STORY-TELLING AND EMOTION: COGNITIVE TECHNOLOGY CONSIDERATIONS IN NETWORKING TEMPORALLY AND AFFECTIVELY GROUNDED MINDS

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INTRODUCTION

As technological agents that we interact with take an increasing amount of autonomy and responsibility from us, acting on our behalf, there are prospects for social changes in our notions of responsibility for our own actions as well as for the development of 'cognitive calluses' in our interactions with such technologies. Other agents that we interact with assist us in such tasks as search, scheduling, organizing the information we access and other parts of our lives, so appropriate design considerations are desirable in order to respect human wholeness and build humanely interfaced social agents (Dautenhahn & Nehaniv 1999). The impact of technology on human modes of existence, experience, and relationships is changing who were are, and how we interact and relate with one another along a broad collection of dimensions that should be considered by the designers and users of technology (Gorayska *et al.* 1997). Yet most software agents today have no consciously designed affective communication skills or, if they do, often display inappropriate affect to the user and are unable to support the high 'affective bandwidth' present in human face-to-face (but not e-mail) communication (e.g. Picard 1997). Moreover, while human cognition may be fundamentally structured to deal with temporal grounding in terms of stories and narrativity (Schank & Abelson, 1977, 1995, Schank 1990, Read & Miller 1995), software agents today tend to lack any semblance of temporal grounding, but merely react to the user on the basis of no or very limited information of what has happened in the past (Dautenhahn & Nehaniv 1998) or behave in (e.g. strangely discontinuous) manner which is not believable to our human narrative intelligence (Sengers 1998, Sengers 1999).

We discuss some of the concerns on current modes of practice in using and building technological artifacts that do *not* respect the fact the humans are emotionally and narratively intelligent beings. We also survey some approaches to remedying these shortcomings of the current technology in a manner that respects human cognitive and social ecology, with special attention to applications in software agents and networked media with which human users interact.

COGNITIVE CALLUSES

Calluses, like those on a violinist's fingers, that develop with long hours of using an instrument help their bearer to adapt to his or her tools. They are changes, such as those on the fingers of the violinist that adapt her to her instrument, and they make it possible for her to play without the pain that beginners feel when pressing down the strings. Some changes in our selves may be reversible. The calluses on her fingers may disappear if she fails to practice, but they will return when she again spends sufficient time on her instrument. Such physical calluses are fairly well understood, and they arise from a human being's interaction with his or her environment and tools. They are one of our bodies' ways of adapting to the world around.

Similarly, in spending many hours with our software tools and agents, we may also develop calluses over time in the way we interact with them. At first, a novice user may be surprised that the program cannot figure out what he is trying to do. A friendly character in a children's computer game may ask a player's name and use it through several hours of play, but the next day the child is surprised and little disappointed that the friendly character in a computer game no longer remembers her. A pop-up cartoon "helper" repeatedly interrupts the user with suggestions, obstructing his view of what he is typing, grinning all the time. Synthetic actors in a virtual world smile at inappropriate times, or behave in a discontinuous way, e.g. Sengers (1998) considers this anomaly in a virtual dog that suddenly appears to fall asleep after frisky running and jumping only a few seconds ago.

These situations represent what would in normal interaction seem pathological to normal humans. Affective signals from the user go completely unnoticed by the software. The sofware's expression of human-like affective state are bizarre or seem out of place. The previous history of the user's actions and of the user's interaction with the system are completely ignored by it. The actions of the synthetic characters do not make narrative sense in light of what they were just doing; their states are resettable and change in discontinuous ways that make no narrative sense. Narrative structure of the interaction is disposable or forgotten.

The child playing with the software soon learns that computer games are like that, later not even remembering her initial disappointment with the initial interaction. She adapts to the fact that most computer agents maintain no history from one day to the next, nor do they recall the biographic details of their users or interaction histories with them. The names and preferences of a user might be put into a database, or his choices gathered for market researchers, but there is little or no temporal grounding in present day software systems. It is not even widely recognized that narrative history should be important in computer-human interaction. For the most part, only applications in entertainment have even addressed such issues as narrative and story-construction at all.

