Stochastic Interfaces.
Towards a Theory of Cultural Prediction
in Time-Based Interaction

June 2003

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In: Schüttpelz, E. und Epping-Jäger, C. (Eds.),
Freund, Feind und Verrat, Dumont, Cologne, 2004, pp. 198-206

Abstract

The investigation begins with the problematic nature of time-based interfaces in digital and electronic media. Relevance to music is given by assuming that prediction is like music and sound a process in time. Are cultural and time-based interactions, as patterns of movements while using software, or performative events, predictable ? To what extent could the very nature of cybernetics as prediction of stationary time-series be expanded to a theory of cultural prediction, assuming that the user input is a signal. Industry asked this question already, Microsofts slogan "Where do you want to go today ?" is a query towards the analysis of the user in real-time, the usage, trying to anticipate his and her paths of consumption. Art and media studies, in contrast, can investigate the nature of time-predictable interfaces in order to open the closure of feedback of communication since World War Two towards a decontrolled and uncertain trajectory of interaction.

'Typical magical applications include
farsensing, shapeshifting, teleportation,
prediction, and mind-reading. Not surprisingly,
technology too has some of these characteristics.
We use specialized software and hardware that is
something sometimes mediated by a helpful agent
or not-so-helpful demon), to communicate ideas,
transport objects, and predict future events.'
Kim Binsted, CSL Sony

Prediction of Motion

Since the electronisation of media and culture there has been a challenge in designing time-based or performative human/machine-interfaces. Advanced and intelligent interface technology in media culture can get 'magical'; at least cultural theorists like Erik Davis and/or computer scientists like Kim Binsted recognise and have begun to investigate. One of these 'magical' aspects of 'new' technology is the prediction of future events. This was, of course, also the aim of early cybernetics, the science of computing, control, and communication before the emergence of new media culture.

Norbert Wiener, often called the founder of cybernetics, used in World War Two mathematical methods to extrapolate trajectories of movements created by human beings. In his "The Extrapolation, Interpolation and Smoothing of Stationary Time Series with Engineering Application" Report to the National Defense and Research Committee (NDRC), written in 1942, Norbert Wiener used existing models based on statistics to predict the future position of objects in motion. The prediction of future behaviour was essential to World War Two defence strategies because with an airplane flying high and fast any shell fired against its actual position would have missed it. "Even before the war, it had become clear that the speed of the airplane had rendered obsolete all classical methods of the direction of fire, and that it was necessary to build into the control apparatus all the computations necessary."[1] New methods of estimating the future for zigzagging airplanes were needed. Norbert Wiener and his colleage Julian Bigelow built machines and explored mathematics to achieve this goal.

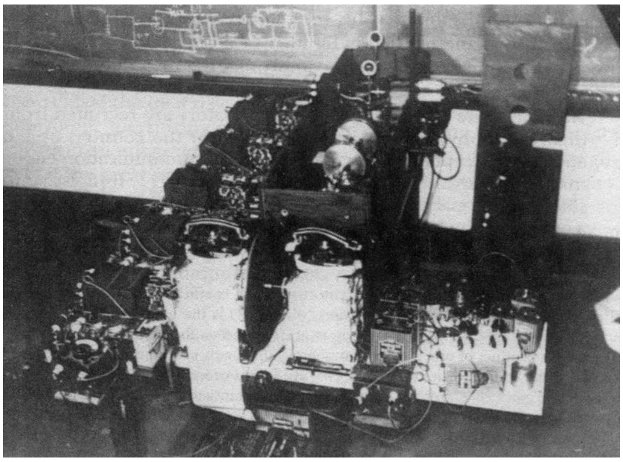

Abbildung 1: Apparatus for the Prediction of User Input, Wiener/Bigelow, 1942

The people in charge of giving Norbert Wiener the contract to investigate predictive apparatus perceived Wieners experimental system as a miracle: "It simply must be agreed that, taking into account the character of the input data, their [Wiener and Bigelows] statistical predictor accomplishes miracles. Whether this is a useful miracle or a useless miracle, W[arren] W[eaver] is not yet convinced."[2] Shooting according to the new needs in artillery had to be virtualised, only aiming and firing to the virtual or 'cyber'-position of the airplane could lead subsequently to a hit. The "AA [Anti-Aircraft] predictor", as Wiener called his machine, became an articulated "prototype for a

[1] Wiener (1948/1961), p. 5.

