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Network Time Where it Counts. Temporality and Critical Approaches to Infrastructure

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Abstract: The default position towards temporality in designing for the web is to treat it as unfortunate constraint that negatively affects user experience. In contrast we look to the complex temporal interactions of networked technologies as a site of theoretical and aesthetic interest with the power to engage users in speculative and critical attitudes towards technical infrastructure. We argue that by valorising the temporality of networks and considering new forms of representation we open a range of creative possibilities with the potential to engage users in fundamental questions about technological infrastructure: who owns it, where it is and how it intra-acts. We provide examples of two artworks that treat with the subject of network time and discuss a basic guiding taxonomy to inform future work in design.

Keywords: Temporality, Networks, Infrastructure, Materiality, Art

1. Introduction

To say that time gives shape to our experience is to add only paucity to a rich history of discussion of the topic in philosophy, aesthetics and media theory. Nonetheless, such an inadequate phrase is worth reflecting on because of the relative lack of interest time has undergone in studies of design and interaction. Our modelling of time for the purposes of design remains locked to a small number of technologies of representation (the timeline, the clock face, the hour glass) and does little to the rich complexity of new forms of technical temporality except aggregate and obfuscate them behind a limited range of these representational forms. Consider the millions of inter-relating actions behind many everyday networked processes, the power they consume, the many layers of software needed to produce them, the human hours to write that software and contrast this with its representation to the user in Figure 1.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{A Progress Bar from Angular Bootstrap}
\end{figure}

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In this paper we explore the phenomenon of network temporality and its manifestations for users. In doing so we have a number of interrelated aims.

- To consider network temporality as metonymical for a broader interest in contemporary computer materiality with its attendant socio-political concerns.
- To reflect on how different users experience different temporal understandings depending on their technical expertise and other factors.
- To consider how temporal patterns of network infrastructure can be explored in creative work.

It is not our intention to design better progress bars or innovate on timelines, we leave that to our able colleagues in the fields of visualisation and graphic design/UX. Instead we wish to think more broadly about how a shift from disguising, to valorising time might affect our view of network technology and our lived interactions with it.

2. Motivation: Obfuscate or Valorise?

At the motivational heart of this paper is a concern that our attitudes to the technologies we buy and use are ideologically shaped in ways that have deep running consequences for our quality of life, for the shape of society at large and for the natural world. We found our concerns in the recognition within scholarship that technologies old and new have the power to strongly encourage particular social formations (Pinch & Bijker, 1987) and in some cases determine political effects (Winner, 1980). Recognition of this tendency has strongly informed strains of media scholarship as well as forms of contemporary creative with technology. In particular, Media Archaeology (henceforth MA) (Huhtamo & Parikka, 2011; Parikka, 2012; Zielinski, 2006) examines defunct media through technical, creative or scholarly means as a way of generating alternative perspectives on our technological present and possible futures.

We cite MA as a motivation here because it runs counter to a trend we identify in the interaction design of common objects whose guiding principle is often to reduce the cognitive load associated with performing everyday tasks, empowering the user to act efficiently within the confines of a task. For justifiable reasons, many contemporary technologies with which we interact operate on a ‘black box’ principle that seeks to obscure the inner workings, the messy guts of the machine(s). The principal effect of this is to cause us to forget that we are engaged in a complex geographical and temporal ecology shaping our experience in fundamental ways. It is frequently only when this veneer is broken, say by a too-rapidly depleted battery, the contemporary Heideggerian hammer (Heidegger, 1962, p. 102), that our connection to this subcutaneous ecology (Bennet, 2010; Schofield, 2014; Star & Griesemer, 1989) actually engages us.

Thus far, we have established two roughly defined positions. One derived from Science and Technology Studies (STS) and more recently MA which looks to the specificity of media technologies, acting as parts of larger ecologies as a resource for insight and speculation contrasting with another which we identify as the dominant trend in everyday interaction design on the web which seeks to unify, aggregate and otherwise polish those specificities into a smooth user experience. With this paper we use temporality as a feature of interest with which to explore these two positions together.

