

The ChatterBox: Using Text Manipulation in an Entertaining Information Display

Johan Redström, Peter Ljungstrand and Patricija Jaksetic
PLAY: Applied research on art and technology
Interactive Institute

Abstract

The ChatterBox is an attempt to make use of the electronic “buzz” that exists in a modern workplace: the endless stream of emails, web pages, and electronic documents which fills the local ether(-net). The ChatterBox “listens” to this noise, transforms and recombines the texts in various ways, and presents the results in a public place. The goal is to provide a subtle reflection of the local activities and provide inspiration for new, unexpected combinations and thoughts. With the ChatterBox, we have tried to create something in between a traditional application and a piece of art: an entertaining and inspiring resource in the workplace. This poses several interesting questions concerning human-computer interaction design, e.g., information and display design. In this paper, we present the ChatterBox, its current implementation and experiences of its use.

Keywords: Art, entertainment, awareness, ambient displays, text transformation, calm technology.

1 Introduction

Within computing science and interaction design, there is a long tradition of using text processing for various purposes, such as creating interfaces based on natural language, and work on how documents can be processed and transformed for better information retrieval (cf. [9, 20]). The ambition of this work has not been to use text processing to develop more efficient information processing and interaction. Instead, we wanted to use text processing to explore technology designed to be more like the works of art, posters and pictures that furnish our homes and offices, than a “traditional” application.

Inspired by the work of writers and artists, we have explored how the texts produced at an office can be transformed in various ways to be used in a public information display aimed to entertain and inspire. Dadaists and Surrealists, such as Tristan Tzara, Brion Gysin and William S. Burroughs [23], used more or less random creation of texts to create works of art. For instance, Tzara created a poem by pulling words out of a hat, and in the 1950's, Gysin cut and rearranged sections of articles in a newspaper at random to create a novel piece. This technique was called “cut-up” and Gysin later even used a computer as an aid in the process. Burroughs used the cut-up technique in several works, e.g., “Naked Lunch”.



Figure 1: An installation of the ChatterBox in a corridor using projection on several layers of fabric. The first layer is very thin and moves as people passes by.

Approximately at the same time as Gysin was working with cut-ups, other writers and artists were experimenting with using words and texts as graphical elements in the composition of a work of art [12]. Transformations of texts were employed to various degrees. If the texts still could be considered as meaningful texts, although presented in a visually striking way, they were called “pattern poetry”. If the visual aspects of the poem were so emphasized that it was no longer possible to read the text at all, it was called “concrete poetry”. More recent contributions in these directions are, for instance, the “Digital Landfill” and the “Shredder” at Potatoland [17] which are both based on the processing of material available on the WWW.

Artists have long been using computers and information technology as media for expression (cf. [11, 21]). Making ideas go the other way, i.e., adopting ideas and concepts from art and design in interaction design, has often taken a bit longer. However, there are examples of such cross-fertilization: Arnowitz et al. employed concepts developed in art to improve interface usability [1]; Kirby et al. used techniques developed in painting to create multi-layered visualisations; and Gaver and Dunne used public electronic

