical and social influences on them. He takes into consideration contexts which go beyond those circumscribed by the place and time in which the core of the process occurs, although he does not go beyond a generic view. Thus, we think it is relevant to consider that the actual agents of a work process setting are those that are circumscribed by and directly present in the space and time in which the core of the work process setting occurs, and that do not have any presence in or influence on other work process settings, although they may be situated in different physical spaces and moments. It is also important to consider that agents of context are also involved in the process but not in a 'live' way or 'in body'. However, they form part of the process and are not just decorative and interpretative. For example, the management, health regulations or unions are normally involved through one of their resources without necessarily being physically present.

## From the Situational Work Process Setting to Contexts

In this section, we will consider agents and their important relationship with contexts as levels of social stratification. The objective is to identify these levels and contextual agents as well as to determine how the levels are involved in the work process setting. To this end, we adopt the classical model of Layder (1990, 1994), with some important modifications. We leave aside levels of 'Self' and 'face-to-face interaction'. The former is not an agent and the latter is not understood here as a minimum unit but rather as a composition of interactions.

Thus, the first level that we have considered is the situational work process setting, which has already been defined and described. As laid out in depth above, with some exceptions this level is similar to Kirsh's idea of space-moment-content, which defines the unit of analysis of the work process, in which fundamental static and dynamic states occur and, of course, the actual agents involved (individuals, machines, etc.) are manifest.

What we call 'co-text' are other settings of adjoining interactive work processes, which are directly involved in the work process setting and, as a result, produce the 'entry points' as an initial phase of the current process and collect the results of the process as entry 'cues' for the subsequent process. The agents of co-text do not take part in the work process setting directly but determine demands and conditions with respect to the setting.

Agents (individuals or collectives), which are structural and/or institutional in nature and have their 'headquarters' outside the current work process setting, but are encompassed by it, may act directly. These agents may act and encompass other work processes settings different from the current one—for example, a university in relation to one of its departments or research groups, or a hospital in relation to one of its services such as the emergency ward. Other contextual agents may be more 'horizontal' to the work process setting, such as a company that funds the research carried out by a research group of a university. We shall call these types of agents generically 'contexts',

which are social, and we differentiate two types. The first type is 'fundamental structural contexts', which, using Layder's terms, are *entities, agents, institutions* and *organizations* that encompass, contain and are involved in the work process setting. Each one is circumscribed by a social field that is relatively homogeneous in content in relation to the nature of the work process setting of which it is the context. They may be organizations, institutions, frameworks and a social order that are made up of the social structure of values, rules, behavior, hierarchy or goals with a degree of specialization in content (the economic field for companies, education for schools, health for hospitals, etc.). They may also be groups, associations, entities, corporations and societies that have a lower degree of social range and structure, greater flexibility and social visibility, varying degrees of specialization (fishing or resident associations) and strong or weak links (mixed or neighborhood groups). The second type of context is that of 'formal structural contexts', which are more generic and cross-cutting and are made up of categories that take hold of key positions in the social structure because of fundamental factors of social differentiation. For instance, social class, cultural categories, ways of life and gender cross the above contexts and the work process setting.

## METHODOLOGY AND DATA

The data were collected between May 2003 and February 2004 according to an ethnographic methodology using different techniques of data collection applied in a way that was both integrated and complementary. Four sessions of observation of the work of the sterilization unit were carried out. In the first two, the data were recorded in the form of field notes written up in situ. The observation in the first session was totally open, while in the second it was semi-structured. The next two sessions of observation were digitally videoed, the first with a fixed camera and the second with a hand-held camera that allowed us to film a variety of scenes from different points of view. We also conducted three semi-structured biographical interviews with women workers about their daily, social and professional stories and their interpretations of their work. In addition, three informative interviews were carried out, two with two managers of the hospital and one with the nurse/supervisor of the sterilization unit. The videos and interviews were analyzed using the ATLAS.ti program of image-video-text.

## A CASE STUDY: A WORK PROCESS OF THE STERILIZATION UNIT BASED ON THE ICS PROPOSAL OF ANALYSIS

To show and exemplify the usefulness of our ICS proposal of analysis, in this section we examine from this perspective the work process of preparing the instruments for sterilization or 'doing boxes', which is part of the work process of sterilization carried out in the sterilization unit of the hospital.

