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Device Boundaries: An Ecological Network Paradox

Cihaz Sınırları: Bir Ekolojik Ağ Paradoksu

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Abstract

This paper discusses the concept of paradox in communication networks and the relations defined by artifacts with living entities in hybrid ecologies. While communication networks are essential in our daily life, this paper presents how the relationship between people and devices poses critical questions as paradoxes and challenges. The paradox of socio-technical impotence and time-pressure presents two challenges: The absence of time and space and the presence of ownership and filter. This theoretical framework constitutes a background for Device Boundaries, a design research project that seeks for sociality among people and devices. The aim of Device Boundaries is to encourage close distance communication among people by superimposing digital layers over physical communities. The resulting ecology shapes an alternative communication network. Accordingly, the paper first illustrates the role of technological devices in our social life and describes the ecological paradoxes and challenges. Then, it explores how we might liberate communication technologies from these paradoxes, and introduces a series of case studies that adopt alternative systems to the creation of networks of services. In conclusion, it factualizes and discusses the theoretical research in a series of design projects under Device Boundaries research.

Keywords: Interaction ecologies, interaction design, design activism, communication technologies, network of digital devices.

Academical disciplines/fields: Visual communication design, interaction design.

Özet

Bu çalışmada, iletişim ağlarında paradoks kavramı ve melez ekolojilerde insan yapıtlarının canlı varlıklarla tanımladığı ilişkiler tartışılmaktadır. İletişim ağlarının günlük hayatımızdaki gerekliliğinin bilinciyle bu çalışma, cihazlar ve insanlar arasındaki ilişkinin paradokslar ve zorluklar babında nasıl kritik sorular yaratabileceğini ortaya koyar. Sosyo-teknik acizlik paradoksu ve zaman baskısı paradoksu iki zorluğu tanımlamak için temel oluşturmaktadır: Zaman ve mekanın yokluğu ile mülkiyet ve filrenin/sansürün varlığı. Bu teorik çerçeve, cihazlar ve insanlar arasındaki sosyalliğin peşinde olan Cihaz Sınırları tasarım araştırma projesi için bir arka plan oluşturmaktadır. Cihaz Sınırları'nın amacı, topluluklar üzerine dijital katmanlar yerleştirerek aynı çevredeki insanlar arasında yakın iletişimi teşvik etmektir. Ortaya çıkan ekoloji, alternatif bir iletişim ağına şekil verir. Buna göre çalışma ilk olarak, teknolojik cihazların sosyal hayatımızdaki rolünü ve ekolojik paradokslar ile zorlukları açıklar. Daha sonra, iletişim teknolojilerini bu paradokslardan nasıl özgürleştirebileceğimizi araştırır ve hizmet ağlarının oluşturulmasında alternatif sistemleri benimseyen bir dizi örnek sunar. Sonuç olarak, Cihaz Sınırları araştırması altında bir dizi tasarım projesi ile teorik araştırmayı gerçekleştirir ve tartışır.

Anahtar Sözcükler: Etkileşim ekolojileri, etkileşim tasarımı, tasarım aktivizmi, iletişim teknolojileri, dijital cihaz ağı.

Akademik disipin(ler)/alan(lar): Görsel iletişim tasarımı, etkileşim tasarımı.

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1. Introduction

A paradox is a self-contradictory statement. Traditional paradoxes, as the ones of Zeno —which explores time, space and motion by reflecting on their dichotomy[1]— are renowned. However, we might consider paradoxes also as our inability to take a course of action against climate change despite a common consensus on its necessity; or our dedication to new technologies to make us communicate better despite becoming increasingly alienated. In both of these examples, we seem to be confronted with a growing number of challenges. Guattari (2000), for instance, tightly juxtaposes the socio-technical aspects of human relations with the relations we maintain with the environment. In his words:

> Wherever we turn, there is the same nagging paradox: on the one hand, the continuous development of new techno-scientific means to potentially resolve the dominant ecological issues and reinstate socially useful activities on the surface of the planet, and, on the other hand, the inability of organized social forces and constituted subjective formations to take hold of these resources in order to make them work. (Guattari, 2000, p. 31) (Figure 1)

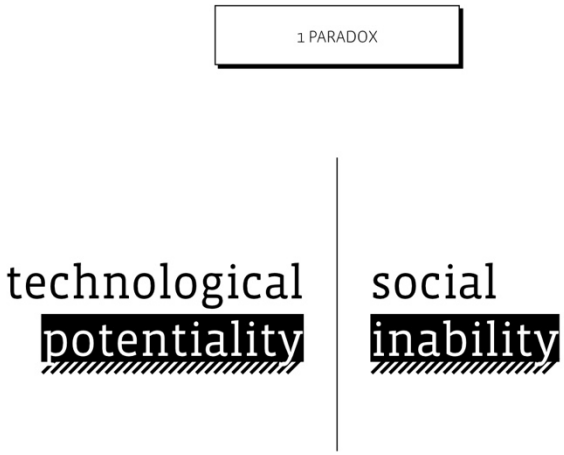

Figure 1. First Paradox. Simplification of Guattari's (2000) paradox of socio-technical impotence.

