This text appeared in Chapter 8 (section 8.6.2) of the Fourth edition of Interaction Design. Distributed Cognition is covered in the fifth edition, but this text provides a detailed example of how to apply this approach, and it is offered on the website in case readers find it useful.

## *Distributed Cognition*

We introduced the distributed cognition approach in Chapter 3, as a theoretical account of the distributed nature of cognitive phenomena across individuals, artifacts, and internal and external representations (Hutchins, 1995).

Typically, a distributed cognition analysis results in an event-driven description which emphasizes information and its propagation through the cognitive system under study. The cognitive system under study might be one person's use of a computational tool, such as a calculator, two people's joint activities when designing the layout for the front page of a newspaper, using a shared authoring tool, or, more widely, a large team of software developers, examining how they coordinate their work with one another, using a variety of mediating artifacts, such as schedules, clocks, to-do lists, and shared files.

The granularity of analysis varies depending on the activities and cognitive system being observed and the research or design questions being asked. For example, if the goal is to examine how a team of pilots fly a plane – with a view to improving communication between them – then the focus will be on the interactions and communications that take place between them and their instruments, at a fine level of granularity. If the goal is to understand how pilots learn how to fly – with a view to developing new training materials – then the focus will be at a coarser grain of analysis, taking into account the cultural, historical, and learning aspects involved in becoming a pilot.

The description produced may cover a period of a day, an hour, or only minutes, depending on the study's focus. For the longer periods, verbal descriptions are primarily used. For the shorter periods, micro-level analyses of the cognitive processes are meticulously plotted using diagrammatic forms and other graphical representations. The rationale for performing the finer levels of analysis is to reveal practices and discrepancies that would go unnoticed using coarser grain analysis, but which reveal themselves as critical to the work activity.

Ed Hutchins (1995) emphasizes that an important part of doing a distributed cognition analysis is to have a deep understanding of the work domain that is being studied. He -recommends, where possible, that the investigators learn the trade under study. This can take a team of researchers several months and even years to accomplish and in most cases this is impractical for a research or design team to do.

Alternatively, it is possible to spend a few weeks immersed in the culture and setting of a specific team to learn enough about the organization and its work practices to conduct a focused analysis of a particular cognitive system. For example, I spent six weeks with an engineering team, where I was able to learn enough about their work practice to gain a good

understanding of how they worked together on projects, how they coordinated their work with each other, and how the technologies that were used mediated their work activities. I was then able to document and analyze a number of problems they were experiencing through the introduction of new networking technology. Using the distributed cognition framework, I described how seemingly simple communication problems led to large delays and recommended how the situation could be improved (Rogers, 1993, 1994).

More recently, distributed cognition has been applied to studying medical teams. For example, Rajkomar and Blandford (2012) examined how healthcare technologies are used; specifically they examined the use of infusion pumps by nurses in an intensive care unit (ICU). They gathered data through ethnographic observations and interviews, which they analysed by constructing representational models that focused on information flows, physical layouts, social structures, and artifacts. They note that "the findings showed that there was significant distribution of cognition in the ICU: socially, among nurses; physically, through the material environment; and through technological artefacts." Based on the results of this study, they were able to suggest changes that would improve the safety and efficiency of the nurses' interactions with the infusion technology.

## Performing a Distributed Cognition Analysis

It should be stressed that there is not one single way of doing a distributed cognition analysis, nor is there an off-the-shelf manual that can be followed. A good way to begin analyzing and interpreting the data collected is to describe the official work practices, in terms of the routines and procedures followed, and the work-arounds that teams develop when coping with the various demands placed upon them at different times during their work. In so doing, any breakdowns, incidents, or unusual happenings should be highlighted, especially where it was discovered that excessive time was being spent doing something, errors were made using a system, or a piece of information was passed on incorrectly to someone else or misheard. While writing these observations down it is good to start posing specific research questions related to them (e.g. 'Why did X not let Y know the printer was broken when he came back from his break?') and to contemplate further (e.g. 'Was it a communication failure, a problem with being overloaded at the time, or a technology problem?').

It is at this point that knowledge of the theory of distributed cognition can help in interpreting and representing the observations of a work setting (see Chapter 3 and Hutchins, 1995). It provides an analytic framework and a set of concepts to describe what is happening at a higher level of abstraction. Problems can be described in terms of the communication pathways that are being hindered or the breakdowns arising due to information not propagating effectively from one representational state to another (see Box 8.6). The framework can reveal where information is being distorted, resulting in poor

communication or inefficiency. Conversely, it can show when different technologies and the representations displayed via them are effective at mediating certain work activities and how well they are coordinated.

## BOX 8.6

**DISTRIBUTED COGNITION CONCEPTS**

A distributed cognition analysis involves producing a detailed description of the domain area at varying levels of granularity. At the micro-level, a small set of cognitive terms are used to depict the representations employed in a cognitive activity and the processes acting upon them. The terms are intended to steer the analysis towards conceptualizing problems in terms of distributed information and representations. This level of description can also directly lead to recommendations, suggesting how to change or redesign an aspect of the cognitive system, such as a display or a socially mediated practice. The main terms used are:

- *The cognitive system* – the interactions among people, the artifacts they use, and the environment they are working in.
- *The communicative pathways* – the channels by which information is passed between people (e.g. phone, email, physical gesture).
- *Propagation of representational states* – how information is transformed across different media. Media refers to external artifacts (e.g. instruments, maps, paper notes) and internal representations (e.g. human memory). These can be socially mediated (e.g. passing on a message verbally), technologically mediated (e.g. pressing a key on a computer), or mentally mediated (e.g. reading the time on a clock).

Performing a detailed distributed cognition analysis enables researchers and designers to explore the trade-offs and likely outcomes of potential solutions and in so doing suggest a more grounded set of cognitive requirements, e.g. types of information resources that are considered suitable for specific kinds of activities, and those that could be dealt with by an automated system. Clearly, such a painstaking level of analysis and the expertise required in the interpretation are very costly. In the commercial world, where deadlines and budgets are always looming, it is unlikely to be practical. However, in large-scale and safety-critical projects, where more time and resources are available, it can be a valuable analytic tool to use.

Furniss and Blandford (2006) applied distributed cognition to an emergency medical dispatch setting (ambulance control). They identified 22 principles underlying the literature on distributed cognition, and used diagrams from Contextual Design (Beyer and Holtzblatt, 1998) to capture relevant aspects of activity they observed. The analysis resulted in suggestions for improving the dispatch room operation. The resulting method for applying distributed cognition, called DiCOT (distributed cognition for teamwork,

Blandford and Furniss (2006)), has subsequently been used to understand software team interactions (Sharp and Robinson, 2008), mobile healthcare settings (McKnight and Doherty, 2008), and the use of infusion pumps by nurses (Rajkomar and Blandford, 2012).

## References


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