One might ask, What type of calluses might one develop in dealing with present day software systems? Tools are not only material, but may be cognitive such as coordinate systems for thinking about a particular domain (e.g. decimal representations of numbers (Nehaniv 1997a), or they may be external non-material entities (e.g. software agents who act, take memos, or buy and sell on our behalf, etc.). The calluses we get may be emotional ones, or ones that affect our interaction with the temporally grounded people and environment around us. We are used to living in a rich physical environment; our ancestors evolved in one. In a perceptually impoverished one, where our previous experiences is not always a good guide to the meaning of objects and agents that we perceive around us, we might develop cognitive calluses to adapt to it, in order to make best use of it, and to avoid being disappointed by it. The actors in the virtual environment, perhaps avatars (representations of other humans interacting with the same world), or perhaps completely artificial chatterbots or program-controlled actors, may have behavior that appears strange to us at first. It may be hard to guess what they are thinking or feeling (if anything); they may not seem to come from anywhere, i.e. they arise without biographies or histories. We might develop cognitive calluses through our social interaction with program-driven agents, which have no feelings or perhaps only awkward simulated ones – which we might deem worthless since we know that there is no one behind the façade. How will we eventually behave toward such agents? How might this change how we eventually interact with other human beings – either in face-to-face interaction, or via networked media? How will our acquired cognitive calluses change who we are?

As Jacob Mey has said (pers. comm., 1997), we do not have a choice about whether we will use tools and technology, but as designers of technology we have an ethical responsibility in trying to ensure that our technology is as humane as possible. Our tools augment our abilities, but they should change us only in ways that respect human wholeness. The task of Cognitive Technology is to optimize the human-technology relationship. Emotion and experience in time are primary aspects of human experience. So part of the task of Cognitive Technology requires attention to the design of the affective and narrative aspects of the information media we interact with, and in the new social media via which humans across the world are becoming networked.

AFFECT, BEING, AND TIME: THE SCOPE OF THE HUMAN TEMPORAL HORIZON

Psychological theories of emotion have sought to describe the structure of emotion in humans (e.g. Ortony *et al.* 1988), and some of these models, along with neurophysiological approaches (Rolls 1999), have informed the recent implementations of the first affective software agents. Rather than a purely descriptive stance, such approaches reveal a shift toward a Constructive Biology stance on drives / emotion, which is agent-centered and attempts to understand through building and to find applications of biological-like mechanisms in engineering and control of interactive systems (Nehaniv 1999a, Nehaniv *et al.* 1999). It is appropriate to consider this programme in the light of Cognitive Technology issues.

A recent viewpoint on emotions in agents begins from a *first-person* perspective, relating to second-person interaction and navigation in a biological and social world (Nehaniv 1998). The nature of agents (human, biological, hard/software) in time, and temporal situatedness is discussed below with respect to emotion and behavior, and in relation to effects on human cognition.

In particular, affect is, for humans, an aspect of situatedness in time. Heidegger (e.g. Heidegger 1972) saw the state of man as being as situated in the Now, being there in imminence of the Future in relation to the impinging Past. The scope of this *temporal horizon* is extremely broad in humans compared to other animals, as is evidenced by our emotions such as hope and regret, concern with planning for future actions and story-telling about past or imagined events (Nehaniv 1999a). This vast temporal horizon means that humans will tend to deal with interaction in a way that makes narrative sense, and may anthropomorphically expect their technological agents to do so. Affect and narrativity thus intertwine with each other and are relevant to issues of human-tool interaction. They are important to human-tool relations over time as well as to human-human interaction via networked media.

DO YOU FEEL WHAT I FEEL? : THE COGNITIVE TECHNOLOGY OF AFFECTIVE COMPUTING

The area of Affective Computing, recently popularized by Roz Picard's book (Picard 1997), considers the possibility of making use of affective dimensions in human-computer interaction, as well as for the synthesis of emotion-like phenomena within software and machines. This is also connected to some questions about consciousness and whether a machine could "feel" (experience *qualia).* Issues arising for interactive systems (including user-interfaces, agents and robots) might be divided into three areas (1) recognizing affect, (2) expressing affect, and, more controversially, (3) having affect (Picard 1997).

