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scientific editors **Łukasz Jonak** | **Natalia Juchniewicz** | **Renata Włoch**

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# Digital Ecosystems

Society in the Digital Age



data visualization  
media **digital**  
neurotechnology  
culture  
communities



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## Society in the Digital Age

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Edition I

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ISBN: 978–83–942809–2–5

University of Warsaw



# Table of contents

Łukasz Jonak, Natalia Juchniewicz, Renata Włoch

**Introduction** 7

Anna Gumkowska, Piotr Toczyski

**New digital genre communication forms as an area.  
Revealing digital competences** 15

Karol Piekarski

**Data visualisation as a tool for preventing information overload** 31

Marcin Zaród

**Beyond laboratories...  
Selected results from the ethnography of Polish hackers** 39

Katarzyna A. Klimowicz

**The role of digital tools in the development of citizen-centred politics** 57

Agata Kowalewska

**Symbionts and parasites—digital ecosystems** 71

Matthew E. Gladden

**Neural implants as gateways to digital-physical ecosystems  
and posthuman socioeconomic interaction** 83

Jarosław Kopeć

**Humans between non-humans.  
The colonization of the analogue by the digital** 97

Łukasz Dulniak

**From journalist to media worker: The study of embodied disruption** 111

Łukasz Mirocha

**Smart home as the Internet of Things black-box: User's agency in open  
and proprietary Smart Home ecosystems** 119





**Łukasz Jonak, Natalia Juchniewicz, Renata Włoch**

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# Introduction

The metaphor of ecosystem captures a number of features that are characteristic of modern social world, thoroughly transformed by digital technologies. Natural ecosystems are communities of diverse organisms, interconnected and interdependent—as they are all embedded within a complex network of matter and energy transfers. Contemporary digital technologies allow for similar increase in diversity of entities that constitute social world and for the growth in complexity of their mutual relationships.

Digitalisation allows for this growth in diversity and interdependence. It provides a common denominator for various analog modes of communication, media, and representations; it abstracts away ambiguities, noise and redundancies of our continuous, analog world (Haugeland 2000), so that they can be all processed by a common, fundamentally discrete mechanism. Certain techniques and technologies use this digital logic to solve everyday problems (and—more often than we would like to—create more of them). Digital computer was not the first nor perhaps the most important of those technologies, when it comes to the development of our civilization; the language itself, and later, the notational systems for mathematics, natural languages and music are obvious examples of digital technologies.

However, we commonly refer to contemporary computational information technology (based on transistors and discrete electrical or optical signalling) as the synonym for digital technology. When we talk about digital media or economy, we mean that they are mediated by computers and databases and smartphones and broadband connections, not that they are made possible by the magic of digital mechanism which equalises what otherwise is incomparable. It is this discrete equalisation, however, that ultimately is responsible for the unprecedented growth of interconnectedness in our contemporary world.

It is not only the number of relationships that is increasing: digitality also allows for rapid development of new interactive entities. Once new device has been created based on digital logic, it can readily participate in a broader communication context using common protocols and techniques. Both these aspects of digitality—enabling interactions between entities that could not have been related to each other before, and the ease with which new entities can be created and "plugged" into existing systems, fuelling their dynamics, contribute to creation of digital ecosystems which complexity can be compared only to that of their natural counterparts.

But why is it important to study digital ecosystems? One way of looking at ecosystems—natural and artificial—is to describe them as interconnection of niches. Each species of the ecosystem contribute to creating a niche for a number of other species which live in it. The system as a whole can be described as an equilibrium of living conditions of all its species. Of course this equilibrium is not set in stone. Due to the systems complexity a disturbance to even one of its elements can cause a ripple effect altering living conditions of all the species. This is not something bad in itself. After even most disastrous disturbance the ecosystems would find new equilibrium, some of the species becoming extinct, many more altered to fit in new or modified niches. Humans, however, tend to value their identity. Even if we recognise and accept the need for transformation, we would rather be in charge of its direction, extent and pace. In the case of digital ecosystems the probability of systemic changes that would influence our living conditions and pressure the transformations of the way we are and function is far greater than that in natural ecosystems. In fact, we can easily observe these profound changes in our day-to-day experience. This is why it is important to try to understand the structure and dynamics of relationship of digital world we are part of—so that we at least are not surprised when it changes us.

