

# Facilitating Knowledge Construction through Information Technology: Beyond the Things that Make Us Dumb

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## **Abstract**

Information and communication technologies (ICTs) offer us assistance in many areas of our lives and are perhaps most notable in the modern workplace. The rise of IT has changed more than just the level of automation and availability of relevant information: it has affected the entire process of working. Knowledge workers, for example, are particularly dependent on the rapid distribution of information and knowledge enabled by the use of ICTs. Drawing on the results of an empirical field study based on participant observation in a specific workplace, this paper examines two problems specific to current tools and argues that these problems are in fact more likely to hinder us in “being smart” than facilitate intelligent problem-solving. The first of these is *segmentation*: instead of being presented in networks or interrelated parts of a whole, information is often delivered as pieces of data, requiring cognitive effort on the part of the recipient to slot this information into its meaningful place in the puzzle. The second is *loss of context*: the segments or units presented to the user are often stripped of meaningful context or their original situation of use. To facilitate knowledge construction, support is lacking for situated pattern construction, including the social dimension.

**Keywords:** Computer-Supported Cooperative Work, Situated Cognition, Translation Technology, Computer-Aided Translation

## **1. Introduction**

In his popular classic advocating a human-centred approach to technology, Donald A. Norman [1993] takes up the Distributed Cognition approach developed by Edwin Hutchins and others (Hutchins [1995]), contending that complex problem solving is enabled by the more or less deliberate use of tools and artefacts. He defended “human attributes in the age of the machine” by showing ways of designing tools to make them easy to use.

A look at the use of technology in the modern workplace raises one very relevant question: do we serve technology, or does it serve us? In this paper, we describe and discuss the results of a recent workplace field study, look at the reasons behind the occasional stress and frustration caused by ICTs in this workplace and propose some shortcomings in (software) tool development from the Cognitive Science and Computer Supported Cooperative Work standpoints, i.e. what such tools lack to really “make us work”.

## 2. The Use of Technology: Why Artefacts?

We live in a world totally immersed in cultural influences. It is hard to find a path, place or object that has not been formed or manipulated by human hand. We are surrounded by artefacts. In fact, they are sometimes so prevalent we consider them second nature, and they almost “feel” like a part of us. (For tools and artefacts, see Susi & Ziemke [2005], in which they discuss the concepts of *functional tone* (von Uexküll), *equipment* (Heidegger), *affordance* (Gibson), and *entry point* (Kirsch).)

People try to shape their environment to reduce their cognitive processing load. Diaries, PDAs, laptops and even the proverbial knot in the handkerchief can all help in the process. They take the strain off our memories and facilitate coordination. In the same way scaffolding is used to help construct large buildings, people use tools to support their actions and understanding. This broad definition of artefacts corresponds to the Situated, Embedded Cognition approach found in Cognitive Science, which includes all forms of human creative achievement, from psychological instruments such as language and rules of thumb to the culturally developed tools and spatial setting of an activity. Artefacts do not need to be high-tech: they include all human creative achievements, from spectacles and diaries to behavioural conventions and guidelines rooted in culture and tradition.

ICTs can help us perform routine tasks and retain an overview when working on complex tasks. They should help us to bridge distances more effectively and enable on-going social interaction and the distribution of information in such a way that all participants share the same level of knowledge on tasks and deadlines.

In a professional context, the way an expert works is influenced by many things, not just by IT solutions targeted at a specific profession. However, technology as such will only be accepted if it can be integrated into accepted ways of behaving. Consequently, interaction with a range of environmental issues also becomes relevant in a comprehensive analysis of a workplace. Consideration has to be given not only to *how* a technology works, but also to *when* it is used and, above all, *when* it is *not* used. Practice shows that despite having access to appropriate expert systems, people often still prefer to go next door and ask a colleague. This complies with results from the field of Computer Supported Cooperative Work, where, for example, Bowker et al. [1997] note: “People and things are mixed together, and extend each others’ capacities.” In other words, the issue is always the combination of sociology and technology, rather than the replacement of one by the other.

The rise of IT has changed more than just the level of automation and availability of relevant information: it has affected the entire process of working. Project teams, global cooperation and teleworking have become an integral part of day-to-day life in many business environments. Many people no longer get their feeling of belonging and stable professional identity solely from working in a static environment, a real place where people regularly come together. Instead, they communicate remotely across networks or join communities of practice to discuss and work on issues of interest, thereby increasing their understanding and becoming more efficient in their work.