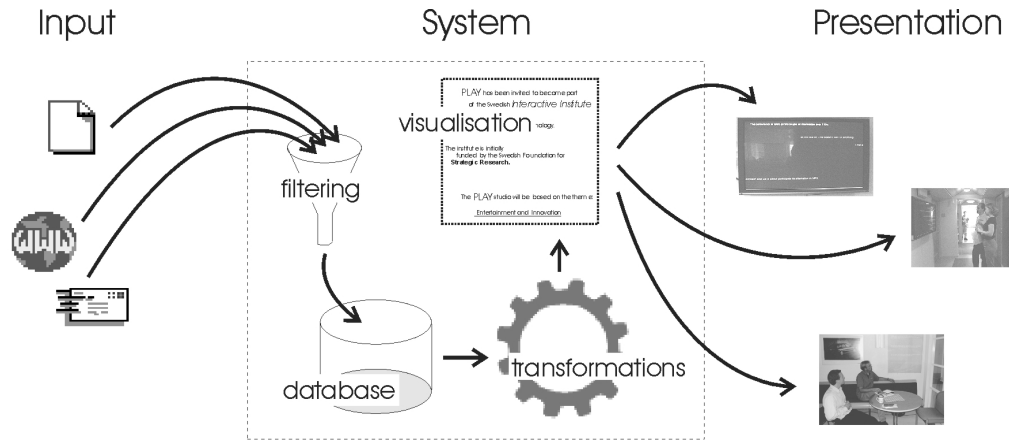


Figure 2: Figure showing the architecture of the ChatterBox system.

displays to enable people to express their opinions and other information [8], to name a few. We believe that, as computers continuously enters new situations of use and interaction designers have to face new constraints, ideas and concepts from the world of art and design will be increasingly important. The ChatterBox is an attempt to explore work in this direction and to expose issues relevant to human computer interaction.

2 The ChatterBox

While waiting for the coffee machine in the lunchroom to finish, you take a quick glance at the ChatterBox display “We believe the SONY PlayStation to be an important part of HCI research”. You recognise the structure of the sentence - it looks like something you were working on last week - but it has obviously been transformed since what you were writing was not at all about the PlayStation. Nevertheless, it makes you think about the usefulness of game consoles in HCI research. You point out the sentence on the display to a colleague who just entered the room. After a short discussion, you agree that using a number of game consoles might be an interesting alternative to using workstations for a project, since they are much less complex to a novice end-user and more easily moved between different locations.

The scenario above describes what an encounter with the ChatterBox can be like. The ChatterBox generates and presents texts based on written material produced by a group of people working at an office. Texts are created by recombining material, e.g., substituting words and parts of sentences, while trying to keep the resulting text readable and grammatically correct. The ChatterBox is designed to be more similar to a poster, a picture or a pot-flower, than a traditional application, as we wanted it to be seen as a part of the environment in a sense similar to

we use decorative objects to furnish our homes, offices, etc.

The ChatterBox relies on being fed with material that can be used to generate texts. This is primarily done by sending emails to it, e.g., by making it subscribe to mailing-lists such as the mails sent to a group of collaborators or a project. The ChatterBox is designed to reflect long-term activities, such as interests or projects that are represented in the material that users submit to it. By continuously adding new material to the ChatterBox, its presentation will reflect changes in the activities taking place (in as much as these changes are evident in the material submitted to it). The aim is to provide inspiring and entertaining variations of mostly familiar texts that can act as inspiration to think about the material in novel ways, and act as an incitement for occasional communication by serving as an information resource in public places.

The need for users to explicitly interact with the system has been eliminated as much as possible. This is similar to the aim with *calm technology* [25]. However, while calm technology often has been about creating something that remains in the background and only calls for attention when certain events or changes take place, the ChatterBox is continuously changing presenting new material, even though at a relatively slow pace. In order not to disturb users despite being dynamic, its location is crucial. Besides the purpose of making it a public resource, this is the primary reason for locating it in public spaces where people move about and, presumably, not tend to sit and work for longer periods. This stands in contrast to, for instance, the ambientROOM where the goal was to integrate a number of ambient displays in a personal office [14].

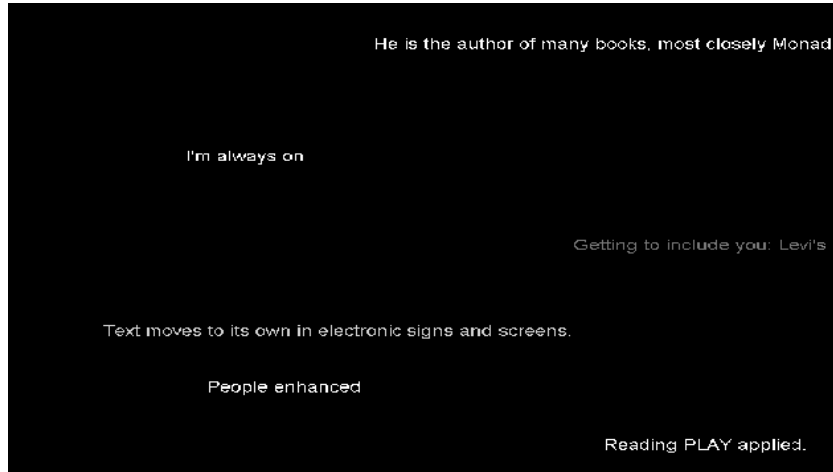


Figure 3: Screen shot showing the “floater” visualisation.