The objective of our analysis is double. First, we wish to justify the identification and delimitation of the work process setting by means of the following four criteria: a) a space-time situation; b) the types of interactions and the phases of the work process setting; c) basic maintenance and invariability of the agents and the instruments handled as resources, and d) the relatively stable state that the product undergoes. Second, we wish to identify and characterize the internal agents in the work process setting and the external co-texts and contexts as agents that take part in the work process setting, and to determine the levels at which they exercise their influence.

The analysis does not focus in depth on the minute detail of how contextual agents operate in the work process setting but rather attempts to characterize their actions generically in order to establish a typology of the contexts. In the analysis of the work process setting, we will describe two characteristics of their contexts: first, their contents, which are the criteria that allow us to delimit and identify the contexts as such, and we will also characterize both the 'internal' and 'external' contexts (understood as agents) in the work process setting; second, we will analyze the ways in which these contexts are involved.

The analysis of internality or externality of contexts is used to decide (a) whether they are external or internal context agents in the hospital; (b) in the case of contexts that are internal to the hospital, to decide whether they are context agents (or co-texts) that are external or internal to the sterilization unit; and (c) within internal context agents (or co-texts) in the sterilization unit, to decide whether they are contexts agents that are external or internal to the work process setting. In this case, if they are external to the work process setting, they are co-texts, and if they are internal, they are 'actual' agents of the setting.

The analysis of modes of action is also important. Particular agents of the work process setting, co-texts and contexts may be involved in different ways: a) by means of their internal or external resources, or both together; b) as entry or exit points of the work process setting and/or markers of flow (which is the case of co-texts) or as mechanisms of participation in the work process setting; c) by following or interrupting the flow of the work process setting; and d) by direct or indirect action of external resources in contextual agents, or by direct action of internal and external resources in the actual agents of the work process setting. Contexts may be involved in the work process setting through internalized norms, attitudes, values, etc. or through externalized orders, rules, etc., both affecting the internal and actual agents of the work process setting.

## The Interactions and Phases of the Situational Work Process Setting of 'Doing Boxes'

The most important interactions that take place in the process setting of doing boxes are placing of the cloth on the tables to 'protect' the instruments; receiving telephone calls and leaving the premises; placing, ordering and classifying the instruments on the table; asking questions about instruments; looking for and using the instruction guides; supervising and placing the instruments in the sterilization box; closing and pre-sealing the box; and registering the box and identifying the person who has carried out the operation. The result of the completed process is hermetically sealed box(es) containing the instruments ready for sterilization. The box also acquires the identity of the person who registered it. The phases of the process correspond to the following tasks or interactions (see Figure 3 and 4):

- State-phase 0 and transition phase 0→1: placing the cloth on the table.
- State-phase 1 and transition phase 1→2: placing surgical instruments on a cloth on the table, arranging the instruments and supervision.
- State-phase 2 and transition phase 2→3: placing instruments in a box and supervision. Closing, sealing, registering and identifying the box.
- State-phase 3: box closed, sealed, registered, identified and ready for the autoclave.

Insert Figure 3 about here

Insert Figure 4 about here

Agents, Co-texts and Contexts of the Work Process Setting of 'Doing Boxes'

*The operating theatre and the maternity unit* are organizing contextual and co-textual agents which are internal to the hospital but external to the sterilization unit and the situational work process setting of doing boxes. They act as external representations on the basis of their resources. They are the contexts which most influence the current work process setting because of providing the criteria for ordering the instruments by placing them on the trays. They affect the process in three ways. First, they directly influence it and become an agent that acts on, and in some cases interrupts, 'the normal flow', i.e., establishing priorities for boxes in emergency cases for sterilization, in loss of parts or in other incidents. Second, they influence the process through previous learning of the nursing assistants who work in sterilization. Finally, they act on the quality of sterilization of instruments through the way in which the cloth is folded to protect the instruments in the box according to the culture, the demands, and how things are done in the operating theatre and maternity unit. Indirectly, they affect the process as a 'system of rules' and a 'quality control' of the hospital and, above all, it affects individual responsibilities through the registration of boxes and the identification of the person who closes them.