Guattari (2000) expounds a fundamental paradox of technological potentiality on one side and social inability on the other, which I will refer to as the paradox of socio-technical impotence. This paradox demands the creation of what we can interpret in design terms as 'enabling platforms'. Ezio Manzini (2005) defines enabling platforms as "the set of material and immaterial elements (products, services, infrastructures, knowledge and rules) that, implemented in a given context, enhance its possibility to be a fertile ground for creative, bottom-up initiatives." In other terms, these platforms are implemented technologies aimed at enhancing social action. Furthermore, these actions and initiatives are bound to resources, which according to Guattari (2000), are critical and difficult to obtain by social forces.

In an attempt to contribute to a better understanding of the paradox of socio-technical impotence, we might ask three questions which drive this research and shape the structure of the paper: (1) How might we use digital technologies to enhance social relations in the city? (2) What if we liberate digital networks to empower citizens, and to conclude, with a provocative twist, (3) How might we become ecological?[2]

[1] An introduction to Zeno's Paradoxes can be found in the Stanford Philosophy Encyclopedia (Huggett, 2018).
[2] The reference here is towards the work of Timothy Morton (2018) and its ontological exploration on the possibility of becoming ecological.

2. Technologies to Enhance Social Relations

Contemporary communication technologies, supported mainly by smart-phones, tablets and notebooks, are supposed to enhance social relations between people. Among other scholars[3], Sherry Turkle claims that our digital companions seem to interrupt our social life, distract our cognitive process and separate us from our bodies. Thus, the influences of these technologies on how we relate with other people reflects on both the dimensions of space and time and their perception. We will further explore these two dimensions in the following paragraphs.

2.1. Absence of Time

"We make the world together with technology and so it is with time." (Wajcman, 2015, p. 4).

Three aspects concerning time and adoption of communication technologies are here of particular relevance. Mobile Internet devices make us always reachable, granting a constant flux of information and, consequently, interrupting the ongoing activity throughout the entire day. "We insist that our world is increasingly complex, yet we have created a communications culture that has decreased the time available for us to sit and think uninterrupted" (Turkle, 2011, p. 166). Furthermore, the possibility offered by these technologies to multitask —the act of distributing our attention to simultaneous activities— takes its toll on our attention span and focus. Multitasking, being often considered as a quality, pushes many people to adapt to its modalities unwillingly or unconsciously in the areas of work, entertainment and life. Lastly, the possibility to separate us from our bodies takes different forms: From the creation of performed identities to the subtraction of our focus from the physical context. Our attention can be captured through our cognition —e.g. executing a task on mobile phone (Chen and Yan, 2016)— or through perception by isolating completely one or more of our senses —e.g. this effect is shown to its extreme with the audio-visual isolation of VR headsets—.

The result of this constant demand for attention produces a general feeling of psychological pressure due to the invasive technologies, the lacking social relation bond, and as a result the feeling of lack of time. This shortening of social time and the absorption of time by communication technologies lowers the quality of our emotional life and consequently practical performance.

Judy Wajcman bases her work on such observations to highlight a contradictory pair of concepts: "This lack of congruence between the amount of free, discretionary time available to us and our contemporary feelings of harriedness has become known as the time-pressure paradox." (Wajcman, 2015) (Figure 2)

This paradox poses a question about the perception of time and use of time and it is to be considered in relation with the available communication technologies[4].

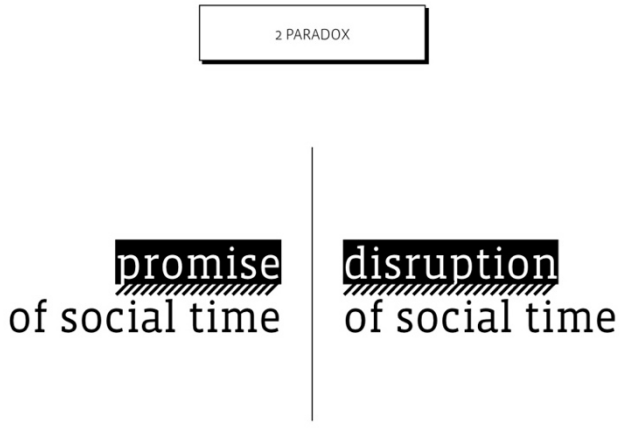

Figure 2. Second Paradox. Simplification of the time-pressure paradox.

[3] Studies on the negative effect of digital technologies on social relations are common; here we list few among the most relevant for this research. On time and technologies: Olivier (2019) reviews the work of Paul Virilio on 'acceleration'; Eriksen (2001) speaks of 'tyranny of the moment'. On social relations and technologies: Webster (1995) analyzes critically Manuel Castells on the 'network society'.

[4] Denovan and Dangall (2019) publish a psychological study on the factors causing chronic time pressure.

2.2. Absence of Space

"There is little sense to be had from making distinctions between time and space – there is only time-space." (Thrift, 1993, p. 93).

The work of Wajcman (2015) focuses on the dimension of time; here, we can extend the same line of thought on how digital technologies also have the capacity to reduce space radically[5]. For example, it is possible to go well beyond the borders of our planet and have a duet across the universe as demonstrated by ISS astronaut Chris Hadfield (Allain, 2013). The distance between us becomes null, cancelled by the speed of the network that connects us.