2.1 System

An early prototype of the ChatterBox was presented in [18]. This prototype generated random “phrases” consisting of 3-5 random non-frequent words occurring in a collection of texts. Experiments indicated that while the generated “phrases” certainly were novel combinations of words, they were rather difficult to make any sense of. Therefore, a second prototype that makes use of more advanced text-processing saving more of the original context of material (thus keeping more of the original semantics), was developed.

The current implementation of the ChatterBox accepts text based input, such as documents, emails and www pages, from users via a dedicated email account. The architecture of the system is illustrated in Fig. 2. When a piece of text is submitted, it is first fed into a text filter component for preprocessing, to remove parts that are

not proper sentences, e.g. email headers, HTML tags, and signatures. The extracted sentences are passed on to a Link Grammar parser [22]. The basic idea with this parser is that words are connected to each other via grammatical links, e.g., if a noun is a subject to a certain verb, there exists a link, or a grammatical relation, between them. The parser takes one sentence at a time and identifies the syntactical function of the words and their grammatical interrelationships. The sentences are stored in a database along with the grammatical information and a timestamp.

A continuously running text synthesizer is generating a new sentence about every 10 seconds. It picks a sentence from the database and randomly selects a relation, or grammatical link, in it. Then, another sentence in the database, which contains the same relation, is retrieved. Both, or just one of the words in the selected relation are

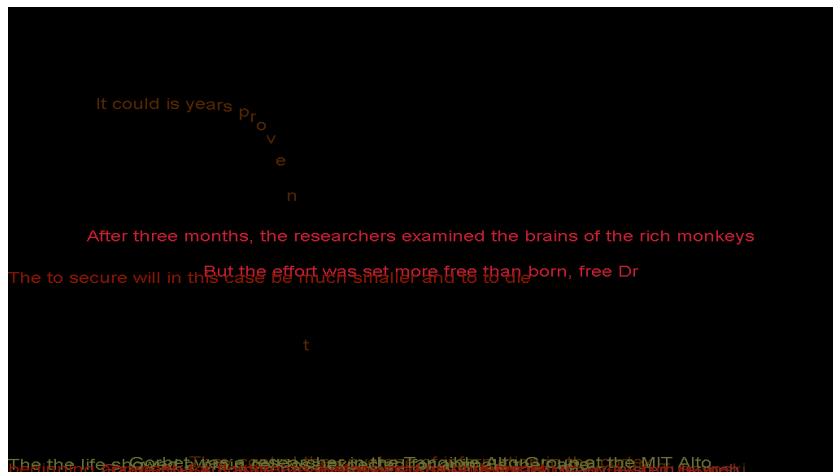


Figure 4: Screen shot showing the “falling leaves” visualisation.

then swapped between the two sentences. This substitution is repeated up to four times before one or both of the sentences are passed on to the visualisation module. Unlike the use of totally random re-combinations used in the original “cut-up” technique, this enables the system to keep some of the original context of the material, and to increase readability by having almost grammatically correct sentences. However, since the Link Grammar parser is not always accurate, the generated sentences sometimes end up being syntactically and semantically ill-formed.

Each sentence in the database has a certain probability to be selected by the text synthesizer. The probability slowly decays as a function of time, meaning that sentences that were recently submitted have a higher probability to be selected than older ones. The probability within a certain time period, such as a few days, does not decay much. Using a scheme like this allows the ChatterBox to keep up with ongoing changes, while still using old material to keep in contact with its history.