*The leasing company of surgical instruments* is an organizing contextual and co-textual agent exterior to the hospital, the sterilization unit and the work process setting of doing boxes. This company owns some expensive surgical instruments and many sterilization boxes and they are in charge of sterilizing some especially delicate surgical instruments. It acts as an external representation and as an internal representation when a representative sometimes comes to the hospital. As a co-text it affects the work process as a time marker of flow when it is asked for sterilizing the especially delicate surgical instruments by the sterilization unit. Moreover, as context it acts as a regulating agent in reference to the right mode of both placing the surgical instruments on the trays and closing and sealing the sterilization boxes.

*Pre-washing/washing* is a co-textual agent internal to the hospital and to the sterilization unit, but it is external to the work process setting. It acts by means of its resources, which are the washed instruments and external representations. It affects the work process setting of doing boxes as an 'entry point' and as a time marker of work flow.

*The supervisor/coordinator of sterilization unit* is an individual agent who is internal to the hospital, to the sterilization unit and to the work process setting. He/she acts by means of resources which are external and internal representations. He/she acts simultaneously as a managing agent for the hospital with clear decision-making power, control, educational functions, and exemplary functions, and as an agent who is part of the sterilization community of practices, helping, collaborating with (and at times replacing) workers in tasks. In both cases, he/she influences both the general sterilization process and the process of doing boxes. This agent manages and coordinates the sterilization unit but is also an external contextual agent to the work

unit. He/she is part of the management of the hospital but is internal to the sterilization unit as part of his/her team of workers.

*The sterilization team* is a collective and cooperative agent that is internal to the hospital, to the sterilization unit and to the work process setting. It acts by means of resources that are external and internal representations. It acts as a community of sterilization practices (or collaborating team) in the sterilization process and the process of doing boxes. As announced, sterilization work is carried out by pairs who change tasks every week. This weekly organization is fairly self-managed. Apart from the collaborating team, which is made up of all the six assistant nurses and the coordinator involved in this process, there is no comparison anywhere else in terms of balance to the people working in this team. Within the team, one person receives the most phone calls and goes to other areas to make inquiries into issues raised, indicating a certain externally attributed level of leadership, responsibility, 'authority' and a higher experience in the work process in which someone has to assume more responsibility than others in some tasks. Despite this, there is perfect coordination between the workers. Without talking to each other, they distribute roles, place trays on the table, move from one place to another, etc. Everything works smoothly. The weekly rotation of tasks is decisive and beneficial for the working of the process and the training of staff. Workers are constantly helping each other throughout the daily work as well as replacing each other when necessary. This facilitates collaboration, coordination, joint learning, collective control, mutual help and smooth functioning of the process.

*The leader of the sterilization team* is a human agent who is internal to the hospital, to the sterilization unit and to the work process setting. He/she acts by means of resources that are external and internal representations. This agent acts simultaneously as a leader of the working team and as an individual agent belonging to the community of practices. This person has previously worked in the operating theatre, so is of great use to the current process because he/she knows all the material. In the operating theatre, this person dealt with the boxes under the supervision of the nursing staff. Previous qualifications do not seem to be important for his/her informally recognized role of 'authority' or seniority. He/she transmits his/her knowledge and skills by communication and advice.

*The workers with operating functions* are human agents who are internal to the hospital, to the sterilization unit and to the work process setting. They act by means of resources that are external and internal representations and act as an individual agent belonging to the community of practices in the doing-boxes.

*The control system of the work process setting* is a contextual and institutional agent that is internal to the hospital and the sterilization unit and external to the work process setting. It acts by means of external representation: the instruction guides which act as an object of regulatory and supervisory representation in the process of doing boxes. There are about 200 instruction guides made of plastic card. Each one corresponds to the written content of the instruments that each sterilization box must contain. Each instrument comes with a written guide according to its placement in the sterilization box. These guides are a regulating and supervising agent. The workers consult them when they take the instruments from the trays and when they place them in the sterilization boxes. Beforehand, the workers check that all the utensils corresponding to the box in hand are laid out on the table. The guides are not just simple resources

without an ‘owner’; they are similar to external resources/representations of a regulating agent: i.e., the supervision and hygiene committee, the medical management, the operating theatre, etc. The person in charge of the operating theatre and the person in charge of sterilization unit take the initiative to prepare, update and correct the guides.

In summary, our description and analysis of the work process setting of doing boxes has shown that our proposal of identifying a work process setting by means of (a) a space-time situation, (b) the types of interactions and the phases of the work process setting, (c) basic maintenance and invariability of the agents and the instruments handled as resources, and (c) the relatively stable state of the product in the work process setting is pragmatically efficient.

