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Autor: Colombetti, Marco / Paolini, Paolo

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Marco Colombetti & Paolo Paolini*

INFORMATION TECHNOLOGY AND HUMAN COMMUNICATION

Digital technologies are currently having a deep impact on how we communicate and interact with others. Such technologies open a variety of new opportunities; which of them will become actual, however, is determined by a host of factors that have to do with human cognition and socio-economical relationships. Thus, the role of digital technologies in communication cannot be correctly appreciated unless they are placed in the context of complex interaction processes among people. In this paper we concentrate on a specific kind of digital media, that is, computer-based systems that support human interaction. Rather than trying to set up a general theoretical framework, we present and discuss some views that have developed from our recent research and teaching experience at the Faculty of Communication Sciences of University of Lugano.

Keywords: Information and Communication Technology, human communication and interaction, collaborative environment, semantic web.

* University of Lugano, marco.colombetti@lu.unisi.ch; paolo.paolini@lu.unisi.ch and Politecnico di Milano, marco.colombetti@polimi.it; paolo.paolini@polimi.it

1. Introduction

We are all aware that digital technologies are currently having a deep impact on our everyday lives, in particular on how we communicate and interact with others. From the point of view of the general public, this rapid change in the way people communicate can be regarded as a necessity, an opportunity, or a sheer nuisance. But from the point of view of the communication specialist, who is called to foster and manage such a change, understanding what is going on is just a professional must.

The development of communication technologies has been around for quite a long time. In its widest acceptation, the term "technology" encompasses the invention, design, production, maintenance and use of artefacts of any kind, for every possible purpose. Historically, the first technological achievement in the human communication line of business has been the adoption of various forms of writing. While there is a sort of continuum between an ancient papyrus roll carried by a messenger and an XML document exchanged through the internet, there are also sharp differences, which make digital communication media quite unique. Such differences, however, cannot be appreciated just by looking at the physical makeup of the different communication-supporting devices: the physics of a medium is essential to enable certain kinds of use, but the use cannot be inferred by the physics. An artefact, by being the physical object that it is, defines a space of opportunities; which of them will become actual is determined by a host of factors that have to do with human cognition and socio-economical relationships; thus, the role of communication media cannot be correctly appreciated unless they are viewed as parts of complex interaction processes among people. But this brings in two main consequences: first, that Information and Communication Technology (ICT) can be understood only if it is properly situated in the context of human interactions; and second, that the technologies underlying significantly different kinds of interactions cannot be treated in the same way.

ICT products enter our everyday life in a variety of forms. Roughly speaking, we can distinguish between the products (like DVDs, iPod™, and digital TV) that support one-way or at least highly asymmetric communication processes, and those (like cell phones and electronic mail) that enable symmetric communication. Certain ICT devices, like the personal computer, may seem to be universal, being able to support both asymmetrical and symmetrical communication (think for example of a

website and of an electronic forum). However, in this case the communication medium is not the computer conceived as a piece of hardware, but the computer plus a certain type of software: thus, a website supporting one-way communication is sharply different from a software application supporting cooperative work.

Since the end of Word War II, the place of digital computers in human life has evolved dramatically. Up to the early Nineteen-fifties computers have been used to carry out technical and scientific computations. Then, from the Nineteen-sixties to the end of the century, the primary use of computers has been data management. But since the advent of the internet, the main function of a computer has been to provide an entry point to a huge, world-wide network supporting human interaction. Interestingly, during the Nineteen-nineties the term "Information Technology" (IT), previously used in Europe to name the world of computer equipment and applications, has been systematically replaced by "Information and Communication Technology" (ICT), thus bringing to the foreground and giving official recognition to what is now perceived to be the main function of computers.

ICT covers the design, production and use of digital artefacts for processing and transmitting information; in other words, it is taken to encompass the union of *informatics*[1] and *telematics*. The term, we believe, echoes a common misunderstanding, that is, the idea that communication consists of an exchange of information. But while of course people do exchange information when they communicate, they do much more than that. Leaving aside one-directional communication (that deserves a different treatment and will not be taken into account in this paper), communicative exchanges are part of wider processes of interaction (see Carassa 2007). When they communicate, people not only exchange information, but also perform a number of complex social actions. This is just as true when people do or do not use ICT tools to support their interactions. To clarify this point, let us consider two examples: a simple business transaction, like the reservation of a hotel room, and a piece of cooperative work, like the collective writing of a document.