Time is reduced to a minimum technical buffer, which allows nonetheless a seamless conversation —or even a duet—. By somehow hiding space and time in our communication, we also neglect our context and, sometimes, our bodies. Turkle (2011) exemplifies this detachment from our bodies with her experience of passively joining the conversation of a fellow passenger on a train. While this passenger was going through a very personal talk, his surrounding was blurred in the background to the limit of complete ignorance. The attitude of the talking passenger shows a twofold fracture with the surrounding space, since by removing the other passengers from the train, he was in fact negating his own presence on the very same train. This research of a private space in a public area can only be actuated with a withdrawal of the person from the space itself: "With the mobile phone, the user separates him/herself from the surrounding space in a "bubble" that is necessary for the private speech act." (Kopomaa, 2004, p. 270)

In a similar fashion, on social networks that show us images and places far from us we navigate with our mind and ignore our actual physical context as well as that of our neighbours. The absence of space is not only valid in terms of distance between the interlocutors but also the absence of their bodies from the context in which they are in. Our absence in physical space and time results in a state of absent-mindedness. While adopting a popular multitasking mind-set, we fragment also the activities and 'teleport' our focus between different spaces, and we end up wearing out our capacity to solve the task at hand. When we jump from one task to the next in a frenetic rush, we cannot guarantee a deep level of focus; we need always to find ourselves in our thoughts in a constant 'where was I'[6].

Furthermore, by separating ourselves from our body, we operate an anti-ecological operation in the sense that by abstracting ourselves from our environment we destroy the relational properties between our bodies and the surrounding physical ecology. In the words of Paul Virilio:

> The paradoxes of acceleration are indeed numerous and disconcerting, in particular, the foremost among them: getting closer to the 'distant' takes you away proportionally from the 'near' (and dear) - the friend, the relative, the neighbour - thus making strangers, if not actual enemies, of all who are close at hand, whether they be family, workmates or neighbourhood acquaintances. (Virilio, 1997, p. 20)

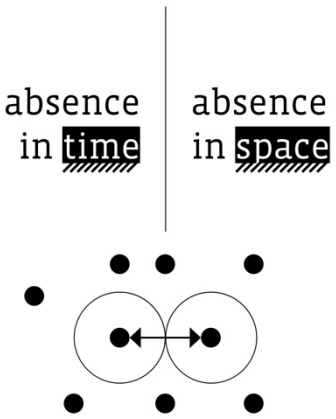

Figure 3. First Challenge. Representation of the challenge of absence.

[5] A reflection on the alteration of time and space perception due to communication technologies is by no means new as shown by similar reasoning, starting from the 18th century telegraph to more contemporary technologies, by Nigel Thrift (1996). It is Thrift who recognize 'absence' and 'boundaries' as two complex elements that characterize modernity next to 'power', 'flow' and 'time'.
[6] Fırat (2013) discusses the notion of continuous partial attention introduced by Linda Stone.

We might say, 'we look away' from our reality, or at least from the reality which entangles our body.

The absences of time and space configure themselves as a challenge, and by doing so, they might produce a solution —or maybe an approach, a critique— to the paradox of socio-technical impotence (Figure 3).

2.3. Presence of Ownership

Reflecting in opposition to the absence of time and space, we observe a presence in technology (Milne, 2003). Technology subtracts ourselves creating absences on one side and adds external presences on the other side. The presences that I will introduce in the following paragraphs are 'ownership' and 'filter'.

The challenge of presence as —lack of— ownership is deduced from Guattari's (2000) paradox of socio-technical impotence, which describes the impossibility of social forces 'to take hold' of technologies. The Internet, the core technology that enables our complex structure of contemporary communications, is built on a utopian view of freedom based on openness and democracy. Tim Berners-Lee sustained this utopia by releasing the structure of the World Wide Web (hyperlinks) as open and democratic (Boyle, 2019). This utopia would aptly sustain the possibility of social forces to take hold of a strategic technology as the Internet.

Unfortunately, as noted by Berners-Lee (2010) and during his several interviews (e.g. Brooker, 2018), the scandals of Cambridge Analytica's involvement in the election in the USA (as well as other countries), thanks to the data collected by social networks such as Facebook, are a demonstration of an ownership that is held on by private companies instead of social forces. Even before these events, Berners-Lee claimed: "People are being distorted by very finely trained AIs [Artificial Intelligences] that figure out how to distract them." (Solon, 2017).

As private companies own data, like in the case of social networks, also the hardware that supports the communication exchange on the Internet is not public. While the aim of the Internet was to constitute an open network of computers connected among themselves, the reality of today's Internet is quite different. The Internet of today is a hierarchical structure constituted by main highways (backbones) —property of few large corporations—, a series of local Internet Service Providers, and at the end, our individual computers connected to them. Social forces do not own the hardware which makes the Internet works, neither this hardware is open or supports a democratic approach as it was aimed at its foundation.