## TOWARDS A TYPOLOGY OF AGENTS AND CONTEXTS OF THE WORK PROCESS

In this section we will establish a typology of the agents (internal to the work process setting, co-texts and contexts) based on their nature (individual versus collective and human versus mechanical artifact) and their internal or external location at the different levels; in addition, the modes of action of the agents will be explained.

*a. Individual agents internal to the work process setting and to the work unit*

*a1. Human-agents*
The individual human-agents are only internal to the hospital, to the sterilization unit and to the work process setting of doing boxes. Their resources for acting are both external representations (e.g. instruments) and internal representations (above all their history and their professionalism). Moreover, the work process setting manifests itself in three ways that makes the mode of interaction and action of these agents different. The first way is that of the supervisor/coordinator, which involves two simultaneous modes of presence and acting: as a member of the community of practices and as a person responsible to (and appointed by the hospital authority) supervising and training functions. The second way is that of the worker who have a certain level of social leadership. In every other aspect, they carry out the same tasks as any other worker. The third way is that of the rest of workers with operating functions.

*a2. Artifacts-agents*
The washing machine and the three autoclaves are two agent-machine/apparatuses in the sterilization unit that are active in the work process of sterilization.

*b. Collective agents internal to the work process setting and to the work unit*
The collective agent of the work team is internal to the hospital, to the sterilization unit and to the work process setting of doing boxes. It employs both internal resources or representations (e.g. tacit agreements, distributed knowledge) and external resources or representations (e.g. distribution of shifts on paper). It acts as a community of practices or collaborating team both in the whole of the sterilization unit and in the process of doing boxes.

*c. Individual agents internal to the work process setting but external to the work unit*

This type is represented by the supervisor/coordinator of the sterilization unit. He/she is a contextual agent who is external to the work process setting as part of the hospital management, and is an internal agent of the work unit as part of the sterilization team.

*d. Agents external to the work process setting but internal to the work unit and co-textual*

The pre-washing/washing process acts as a co-text in the process of doing boxes. It acts as a time marker of productive flow and, in doing so, it also affects the reality which is transformed into the work process, because what is produced are entry 'cues' for the process of doing boxes.

*e. Co-textual and contextual agents external to the work unit but internal to the institution*

Operating theatres and the maternity unit are internal to the hospital. They affect the process in three ways. Firstly, they act as a time marker of flow, so this is their contextual facet; in doing so, they also affect the reality, which is transformed in the process because its result is 'entry' or 'exit cues' for the work process of sterilization (its co-textual facet). Secondly, they act as regulating agents because they decide where to place the instruments on the trays on the table and in the sterilization boxes. They act by means of external resources although they are internalized in the agents that are involved. Finally, they act interrupting the whole process of sterilization and so also the process of doing boxes. These two latter modes of action represent the contextual facet of these agents.

The hospital's Supervision and Health Committee and the medical management are regulating agents that are exclusively contextual in nature. They influence the placing of the instruments in the sterilization boxes by means of the instructions guides whose written contents corresponds to the instruments that each sterilization box must contain.

*f. Contextual and co-textual agents that are external to the hospital*

The leasing company of some expensive instruments is external to the hospital. It affects the process in two ways. Firstly, it acts as a time marker of flow, so this is its co-textual facet. Secondly, it acts as a regulating agent of the mode of both placing the surgical instruments on the trays and closing and sealing the sterilization boxes; this is its contextual facet.

## DISCUSSION AND CONCLUSION

In conclusion, our ICS proposal of analysis seems more exhaustive and broader in scope than that of Kirsh (1999; 2001), and better at capturing the 'social' dimension embedded in the work processes. It focuses not only on agents that are 'internal' to the work process setting, but also on other contextual contents, and takes into account mechanisms of action in each of the contextual agents. It also seems more complete and workable than Layder's (1990; 1994) model and also differs from it in some aspects. We do not consider his 'Self', because it seems more like an internal resource/representation of agents/individuals: the result of interaction between the agent and its social contexts. Although Layder's situated activity as the 'dynamics of face-to-face interaction' may be equivalent to his idea of social interaction, his setting, the 'immediate environment of social activity' (e.g. organization, department and so on)

cannot be strictly equated to what we understand here as a situational work process setting, which does not fit into Layder's classification. His setting seems closer to what is referred to in this article as 'fundamental structural contexts'. By contrast, Layder's idea of context as 'macro-social forms' (e.g. gender, national culture, economic situation, etc.) coincides with what he and we call 'formal structural context'. However, the major contribution of our model comes from what Layder suggests but does not put into practice: the diverse forms of interaction between the levels as we have proposed and identified are like situational work process settings.