[1] While the term "informatics" is widely used in Europe, in the USA the same area is named "computer science." Possibly the reason is to be traced back to the fact that, in the USA, "Informatics" has been a registered trademark since March 1962, being the name of what has probably been the first software company in the world.

1.1. Reserving a hotel room

A traveller reserving a hotel room is a simple example of business transaction, of the B2C (business-to-client) kind. It can be performed without the support of any technology, just by showing up at the hotel's reservation desk, or by exploiting older technological tools, like exchanging letters, making a phone call, or sending a fax. Today, the internet allows us to do the same thing in two new ways: by exchanging email messages, or by submitting an electronic reservation form through a web page. Independently of the means used by the two actors to communicate, the interaction process is aimed at making an agreement which, if successfully completed, will bind both actors (the customer and the hotel) to certain courses of behaviour. Proposing, negotiating and making agreements are a larger part of human interaction that the previous example may suggest. Even a simple communicative exchange like, "Shall we take a walk?", "Why not", is an example of successful agreement-making (see Gilbert 1989, 1996). All agreements are made through communication, and involve much more than an exchange of information: indeed they create a set of commitments for the actors to fulfil, and thus modify the network of social relationships binding the actors to one another. This fact is independent of the means used to communicate, but ICT tools now allow people to modify their social relationships in a variety of new ways.

Going back to the room reservation example, we note that the use of email messages does not make a big conceptual difference with respect to an exchange of paper letters: electronic mail is just faster and more efficient than "snail mail"[2]. On the contrary, the direct submission of a web form to the hotel's automatic reservation system brings in something new. An agreement presupposes that (at least) two actors manifest, through communication, their matching wills: I shall do *X* if, and only if, you do *Y*. But how can a person match his or her will with a computer program? To answer this question we must see that the program

[2] Whether email is also less expensive that traditional mail is difficult to say. Of course, the marginal cost of sending a message is much lower in the case of electronic mail. However, the global cost of switching from traditional communication tools to the new electronic media is high: in December 2006, newspapers have reported that in order to decrease costs, computers have been completely eliminated from the check-in procedure in the new terminal of Marseille airport reserved to low-cost flights.

embodies a standing intention of the hotel manager to make certain types of agreements (e.g., reserving a room for a customer), in certain circumstances (e.g., when a room is available on the required dates). Adopting the technical terminology proposed by John Searle (1983), a computerised reservation can be viewed as the interaction of an *intention-in-action* of the customer, manifested by submitting the form, with a *prior intention* of the hotel manager, embodied in the reservation program and manifested through its web interface.

The possibility of embodying prior intentions into computer programs brings in a significant change in social life: when interactions follow a predefined pattern, people can delegate some of their actions to computer programs. Indeed, we can imagine a situation in which not only the hotel manager, but also the customers delegate part of their actions to computers. For example, a traveller may enter a description of his or her travel plan and let a program search the web for appropriate hotel reservations. A standardised technology suitable to implement this type of computer-to-computer interaction is available, under the name of *web services*; also many of the institutional aspects involved in delegating human agreements and similar transactions to computers have already been analysed and modelled (see for example Fornara et al. 2007).

1.2. Writing a document together

Joan, who lives and works in Edinburgh, and Stavros, located in Athens, are due to write the final report of a research project they have carried out together over the last two years. They have not started yet, and the report has to be delivered in two days from now. The job, virtually impossible without the internet, can now be completed with the help of a variety of tools. The simplest thing Joan and Stavros can do is to exchange documents written with a document processor that allows for change tracking and commenting. A more sophisticated procedure would involve the use of software tools supporting the joint editing of a single document. At times, Joan and Stavros may want to exchange email messages or pick up the phone and call one another, but this is not strictly necessary: in principle, all the work can be done by exchanging draft versions of the final document, or by working together on a single, shared version of the document.