2.4. Presence of Filter

The Internet Service Providers (ISP) are companies with contracts within the countries in which they operate in a way that local politics can easily influence. In order to maintain their contracts, ISP apply filters that limit access to what Berners-Lee imagined as an open and democratic space (Gharakheiliy, Vishwanath and Sivaraman, 2016). The cases of China censorship on the Internet as well as at least 60 other countries are sadly popular (Xu, Mao and Halderman, 2011; Niaki et al., 2020). Turkey among other countries is famous for its bans on social networks as well as the open encyclopaedia Wikipedia, between the years 2014 and 2019 (Genç, 2019). These bans and censorships are in fact a filter that limits access to knowledge and creates "economic inequality, inequality of ideas, educational inequality, and more" as noted by Jillian C. York (Fiscutean, 2017).

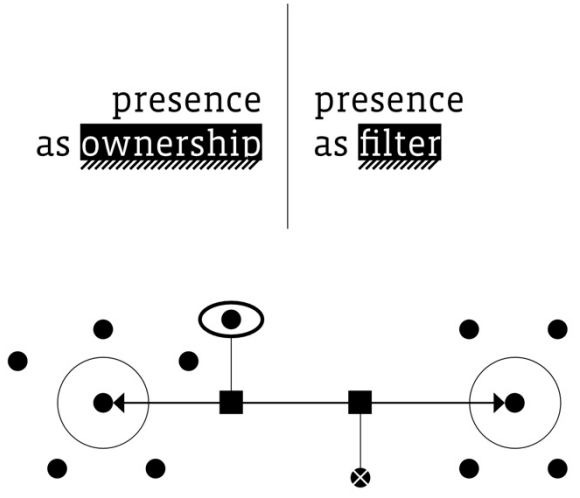

Figure 4. Second Challenge. Representation of the challenge of presence.

To summarize the challenge of presence, we should acknowledge the sprawl of communication technologies that shapes our lives while being owned by third parties (governments and companies with interests) and that offer partial services controlled and filtered by the same interested parties. People do not own and cannot control what they can do or see, and even —as in the case of the elections— they cannot know what they really want. Communication technologies are today a manifestation of the challenges of presence and absence between technology and social control (Figure 4).

3. Alternative Technological Models

We will now observe some examples of alternative technological models, which can provide potential solutions to the paradoxes and challenges described (Figure 5).

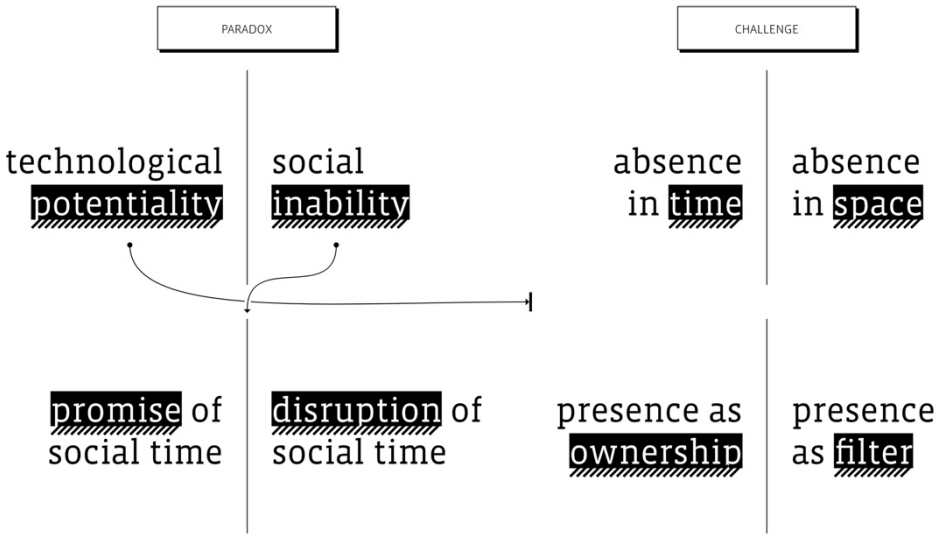

Figure 5. Diagrammatic synthesis of the four parameters to approach the paradox of techno-scientific development versus social and ecological growth.

These examples will help us understand how we might reconfigure the social approach to communication technologies towards new networks as enabling platforms. These platforms can be engines of freedom, subjects of common good, and expressions of local identities to ensure a slow ecological pace of life. Numerous hopeful alternative network systems are appearing on the FLOSS (Free Libre Open Source Software) horizon based on peer-to-peer and blockchain technologies. A review of these proposals at this point can be beneficial to oversee their potentials in reconfiguring our approach.

3.1. Blockchains Machinic Socialities

Recently, following the path of peer-to-peer technology, the model of blockchain is affirming itself in several fields because of the diffusion of cryptocurrencies. Bitcoin and similar new digital currencies, defined as cryptocurrencies, are decentralized money. These currencies work on the principle that a shared information among peers is what determines a recognized truth or, as in the specific case of the economy, the validity of a transaction. It is a form of social agreement among machines; by comparing the data available on their tables, computers evaluate and keep records of each transaction. This type of technology bases its principles on non-hierarchical relations among nodes, thus every peer has the same value. This system is in clear contraposition with the bank system in which the banks are the ones who hold the transaction tables and people can only trust their tables and be subject to banks' rules. Blockchain technology is exploited vastly in the case of cryptocurrencies, but numerous other applications are growing around this model and some are already in a state of stable development.