Our contribution therefore is twofold. We will describe and identify some temporal features of networked technology and by doing so we hope to describe how some basic interactions involve extremely contemporary arrangements of time, unprecedented in human experience. Having done so we will return to interaction design and identify some initial steps in rendering these kinds of time manifest.
3. Thinking about Time

It is simultaneously curious and unsurprising that after some hundred and fifty years of technical, graphical representations of time in the West\(^1\) we remain bound to only small and incremental innovations as to our representation of it. Curious when one considers as Davis does a comparison with cartography wherein,

“Controversy rages over the respective merits of the Mercator, Gall-Peters, and other projections, with a clear understanding that each presents a different world view and that these differences matter....” (Davis, 2012, p. 5)

At the same time this aporia is unsurprising given the complex theorisation of time in aesthetics and philosophy (c.f. Barker, 2012; Gere, 2006; Virilio, 2008), not to mention physics, and the lack of unified consensus over its description. Time, it seems, remains elusive to graphical representation, *tempus fugit* in more ways than one.

Previous work in design research (Lundgren & Hultberg, 2009) has sought to characterise particular patterns of time corresponding to commonly understood experiences. Live time, real time, unbroken time, sequential time, fragmented time and juxtaposed time are all offered as patterns found in day to day experience, narrative fiction and the use of various technologies. The authors take these patterns and seek to apply them as a resource for interaction design (their example is a drawing programme that experiments with, for instance, ‘fragmented time’ by causing faded lines to periodically reappear). While there is much to recommend this work, our interest is instead on kinds of time which resist such comfortable characterisation assuming complex and materially contingent formalities.

3.1 Time and Technology

Central to our arguments in this paper is that technology shapes not only the experience of time, but actually *constitutes* new arrangements of it, in effect producing new kinds of time with concomitant socio-political effects. As Doane (2002) reminds us, a key product of industrialisation was the rationalisation of time itself into measured and synchronised units. The synchronisation of time necessary for a successful railway network, the division of the working day into shifts, the moment by moment analysis of workers’ movements under Taylorism actually produced new formal arrangements of time that had no previous precedent. It is fascinating then that she identifies an emerging technical art form, cinema, as the counterpoint in the development of time and modernity. Contingency was at the heart of cinema’s appeal. It was compelling because it adopted the technology of rationalisation (a point she takes from (Bergson & Mitchell, 2005)) to index to the contingent. The developing language of filmic cuts brought about new possibilities for time (Radstone, 1995), which despite having analogies in human experience (particularly in memory) brought unprecedented formal structure to kinds of temporality involved.

“...film narrative can and does depend upon the temporal aberrations of memories and projections, incarnated in flashbacks, flashforwards, and radical ellipses. Each of these, however, depends upon the cut, which allows the disarticulations of filmic time and profilmic time.” (Doane, 2002, p. 131)

The cut afforded a disconnection between the time that takes place before the camera, with the time embodied by the film as produced. The public saw, for the first time, time disturbed, rearranged...

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\(^1\) Taking Joseph Priestly’s 1865, ‘Chart of Biography’ as a starting point. For a fascinating overview see (Rosenberg & Grafton, 2010)
and fragmented. This perturbation developed and nuanced our common understandings of what time actually is.

4. The Time of Networks

The development of cinematic techniques described above are cited to emphasise the precedent for technologies, time and experience coming together in reciprocally informative ways. Network technologies and cinema share claims to be epistemologically defining, forming a rupture around which so-called “discourse networks” (Kittler A, 1992) find their definition. Such technologies including for example protocols such as TCP/IP, hardware infrastructure including cabling, routers, WiFi cards, satellites, cellular towers and data centres (aka server farms) we claim perform a similar function in producing new formal and experiential temporalities.