Finally, the generated sentences are passed on to a visualisation module. Several different visualisations have been used. The first visualisation used continuously scrolling text, similar to how text is displayed at the end of a movie. Another visualisation used sentences printed in different colours appearing as floating around on a large display. Some sentences would fade in or out, some would move slowly across the screen, and sometimes different sentences would overlap (Fig. 3). Still another visualisation was based on a “falling leaves” metaphor in which the sentences were printed in different colours (typically in the colours leaves get in the fall) and appeared as slowly “falling” from the top of the screen (Fig. 4). Some sentences would fall faster than others, and some would have its letters fall off individually. The “leaves” would then whirl around at the bottom of the screen for a while before fading away. Generally, all visualisations have a relatively slow appearance in order not to attract too much attention. Several different display techniques have been used, including large plasma screens and projections on a variety of surfaces (cf. Fig. 1 and Fig. 5).

2.2 “Users”

The notion of “users” becomes somewhat problematic with the ChatterBox since it, being designed to be a part of the design of an environment, is hardly “used” at all in the sense more traditional applications are used. Considering what role people have in relation to the Chatterbox, it is possible to make a distinction between submitters and spectators. Submitters are the ones who contribute to the ChatterBox by sending in material. What material to

send, is entirely up to the submitter. Spectators, on the other hand, are the ones watching the ChatterBox displays. Thus, both people working where the ChatterBox is located as well as occasional visitors can act as spectators. While most submitters also will take on the role as spectators, visitors are likely to be spectators only.

Being both a submitter and a spectator might be different from being an occasional spectator. The main reason for this assumption, is that since the texts are transformations of submitted material, knowledge about the original material can play an important role in how to make sense of the generated texts and to what extent this can be done at all. Someone who is familiar with the original material or domain will in some cases be able to see what sources have been combined or transformed (in case the transformation is not too extensive). A visitor, on the other hand, will perhaps only be able to recognise in what context or interest domain the material has its origin, for instance if it comes from an information technology research facility, a marketing company or a college school class. Still, its presentation can provide useful or entertaining cues to the local office culture. When we use the term “user” below, we refer to the people taking on both roles as submitters and spectators, in case not otherwise noted.

2.3 Privacy

The difference between an awareness system and a surveillance system is often a matter of degrees. Important aspects are, for instance, the degree of user control, the nature of the information displayed and how symmetrical the system is, i.e., if all users give and obtain the same amount and kind of information or if someone has greater access than others (cf. [13]). To the ChatterBox, users are anonymous to some extent: who submitted what and when, is not very interesting to know since everything the ChatterBox generates will be combinations of material from a number of different sources.

One way to deal with privacy issues is to rely on abstractions in some form to protect the privacy of the users, the abstract representation as such making the difference between a surveillance system and an awareness support system [6, 10, 16]. In the case of the ChatterBox, this might be a more or less efficient action, depending on the extent of the transformations, sometimes making it necessary to use other methods as well.

Although automatic collection of text material would have eliminated the need for explicit actions on behalf of the users, reducing worries about unwanted submissions is usually more important. In order to prevent private or otherwise delicate information from turning up on the display in the lunchroom, the control over the submission is put in the hands of the users in terms of sending

texts to a specific email address. Still, automatic collection of material might be a possibility in some cases, especially if transformations are extensive or if the source material already is official, e.g., web pages, reports, and other public documents.

2.3.1 Groups

There are also privacy issues associated with groups of users. For instance, there might be information that is happily shared within a group, that they do not want others to see, such as corporate secrets or work in progress. To address this, one could either limit the access to the displays in question, shut them down during external visits or only use the ChatterBox with official material. All these variants have their drawbacks. The last one perhaps most notably so, since it will decrease the usefulness of the ChatterBox the most, in particular to the people who potentially benefit the most. However, given the way the ChatterBox works, it is probably difficult to infer detailed information about what is going on unless the original material and its context is partly known. This, in combination with the fragmentary nature of the ChatterBox texts, reduces the risks of showing it to external visitors, should the texts be based on any non-official material.