There is also another way of understanding the function of (digital) ecosystems. They are not just the communities of entities dependent on each other, better left alone, unchanged, inert. Rather, they are mechanisms that generate change and novelty. The complexity of their interrelatedness unavoidably results in creation of innovations, which are basically unique combinations of old elements. Each innovation can in turn become part of a new configuration, the process—in case of digital ecosystem—greatly facilitated by the existence of digital common denominator for all involved entities (Kauffman 2008). This means that the change, not stability, is natural for digital ecosystems. Surely, some changes disturb equilibrium in a way detrimental to the well-being of the species inhabiting digital ecosystems, but more often the emerging novelty will be beneficial and enriching, as new products, ways of expressing, engaging in social relationships, new business models, genres of art,

etc., appear. And again, studying the dynamics of digital ecosystems, the interplay of dependences, the mechanisms of novelty emergence is the only way to ensure that more beneficial than potentially threatening changes are occurring.

The authors in this volume address various aspects of the processes that constitute and take place in digital ecosystems. Anna Gumkowska and Piotr Toczyski in their essay *New digital genre communication forms as an area. Revealing digital competences* indicate the fact that nowadays new means of communication and social bonds are strictly connected with the escalation of social media. However such media as Facebook, Twitter and Pinterest seem to be not only means of communications but the source of new genres as well. The social media mentioned above are the source not only of social content, but of semantic phenomena such as memes and microblogs (Kamińska 2011). To understand them user of one of these media has to have some competence in ICT and in understanding the "common sense" signified to different signs in the sphere of the media. To participate in the circulation of "knowledge" in the sense that user knows the popular themes and motifs on Facebook or Twitter means that he or she has some skills to decipher the meaning, to name the phenomenon, to use it (to copy-paste or to re-use it). Gumkowska and Toczyski show that such ability as "reading" the meme is a new competence of users of social media. It is a new ability especially for young people. Showing the difference between young users of social media and adult (45+, 55+) in Poland Gumkowska and Toczyski raise the general questions: does the user of social media need some competence to understand the content and is there any difference in this competence between young and adult users? Authors try to answer these questions not only by the analysis of users per se, but by the consideration what it means that social media produce new genres. Moreover, Gumkowska and Toczyski try to analyse the problem of digital divide (Norris 2001) on a completely new level—not the level of simple access to the Internet, but the possibility to take advantages of this access.

Similar problem, but on the level of visualisation tools, raises Karol Piekarski in his paper titled *Data visualisation as a tool for selecting information on the Internet*. The author undertakes the important aspect of Internet data, which can be visualised in different manner and by this process of visualisation it can show diverse topics which in the regular text version would not be interesting at all. What is crucial, Piekarski explains that data visualisation is an element of culture, "a regular phenomenon" which gives possibility to counteract the process of surfeit of data production. Such elements of data presentation as diagrams, charts and maps are in fact new methods of taking control over information which is statistical and difficult to be analysed without support of such Internet visualisation tools. We can observe this

phenomenon in the social sciences by the interest of scholars in ethnographic methods of researches such as taking pictures or collecting them (Collier 1967; Margolis 1990). The same shows Latour in his *Visualisation and cognition: Drawing things together* explaining that methods of inscription of data are the most important for the possibility of understanding the meaning of some data, to correct the mistakes and finally to decide what is true in the scientific knowledge (Latour 1986). Moreover, as Piekarski explains in his paper, information showed on the websites and described by the visual elements—like for example pins on maps—makes the whole information more meaningful. In effect not only social researches have changed by the introduction of visual tools to the process of analysis of data but "visual journalism" started to be a new strategy of explaining and presenting of information and should be considered as a separate trend in creation of transparency in public sphere. Piekarski indicates that visualisation of data is not only a method of the structuring of information and circulation of knowledge. It affects citizen involvement in the current social and political problems, because it can direct attention to completely different aspects than these showing by mainstream media and journalism.