In pursuing this line of enquiry we are mindful of Wolfgang Ernst’s neologism “Eigenzeit”. Ernst, identifies a rupture between older media writing what amount to forms of literary narrative, arranged linearly in time, and new arrangements dominated by the symbolic and characterised by complexity (Ernst, 2011, p. 242). For Ernst the destruction of indexical relationships with recording media (say the track of a gramophone record) is a paradigm-shifting event in our relationship with temporality. Where in media such as film, vinyl records, magnetic audio tape and printed text, time proceeded sequentially along the medium, in contemporary storage such as solid state hard disks or DVDs, memory is fragmented in to blocks, decomposed, encoded in summary de-indexed from its referent. The perdurant metaphors of memory as writing or memory as archive bringing with them, their particular temporal associations, falter in the face of this decoupling. Our interest then, is to take a closer look at some of the technologies cited and ask what they mean for time and what that in turn means for experience.

5. Hidden Complexity: Webpage loading

Modern web browsers such as Chrome, Firefox, Internet Explorer and Safari provide a fascinating glimpse into the incredibly complex temporal ecologies of the contemporary internet. They are also one of the principal ways that people interact with networks and as such are ideal subjects around which to think about how temporality is arranged, and what aspects of it we might choose to manifest and why. To begin, let us take a very brief look at some of the things that happen when we load a typical webpage.

Web pages are typically composed of set of text files that combine to instruct browsers on what to show and how and additionally on where to look for additional resources. Very often they will consist of HTML, CSS and some script files (such as JavaScript or PHP). Because of the variety of kinds of operation involved, the temporal picture is very complicated. For the purposes of discussion we will restrict the description to some of the activities of the browser when the page loads initially.

“When you first request a page, your browser sends a GET request to the server, which returns the HTML to the browser. The browser then starts parsing the page (possibly before all of it has been returned). When it finds a reference to an external entity such as a CSS file, an image file, a script file, a Flash file, or anything else external to the page (either on the same server/domain or not), it prepares to make a further GET request for that resource. However the HTTP standard specifies that the browser should not make more than two concurrent requests to the same domain. So it puts each request to a particular domain in a queue, and as each entity is returned it starts the next one in the queue for that domain. The time it...
takes for an entity to be returned depends on its size, the load the server is
currently experiencing, and the activity of every single machine between the
machine running the browser and the server.” (tahd haze09, 2009)

The straightforward and helpful description above provides a clear overview of the process of page
loading but the reality is, predictably, far more complicated, To begin to illustrate this complexity we
have used Chrome’s Developer Tools’ timeline visualisation facility to generate the screenshots
below while loading an example webpage, in this case the home page of the Guardian newspaper.
Figure 2 shows colour coded representations of four defined functionalities (loading, rendering,
scripting and painting) along with a colour for ‘other’ and white for inactivity. The degree of
concurrent activity within even the first couple of seconds highlighted in the graph is quite
staggering. What is also clear is that the task of visualising this information is (with due credit to the
designers involved) an extremely challenging one. Although the timeline visualisation in Figure 2
shows the activity under the categories defined it does not show the interrelations between
processes. Many of the activities visualised are inter-dependent, relying on one script to load before
another is called. This may be because they themselves are written into particular loading scripts
which fetch things in an interdependent order. It may be that they exist in the same domain and thus
are subject to the ‘two at a time’ rule stated above. In the case of JavaScript they may be artificially
constrained by the user of ‘defer’ or ‘async’ attributes added to the ‘<script>’ tag in HTML which
prevent the script from loading until the page has finished parsing (defer) or force it into an
asynchronous thread (async). To comprehensively visualise these connections, existing as they do, on
tiny temporal scales would be a huge task both for computation and also for the design of such a
visualisation. Despite this, their outcomes are considered regularly by designers who must consider
how the chain of execution is likely to affect the actual rendering of the page, the interactivity
desired and experience of people using it. Thus despite the significant number of unknown factors
(how long will it take to fetch this image from a server in china say) web designers are using
experience, rules of thumb and debugging tools like the one shown below to make this temporality
tractable.