Another problem is how to deal with offensive material. In the present prototype, problems with how to, for instance, filter out offensive submissions to the ChatterBox have not been considered. However, a user group might have to take actions against submissions of offensive nature, or restricting who are allowed to contribute. It is more difficult to do something about the ChatterBox own text-generation. As the system is not to be considered as an intentional agent, any such offensive material should be seen as a coincidence.

3 Awareness, Ambience and Art

The ChatterBox can be seen as related to work on novel information display strategies such as ambient displays, since there is an intention not only to create random texts, but to create texts about something related to the environment the Chatterbox is located in. This also makes it related to work on how to support awareness about different aspects of a workplace. Below, we discuss some of the ChatterBox properties in relation to these lines of work.

3.1 Awareness

A variety of applications have been developed to support communication within physically distributed groups of people working together, by providing both a channel for communication and a context that enables users to determine when and how to engage in communication (cf. [4]). Displaying information about presence when sup-

porting communication among physically collocated people will often not be of great importance, unless there are for example obstacles in the environment that hinder people from obtaining that information. Instead, information about who is doing what, what is happening and where, is of greater interest [6, 7]. A number of applications have been developed to support awareness in virtual environments as well, for instance applications that visualise the development of communities on the web, or how the content of on-line discussion groups change over time [5, 6].

Compared to awareness support systems, the ChatterBox presentation is based on information aggregated over longer periods of time. Further, since the original material is transformed in various ways, it will never be an accurate source of information about what has actually happened. However, it might support occasional or “informal” [3, 27] communication by providing incitements for various discussions (as were illustrated in the scenario described earlier). By placing the ChatterBox at places such as in the lunchroom or in the corridors of an office, we aim to make it readily available for people moving around. “Serendipitous” or “informal” communication is often part of the reason for people's local mobility, or “local area roaming”, i.e., when people move around in order to get a sense of what is going on [2, 3, 27].

Common to several applications supporting awareness is that they can be seen as a way of enabling users to see a “trace” of what has happened. This trace is often visualised as some sort of history, with chronologically ordered events. In the ChatterBox, events also leave a trace in the sense that information is aggregated over time and only slowly decays. While the actual phrases and sentences that are shown on the display change relatively quickly (a new sentence every 20 seconds or so), the underlying text data evolves and changes much more slowly. Compared to the transient nature of the information presented in many awareness systems, the ChatterBox has a rather slow appearance, especially in terms of how the content changes over time.

3.2 Abstract and Ambient Information Displays

An important aspect of how the information is represented to the user is what level of abstraction is being used to present it. In the case of information displays, abstraction often means a transformation of the original signal or information that reduces the level of detail in the presented information. The reasons for using abstract representations might be to create a presentation that is more easily perceived, that protects the privacy of users by not presenting too much information about them (e.g.,

“availability” instead of activity and location), or in order to create an aesthetically pleasing or entertaining way of showing the information.

Creating displays that are easily perceived and more “calm”, at least compared to traditional GUIs, is the course taken by work on ambient media and ambient displays [14, 28 cf. also 16, 25]. Ambient displays make use of a re-mapping from the media of the original information to another, and presumably, less obtrusive media. In some cases the re-mapping itself, for instance from the number of hits on a web site to the intensity of a rain-like sound [14], constitutes such an abstraction.

A problem with abstraction through re-mapping is how to create an intuitive connection between the original information and its abstract representation. One of the seemingly more successful examples is the Dangling String [25]. In this design, the connection is rather strong: the dangling of an Ethernet cable hanging from the roof reflects the traffic frequency on the adjacent network cable. In many cases, the re-mapping seems less self-evident and thus, at least before some learning has taken place, associated with greater cognitive load (cf. [14, 16, 28]).