3.2. Akasha: A Collective Memory of the Web

The Ethereum and the InterPlanetary File System projects share computational capabilities among computer nodes in exchange for economic and computation value. One of their co-founders, Mihai Alisie, started a new enterprise called Akasha in the area of social networks. With Akasha (n.d.), he aims at "exploring the applications and implications of blockchain technology in the search for solutions that can transform the Web into an ecosystem in service of humanity." In a more explicit way, the system aims to

record the content of the Web and re-distribute it among servers, so as to keep the memory independent from the single web server. Blockchain networks can redistribute, archive and keep accessible any web service by creating a sort of collective memory.

3.3. Solid: A Language for Data Ownership

Another project receiving a lot of attention is Solid; a technology that aims at building better web applications by structuring a fair system of data ownership. The project, directed by Berners-Lee, is a design solution against the corporative approach to data ownership over the Internet that is generally applied by social networks. It should be emphasised that Berners-Lee structured HTML (Hyper-Text Mark-up Language) in a way that it could be accessible to anybody and always kept open source. This was done in the context of software development, focused on killer-apps —even the language is adversarial— and proprietary formats. The open source movement was still in its infancy and Linux, the open source operating system, was still to be released. While the most popular operating systems were having their usual complicated 'social relation' —the conflict between Apple and Microsoft is renowned with their files incompatibility, different drive formats and patterns— Berners-Lee's proposal was a formula for independence by any individual system. He structured, instead of a proprietary format or software, a common set of rules to establish a language for communication among servers and clients; furthermore, he kept it accessible to humans.

The proposal for Solid follows the same radical approach of HTML and the World Wide Web Consortium (W3C). Solid aims at creating a series of protocols and standards to regulate the presence and exchange of data among social networks and on-line platforms. The aim of these protocols is to keep the rights of data in the hands of their owner instead of selling them out to private companies. For example, many photographers who care about the ownership of their work do not publish on social media due to the acquisition of copyright rules applied by most of the social network platforms. Solid wants to give control to people over the meta-data of the resources they release, over the resource itself and who can have access to it. Furthermore, Solid aims at appointing individual ownership of resources-data to the individual instead of giving away the rights to publishing platforms and other third parties.

The ability to share or privatize a datum should stay under clear control by its creator. Having an independent technology which regulates the exchange of information, like W3C does for the structure of the Web itself, should guarantee, according to Berners-Lee, impartiality and freedom to decide what to do with one's personal information. Although the platform is still in an early stage of development, it is possible to start creating pods (digital identity repository) and participate in the early prototype. If this technology will spread, it might become a foundational stone to redefine how we communicate through digital media and a turning point for data ownership and privacy online.

3.4. Mesh Networks: Owning the Infrastructure

While Solid and Akasha (at least at this stage) aim at changing the way we understand software, projects like Commotion and LibreMesh, as well as activist groups as NYC Mesh and BuffaloMesh, aim at offering solutions for the ownership of the hardware that constitutes our communication networks.

Commotion (Figure 6) is an open source tool to create mesh networks, networks constituted of peer nodes, by connecting multiple devices in a local area. The project, initiated by the Open Technology Institute in Detroit —and silently unedited since 2015— allows people to install the software on routers, phones, and computers to create a 'local' network that can offer access to the Internet. The idea is to create local Wi-Fi areas in the city belonging directly to the community, and not to private companies, which can be used independently from the Internet or connected to it. The routers and antenna required are solutions that cover wide ranges (going from 1km to 10km) and relatively economical considering the covered area (a neighbourhood association could easily cover the costs) but not cheap enough to be in everyone's house.

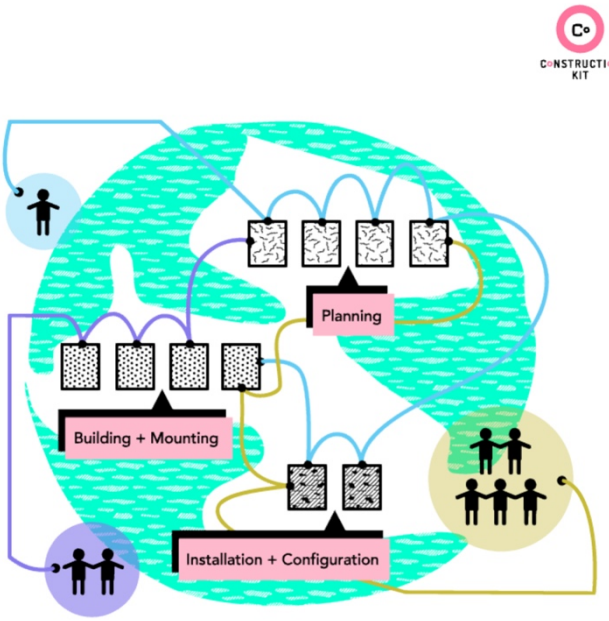

Figure 6. A diagram illustrating the ecology of people and devices involved (Commotion, n.d.)