[2] Quotation from Galison (1994), p. 243. Warren Weaver was head of Division 7, Fire-Control, in the NDRC and later co-editor of information theory by Claude Shannon.

new understanding of the human-machine relation".[3] The overall integration of the system, the closure of the feedback, was achieved by minimizing the root mean square error in the harmonic analysis of the observer's input. The "man-airplane-radar-predictor-artillery"[4] feedback loop became one integrated system, later in science called first order cybernetics. The closure of the system is equivalent to the task of shooting down an airplane or human as pilot.

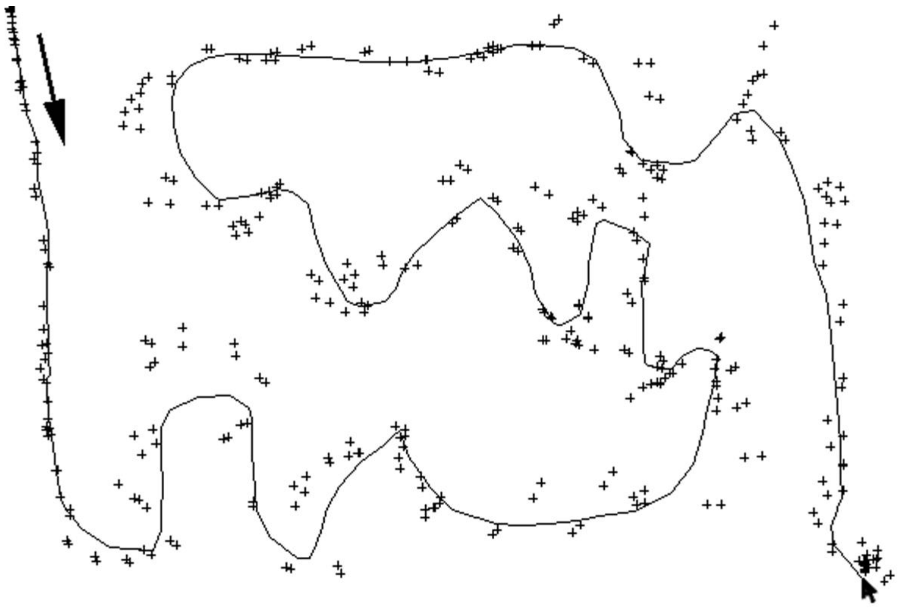

Abbildung 2: Linear Prediction of Irregular Movements after Wieners Algorithm

The basis of the estimation of the future are short-term traces of the past. Data is collected through tracking; the innovation of cybernetics is to treat these data as time-series and perform a real-time analysis based on the tracking input. "Control is short-term ... whereas discipline was long-term."[5]

[3] Galison (1994), p. 235.

[4] Galison (1994), p. 252.

Instead of looking up firing data in ballistic tables, the procedure and computing involved had to happen in the very now. Fire-control directors have been called 'on-line computers' in contrast to ballistical machines that performed their operations 'off-line'. The static numerical table as database was substituted through dynamic tracking and real-time computation.[6] Wiener himself did not forget to conclude: "Information is more a matter of process than of storage."[7]

A major difference to users and cyborgs today is that in Wiener's case humans were pilots and the machines were airplanes. This combination of pilots and machines is an archetype of the electronic user. Due to the cyberisation of media culture it is not surprising that electronic media today trie to track, analyze, and forsee the user in the process of interaction. This dispositif of new media, persecution, tracking the history of human input and predicting its future, in real-time, matching patterns of interactions onto each other, reappears (re-presents) itself half a century after the emergence of cybernetics: in software, as mixed techniques of surveillance and control of time. Persecution is one of the "sociotechnological principles of control mechanisms"[8] that are in need of investigation to overcome the domination and control in time.[9]

Persecution in Software

The software industry tries to keep up with the desire and imagination of the user by analyzing the data of interaction processes. Microsoft, for example, announced the aim of tracking the user in their applications and in the world wide web in the licensee agreement of Windows 95. Therein, the

[5] Deleuze (2002), p. 320.