What pieces together Piekarski's and 'Toczyski and Gumkowska' papers is the focus on the problem of skills that people need to have to use new, digital tools. Memes, microblogs similarly to visualisation of data open the problem of that in what sense "information society" is "informed" or "can be informed", what kind of competence it needs to act in the digital ecosystem and the last but not least what it means that we can understand the society by the ways of using digital tools.

The aspect of new social communities and security in the digitalised world is undertaken by Marcin Zaród and Katarzyna Klimowicz.

The notion of "hacker" is surrounded by plethora of stereotypes, and for a sociologist this is full justification for undertaking a study on hackers and hackerspaces. In his article *Beyond laboratories... Selected results from the ethnography of Polish hackers* Zaród relates the preliminary results his on-going exploratory study of hacking communities in Poland. Building on rich empirical material consisting of interviews and many hours of engaged observation he sketches a social profile, attitudes and educational backgrounds of the Polish hackers. The bulk of his article is devoted to the phenomenon of hackerspace construed from perspective of different social actors connected to it, using as theoretical point of view the already well-established theory of Science and Technology Studies. Interestingly, he argues that "hacking communities could act as a meeting places for different epistemic cultures, establishing what was called "trading zones", where different purposes or knowledge systems might interact or be exchanged". He revises the different kinds of hackerspaces to conclude that

what they have in common is commitment to openness of their activities and specific "hacker ethics". His inspirational concluding remarks relate to the intermediary and facilitative role of hackers and hackerspaces in society.

The activities of hackers and hackerspaces have easily discernible economic and political potential. And the question of the political potential of digital tools clearly preoccupies Klimowicz. In her article *The role of digital tools in the development of citizen-centred politics* she tries to determine whether digital tools—or digital media, to be more precise—may rather serve the rulers or the ruled. Calling the support of the wide choice of authors writing on cyber revolution in dissemination of information, from Castells to Morozov, she boldly attacks the idea of political participation in its classical shape as sadly unresponsive to "the basic concerns, needs and rights of ordinary citizens". She counters the traditional political processes and systems with the notion of online and offline interdependencies, which she duly illustrates with the examples of the transnational Pirate Party International and the Spanish party Podemos, both parties abhorring the established right/left divisions and focusing only on stimulation of participatory citizenship. She leaves the reader with nagging question whether all those new digital tools may be the cure-all for the tarnished ideal of democracy.

Agata Kowalewska (*Symbionts and parasites—digital ecosystems*) most directly addresses the major topic of our book. She offers an undiluted and philosophically anchored analysis of the concept of "digital ecosystems". Specifically, she tries to use the concepts and approach of evolutionary ecology in order to look deeper into the Latour theory of ANT. The article diligently explains the foundations of both the ANT and evolutionary ecology—which makes it particularly valuable for those who do not easily differentiate between ANT and ant—and then takes the reader further into their application to the analysis of competition (e.g. between computer mouse and trackball) or mutualistic symbiosis (e.g. between artificial cardiac pacemaker and human with cardiac problems).

Matthew E. Gladden maps the space of possible realisations of a special kind of digital ecosystems—one which is based on interfacing its components (in this case humans and artificial computational systems) on fundamental, neurological level. This kind of interconnectedness, realised in this case by neuroprosthetic devices, can have both beneficial and detrimental effects in various areas for individual user, ranging from cognitive effects to socioeconomic consequences. Gladden in his text, *Neural implants as gateways to digital-physical ecosystems and posthuman socioeconomic interaction*, develops precise classification, ready to track the changes neurotechnology is about to bring to our world.