A different approach is found in the Serval Project (Figure 7) as well as in B.A.T.M.A.N. for which a specific hardware is not required. These projects create networks based only on mobile phones and aim at being effective especially in disastrous conditions or in places where other network systems are not available. Peer-phones are connected together in a horizontal organization in which each phone-node links to all the nodes in the vicinity and by neighbouring relations with other phones that are more distant. Exploiting the close distance among phones, these systems remove the need of the entire heavy infrastructure usually needed in cellular phone networks. Obviously, the limit of this system arises with lower density of nodes; however, combined solutions in which some nodes connect to a larger network, can be imagined for further reach of the network. Furthermore, these systems can open the possibility to recycle obsolete devices by assigning them a role as node distributor.

Figure 7. An application of the Serval Mesh in Vanuatu, Oceania ("Third Visit to Vanuatu", 2017)

4. Device Boundaries

After seeing different examples, both software and hardware, we will now go through the design projects under Device Boundaries research and discuss them based on the theoretical framework introduced.

4.1. Design Projects

Device Boundaries is a research project looking for sociality among devices. The aim of the overall project is to question the potential roles of artifacts and living entities (beyond humans) in defining hybrid ecologies. The design projects developed by the author within Device Boundaries act as 'object as research discourse' modality (Seago and Dunne, 1999). Their aim is not only to be design artifacts in themselves but, also, to be considered as a part of building a theory. In other terms, they are not affirmative solutions to the paradoxes and challenges proposed, but they are rather critical questions.

The first experiments, Feline Colonies and ArcadePong, aimed at the creation of devices that would be owned collectively (with a do-it-yourself perspective) and would be adopted in public spaces as an answer to simple social needs: such as care and fun. Following the fun aspect, a third project presented here is WiPong, which shifts the same context with new mechanics. Lastly, a design proposal for an on-going project focuses on questioning the area of environmental monitoring.

4.1.1. Feline Colonies

One of the design projects under the Device Boundaries is called Feline Colonies (Figure 8). This project allows people within a neighbourhood to overview the condition of the feline community and to distribute tasks as feeding or healthcare among people. While this is a very specific application, it is based on the observation about the excellent care people have for stray animals in Turkey and the social function that this plays in enriching the human social community.

While this example focused on cats, it could be reframed to include a wider range of animals including wilder animals and maybe endangered species in the urban borders of our cities, in order to hybridize the urban environment with the wilderness[7].

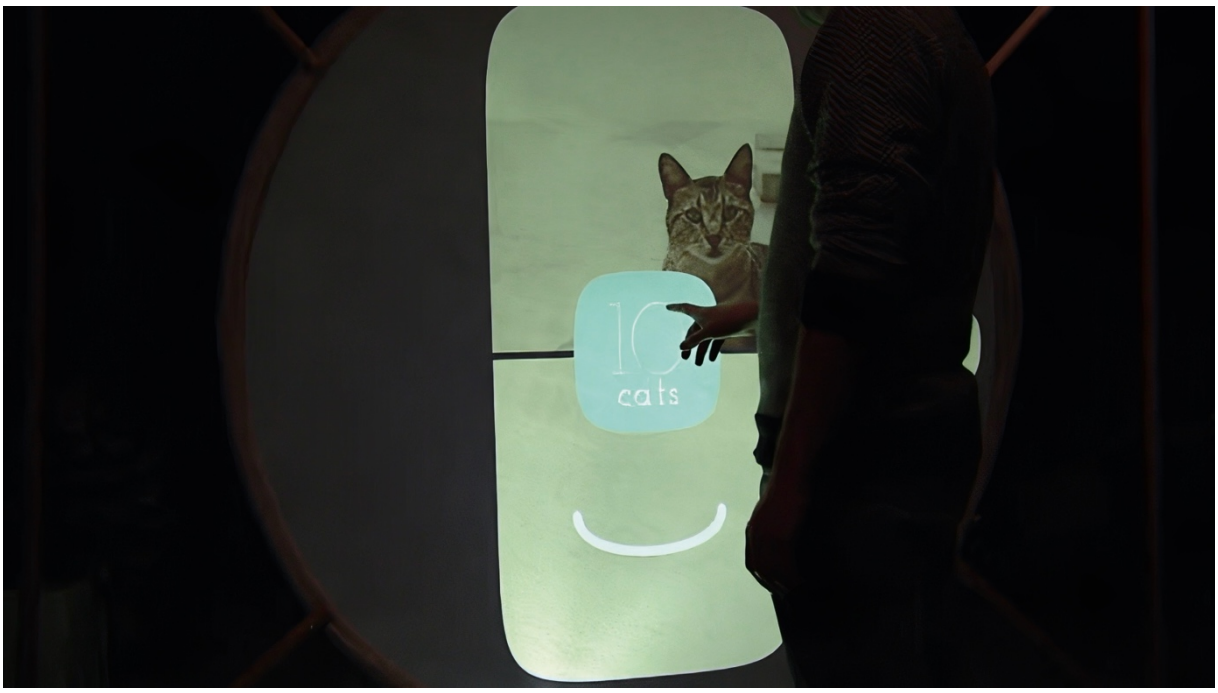

Figure 8. Feline Colonies. Views of the system that tracks the cats' location in a map and the state of the overall community (Savasta, 2015).

[7] In a similar way, an application can be imagined to track the wild animals of the Australia's forests where Serval mesh was deployed after the renowned fires.