[6] See Wiener (1962), p. 196.

[7] Wiener (1950), p. 121.

[8] Deleuze (2002), p. 320.

[9] Compare Peter Weibel's critique of media chronocracy.

user of the Microsoft Network allows Microsoft to track, analyze, and estimate data of interaction. “Habitual behaviour and patterns of usage” of all participants are gathered and represented neither as a demoscopical regime, nor as demography of users, but as a future estimation of current usage. Intentionality of action might be measured through an information signature without the need to be personalised. Only recently, Microsoft revealed its strategy of persecution with a slogan that become once very popular: *Where do you want to go today ?* This slogan, which is a question, not an answer, implies that computer media tend to do real-time analysis of usage 'on-line'. In an advertisement published in various magazines Microsoft explains the meaning of their slogan to its customers.

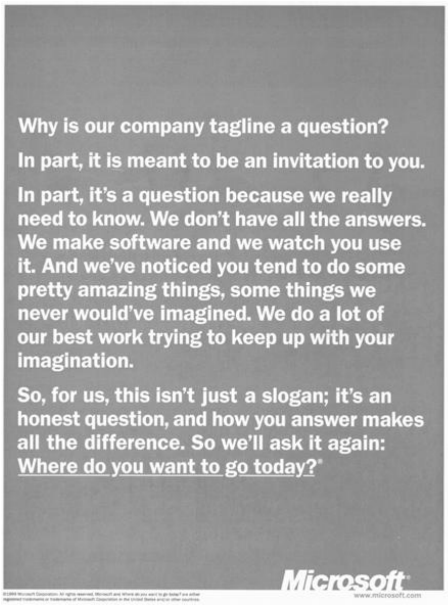

Abbildung 3: Ad by Microsoft explaining their strategies of persecution

The self-description of Microsoft in public through advertisment deserves close reading. Microsoft announces:

"Why is our company tagline a question ?
In part, it is meant to be an invitation to you.
In part, it's a question because we really need to know. We don't have all the answers. We make software and *we watch you use it.* And we've noticed you tend to do some pretty amazing things, some things we never would've imagined. We do a lot of our best work trying *to keep up with your imagination.*
So, for us, this isn't just a slogan; it's an honest question, and *how you answer* makes all the difference. So we'll ask it again: Where do you want to go today ?"

The statement "We make software and we watch you use it" clearly shows that any user is tracked while working and/or experimenting with software. Electronic industry does not even restrict itself to anticipate the needs of consumers and to trade products which is, of course, their only interest. They go one step further through analysing the usage and hunt down something usually associated with the field of creative art and media culture: imagination.

If industry tries to calculate and predict human user interaction to gain money and optimize the throughput of communication channels, if industry tries even to track and determine cultural imagination, art and media studies have to face the very same question in creative and performative fields that use software in real-time, but the answer is very different. It is to disturb and decorrelate the messages of communication. Interfaces are able to put noise into the process of interaction, so that the computer does not predict the user, but opens new non-analytical paths in the trajectory of interaction.

One could assume that Wiener's theory is already complex and covers a wide spectrum of movements, because his statistical prediction works with a very irregular trajectory and is even designed for these extreme conditions. With random paths in the course of interaction, Wiener calls it the 'drunken sailor problem', his methods clearly have advantages. In case the user approaches the behaviour of Brownian motion Wiener's statistical solution to time-axis manipulation pays off. Often the input of electronic media is not only a jerky, zigzagging, analog signal, it is a pattern of digital symbols as well, and most likely a mixture of discrete and continuous patterns of interaction. Therefore, other and more recent methods than Wiener's statistical theory come into place. In recent investigations of information theory the question of coding has been linked with prediction. Of course, any elimination of redundancy in a signal, the task of coding, implies the anticipation of the decoding of a signal on the time-axis. Any measurement and quantification of information can be read as an attempt to predict the unfolding of time-based processes. Therefore, it is not surprising that the founder of modern information theory, Claude Elwood Shannon, himself investigated and built devices that try to anticipate the users discrete choices while interacting with these devices.