As in the case of hotel reservations, this example shows that communicating is much more than exchanging information. Here Joan and

Stavros interact to build a common product, much like two carpenters may work together to make a single piece of furniture. Also in this case, the interaction involves a number of agreements: Joan and Stavros have to agree on the procedure and the software tools they are going to use, and at the end of their work they will have to agree on the final version of their report. But here the most interesting aspect is that the two actors mainly communicate by sharing different versions of a collective artefact. The report drafts are not, strictly speaking, "messages" exchanged by the two actors: rather, they are intermediate steps to a final, common product. Much of the communication that goes on between Joan and Stavros is *stigmergic*,[3] that is, is embedded in the traces that their individual actions leave on the shared document. Every such action has two effects: on one hand, it makes the shared document proceed towards its final version; on the other hand, it provides the other actors with new *affordances*,[4] that is, with invitations to act on the document in certain ways. In such a situation, communication is so entrenched in the global activity that it is not even possible to separate a communicative from a non-communicative part of the interaction.

1.3. Human interaction technologies

The two examples suggest that the term "Information and Communication Technologies" fails to convey a major aspect of current computer-based technologies. Networked computers allow people to develop complex patterns of interaction, involving the negotiation of agreements and the development of joint activities. A term like "Human Interaction Technologies", we believe, would be more suitable (and HIT would not be bad as an acronym, after all).

Our aim, however, is not to open a terminological debate. Rather, the point is that technologists are typically raised to think, *à la* Shannon and Weaver, that communication just consists in exchanging information.

[3] The term "stigmergy" was introduced by Pierre-Paul Grassé (1959) to denote an agent's ability to exploit the traces left in the environment by other actors. Originally proposed to characterise insect behaviour, the term has been recently adopted in ICT.
[4] The term "affordance" was introduced by James J. Gibson in the Nineteen-sixties, and then thoroughly analysed in his seminal book on visual perception (1979), to denote all action possibilities objectively existing in an environment. Later on Donald Norman (1988) used the term in the context of human-machine interaction, to denote the action possibilities existing in an environment and actually perceived by an actor.

This view is strongly misleading when one comes to the design of tools for supporting human communication processes, which are most often part of wider social interactions, involving such aspects as negotiating agreements, arranging and interpreting stigmergic cues, and creating and exploiting affordances embedded in shared artefacts.

In this paper we shall concentrate on a specific kind of ICT media, that is, computer-based systems that support human interaction. We consider such applications as particularly interesting in a highly multidisciplinary context, like the one provided by the Faculty of Communication Sciences of the University of Lugano (USI-Com), in which both authors carry out research and teaching activities. Rather than trying to set up a general theoretical framework for computer-based cooperation, in the following sections we shall present and discuss some views that have developed from our concrete research and teaching experience in the last few years.

2. ICT and human communication

To foster cross-breeding among ICT and the various fields of the Human and Social Sciences dealing with communication, the Technology Enhanced Communication Laboratory (TEC-Lab) was founded at USI-Com in 2001. In this section we report on some of the research activities carried out at TEC-Lab since then.

Broadly speaking, we can classify the intersection between ICT and the Human and Social Sciences along the following lines:

- *human communication as an "ingredient"*: the quality of professional communication is a key factor for the everyday activities of ICT researchers and professionals;
- *human communication as a conceptual ground*: theories and models of human communication processes are important for understanding ICT-driven phenomena and improving ICT artefacts;
- *ICT research and practice as a stimulus for innovative research on human communication*: the need of solving ICT problems often stimulates research on new topics of communication science, or casts new light over well studied phenomena;
- *human communication as part of technology-enhanced communication*: when ICT is used for communication purposes, human communication issues must be balanced with technological issues.

Below we describe a few specific problems we dealt with at TEC-Lab while carrying out research, design and teaching activities.