Jarosław Kopeć (*Humans between non-humans. The colonization of the analogue by the digital*) shows what happens when a particular community of practice becomes a digital ecosystem. He uses the word "digital" in a special meaning, denoting modern IT technology. In the case he describes, this digital technology is being introduced to the analog world of a newsroom, changing practices of creating, editing and publishing content, and even altering the definition of what a good, acceptable from publisher's point of view piece of writing is. Kopeć is another author in our anthology who employs Actor-Network Theory as a tool for description of an ecosystem. From this point of view, the dynamics of digital ecosystem presents itself as interplay of interests, strategies, alliances and agendas.

Łukasz Dulniak is an interesting case of journalist-turned-sociologist. Clearly building on his own personal experience in his article titled *From journalist to media worker: The study of embodied disruption* he traces the effects of digital revolution not only on media, but primarily on journalists. Academically correct, he offers the general review of the theories of disruption and continues to paint a bit bland landscape of media in the course of digitally powered transition, with digital media gaining in as its main feature. The empirical part of his article concerns the case of disruption suffered by one of the most renowned American newspapers, the New York Times viewed from the perspective of Christensen theory of innovation. Dulniak proceeds to analyse how the digital revolution changes the work of journalists, concluding that "Digital journalism production is less a praxis of straightforward publishing and more a process of continuous development".

Łukasz Mirocha in his article Smart home as the Internet of Things black-box: User's agency in open and proprietary Smart Home ecosystems successfully attempts at explaining the complexities of user-oriented implementation of Internet of Things. He assumes that "smart home" is a kind of ecosystem that may be treated as a technological black-box. He concludes with emphasis on the importance of large-scale education in the area of programming and basic engineering in order to use the benefits coming from open philosophy of implementing IoT ecosystems. Overall, he offers the eclectic perspective of a post-digital, critical cultural and technology studies.

Our authors tackle the problem of digital ecosystems and the place of humans within them from various vantage points. From conceptual maps of directed human and digital hardware interfacing to analyses of influences digital ecosystems exert on existing social and economic communities—we have still only touched the variety and complexity of human and digital world interplay. However, we believe, and hope the readers of this anthology agree, that it consists of a good representation of areas that need to be addressed and analysed if we are to understand the significance of digital ecosystems.

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**Anna Gumkowska, Piotr Toczyski**

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# **New digital genre communication forms as an area. Revealing digital competences**

Anna Gumkowska's contribution to the text is the result of a grant headed by her at the National Science Centre. Grant number 2013/11/N/HS2/03560 237081: "A Mechanism for Creating New Web Genres on the Internet: Facebook, Twitter, Pinterest–Memes and Microblogs". This paper was written with a financial support from the National Science Centre.

## **Introduction**

Nowadays, digital–and thus social–inclusion requires competences which enable effective communication: creating social bonds, implying an agreement, and sometimes even participating in community actions.

Once genres were as stable as stalactites but today, especially online, they are more like fireworks. In the digital world, there are no long-lasting genre indicators but only elements of structure forms. Both creating and receiving, new digital genre communication forms can have two levels: one inside the text and the other outside of it. What is inside the text is strictly connected to the semantic comprehension of logo-

visual texts. The factors outside the text are both formal organisation (a publishing frame which allows for a specific visual arrangement of the content) and organisation of social circulation that enables dialogue between the senders and their audiences.

Thus creation and reception of digital genre communication forms reveal digital competences, which may be relevant to mutual understanding of people. New genres are not just objects of aesthetic perception. They are a significant social phenomenon of communication between different generations of people and a challenge for their digital inclusion, especially when we realise that there can be barriers to the dialogue between them.

## Big questions

There are many general questions in internet studies, and with the present paper the authors wish to contribute to two of them which we consider worthwhile. The first question is whether digital competences in navigating digital ecosystems change social relations and institutions. The second question is whether "the digital" diminishes or strengthens human competences. The new digital genre communication forms are an area revealing digital competences.