## 3. Knowledge Construction

From the Situated, Embodied Cognition perspective (also known as “Situated Action” or “Embedded Cognition”), knowledge construction primarily requires ongoing, contextually

rich and meaningful interaction with the environment [see, e.g., Suchman (1987), Clark (1997), Hendriks-Jansen (1996), Clancey (1997), Lave & Wenger (1991)]. The closer the dynamic unity of mind, body, and environment is weaved, the smarter and more intelligent the behaviour of the individual in question, i.e. the better the cognitive system is able to tackle new challenges. Similarly, the closer this dynamic unity is weaved, the more intelligent the behaviour of a group/organisation and the better its ability to deploy the social and cultural knowledge developed in prior activities and generations (e.g. “collective intelligence” [Lévy (1997)] or “organisational knowledge” [Spender (1996)]).

Given the experience-based and constructive character of human learning, adapting and building new patterns of thought and behaviour requires time, repetition and concentration. Knowledge construction is a time-consuming, incremental activity that weaves available knowledge to ever bigger, increasingly complex and contextually richer networks. These “paths of activity” or “tracks of experience” have a non-linguistic, sub-symbolic character [Rumelhart & McClelland (1986)]. Language can be seen more as the “ultimate artefact” [Clark (1997)] than as the structure and substance of the internal workings of the mind.

But it would seem we include far more than just environmental details in our mental units: our internal representations themselves also include information about our own activities or experiences and the correlated perceptual input [see Mataric (1991)]. Thus, our internal “maps” act as the guiding force behind action.

It is this combination of representation and control that is of most interest here. A more classical approach would posit both some kind of internal representation/information together with a central control module that accessed the information and used it to make decisions or to understand [Clark (1997:49)]. In contrast, here the internal representation simultaneously describes aspects of the world and prescribes possible actions (“action-oriented representation”). Depending on the course and goals of a given action, different aspects of the internal representation become activated – not all of our potential knowledge is available for use at any time and in any place.

#### **4. Designing for Knowledge Construction**

Given the propositions above, knowledge construction can be seen to depend primarily on:

- a) incremental pattern construction, and
- b) contextual, situation- and action-dependent activity.

In this paper, we look at the role played by technology in knowledge construction and contend that greater attention and importance should be attached to these two principles of human cognition in the development of ICT tools. In contrast, the classic software development paradigm seems to align cognition with information processing, placing the software tool (as external, de-contextualised representation) on one side and the human user (as central control module) on the other. Following this approach, the information provided by the tool serves only as data input, with the human being responsible for attaching meaning to this data and using it for action-oriented, context-dependent purposes. Instead of facilitating knowledge construction, tools based on such an approach in fact “make us dumb”, since they rip out the essential contextual and situative clues we need to keep on weaving our knowledge network.

It's the mind that matters, not the media. Fortunately, a significant proportion of today's ICT industry now focuses on developing tools to support people, not replace them. Indeed, this will be one of the key future tasks of applied research: to actively participate in technology development and not simply leave it up to the forces of a market that does not focus primarily on quality and usability.

## **5. Case Study: Knowledge Construction & ICTs in a Translation Agency**

To shed some practical light on the theoretical discussion, we will now look in detail at a real life example of a technologically advanced workplace, namely an international translation agency in Vienna, Austria. The central issue at hand are the conflicts that can arise between creativity and control on the one hand and quality and economic viability on the other: How can professionals best utilise technology to improve their work and increase their efficiency, without compromising their creativity or lowering the quality of their products? To what extent and with what consequences are the available tools used?

A valid assessment of the sense and purpose of a particular technology is only ever possible if the researcher is aware of and understands the environment in which such a technology is (to be) used. Or, in the words of the Finnish architect, Eliel Saarinen, "Always design a thing by considering it in its next larger context – a chair in a room, a room in a house, a house in an environment, and an environment in a city plan." Such awareness demands a detailed analysis of the target user group and the work it does, to identify where the use of technology-based tools can help solve real problems and where such tools might even be counterproductive or cause problems of their own. Consequently, an appropriate assessment must be made of the context in which ICTs are to be used, the aims of using such technologies and the target user group.