![Figure 2: Timeline of Browser Loading Processes from Chrome's Developer Tools](image)
5.1 Experience is Unevenly Distributed

A consequence of this, we contend, is that the temporal character of the experience of loading a webpage for experienced developers is entirely different from that of a person without such expertise. The staggered temporality of a rendering webpage for a JavaScript developer gives tacit clues not only as to the underlying structure of the code but also to the kinds of real world constraints likely to cause things to behave in particular temporal patterns. This in turn indicates a particular kind of orientation to the world beyond the browser where timeliness can variously indicate quantity of data, quality of WiFi connection, geographic distance of particular servers or the busyness of internet traffic. These factors are not abstract. Knowledge of them represents a particular kind of engagement with our technological world and a knowledge base which subtends our capacity for critique. As we have argued, based on the thoughts of many others, a social and political critique of technology is built on the specifics of the technologies involved, not only by looking at what users think about them but by considering what they technically afford. Just as Winner (1980) demonstrated that the design of tunnels on the approach to popular New York beaches precluded the possibility of access to poor, particularly black, residents of the city, we assert that the temporal constraints imposed by network technologies are in fact agential in defining what we can and cannot do. As Graham and Marvin point out (2002) the speed of networks is socially, politically and economical vital and creates tangible, even architectural, effects in the city. Describing how physical proximity to large data exchanges brings about temporal advantages on the micro scale they explain the significance of this in algorithmic stockmarket trading (Graham & Marvin, 2002). To gain tiny temporal gains, traders are literally moving buildings closer and closer to the source of the data. Network time has city scale consequences.

6. Visualising interest

But what of everyone else? Those without the technical experience to interpret the late appearance of a map icon as evidence of a complicated server-side script but with the curiosity to wonder where the data they are loading is sourced from. To speculate as to the number of miles of cabling it has passed through to reach them. To reflect on the many interwoven material factors which cause their requested content to reach them at different moments. How might they be provided with cues to these processes that increase that engagement instead of obscuring it behind a spinning wheel?
6.1 Ring Network

This question is explored by artist Tim Shaw in his recent work ‘Ring Network’ (2016) Figure 4. In this piece Shaw uses recordings of solenoid actuated bells in a gallery space to explore the spatio-temporality of network file transfer. A recording is taken of the bell sounding. This is then uploaded to server space in Korea, Las Vegas or Iceland. On receiving the complete file transfer this server immediately transfers it back to the local computer in the gallery space and plays the file at a speed dictated by the length of time it has taken the sound to travel around the world. The process then repeats.

![Figure 4: Ring Network Installation View. Image Tim Shaw 2016](image)

Shaw’s work complements an earlier design work, Ride the Byte (Art+Com, 1999) which exploits a similar principal, following http requests through router exchanges globally. His work differs in its explicit exploitation of the temporal affordances of network distances to produce a spatialised audio work. Although Shaw’s imaginative audio practice appears far from conventional web design it offers a provocative lesson. The three bells and three matching speakers which constitute the exhibition layout produce sounds which overlay each other in arrhythmic fashion. This staggered layering produces a distinct impression of both distance and material connection. It is clear that the sounds are bound to material constraints and the aesthetic interest of the piece for the audience is in many ways projecting imagination into the spaces of silence as we wonder where the sound is now and how long it will take to return.

6.2 Neurotic Armageddon Indicator

This sense of material contingency is expressed by another artwork, Neurotic Armageddon Indicator (NAI) (2013) Figure 5, by author Schofield. NAI takes the form of a small wall clock, resembling a Sci-Fi time-bomb which continually scrapes the website hosting the ‘Doomsday Clock,’ a symbolic clock representing the length of time until the end of the world expressed as minutes to midnight (“Timeline,” 2013). NAI contains a micro controller running a small web client that continually...
requests the page content from the site, looks for the current Doomsday Clock time and updates itself, ‘neurotically’. Relevant to our argument here is the inclusion of a small LED indicator on the front of the clock that flashes on receipt of a new data packet in the manner of a router indicator light. In previous work we have described the function of this LED as an indication of ‘liveness,’ (Schofield, 2013) in essence a guarantee for the indexical connection of the NAI to a source of data accessed in fast, present time. Here it is once again the arrhythmicality that is exploited but this time instead of suggesting distance travelled, it is positioned to instil a sense of urgency and danger in audiences.