2.1. Human communication as an "ingredient"

ICT is obviously a technological field, where scientific and technical competence is considered to be the kernel for both research and professional practice. It turns out, however, that ICT, much more than other technical disciplines (say mechanics or electronics, for example) requires a lot of communication skills that are often neglected both in the research community and in university curricula[5]. A few examples, taken from the activities where TEC-Lab is involved, may clarify this point:

- *Requirement analysis*. Collecting the needs of the stakeholder, and organizing them in a coherent set of requirements, is a critical step for most ICT applications. Significant communication skills are required in a number of situations: one-to-one dialogue, small-medium sized meetings, presentations, memo-writing, and so on. Indeed, high-level requirements elicitation combines technical competence with communication skills, which, in general, are not part of engineering curricula.
- *Professional writing*. ICT projects produce, quite often, a large amount of documents of all kinds for a variety of readers. While in other engineering disciplines similar documents consist, for the greatest part, of technical drawings, mathematical formulas and the like, in ICT documents are mostly written in natural language and express concepts. In addition, while in other engineering disciplines similar documents are intended for a professional audience only, in ICT documents are often intended to be read by laymen. Again, sophisticated communication skills are needed to properly organise these documents and make them effective (i.e., readable and making the point).
- *Professional argumentation*. Many ICT documents (from contract proposals, to design specifications, to final presentations, to scientific papers, etc.) are basically argumentative. Very seldom ICT researchers are able to "prove" that a proposed solution is better than its alternatives. The most common situation is "arguing" for the proposed solu-

[5] A relevant exception is MIT, where a "communication skills" course is a prerequisite to get a Bachelor degree.

tion, in the attempt to persuade some stakeholder. To this purpose, first class communication skills are needed.

- *Multimedia content.* Multimedial content has become an essential component of many ICT applications. ICT professionals are therefore involved in this new type of activity, requiring specialised communication skills. We shall come back to this issue, since it is strictly related to technology-enhanced communication.

2.2. Human Communication as a conceptual ground

Some research projects carried out at TEC-Lab involved the development of websites, and some of them had the peculiarities of an additional requirement: accessibility "also" (not exclusively) by blind users. In one such project the website was developed as a support for an exhibition at the State Museums of Berlin devoted to Munch's prints[6]; in another project, ORA (Bolchini et al. 2006), three different websites for the Italian Region of Campania had to be developed keeping in mind the needs of blind users. The basic technique used for blind users is called "screen reader": a piece of software reads aloud (in a non trivial way) the web page shown on the screen. The reading includes text, alternative text for images, labels, and links (identified by their names).

The starting point for TEC-Lab, as for all the researchers in the field, where the W3C guidelines, that is, a set of rules specifying how to build a "readable" web page, avoiding all the techniques that can create problems to screen readers. But we soon realized that to build an effective application something more was needed, since there are web pages that are technically readable, but are not easily understandable or enjoyable by blind users.

After realizing that the W3C guidelines were not sufficient, we addressed to semiotics and linguistics to understand what else was necessary. After empirically building some effective solutions[6], we launched a new project[7] with the aim of understanding the underlying conceptual issues. We found out that the use of a web page can significantly be assimilated to a dialogue between a person and a machine, in which human turns consist of clicks on active links, and machine turns consist in showing pages (Bolchini & Paolini 2006). In a human-web dialogue,

[6] Consult http://www.munchundberlin.org
[7] Web As Dialogue (WED), http://www.tec-lab.ch/wed

communication from the machine is mostly visual, and therefore highly parallel, while in a human-human dialogue communication is mostly oral, and therefore sequential. Exploiting linguistic and semiotic theories of human dialogue, we were able to pinpoint additional guidelines for building effective web pages for blind users.

2.3. ICT research and practice as a stimulus for innovative research on human communication

While working on the WED project, trying to exploit results from linguistics and semiotics to improve websites, we realized that the theories and models we needed were partly different from those commonly adopted in these two fields.

Part of our work consisted in analysing a large body of dialogues between patients and doctors, and comparing them to dialogues between persons and websites. As a result of a cooperation between TEC-Lab and the USI-Com Institute of Linguistics and Semiotics, we developed a "hybrid model", attempting to describe in a unique framework both human-human and human-web dialogues (see the project's deliverables at the project's website[7]).