In our case, a qualitative field study was carried out on the practical effects of ICTs in the translation workplace. This involved the on-site observation of daily working life in a translation agency over a four-week period. The resultant case study serves as a practical illustration of some of the key aspects of technology use in professional translation management (see Fig. 1).

With a total of five staff (all female and educated to degree level), the agency works with hundreds of specialised translators and interpreters around the world, as well as with other translation agencies. To ensure they remain at the forefront of translation technology, they also have a cooperation agreement with a major supplier of language technology tools.

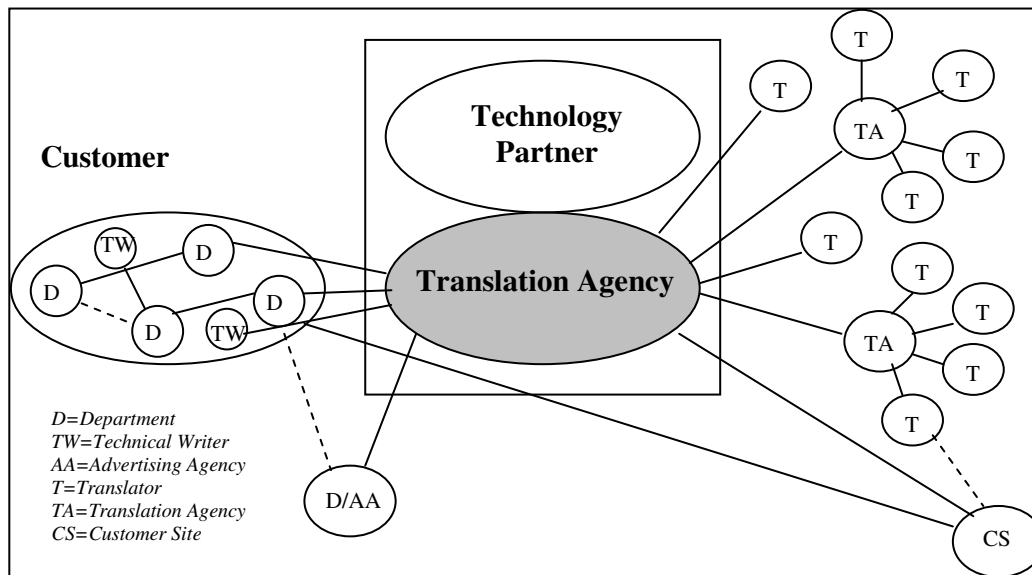


Figure. 1: Translation Management: Partners in the Case Study

In 2001 alone, the agency handled a total of 2127 orders. In one case, an 8-page company newspaper had to be translated into 12 languages (including Chinese) with a 4-day deadline. During the proofreading phase, the various language versions of the text (in .pdf format) went back and forth at least 4 times between the agency, the customer and the translators; the Chinese version required a total of 12 revisions. The layout was handled at the customer's site, again with the exception of the Chinese text, which was outsourced to ensure correct handling of the character set. By the time it was completed, a total of 225 e-mails had been sent or received for this one project alone.

This offers an idea of what work can be like in a translation agency. The working environment is characterised by rapid developments in technology and an increased need for specialisation and networking. "Lone guns", single-handedly dealing with every aspect of the translation process, are rapidly becoming a thing of the past. Consequently, ICTs and translation technologies not only support translators, they also influence the whole intercultural communication network.

The study revealed a number of areas that might benefit from the use of ICTs or translation technologies, including:

- Cooperation (between agencies, clients, translators and other partners)
- Research and text design (target group orientation)
- Quality of source and reference materials (e.g. terminology and file formats)
- Context
- Textual interdependence and dynamics

### 5.1 Translation Management

The partnerships in translation (i.e. intercultural communication) networks are varied and complex and include suppliers, customers, consultants, applicants and long-term partners. They communicate with each other not just as representatives of specific expert roles, but also as *individuals*. Managing translation and interpreting projects involves far more than just the coordination of texts and deadlines: it is above all about managing and coordinating people.