Benefits of introducing affect into the control of systems such as robots and software agents include (1) releasing them from the combinatorial explosion of considering impractically many possible courses of action as in purely "rational" action-selection (Picard 1997); (2) due to the valence and degree of emotions, they provide an agent with a "common currency" in terms of which the expected relative worth of pursuing or avoiding different stimuli may be compared and which can serve as a general reinforcement signal for learning (e.g. Rolls, 1999); (3) affect provides for a more complex internal state in which a system is freed from the lowest levels of reactivity, since affect serves to modulate the control of action-selection and in some systems of deliberative planning so that behavior can be contextualized (cf. Sloman & Croucher 1991, Wright *et al.* 1996, Blumberg 1996; Nehaniv *et al.* 1999).

Agents, e.g. with architectures based on cognitive appraisal theories, can reason about human emotions in social contexts and human relationships (Elliott 1992). Devices for detecting the emotional state of human users of software can use this information in modulating the behavior of the software in responding to a human user in a useful way (Picard, 1997). Such interaction with affective agents should be considered from a viewpoint of Cognitive Technology. A user might not wish a program to gather information about his affective states for reasons of privacy, especially if he does not know how and by whom this information might later be used. The affective expression of software agents can also enhance entertainment. But if this is done poorly it can be disturbing and unpleasant to use software agents or network interfaces that make use of it. On the other hand, if it is done well, it will be next to invisible, because it will take advantage of our human nature of exploiting affective signals for communication and understanding, acquired over the course of evolutionary history (cf. Byrne & Whiten 1988, Nehaniv 1999b).

We see a case of reduced channel capacity in the communication via the low affective bandwidth of e-mail. E-mail required the evolution of 'smileys' such as e.g. ^_^ and **:)** and **: (** to claim back some way to convey minimal affective coloring in a message. Temporal delay or rate of interaction in e-mail exchange can convey some affective sense, at least of whether the interaction partner is interested in the exchange (or even present); but this information is often also subject to perturbation by internet transfer protocol delays and other noise.   With low affective inflection and marking, e-mail acts like a zen mask onto which a reader can project onto the writer either a kindness and friendly calm, or unreasoning rage, or a mean spirit of criticism and nastiness (where only lighted-hearted humor may have motivated the writer). The latter perception commonly precipitates newsgroup flame-wars, etc. See also Janney (1996) on e-mail and intimacy.

Video and voice link-ups over the internet provide much more affective information, and users may choose whether or not to transmit a video stream in addition to voice, giving them control over some aspects of the affective bandwidth. Whether a participant allows himself to be seen, heard, or read, conveys additional information to the recipient if she knows that the sender has a choice.

Affective expression by avatars of real human users can, if carefully designed, enhance their interaction with each other via networked media. But there are dangers and opportunities here too: One can imagine that affective information among inter-actors might even be perceptually amplified, e.g. nervousness might be conveyed as a change of background in a virtual environment to say a yellow color and be accompanied by a buzzing sound whose loudness could vary with the intensity of the nervousness. A regular banging could be a signal of the another interaction partner's heartbeat as it speeds up when he raises some particularly important issue in a negotiation. Satisfaction might appear as a bright blue haze around a participant; boredom might appear as a greyish haze. Affective coloring of avatars and synthetic actors could be then literally seen and heard. It could be represented in ways familiar or unfamiliar to normal human interaction.

Detecting such affective state and communicating it (or miscommunicating it) offers possibilities for augmentation of entertainment or interaction, but in a context such as a business meeting could lead to very strange scenarios — all the more so if only one participant could augment his own perception of the others' unconscious affective signals, or could manipulate the system to falsely convey misleading affective signals concerning his own state. Cynically speaking, such applications to marketing – exploiting a customer's affective signals and conveying only selected ones that encourage buying – are to be expected. At present, with software that neither recognizes our affectively grounded natures nor expresses itself well with human-like affective signals, our interaction with non-affective agents and software may be leading to calluses that damage normal human interaction.

Some researchers have even argued that dealing with current computer technology is similar to dealing with a psychotic interaction partner, and could affect us in similar ways (Janney 1997).