Although genre studies go back to ancient times, with the revolution of information of recent decades, a number of changes have occurred in genre research. On the one hand, these changes show some anachronism in substantial research aimed at the existence of permanent types of genres in cyberspace; on the other, they allow to appreciate the wealth of new forms and their quick applications, based on the personal and individual consciousness of online users. When we consider changes of the medium and the structure of a message, a number of specific issues open up: To what extent can we speak of new genres on the web? How should the new forms of communication be combined with the tradition of genres? Also, how do technological capabilities of network users, along with their activities and past experiences, allow to create new forms of communication in a group and on an individual level?

## Short history of our interdisciplinary approach

Before we started researching new media genres within the framework of digital competences, in 2009 we prepared a two-part post-conference edited volume *Text (in) the Net* [Ulicka, Gumkowska 2009] and presented it to the academic and digital industry audiences in Poland. In its first part, "Text, Language, Genres," we included our own essay on new genres in the new media along with a co-authored research report on the perception of blogging. In the second part of the volume, "Literature, Society, Communication", we also included another co-authored research report on Polish online content creators.

Clearly, there was a need for integrating these perspectives, so five years (and many other research projects) later we launched a new interdisciplinary undertaking to analyse two logo-visual multimedia genres, namely memes and microblogs. We approached them as digital genre communication forms revealing digital competences of their creators and recipients.

Thus, what we currently study are the new media genres, that is, the memes and microblogs on Facebook.com, Twitter.com, and Pinterest. We do it within the joint framework of literary research and the digital competence approach.

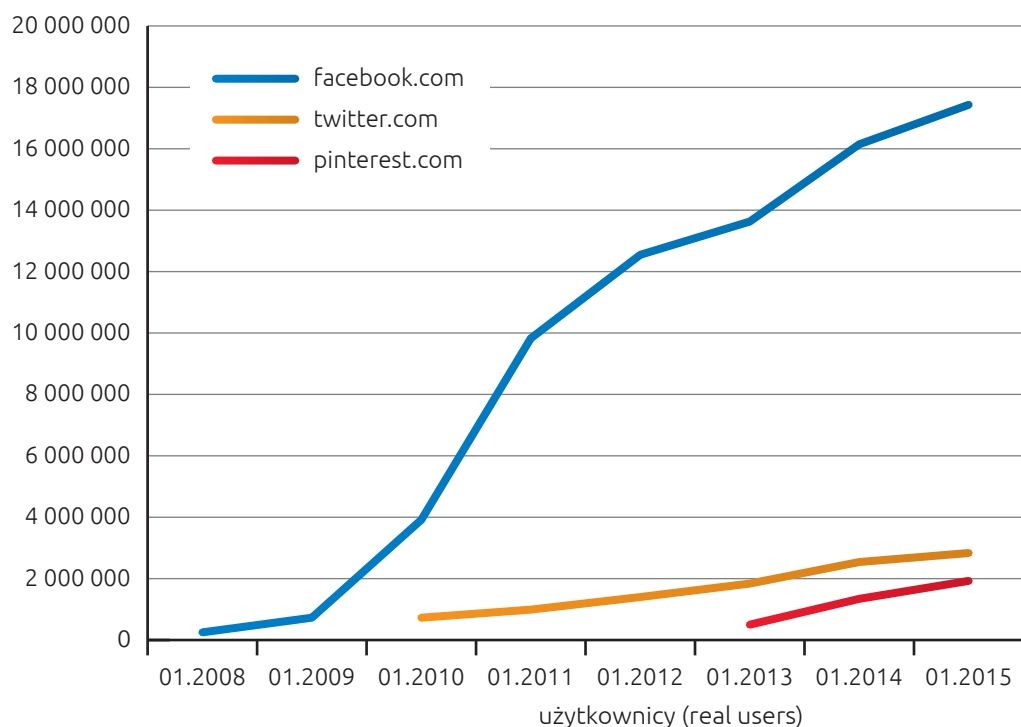
## Overview of three ecosystems in Polish digital space

There are three global "ecosystems" currently developing in digital Poland: Facebook, Twitter, and Pinterest.