With the ChatterBox, we have taken a different path towards more abstract representations of the original information. Perhaps “abstraction” is a misleading description of what the ChatterBox does, but its transformation of texts serves many of the same purposes: it creates something that reflects but not necessarily presents the original information and it leaves room for protecting the privacy of the source of the presented information. Re-mapping the content of the texts submitted to the ChatterBox to, for instance, an ambient display like the Waterlamp [28] would have been a radical abstraction that would not likely have been of much use. Instead, we chose to stay with using texts, as these have been claimed to have a calm nature due to their ubiquity [24]. Another interesting property is that while the texts generated by the ChatterBox might be a bit strange and difficult to trace back to original material, this is an intended part of its design, i.e. to provide a novel view of the material.

There is at least one important difference between the strategy explored with the ChatterBox and that of ambient displays: while abstraction through re-mapping to an ambient display focuses on how to provide information about the main character of some set of information, for instance to what extent a continuous flow of information changes (e.g., [28]), the ChatterBox is all about manipulating the details of some information; the ChatterBox does not provide an overview. Further, it should not be



Figure 5: Picture showing the ChatterBox projecting the text transformations on the wall at one of the test locations.

considered as a reliable source of information, but rather as a source of inspiring, entertainingly mind-boggling “one-liners” that, nevertheless, have a strong connection to the place where it is being displayed.

3.3 Art

Art and design can influence technology design in many ways (cf. [1, 8, 11, 15]). While the ChatterBox was influenced by the work of artists as presented in the introduction, the purpose was not to create an artistic installation *per se*, but to explore issues in human computer interaction from a slightly different perspective [19]. Given these constraints, the ChatterBox is related to work halfway between applications and art such as Gaver and Dunne’s Projected Realities [8], The Interactive Poetic Garden [26], and the Dangling String [25].

4 Experiences

The prototype was tested at two different locations, for approximately one week each: at the IT-department of a large manufacturing company and at an IT-consultant company. The ChatterBox display was placed in the local lunchroom and could be seen by 30-50 people at each site, most of them working at that location. Both places see a lot of both local mobility and occasional visitors. In both cases, a projector was used to display the ChatterBox on a wall.

The ChatterBox was presented at the time of the installation, but since people are rather mobile, many potential “users” were not present at the time of the introduction. Thus, a complementary poster describing its purpose and how to submit material to it, was available next to the ChatterBox display. Since the parser we are using only accepts English texts, the users were informed that they should only submit text in English.

After a week, semi-structured interviews with eleven users were performed. As a complement, a questionnaire was sent out via email. We received 19 answers to the questionnaire. The purpose with these experiments was to find out more about the ChatterBox and to gain knowledge for future development. A common, and anticipated, comment from the users at the two offices was that the tests were too short: they did not have the time to use it long enough to evaluate it properly.

As a comparison, the ChatterBox was also tested in a setting more oriented towards entertainment and leisure, i.e., at two reception parties. Due to the rather brief nature of the experiments, the following findings should be seen as indicators that have to be followed up in future evaluations.

4.1 Results

There were numerous comments on the benefits of the ChatterBox. For instance: "It's like a scribble board that makes you think in new ways"; "It's a cool thing that gave rise to discussions"; "The poster said the ChatterBox should be seen as similar to a piece of art or a pot-plant. I think that describes it well. I see it as an installation. And as such, a pretty fun one."; "Fun idea to share thoughts, questions, ideas etc.". The ChatterBox ability to act as an incitement for discussions also received many positive comments.

Especially at the two offices, many users considered the transformation as problematic: "It is not very serious"; "What's the real use of this?"; "How do you know what is true and what is not?" Several users complained about the meaninglessness of technology that could not be trusted. One user expressed that the ChatterBox would add to the information overload since she felt she would have one more thing to attend to.

Some of these more sceptical users also seemed to think that the text transformations would be more useful to people working in more "creative" domains, for instance: "This random transformation of the messages seems to me more suitable to for instance an advertising agency. In that case, one could imagine to feed the system with different words and hopefully get something that can support new directions for slogans etc."