STORY-AWARENESS AND STORY-TELLING: THE COGNITIVE TECHNOLOGY OF NARRATIVE ARTIFACTS

We mentioned above that affect is a way of transcending low level reactivity in the control of artificial agents. Situatedness in time, and the wide scope of the temporal horizon in human beings, imply that we exist not only in the Now, and do not merely respond only to the present environment and the others present using only emotionally modulated-behaviors. It seems that unlike other animals, such as squids, insects, chickens, and probably cats, dogs, and wombats, humans spend a great deal of time thinking about the past and future, about plans and goals that extend beyond the moment, and even beyond the present day. Whether other animals such as chimpanzees, bonobos, and dolphins might also be able to do so is unknown.

Widening of the temporal horizon releases humans (sometimes pathologically) from the concerns of the moment. Some of our tools are meant to support this, e.g. calendars, schedulers, alarm clocks, etc. We make use of past experiences, and can communicate them and learn from the experiences of others without actually undergoing them ourselves. A certain human tool supporting this is language. We can also learn by observing the successes, failures, and methods of others. We also have a rich enough internal state to facilitate remembering, not only our own experiences, but in constructing an understanding of others and predicting their likely behavior based on what we know about their histories, relating them to our own. Human beings are thus naturally aware of stories and are natural story-tellers, and their intelligence is in large part a *narrative intelligence*, meaning that we understand ourselves and other agents in our world through complex constructions that are extensive over larger portions of time than just the immediate past and near future. Further aspects of narrative intelligence and temporal grounding are identified by Schank & Abelson (1977, 1995), Schank (1990), Read & Miller (1995), Dautenhahn (1996, 1997), Dautenhahn & Nehaniv (1998), Nehaniv & Dautenhahn (1998b), Nehaniv *et al.* (1999).

Humans tend to project a narrative intelligence onto artifacts that may completely lack it. For example, the classical ELIZA chatterbot (Weizenbaum 1966) responds to interaction by simple syntactic manipulations of user input based on keyword matches, but builds up absolutely no internal state information in response to the interaction. ELIZA does not remember anything beyond the current input, and is completely uninfluenced by previous history of the interaction. Yet many users feel that the program understands them and their personal problems. Human beings expect awareness of the history of interaction and that their partners construct a picture of them in the course of interaction, although nearly all of existing software does not provide anything like this.

Despite the vast temporal horizon that seems to be a defining part of human *being*, almost no consideration of this important issue has touched the human-computer interaction community. In dealing with interactive systems which cannot support temporal grounding, humans are spending an increasing amount of time immersed with reactive-level artifacts, and with agents who neither remember us (beyond a few preferences) from one day to the next, nor have any internal representation of ourselves as beings who have a story and who relate to other similar beings around us. If the agents we deal with most of the time in our jobs and homes have such a limited temporal scope and we grow cognitive calluses through long hours spent with them, might we be likely to generalize our behavior toward these artifacts and our understanding of them as agents to the people around us?

As is similar to the case of affect, which has only a *localized* influence (broadest in temporal scope for moods), narrative considerations for computing and technology involve at least three broad aspects: (1*) recognizing narrative structure*, (2) *expressing narrative structure – story-telling*; (3) *having narrative structure, i.e. having an autobiography, being temporally grounded*. Each of these three aspects are properties of human temporal embeddedness that contribute to the phenomenology of our existence and to our ability to relate to each other as historically grounded beings. They contribute in freeing us from reactivity, and support arbitrarily large *nonlocality* of structure in the temporal influence of events, going well beyond the scope of affect in importance to us as social agents who develop and change over the course of our lifetimes. By building technology that is capable of (1), (2), and (3) in various realms, and of humanely respecting the fact that we have these properties, designers of software systems and networked media can help us augment our human natures with appropriate technology rather than stifle them.