In NAI, the temporal arrangement of networked technologies is actually the subject of a kind of parody. The audience is presented with a temporal feature of the particular kind of network connection (an HTTP get) but that temporality is made a mockery of because of its sheer redundancy. By exposing the time taken to poll an unchanging data source, the artwork makes a feature of the time taken and by extension casts focus on the mechanisms which make it possible.

7. Conclusions

In this paper we have presented our motivations for exposing aspects of network temporality to users and audiences. Central to our argument is a distinction between a broad principal that we identify in commercial interaction design and an attitude that we encounter in critical approach to technology. The former seeks to blackbox the material infrastuctures underlying network interactions while the latter treats them as a site of critical interest recognising that those very infrastructures are a matter of political (Graham & Marvin, 2002), social (Star, 1999) or aesthetic concern (Ernst, 2016).

Our purpose with this paper was to consider how exposing and indeed valorising forms of network temporality represented a set of new possibilities for engaging critically with technology. Although
our treatment of this subject has been limited by lack of space for extended examples we feel that there are some distinct descriptive handles which might help us identify tractable features of the complex infrastructural times we have tried to exemplify and recommend them for future design consideration.

7.1 Liveness
We share with (Lundgren & Hultberg, 2009) an interest in liveness founded in our previous work (Schofield, 2013; Schofield et al., 2015). Where their treatment of the concept though is intended to represent the inevitable passage of time “regardless of what the user does, like in World of Warcraft, or the live broadcasting of the Super Bowl” (Lundgren & Hultberg, 2009, p. 35) we invoke this term to emphasise the urgent, contingent and fragile nature of network infrastructure. For us, to design with liveness is a way of involving users or audiences in a thought process about the timeliness of networked infrastructure, the technologies it sits in and the data it supports. NAI for example uses a single LED lamp to promote this reflection.

7.2 Complexity and Interdependence
Our example of the browser loading a webpage demonstrated the unprecedented levels of fast, complex interdependence enacted in the loading of a ‘simple’ webpage. Coextensive processes, such as threads occur throughout computational technology and produce enormously complicated demands on architecture (for instance to avoid race conditions or deadlocks) while allowing vast speed gains taking advantage, for instance, of multi-core processors. The value of exposing such complexity with new forms of representation is already recognised among programmers who visualise such processes to evaluate performance using purpose built tools.

For our critically curious user though the interdependent nature of heterogeneous resources and rapid communication between them is a reminder of our enmeshment in an infrastructure which carries political, financial and literal weight. Technical complexity carries with it political complexity as various aspects of owned infrastructure interact introducing constraints, influence and freedoms according to their material and political positioning. The interaction of geographically distant resources, indexed by their own temporalities may function as a reminder that networks (like the future) are not evenly distributed.

7.3 Duration and Exchange
The duration of networked processes such as loading a resource from a URL is perhaps the most palpable among the concerns for users that we have identified. Early in the paper we criticised the loading bar or waiting timer as wrapping up meaningful complexity and hiding it in plain view. Tim Shaw’s work makes a feature of the long duration of loading resources while highlighting the sequentiality of their exchange. Based on this work we identify significant concerns to users regarding the performance of their devices but also the network of resources on which they depend which are not exposed at the interface level but whose involvement may be of concern. Obvious examples of this tendency would include the bandwidth-occupying demands of tracking scripts such as google ads. Similarly so-called ‘bloatware’ in mobile phones is intimately enmeshed with common activities but exists in what is arguably a parasitic relationship with them, drawing their data and slowing them down in the process.
8. Afterword: Immanence

In the paragraphs above we have attempted to open out a practically-oriented and creatively fruitful line of enquiry into networks and time. In doing so we identify with a domain of contemporary scholarship critical concerned with the materialities of contemporary computing. In our current thinking, we characterise this close attention to technical detail as an attention to **immanence**.

Contrasted with a transcendent view of technology which thematises, idealises and otherwise treats of a whole, an immanent view emphasises activity constrained within its context, limited to that which empirically available to experience. By adopting this view we shift our focus on to the individual actions of interacting agential technologies and in doing so promote a grounded but speculative orientation to everyday interaction.

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