Several users expressed their interest in having public displays providing information that they did not want, or needed, on their PC. Other users commented that they wanted to have the ChatterBox running on their personal computers, either in the background or as a screen saver. Users also felt that the visual presentation of the ChatterBox could be improved in order to make it more appealing.

While there were a number of remarks about privacy concerns, there were in fact fewer than we had anticipated. One user asked about assuring the security of the system, e.g., who would control what would be submitted, but several users expressed an interest in even using automatic collection of information, for instance from the local intranet. Many users thought that using already official material would be an interesting option.

Generally, it seems that the entertaining or inspiring properties of the ChatterBox were more successful than its support for awareness in the workplace. It also seemed that the introduction of the ChatterBox was crucial to how people perceived it. This is especially evident in the general difference between how people at the offices and at the parties perceived it. Whereas people at the offices commented about uselessness due to the lack of seriousness and accuracy, people at the parties found the very same properties entertaining. This is probably due to the fact that people do not seem to be as focused on usefulness and efficiency, properties which the ChatterBox at large lacks, at a party, as when at work. Investigating the trade-off between creating something entertaining and inspiring while still keeping its relevance and strong connection to a certain context, e.g., the work conducted at an office, is important in order to further develop strategies for how to design this type of applications.

5 Concluding Remarks

We have presented the ChatterBox as an application somewhere between a tool and a piece of art. It has not been designed to solve a particular problem, but rather to be an entertaining and inspiring resource in public spaces. We have tried to show that these aims are associated with a number of problems relevant to HCI research by discussing the properties of the ChatterBox and relating it to other work. We have also presented and discussed experiences of its use.

Future work will include more long-term studies of the ChatterBox. By comparing how it can be used, how it is perceived in different workplaces or settings and how to balance the trade-offs between creating entertaining and inspiring technology while still keeping its relevance and connection to the activities taking place where it is located, we hope to gain more knowledge about the ChatterBox and similar applications. We believe explorations in these domains of usercentered technology will play an important part in the development of the next generation of human computer interfaces.

6 Acknowledgments

The ChatterBox has its roots in a system envisioned by Lars Erik Holmquist, that would create random texts

based on material collected from various web-pages, by for instance associating sentences that contain similar words.