The translation managers and freelance translators studied have to make do without those classic meeting places for informal communication, the coffee machine or the water cooler. Technology-based solutions for communication, personal conversation and exchanging anecdotes therefore become increasingly important. The narrative elements of such conversations are often re-used and distributed further using various media. They create continuity of time and place, particularly in fast-moving projects. They also help people to get back on track with project status following a change of location or a longer break. In this way, an ongoing shared history is established with each communication partner and relationships are maintained through the continuous flow of information. This, of course, has far reaching consequences for any ICTs used: *they must be designed as tools to support cooperation.*

### **5.1 Research and Text Design**

Text design is a perfect example of an activity that involves the processing of information and knowledge as raw materials. The text design process involves all manner of tasks, including research, archiving, indexing, forwarding, versioning, updating and sharing information using a wide range of different formats and media.

Thus, translators act as knowledge workers and information hubs. They have to be able to collect and filter information, adapt it to the needs of the target group and distribute it. Consequently, increasing importance must be given to the issue of re-usability, as illustrated by the use of tools such as *translation memories*, *content management* or *single source publishing tools*. Cost is often a determining factor: translation has to satisfy strict economic criteria.

### **5.2 Context, File Formats and Specialised Translation Technologies**

The main specialised translation tool encountered in the agency studied was a *translation memory* system. Translation memories are particularly useful for handling large translation volumes, particularly when a project is coordinated centrally and the client places great importance on consistency.

The particular system used in this case (like many of its compatriots; s. Freigang & Reinke 2002) cuts source text and target texts into word or sentence segments and saves the segment pairs for further use. New texts to be translated are run through the system, and any sentences already translated for other purposes are automatically pre-translated. However, with this comes the risk that solutions devised for a different context could dominate the current text. This is further aggravated by poor source and reference material or file format problems: the most commonly used translation memory systems require correctly formatted continuous text, which often means that the source file has to be converted. Consequently, in some contexts, the staff at the translation agency considered translation memory systems more of a hindrance than a help.

Ultimately, translation memory systems can only make a positive contribution to the quality of a translation and increase cost-effectiveness if specific criteria and requirements are also met, including the availability of specific text formats and high quality reference material, adequate updates and maintenance, well-considered definition of program parameters and a link to a well-maintained terminology management system.

From a quality aspect, translation technologies are a double-edged sword. Although they provide access to existing context and “history” and thus increase productivity, they are nonetheless based on a comparison of individual segments and follow an outdated, amateurish strategy of translation as simple substitution of segments in different languages, thereby ignoring the cultural, target-group and situation specific factors that must be taken into account. Instead of being presented in networks or interrelated parts of a whole, information is delivered as pieces of data, requiring cognitive effort on the part of the translator to slot this information into its meaningful place in the puzzle.

Translation memories also work on a garbage in, garbage out principle. Whilst a translator might accept the proposal of a translation memory system for what it is – namely just a suggestion – cooperation partners might misunderstand this and assume the solution to be a viable translation which does not need to be checked or validated in light of the current context. The segments or units presented to the translator are thus stripped of meaningful context or their original situation of use. Similarly, translation memory systems cannot replace the way human translation construes meaning. They cannot, for example, develop situation-based communication strategies, decide which research criteria to use, or choose between two possible solutions.

Consequently, the basic conflict between creativity and control remains. Furthermore, such systems force translators to organise their work in a very specific way. According to Wagner [1997:429], the way of working induced by technology often assumes the role of a “powerful standard image from which it is difficult to step back”. This is a central issue in the field of Computer Supported Cooperative Work, where the discussion focuses on how (despite the use of technology or, even better, with its help) to encourage flexibility and creativity, to support methods of work that have grown and become established over time, and how to use unconventional or “quick and dirty” methods if so required.

## **6. Consequences and outlook**

ICTs can save knowledge workers a great deal of effort and leave them with more time to concentrate on their “real work”, which is often highly creative and benefits greatly, for example, from the availability of contact details and reference files in electronic format.

The antinomy between creativity and control conveys some of the basic questions facing ICTs. Heavy workloads and high productivity requirements leave workers in danger of letting tools reduce their perspective to a worm's eye view: they can't see the wood (i.e. the big picture) for the trees (e.g. the text segments, incoming messages, individual tasks, the windows open on the screen). ICTs should, however, in fact facilitate the taking of a bird's eye view. In this way, they would enable their users to benefit from potential advantages in productivity and consistency, yet avoid any reduction in quality as a result of segmentation and loss of context.

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