2.4. Human communication as part of technology-enhanced communication

Many recent ICT applications (like for example websites, interactive installations, information points, mobile applications, and so on) are conceived as full communication media, in the sense that they go beyond the traditional idea of neutrally delivering information to the user; rather, they try to have an impact on the user, somehow trying to convince him or her about something. The actual communicative purpose can differ from application to application: a museum website, for example, may have the purpose to convince the user that the museum itself is worth a visit; a tourism website may attempt to attract new visitors and to persuade them to stay longer; and so on. The situation is made more complex by the fact that different user profiles must be addressed, and that for each profile the impact of the website may have to be different (Bolchini & Paolini 2004).

[7] Web As Dialogue (WED), http://www.tec-lab.ch/wed

In a real-life project carried on within USI-Com's Master Programme in Technology Enhanced Communication for Cultural Heritage[8], we had to shape the communication strategy for Caffè Pedrocchi, a historical café in Padua. We identified different target users (e.g., local families, local young people, international sophisticated visitors, middle age Italian tourists, etc.), and for each of them the desired impact was analysed; it turned out that they were quite different and sometimes even contradictory. The message addressed to families, for examples, had to be, "We are a quiet place"; the message addressed to young people, "We are not at all expensive"; the one addressed to sophisticated international tourists, "We have the best food around, and are a historical place". For each target, the best channel was selected: while local press was chosen for local people, the web was considered to be more effective for international tourists.

Similar issues were raised when we analysed, in a team led by Politecnico di Milano, the communicative needs of the Syrian Ministry of Tourism[9]. To cope with the relevant problems we started developing a new approach to requirement elicitation, where impact and communication needs take an explicit and more important role, in contrast with the more traditional ICT approaches where task analysis and information delivery take the central stage. This new approach to requirements analysis is now becoming a cornerstone of the previously mentioned Master Programme in Technology Enhanced Communication for Cultural Heritage.

3. Supporting collaboration

Networked computers allow for new forms of human collaboration. Even if this is already possible by using very simple applications, like electronic mail and document processors, since the Nineteen-eighties many researchers devoted their efforts to the development of special tools, specifically aimed at supporting cooperative work. Initially, this research area was called CSCW (Computer Supported Cooperative Work). Gruding (1994) reports that this name was first introduced by Irene Greif and Paul Cashman during a workshop held in 1984. By 1988, however, it was already acknowledged that building successful applica-

[8] See http://www.tech-ch.unisi.ch.
[9] See http://www.syriatourism.org.

tions of this kind was a hard task (see Gruding 1988). Later on, suites of software applications intended to support cooperative interactions started to be distributed under the names of "groupware" or "collaborative software" or even, more generally, "social software." More recently, the goals of CSCW have been proposed again under the new name of "Collaborative Environments" (CEs) or "Collaborative Work Environments" (CWEs). Indeed, the availability of such environments is often considered to be a key factor for the future success of organisations and enterprises[10].

In any case, it is fairly clear that so far, despite of significant investments, such applications have not been as successful as it was hoped (Andriessen et al. 2003). The limited success of collaborative software has often been attributed to the immaturity of the relevant technologies. However, there seems to be a growing awareness of the fact that the critical factor is rather to be found in the dynamics of human interaction. The striking success of certain collaborative systems, like for example wikis[11] and blogs[12], show that under appropriate circumstances people do spontaneously cooperate via software tools. The key to a happy end of this story seems to lie in the role that sharing certain artefacts can play in fostering participation to some common enterprise carried out within a community of practice (Wenger 1998).

Even if the dynamics of human interaction are still poorly understood, some fundamental aspects are starting to become clear. As pointed out by Schaffert et al. (2006), the following elements appear to be important for success: no need of special tools besides a usual browser, simplified editing, version management, and unrestricted access. Another important feature, by now widely recognised, is *instant gratification*, that is, the fact that users perceive that every contribution brings them some kind of immediate pay-off. However, even the most successful collabora-

[10] See for example the European Commission reports on new working environments, http://ec.europa.eu/information_society/activities/atwork/

[11] "A wiki ... is a website that allows the visitors themselves to easily add, remove, and otherwise edit and change some available content, sometimes without the need for registration. This ease of interaction and operation makes a wiki an effective tool for mass collaborative authoring." This definition of a wiki is taken from Wikipedia (http://en.wikipedia.org/wiki/Wiki, accessed on 7 January, 2007), the largest and most famous wiki on the Web.