Chart 1 shows a comparison between the number of users of all these three ecosystems among Polish internet users. The indicator "użytkownicy" is translated into English as "real users" and refers to the number of people who have visited any website within the ecosystem's domain.

In order to picture the extent of the three ecosystems among "digital" Poles, we took into account only the results from the month of January in the years 2008–2015. New ecosystems emerged within Polish digital space every two-three years. It seems that in 2015 they are still in the process of growing, even though the growth is not as fast as it was for Facebook between 2008–2010.

**Figure 1.** The growth of Facebook, Twitter and Pinterest in Poland, 2008–2015

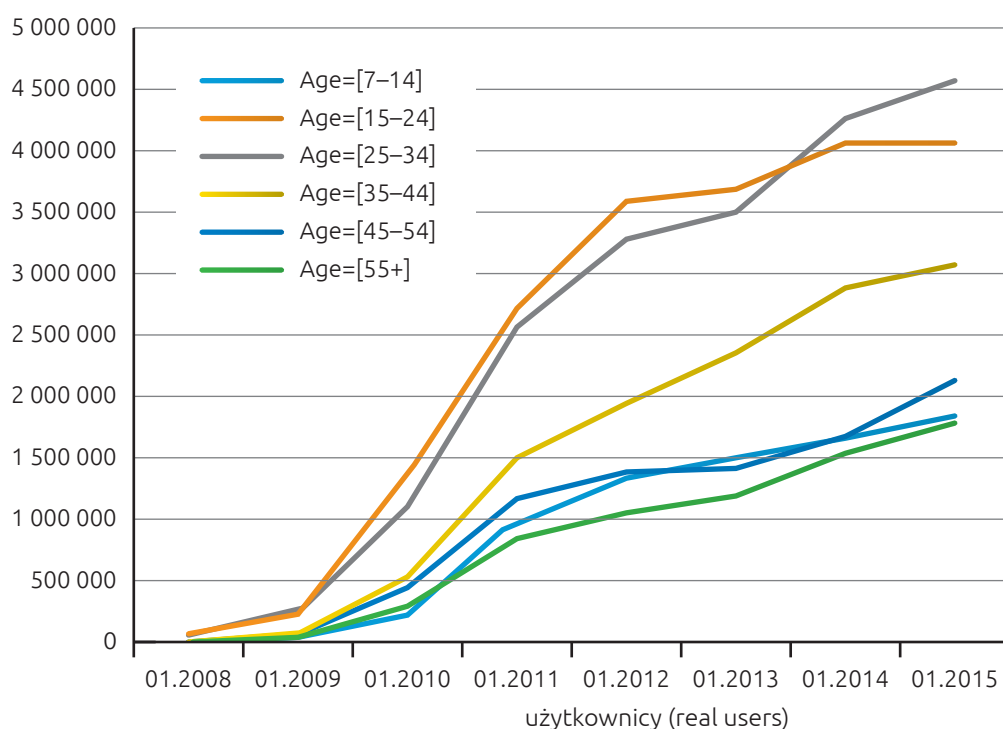


Source: Megapanel PBI/Gemius.