The proposal we put forward here in relation to the nature of the work process setting and its co-textual and contextual levels allows for an analysis of flexibility in the work process which does not exclusively focus on the expansion, reduction or elasticity of productive time as a result of **'**made-to-order**'** market demands. Aspects such as decision-making, power, competition and hierarchical responsibilities in the company are dissolved as a result of this flexibility of articulation and relations between levels and contexts. Our proposal of analysis allows us not only to build the structure of the distribution, but also to reveal the internal dynamics and mechanisms of interaction that occur between the levels and the work process setting. Though it has drawn from (and is in tune with) the SDC approaches of Hutchins (1991; 1995a; 1995b; 2001; 2006; 2014) and Kirsh (1999; 2001), this study has aimed to fill some of the gaps in their empirical application: in particular the lack of pragmatic criteria for identifying and delimiting the unit of analysis, the absence in their analysis of broader contexts than simply the work process setting (which they admit), and the lack (or lack of definition) of a social theory of social interaction and even of social action.

In reference to these aims, the choice of reference and analytical units that go beyond minimum interactions, such as the work process setting, has turned out to be informatively beneficial. Concretely, our proposal of identifying a work process setting by means of (a) a space-time situation, (b) the types of interactions and the phases of the work process setting, (c) basic maintenance and invariability of the agents and the instruments handled as resources, and (c) the relatively stable state of the product in the work process setting is pragmatically efficient. Moreover, the choice and definition of contexts and co-texts and their contextual agents as well as their internal and external resources make for a more consistent and coherent global structure of all the levels that enables us to identify, classify and explain their influence on the work process setting. Furthermore, the idea of conceiving of defined and, in particular, contextual levels not just simply as decorative scenery but as 'personifying' (and acting as) real social and contextual agents is fundamental in introducing and focusing on the social connotation of the interactive cognitive system linking the micro-social contents to the macro-social sphere. The influence that these contextual agents have on the agents of the work process setting goes beyond the simple interiorization of regulations, culture, rules, modes of behavior, etc. by the internal agents of the setting. Finally, it is clear that, from this perspective, the distribution and appropriation of goods produced in the work process involve not only a cognitive distribution between micro-agents that are internal to the work process setting, but also an appropriation of a much greater social significance by agents and contextual agents.

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NOTES

[1] Nardi (1996, pp.38-44) provides a good summary of the SDC treatment of the units of analysis and contexts before the contributions of Kirsh (1999; 2001).

[2] To solve this, Lozares et al. (2004; 2013) and Muntanyola-Saura (2008) complemented their empirical studies based on the SDC approach with several sociological perspectives.

[3] The theoretical framework of this research can be found in Lozares *et. al* (2004) and its main results in Lozares *et al.* (2013).

REFERENCES


Ackerman, M.S. and Halverson, C. (2004). Organizational Memory as Objects, Processes, and Trajectories: An Examination of Organizational Memory in Use. *Computer Supported Cooperative Work (CSCW)*, 13(2), 155-189.

Arnau, E., Estany, A., González del Solar, R., & Sturn, T. (2014). The extended cognition thesis: Its significance for the philosophy of (cognitive) science. *Philosophical Psychology*, 27(1), 1-18.

Cicourel, A.V. (2006). Cognitive/affective processes, social interaction, and social structure as representational re-descriptions: their contrastive bandwidths and spatio-temporal foci. *Mind & Society*, 5, 39-70.

D'Andrade, R. (1989). Culturally based reasoning. In ARH. Gellatly, D. Rogers & J.A. Slodoba (Eds.), *Cognition and Social Worlds*, (pp. 132-143). Oxford: Oxford University Press.

Giere, R.N. & Moffat, B. (2003). Distributed Cognition: Where the cognitive and the Social Merge. *Social Studies of Science*, 33(2), 301-310.