[12] "A blog is a user-generated website where entries are made in journal style and displayed in a reverse chronological order" (Wikipedia, http://en.wikipedia.org/wiki/Blog, accessed on 7 January, 2007).

tive systems are still plagued by open problems, like lack of precision, insufficient recall, and gaming.[13] In the open territory of the Web these problems seems difficult to overcome; but if we are interested in the much more controlled province of a corporate intranet, some remedy may be relatively easy to find.

One promising approach is based on the adoption of Semantic Web technologies. With the exception of gaming (which, however, is not going to be a problem for applications running within corporate intranets), the main problems of collaborative software have to do with semantics. The point is that a shared artefact has, for those who build and use it, a rich meaning which is not accessible to computers: automated procedures are sensitive to the *form* of an artefact, not to its *meaning*. The Semantic Web aims at overcoming this limitation: in the words of Tim Berners-Lee et al. (2001: subtitle), the Semantic Web is "A new form of Web content that is meaningful to computers [and] will unleash a revolution of new possibilities." The idea is that Semantic Web will be populated by documents and services which can be directly understood by computers, because they are written in a computer-readable language with rigorously specified semantics. In a nutshell, Semantic Web technologies involve the use of markup languages with a standard syntax, based on XML, in which the logical relationships among tags are defined by sets of logical axioms, called *ontologies*, that are then exploited by automated procedures, called *reasoners*, to infer underlying connections. For example, in a Semantic Web environment a reasoner able to access a suitable ontology may locate a dealer of Tibetan cupboards while searching for "oriental furniture," even if the dealer's website does not contain the terms "oriental" and "furniture".

It is still too early to evaluate the real potentiality of Semantic Web technologies (see for example Shadbolt et al. 2006). Two severe difficulties, however, are lurking in the dark. The first is that ontologies, which are nothing more than sets of logical axioms, can only partially represent the meanings of linguistic terms (Colombetti 2005). The second difficulty is that ontologies ought to capture the semantics of a set of terms used by some community: but meanings change over time, and in any case it will not be easy to negotiate semantic definitions that can be accepted by an articulated community.

[13] In a collaborative system, the term "gaming" is intended to cover all forms of voluntary disrupting behaviour, like for example the intentional addition of false information in a wiki.

The first problem does not seem to have an obvious solution: human meanings are rooted in individual experiences, and can only be partially reflected by logical axioms. Further research is needed to understand whether the partial representation of meaning supported by ontologies will be sufficient to significantly improve the effectiveness of Web applications, and in particular of collaborative software. The second problem, which is going to be very hard to solve in the open Web, is likely to have a smaller impact on applications running on corporate intranets. In such contexts, meanings are likely to be effectively shared by the relevant communities, and reasonably stable over significant periods of time.[14] Starting from such considerations, at USI-Com's Institute of Communication Technologies we have started to work on the hypothesis that Semantic Web technologies can improve the effectiveness of collaborative environments within corporate intranets.

4. Conclusions

In this paper we presented some views that have developed from our research and teaching experience at USI-Com. It is certainly difficult to draw conclusions on matters concerning ICT, an area where landscapes change as fast as the shape of sand dunes in a windy season. We think, however, that the recent development of computers into means of human communication and interaction is here to stay. Spontaneous, self-organising communities connected through computers will go on flourishing, and researchers will be able to learn much on human participation and collaboration by observing their interactions and studying the emergence of new types of ICT environments. Hopefully, in the long term it will also be possible to develop theories of human interaction powerful enough to guide the design of effective collaborative tools. We still do not know what shape such theories will take, but we are confident that only an open-minded, interdisciplinary research environment like the one we work in will allow researchers to create them.

[14] We know this is the case because we do have databases, and this presupposes a shared and stable conceptual model of some portion of reality.

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