## Age-related differences in the use of Facebook, Twitter and Pinterest in Poland

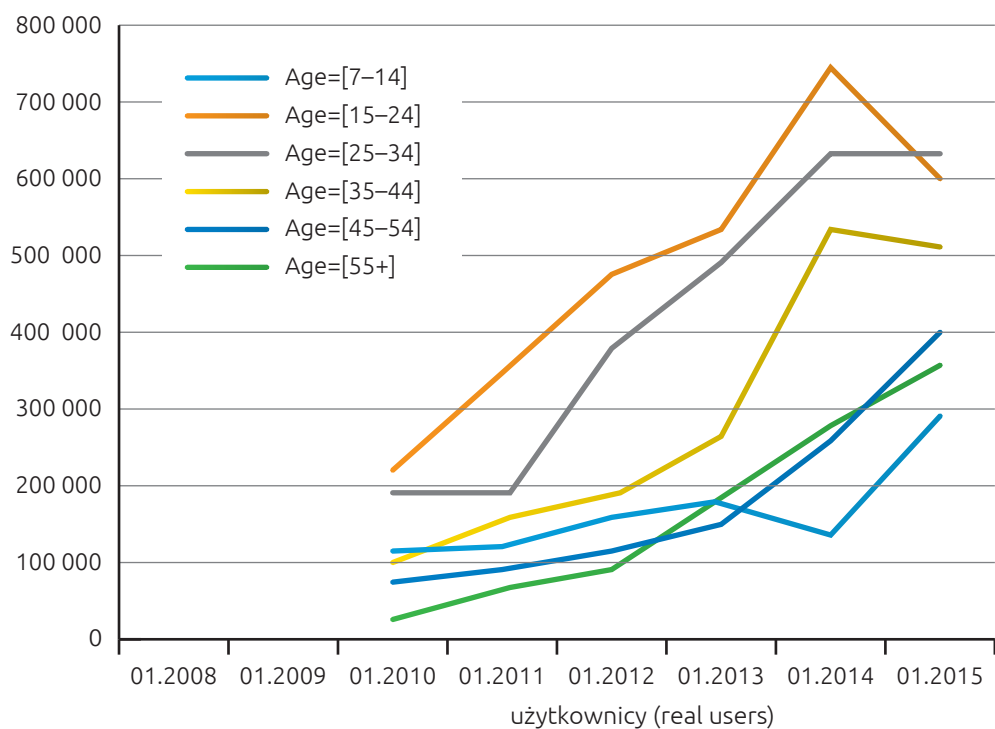
Is the growth dynamic the same or equal among social groups? We have checked the growth of Facebook among different age groups since the beginning of the service in Poland. As chart 2 shows, even in the aging population of Poland—and that is "digital" Poland—the increase of the number of people (expressed in "real users" measure) who are 45 and older is less considerable than the growth of the number of users aged 15–34.

**Figure 2.** Facebook popularity among age groups in Poland



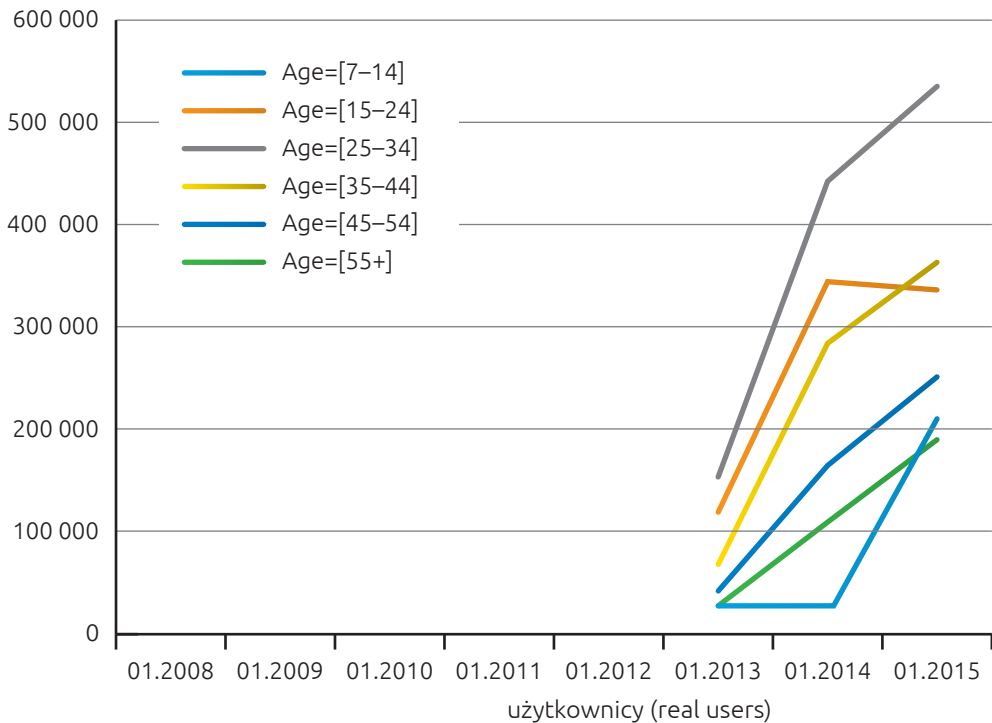
Source: Megapanel PBI/Gemius.