Mind-Reading Methods and Universal Prediction

Claude Elwood Shannon, the founder of information theory, explored in the early fifties together with his colleague David Hagelbarger at the Bell Telephone Laboratories, the predicting capabilities of machines on the most basic level of relay switching circuits. In a play which they called 'Mind-Reading Game' a machine plays with a user the odd/even-game.[10] The user can alternate or select always 0 or 1, odd or even, head or tail, + or -. The machine, by analyzing the most recent patterns of binary choices, tries to predict the selection of the user in the time domain.

The results have been amazing: after a large series of choices the machine always wins. This is, because any user follows patterns while interacting, even if she or he tries to act randomly. Although the machine just wins usual-

[10] See Shannon (1993), p. 688.

ly about 55 up to 60 % (per cent), which is of course a very low prediction rate and not really good for any broader applications, it shows clearly that the user is unable to produce pure contingency. Human minds are not used to generate random noise. From that it follows that in any kind of interaction there is redundancy and therefore predictability. The capabilities of building machines experimenting with more complex input signals have risen since the fifties, of course, although the predictive capabilities in using or controlling machines have not been investigated in the context of media culture. I think that users produce codes as digital patterns by interacting with machines that can be countered or counter-countered by the same machines in using short-time prediction algorithms based on real-time analysis of interaction data.

Shannons Mind-Reading Machine was one of the first experimental tries to anticipate decision-based interaction in the time-domain. But Shannon himself never elaborated further and linked the theory of coding with prediction and discussed advantages and disadvantages of models of prediction. Much later than Shannon the Israelian information theorists Feder, Merhav, and Gutman from the Technion in Haifa, Israel, under the threat and unpredictability of Scud-Missiles from Saddam Hussein enlarged the existing 'Mind-Reading Machine'-methods to a, what they call, 'Universal Prediction Theory'.[11] This theory explores the predictability of any kind of cultural codes in time-based media.

"[A] universal predictor is one that does not depend on the unknown underlying model and yet performs essentially as well as if the model were known in advance."[12] Prediction theory defines itself through the exploration of the minimisation of the so-called 'self-information loss function'. This

[11] Feder et al. (1992), p. 1260.

[12] Merhav und Feder (1998), p. 2124.

function in universal prediction is defined as

$$l(b, x) = -\log b(x)$$

in contrast to the root mean square error in classical prediction which is defined as

$$\epsilon_h^2 = \lim_{T \to \infty} \frac{1}{2T} \int_{-T}^{T} |y(t) - x(t+h)|^2 dt$$

. The approaches in prediction minimize these functions.[13] The possible movements of the user, the changes in voltage of a signal, do not need to be represented in a model or stored in an archive. In turn, 'Universal Prediction Theory' does not need or assume a model or a known source P as in classical prediction. "While classical theory (e.g., Wiener prediction theory) assumes that the source P is known, the more realistic and interesting situation occurs when P is either unknown, or nonexistent."[14] In new media we need to make a distinction between tracking and real-time prediction on the one hand [15] and a static or even dynamic updated database [16] on the other hand. The difference is that learning or predicting algorithms do not store content, but operate in real-time on the time-axis and are, therefore, of interest to performance and composition. Like coding and compression are independent of content, prediction is a play of difference and repetition as well independent of auditive or visual content.

Electronic trajectories of usage today are digital and analog, discrete and continuous. Mouse and trackballs, e.g., give a continuous input.[17] A typical game console consists of semi-continuous and semi-discrete control devices. Navigation in games is a stream of up-down, left-right, +/- patterns. The

[13] See Merhav und Feder (1998), p. 2125, Wiener (1942), p. 84, and Masani und Phillips (1985), p. 154. For a broader discussion of Wiener's prediction theory with emphasise on questions regarding temporality and for a comparison with previous works on prediction by Kolmogoroff see also Wiener (1985), p. 109.

[14] See Merhav und Feder (1998), p. 2125, and Wiener (1942), p. 69.

[15] Kittler (1993), p. 199.

[16] Manovich (2001), p. 218.

[17] Roch (2000), p. 115.

question, how to *control a random walk*[18] as a concrete reformulation of *Where do you want to go today ?*, is a serious query not only to the industry of consumption. It is an inseparable element of communication in new media. Communication in its electronic mode is control and computation.