Halverson, C. & Ackerman, M.S. (2008). The Birth of an Organizational Resource: the Surprising Life of a Cheat Sheet. In M.S. Ackerman. C.A. Halverson, T. Erickson & W.A. Kellog (Eds.), *Resources, Co-evolution and Artifacts* (pp. 9-35). London: Springer

Heersmink, R. (2013). A Taxonomy of Cognitive Artifacts: Function, Information, and Categories. *Review of Philosophy and Psychology*, 4(3), 465–481.

Hollan, J., Hutchins, E. & Kirsh, D. (2000), Distributed Cognition: Towards a New Foundation for Human-Computer Interaction Research. *ACM Transactions on Computer-Human Interaction*, 7(2), 174-196.

Hutchins, E. (1995a). *Cognition in the Wild*. Cambridge, MA: MIT Press,

Hutchins, E. (1995b). How a cockpit remembers its speeds. *Cognitive Science*, 19, 265-288.

Hutchins, E. (2001). Distributed Cognition. In N. Smelser, & P. Balter P (Eds.), *International Encyclopedia of the Social and Behavioural Sciences* (pp. 2068-2072). Oxford: Elsevier

Hutchins, E. (2006). The distributed cognition perspective on human interaction. In N.J. Enfield, & S.C. Levinson (Eds.), *Roots of human sociality: Culture, cognition and interaction* (pp 375-398). Oxford: Berg.

Hutchins, E. (2014). The cultural ecosystem of human cognition. *Philosophical Psychology*, 27(1), 34-49.

Hutchins, E. & Klausen, T. (1996). Distributed cognition in an airline cockpit. In Y. Engeström & D. Middleton (Eds.), *Cognition and communication at work* (pp. 15-34). Beverly Hills, CA: Sage Books,

Kirsh, D. (1999). Distributed Cognition, Coordination and Environment Design. *Proceedings of the European Conference on Cognitive Science* pp. 1-10

Kirsh, D. (2001). The Context of Work. *Human-Computer Interaction*, 16 (2-4), 305-322.

Kirsh, D. (2010). Thinking with external representations. *AI & Soc*, 25, 441-454.

Kirsh, D. (2014). The importance of chance and interactivity in creativity. *Pragmatics and Cognition*, 22(1), 5-26.

Layder, D. (1990). The Realist Image in Social Science, Macmillan, London.

Layder, D. (1994). Understanding Social Theory. London·Thousand Oaks: Sage Publications

Lozares, C., Verd J.M., Moreno, S., Barranco, O., & Massó, M. (2004). El proceso de trabajo desde las perspectivas de la Actividad Situada y del Conocimiento Socialmente Distribuido. *Cuadernos de Relaciones Labores*, 22(1), 67-87.

Lozares, C., Verd J.M., Barranco, O., Moreno, S., & Massó, M. (2013). La complejidad y opacidad de las tareas auxiliares en los procesos de trabajo: un análisis etnográfico comparado en dos servicios hospitalarios. *Cuadernos de Relaciones Laborales*, 31(1), 221-242.

Muntanyola-Saura, D. (2008). *Un nou model integrat del procés cognitiu expert: el cas d'una unitat hospitalària*. Unpublished PhD thesis. Universitat Autònoma de Barcelona

Muntanyola-Saura, D. (2014). How Multimodality Shapes Creative Choice in Dance. *Revista Internacional de Sociología*, 72(3), 563-582.

Muntanyola-Saura, D. & Kirsh, D. (2010). Marking as Physical Thinking: A Cognitive Ethnography of Dance. *Proceedings of the IWCogSc-10 ILCLI International Workshop on Cognitive Science*, Donosti, Universidad del País Basco

Nardi, B.A. (1996). Studying Context: A Comparison of Activity Theory, Situated Action Models, and Distributed Cognition. In B.A. Nardi (Ed.) *Context and Consciousness. Activity Theory and Human-Computer Interaction* (pp. 69-102). Cambridge·London: MIT Press

Nersessian, N.J., Kurz-Milcke, E., Newsletter, W.C., & Davies, J. (2003). Research laboratories as evolving distributed cognitive systems. In R. Alterman & D. Kirsh (Eds.), *Proceedings of the 25th annual conference of the Cognitive Science Society* (pp 857-862). Mahwah NJ: Erlbaum

Osbeck, L.M. & Nersessian, N.J. (2005). The Distribution of Representation. *Journal for the Theory of Social Behabiour*, 36(2), 141-160

Osberk, L.M. & Nersessian, N.J. (2014). Situating distributed cognition. *Philosophical Psychology*, 27(1), 82-97.