References

- [1] Arnowitz, J. S., Willems, E., Faber, L. & Priester, R. Mahler, Mondriaan, and Bauhaus: using artistic ideas to improve application usability. In: *Proceedings of DIS (Designing Interactive Systems) '97*, pp. 13-21. ACM Press, 1997.
- [2] Bellotti, V. and Bly, S. Walking Away from the Desktop Computer: Distributed Collaboration and Mobility in a Product Design Team. In: *Proceedings of CSCW '96*, pp. 209-218. ACM Press, 1996.
- [3] Bergqvist, J., Dahlberg, P., Ljungberg, F. and Kristoffersen, S. Moving Out of the Meeting Room; Exploring support for mobile meetings. In: *Proceedings of ECSCW '99*, pp. 81-98. Kluwer Academic Publishers, 1999.
- [4] Buxton, B. Integrating the Periphery and Context: In: *Proceedings of Graphics Interface Conference '95*. ACM Press, 1995.
- [5] Donath, J. S. VisualWho: Animating the affinities and activities of an electronic community. In: *Electronic Proceedings of ACM Multimedia '95*. ACM Press, 1995.
- [6] Erickson, T., Smith, D. N., Kellogg, W. A., Laff, M., Richards, J. T. and Bradner, E. Socially Translucent Systems: Social Proxies, Persistent Conversation and the Design of "Babble". In: *Proceedings of CHI '99*, pp. 72-79. ACM Press, 1999.
- [7] Fitzpatrick, G., Mansfield, T., Kaplan, S., Arnold, D., Phelps, T. and Segall, B. Augmenting the Workaday World with Elvin. In: *Proceedings of ECSCW '99*, pp. 431-450. Kluwer Academic Publishers, 1999.
- [8] Gaver, W. & Dunne, A. Projected Realities; Conceptual Design for Cultural Effect. In: *Proceedings of CHI'99*, pp. 600-607. ACM Press, 1999.
- [9] Gazdar, G. and Mellish, C. *Natural Language Processing in PROLOG*. Addison-Wesley, 1989.
- [10] Gutwin, C. and Greenberg, S. Design for individuals, design for groups: tradeoffs between power and workspace awareness. In: *Proceedings of CSCW '98*, pp. 207-216. ACM Press, 1998.
- [11] Harris, C. *Art and Innovation - The Xerox Artist-In-Residence Program*. MIT Press, 1999.
- [12] Higgins, D. *Pattern Poetry: Guide to an Unknown Literature*. New York, State University of New York Press, 1987.
- [13] Hudson, S. E. and Smith, I. Techniques for Addressing Fundamental Privacy and Disruption Tradeoffs in Awareness Support Systems. In: *Proceedings of CSCW '96*, pp. 248-257. ACM Press, 1996.
- [14] Ishii, H. and Ullmer, B. Tangible Bits: Towards Seamless Interfaces between People, Bits and Atoms. In: *Proceedings of CHI '97*, pp. 234-241. ACM Press, 1997.
- [15] Kirby, R. M., Marmanis, H. & Laidlaw, D. H. Visualizing Multivalued Data from 2D Incompressible Flows Using Concepts from Painting. In: *Proceedings of IEEE Information Visualization 1999*. IEEE, 1999.
- [16] Pedersen, E. R. and Sokoler, T. AROMA: abstract representation of presence supporting mutual awareness. In: *Proceedings of CHI '97*, pp. 51-58. ACM Press, 1997.
- [17] *Potatoland*: www.potatoland.org
- [18] Redström, J., Jaksetic, P. and Ljungstrand, P. The ChatterBox. In: *Proceedings of Handheld and Ubiquitous Computing (HUC '99)*, Lecture Notes in Computer Science No. 1707, pp. 259-261, poster presentation. Springer-Verlag, 1999.
- [19] Redström, J., Skog, T. and Hallnäs, L. Informative Art: Using Amplified Artworks as Information Displays. To appear in: *Proceedings of DARE 2000 (Designing Augmented Reality Environments)*, ACM Press, 2000.
- [20] Salton, G. *Automatic Text Processing*. Addison-Wesley, 1988.
- [21] Schwegge, M. & Blau, B. (eds). *Electronic Art and Animation Catalog, SIGGRAPH 99*. ACM Press, 1999.
- [22] Sleator, D. and Temperly, D. Parsing English with a Link Grammar. In: *Proceedings of the Third International Workshop on Parsing Technologies (IWPT'93)*, Tilburg, The Netherlands, 1993.
- [23] Vale (ed.). *RE/SEARCH #4/5: A Special Book Issue: William S. Burroughs, Brion Gysin and Throbbing Gristle*. San Francisco, RE/SEARCH, 1982.
- [24] Weiser, M. The Computer for the 21st Century. In: *Scientific American*, pp. 933-940, 1991.
- [25] Weiser, M. and Seely Brown, J. Designing Calm Technology. In: *PowerGrid Journal 1.01*. Available at: <http://www.powergrid.com/1.01/calmtech.html>. 1996.
- [26] White, T. and Small, D. An Interactive Poetic Garden. In: *Summary of CHI '98*, pp. 303-304. ACM Press, 1998.
- [27] Whittaker, S., Frohlich, D. and Daly-Jones, O. Informal Workplace Communication: What is it Like and How Might We Support it? In: *Proceedings of CHI '94*, pp. 131-137. ACM Press, 1994.
- [28] Wisneski, C., Ishii, H., Dahley, A., Gorbet, M., Brave, S., Ullmer, B. and Yarin, P. Ambient Displays: Turning Architectural Space into an Interface between People and Digital Information. In: *Proceedings of International Workshop on Cooperative Buildings (CoBuild '98)*, pp. 22-32. Springer Verlag, 1998.