Stochastic Interfaces

In the early fifties another machine was built by Claude Shannon based on an idea of Marvin Minsky. This device has been called the 'Ultimate Machine', but it would not be inappropriate to call it simply the 'On/Off-Machine':

"It is the Ultimate Machine-the End of the Line. Beyond there is Nothing. It sat on Claude Shannon's desk driving people mad.
Nothing could look simpler. It is merely a small wooden casket, the size and shape of a cigar-box, with a single switch on one face.
When you throw the switch, there is an angry, purposeful buzzing. The lid slowly rises, and from beneath it emerges a hand. The hand reaches down, turns the switch off and retreats into the box. With the finality of a closing coffin, the lid snaps shut, the buzzing ceases and peace reigns once more.
The psychological effect, if you do not know what to expect, is devastating. There is something unspeakably sinister about a machine that does nothing – absolutely nothing – except switch itself off.
Distinguished scientists and engineers have taken days to get over it..."[19]
The On/Off-Machine displays the consequences of the closure of the feedback of communication since World War Two. This machine can be considered as being the electronic subject. Every try in communication, every interaction or every difference is switched off, is simply disabled. The sinister message of the electronic subject is to switch participation and communication off.

[18] Blackwell (1956), p. 336.

[19] Clarke (1958), p. 166/167. Clarke visited the BTL in New Jersey often in the course of writing his book in close cooperation with John Pierce, Author of Symbols, Signals and Noise.

The message as the order of the symbol is the articulation of death.

Interactive and electronic media that analyze the codes of the process of interaction stochastically can play with decisions or switches of the user by either steering to the intention of the user or by creating unpredicted and uncertain situations in the process of communication.[20] [21] Not pure random, but decontrolling the process of interaction and shifting it into a denser space of entropy. That is even in terms of information theory an optimal designed communication channel.

An interface unlike a machine is usually not a closed system. Electronic interfaces in software try to close themselves not only on the level of function; any input is followed by a set of computations or transformations called processing whichs leads to a reversible output. Intelligent software tries to close itself on the time axis through stochastic anticipation of users usage. Manfred Fassler in his book "Cybermodernity" characterises open and contingent systems as 'stochastical interactivity'.[22] Fasslers "Cybermodernity" is meant to extend postmodern thought that focuses to much on theories of information as theories of transmission, refering to the sociologist and system theorist Niklas Luhman who said once very sharply: "There is no postmodernity, there is just a modern post." First and Second Order Cybernetics, in contrast, emphasise the observer in media environments and the process of self-observation as a key to highlight the time-based nature of electronic

[20] The "Mind-Reading Machine II" and its successor the "Diagrammatical Read/Write-Head" are experimental tries into the direction of unpredictable communication situations with machines using Markov-chains to model and display text. In respect to their mainly theoretical questioning the installations try to contribute to the art of stochastic interactivity in experimental interface culture. See Roch (2001a) and Roch (2001b).

[21] Another example of the importancee of prediction in creative culture is Margaret Boden. In her article "Creative Constraints and Unpredictability" she linked uncertainty and unpredictability with the theory of creativity in computer science. Unpredictability becomes the very source of change. This, on the contrary, involves models of prediction like two faces of the same coin.

[22] Faßler (1999), p. 126.

media. Media that develop, evolve, and emerge with users usage fed back into the system. In contrast to the determination of command and control structures, the modern post, electronic media can be reminded to be open and contingent systems of interfaces.

Stochastic interfaces, therefore, are interfaces that do not compare the user input only with a database, but learn and track in real time the history of the user. The archive of new and intelligent media, then, is not a database, it is the history of the usage itself. Communication in a broad sense becomes a controlled random walk. Electronic media ask for the predictability in human/machine interaction based on time-analysis, in order to either control or decontrol the observer and user. In other words: by forseeing the trajectory of interaction, media technology can either close the feedback of communication through anticipating the future move of the user or open the course of the human user by disturbing and decontrolling the path of action. Noise operates not as data, but as program. Any critical thinking of time-based or real-time media, the culture of so-called "live-events", have to take into account the capability and the dispositif of the closure of the box, which is the lethal integration of tracking, proccessing, and output. An archaeology of the present, in contrast, is considering observing, computability, and states of human and machines as open-ended systems.

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