NARRATIVE FOR ARTIFACTS

The author and Kerstin Dautenhahn have been developing algebraic tools for a mathematically rigorous framework expressing histories and, more generally, subjective views on the temporal experiences of (possibly non-human) agents (Nehaniv 1997b, Nehaniv & Dautenhahn 1998a, Nehaniv & Dautenhahn 1998b). Such a framework is intended to provide formal support to realizing in robotics and software the notion of dynamic *autobiographic agents* that actively construct and reconstruct their memories and autobiographies as they interact with the world (Dautenhahn 1996). By opening up the possibility of using their own and each other's stories (*histories* and *biographies*), this work provides for narrative grounding to help release such agents from mere reactivity and provides an approach to post-reactive robotics and agents (Nehaniv *et al.* 1999).

There are many possibilities such an approach to story-awareness and story-telling affords in relation to cognitive impacts on humans interacting with technological artifacts. Artifacts, software, and agents could keep track of their relationship with individual users. They could learn about the user throughout the interaction history and dynamically adapt their behavior in light of this history, and could also learn new behaviors from observing the user or other artificial agents. They could remember their own actions and autobiographies. Humans interacting with each other through the presently affectively and narratively limited media such as avatars in MUDs (**m**ulti-**u**ser **d**omain/**d**ungeons) or VR (**v**irtual **r**eality) systems, and in larger societies of networked minds, could be provided with support, through augmentation of these media, of their emotional and narrative intelligence. Agents with narrative intelligence would try to build up a user-profile including some details of a biography, to better respond to user needs and support human narrative intelligence. This could help make such artificial environments more humane by respecting and responding to aspects of human nature which at present are nearly completely ignored.

Furthermore, the narrative and affective facilitation of agent interaction raises interesting possibilities for the realization of affective and narrative intelligence in non-human agents as they experience their own worlds being embedded and situated temporally with each other and with the humans with whom they interact.

THE FUTURE: ARTIFACTS SUPPORTING HUMAN NARRATIVE AND AFFECTIVE INTELLIGENCE

Some emerging alternatives (and transcendences) of such problems include the interactive construction of keepsake objects (Glos & Cassell 1997) for saving one's memories; imbuing agents with a modicum of narrative intelligence as a guide to the narrative structure of behavior (Sengers 1998); actively keeping track of what has been communicated to the human (Sengers 1999) in light of Bruner's ideas on narrative construction of reality (Bruner 1991); related work on educational environments taking in pedagogical and believability constraints when sequencing agent behaviors (Lester & Stone 1997); ideologically biasing documentaries in response to feedback with rhetorical goals (Domike *et al.*); affective coloring of a narrative script (Elliott *et al.* 1998) using computationally implemented cognitive appraisal theories of emotion (Ortony *et al.* 1988, Elliott 1992); and software assistance for children's construction of story-telling agents (Umaschi & Cassell 1997); affective wearables and emotionally aware / expressive agents (Picard 1997); and the study of emergently emotional agents to which observers attribute emotional and intentional states (Pfeifer 1994).

Another important direction in the historical grounding of interface technology is the implementation of *instructible agents*, that learn from the history of user- or group-interaction with a software system and can suggest courses of action based on this history (e.g. Lieberman *et al.* 1999), or that can learn by example and are later able to act as personal assistants for a human user (e.g. Cypher 1993, Lieberman & Maulsby 1996).

Interest in narrative, historical and temporal grounding of agents, as well as related issues in story-telling and applications in agents, interactive drama, and entertainment, and story-generating technology is beginning to grow (e.g. the 1999 AAAI Fall Symposium on Narrative Intelligence), but should be developed with regard to the Cognitive Technology issues discussed here: in particular, these include the phenomena of cognitive callusing, techniques for generation of a system's or agent's own autobiography, recognition of the narrative grounding of human agents and human relationships, the narrative structure of human memory, biographic reconstruction of other agents' stories, respecting the historical nature of individuals, support for human narrative intelligence, and expression of narrative grounding through stories and transmitted histories, as well as affect in temporal grounding and learning.

A point of optimism is that, although much of existing software and networking technology fails to be historically grounded, to some extent the natural tendency of humans to prefer affectively and temporally grounded forms of interaction has and will continue to lead the development of support for these characteristics of human users. Moreover, with the conscious identification of the issues of affective and narrative intelligence surveyed here, it should become possible for the software design community and other developers of new media to systematically address these issues in the early stages of the emergence of many new systems and technologies.

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