Pea, R.D. (1993). Practices of distributed intelligence and designs for education. In G, Solomon (Ed.), *Distributed cognitions: Psychological and educational considerations* (pp. 47-87). Cambridge, UK: Cambridge University Press.

Roberts, J. (1964). The self-management of cultures. In W. Goodenough (Ed.). Explorations in Cultural Anthropology (pp. 433-454). New York: McGraw-Hill.

Rogers, Y. (2006). Distributed Cognition and Communication. In K. Brown (Ed.), *Encyclopedia of Language and Linguistics* (pp. 2731-3). Oxford: Elsevier.

Spackman, S.J. & Yanchar, S.C. (2013). Embodied Cognition, Representationalism, and Mechanism: A Review and Analysis. *Journal for the Theory of Social Behaviour*, 44(1), 46-79

Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin and Review*, 9(4), 625-636

Figure 1. The whole work process of the sterilization unit

a.Pre-washing/washing

d.Autoclave sterilization & e.Instruments and fabrics sterilization

b.Doing boxes

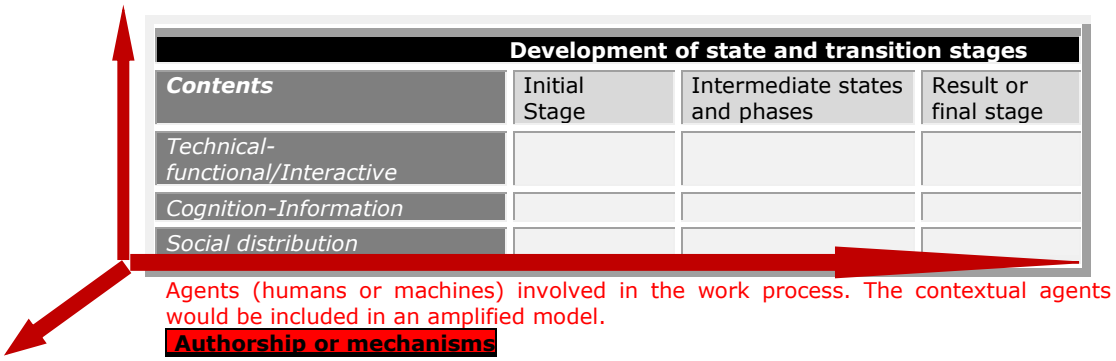
Sterile room

c.Folding cloths

f.External distribution

Source: Images from our video recordings

Figure 2. Situational work process setting



| Contents | Development of state and transition stages: Initial Stage | Intermediate states and phases | Result or final stage |
|---|---|---|---|
| *Technical-functional/Interactive* | | | |
| *Cognition-Information* | | | |
| *Social distribution* | | | |

Agents (humans or machines) involved in the work process. The contextual agents would be included in an amplified model.

**Authorship or mechanisms**

Figure 3. The phases of ‘doing boxes’

**State phase 1 and transition phase from phase 1 to phase 2**

**Placing surgical instruments on a cloth on the table, arrangement and supervision**

Transfer of surgical instruments from tray to cloth on table

Removal of empty tray

**State phase 2 and transition phase from phase 2 to phase 3**

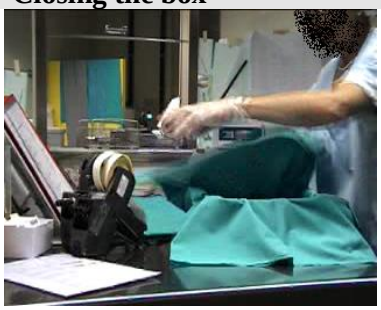
**Placing instruments in a box and supervision**

Placing instruction guide

Placing box

Placing surgical instruments in box

**Closing the box**



Folding box cloth

Closing box

**Registering the box and identifying the worker**

Registering box and identifying worker on marker paper

Attaching marker paper to box

**State phase 3**: Box closed, sealed, registered, identified and ready for autoclave

Source: Images from the first 10 minutes of one of our video recordings.

Figure 4. The work process setting in the sterilization unit with its co-texts and contexts