4.1.2. ArcadePong

The second project developed under Device Boundaries focuses on fun. The project called ArcadePong is a variation of Atari Pong played with the accelerometer sensor equipped by smartphones. In ArcadePong (Figure 9), players use their own devices and connect to a server that synchronizes them (Savasta, 2015). The two players face each other and are free to move in their half of the field, as in a real tennis game, while a display interposes itself between them and shows the position of the virtual ball as well as the state of the game. The smartphone, used as a racket, captures the movement and communicates to the server-display the players' reaction time and type of movement. ArcadePong is an example of bring-your-own-device logic (Ballagas, Rohs, Sheridan and Borchers, 2004), in which the system acknowledges the existence of different devices and capitalizes on them by using their unique potentialities. The players become performers, the phones controllers, and the public space becomes a temporary virtual playground. The hypothesis is that by shifting the role of communication devices, we might transform the perception and use of public spaces, and consequently transform the social relationships entertained in these spaces.

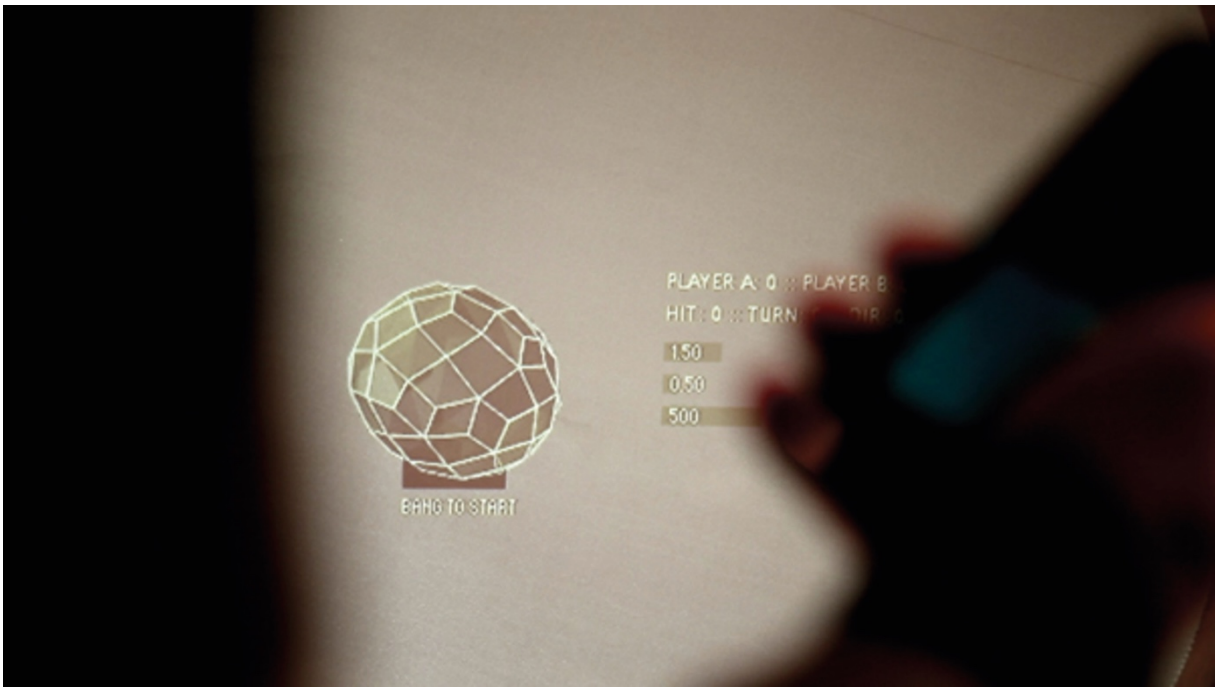

Figure 9. ArcadePong. A view of the player setting their phone to play ArcadePong.

4.1.3. WiPong

The WiPong design project (Figure 10a/10b) is another Pong-based game with a virtually infinite number of simultaneous players. The only limitation imposed by the system over who can join the game is geographic; the game is played only within the range of the Wi-Fi signal of the server and not online as many popular games. Each player sees a half of the playing field on their own screen. The other halves are as many as the numbers of in-game players. The ball bounces from one to the next field randomly creating a strong tension for the players who do not know either when the ball will come to their field or from which direction. While in the traditional game, the whole field is visible and the limits of the movements are clear, in WiPong the waiting time and so the reflex are a participative act in a larger dialogue.

(a) (b)

Figure 10. a) WiPong. People playing together near the server, **b**) the server itself (Savasta, 2016).

In these two examples of projects focused on fun, the relation among devices was transformed from competitive to collaborative, from allowing the use of a single device per time to a relation in which all devices can be used at the same time for the same purpose, in the same environment. As demonstrated by the literature review, when we operate on the level of communication technologies we might directly affect the human relations connected to their use. When these projects were tested people were pairing or grouping each other to 'beat the game' creating natural social connection among strangers. Furthermore, the people needed to be present in the space to participate and, as their proximity was a requirement, they were bound to each other and for that pushed to entertain social relations.

4.1.4. Environmental Mesh

The last design project, currently under development, focuses on creating a mesh of environmental monitors. The same server which executes each project of Device Boundaries research can be extended by connecting commonly available environmental sensors. These sensors can analyse the quality of air by distinguishing the main pollutant gases and dust presence in the air. Many projects related to monitoring environmental conditions have been released online as well as entire publications (e.g. Gertz and Di Justo, 2012) in recent years, but a solution that creates meshes of monitors is still not diffused.

Many projects, such as Airboxlab and City Air Quality, guide people to create their own individual monitor but without the involvement of the community. On the other edge of the spectrum, projects such as Smart Citizen connect monitors in different cities aiming at a global perspective. Once more this concept acts without the involvement of the community or neighbour districts. This last project, although relevant in its attempt, seems to create an explorative map that shows where we could live better —inherently suggesting somewhere else— more than helping us to discover how to improve the here and now.

All these examples introduce the representation about the state of our microenvironment which is certainly a first step towards awareness. A more inclusive solution though should consider the participation and involvement of communities in its result if not directly in its planning and development. Within the project Environmental Mesh while the addition of components to extend the system is almost trivial, particularly due to the previously mentioned instructive examples, what is challenging is the language and the modes of delivery of this concept.

A series of unsolved questions are presented here to stimulate and anticipate the development of the project and as a way to illustrate the directions and leads towards further design proposals. Does a scientific numerical representation guide our fellow citizens towards a better attitude towards their environment? What language shall this system speak? How might we give suggestions on how to intervene practically to improve the local condition without 'paternalizing' our fellows but making them involved? How might we promote awareness to the idea that our actions are in any case ecological in their effects?

4.2. Design Qualities

All design projects presented under the scope of Device Boundaries embed three qualities, which we can discuss as evaluation parameters for their role as social devices. Each of these qualities confronts the assumptions of the challenges of absence and presence, and aims at creating potential questions to the status quo of device ecologies and their paradoxes.

4.2.1. Decentralization

The design projects of Device Boundaries are built on the same DIY system, named Antenna, composed by common cheap electronics as Raspberry Pi —the single board microcomputer notorious for its low price— and a router to extend the reach of the network. By being cheap and technically approachable, it is imaginable that informal groups of people in a neighbourhood might power up their node servers and install the application services of their choice. In this case, each of the design projects presented can constitute a single application service. This self-owned system allows complete customization without any limitations since people are the owners of their own infrastructure as in FLOSS architectures. Furthermore, each of these nodes has the same hierarchical status as the other nodes in the network, making the mesh a pure horizontal organization. Even if one node is pulled out of the network, if the other nodes can reach each other signals the network maintains its structure.

4.2.2. Independency

These single Antenna nodes connect directly to each other, are able to generate a mesh network and further they can be connected to the Internet. Through this logic, nodes directly connected among themselves can communicate without any filter or censorship and independently from ISP or governing entities as well as independently from Internet services. The filter could only be applied, if required, by the community that owns the server. This independence from institutions or companies in terms of ownership, as well as the independence of the network from the Internet, makes the system a reliable alternative to adverse conditions, being adverse themselves in terms of privacy, politics or economy.

4.2.3. Upgradability

Most of the projects under Device Boundaries work due to additions only to the software of Antenna, which as mentioned has minimal hardware requirements. To extend the system functionalities the only need is to upload a new service application and thus making it available to the community. While the software makes the differences the hardware extends, at most, by the participation of individuals' smartphones to form smaller device ecologies. The simplicity of the system constitutes its opportunity to be upgraded, modified and hacked by the communities who owned them. The adoption of a Raspberry Pi in the system allows to further extend the hardware to add new functionalities as presented in the last ongoing project. In this last case the additional components add functionalities without interfering with the use of other service applications.

5. Conclusions

Throughout this paper, we discussed the paradox of socio-technical impotence, proposed by Guattari (2000) and further explored the paradox of time-pressure and the challenges of presence and absence under different lenses by authors such as Wajcman and Turkle. We explored how these paradoxes act as Matryoshka dolls, which becomes 'bigger in the inside', or can be studied —through an object-oriented ontology approach— as objects (Morton, 2018). It is unsurprisingly challenging to anticipate solutions to our dramatic environmental condition as well as our overlooked serval position towards social devices and their affect on human social relations.

I listed design projects that might improve our daily life as potential paths to delineate a different future. Although some of these projects are already suspended or dormant, still they manifest their role as explorations to be studied, comprehended and maybe restarted in the years to come.

Consequently, a series of design projects under the research Device Boundaries were presented as 'objects of discourse', to raise awareness regarding the paradoxes in our society and to show an approach on how we can tackle these issues as communities.

Each of the projects tries to answer the theoretical questions explored, and contextually tries to create new and more compelling questions. Lastly, three qualities are deduced by the examples presented and by the projects developed. Decentralization, independency and upgradability might be the starting point of a series of qualities to be discussed in the definition of new devices, especially in the definition of new ecologies.

Being an involuntary actor in our ecologies is not a sustainable position in terms of the ecological environment, and being a passive user of technology is not a position sustainable in terms of the hybrid ecologies.

"What is alluring about such explorations has little to do with the aesthetics of extremism and a lot to do with the very real possibilities of social transformation they open up before us." (Bonnett, 1991, p. 200).

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