Is such a situation unique only to Facebook? Chart 3 shows a similar phenomenon for Twitter. Since the beginning of this ecosystem's operation in Poland, the highest point of its usage among those aged 15–34 was in January 2014 (although this number decreased in 2015). The age group 45–54, as well as 55+, are among the least present among the "real users" of Twitter.

**Figure 3.** Twitter popularity among age groups in Poland

Source: Megapanel PBI/Gemius.

In the case of Pinterest, it is also visible that this ecosystem is the newest as to its usage in Poland. But it has been growing steadily year after year in all age groups, especially in the age group 25–34.

**Figure 4.** Pinterest popularity among age groups in Poland

Source: Megapanel PBI/Gemius.

All the data we have shown make it clear that the three globally present ecosystems—Facebook, Twitter, and Pinterest—are popular mostly among young people in Poland. When comparing their audiences from the age perspective digital inequalities can be seen. Older users seem to get engaged in Facebook, Twitter, and Pinterest more slowly than young users. Sometimes, as in the case of Facebook, this trend lasts continuously, but sometimes it changes slowly over a period of time. The general age gap remains and is visible especially in between those aged 15–34 and those aged 45+.

The Facebook user age structure expressed in "real users" in Poland is 5,9 million "young" and 3,9 million "old" users. Twitter "real users" in Poland are 0,89 million "young" and 0,76 million "old" users, whereas Pinterest "real users" in Poland are 0,54 million "young" and 0,44 million "old" users, as expressed by the number of "real users." All this data can be shown through indices highlighting the age gap in these three ecosystems: for Facebook, the proportion of "young" to "old" users is 1,51; for Twitter, it is 1,17, and for Pinterest, it is 1,22.

This description raises the following question: are FB, TT, and Pin—as they are called unofficially—not equally attractive to everyone? Why are there so few Polish users aged 55+ (see charts 2–4) within these three ecosystems? Are the users who are 55 and older not interested in the new ecosystems or are they excluded from them in some way?

## **Content-related digital divide and genre-related digital inequalities?**

The age-related digital divide has already been well described in internet studies. Here, our main idea is that, in relation to digital ecosystems, it is the content-related digital divide rather than the age-related digital divide that constitutes a barrier to digital communication between different generations of people. Both sides of the digital divide are inter-related but content-related aspects are more dominant.

If this is so, the question emerges as to what content-related competences do internet users aged 55+ miss?

One of the main absent competences is understanding digital genres. The genres can be incomprehensible and, as a consequence, they can erect barriers to intergenerational dialogue.

Thus, at present, digital (and social) inclusion requires new tools of understanding the genres. In other words, for a successful digital inclusion we need to understand digital genres and in order to do so we have to teach them. Therefore, the following research areas are subjected to scrutiny: the use of communication techniques (including technological dimension), the construction of distribution and the exchange of opinion, and semantic comprehension of logo-visual text and understanding of their internal message structure.

Why is it so? Nowadays, genres are frequently created anew, although in some way they relate to the genres well known in non-digital reality. However, the medium fundamentally changes the texts created in it and their functioning. Our metaphor of stalactites and fireworks can be helpful in understanding new digital ecosystems and genres in question. According to this metaphor, once genres were as stable as stalactites; nowadays, and online, they are more like fireworks. In other words, there are no long-lasting genre indicators in the digital world. There are only parts or fragments of structural forms (e.g.: recurrent themes, publishing framework, particular



styles, etc.) that continually change, transform, and migrate further, but the function of communicating remains and is predominant. Hence, we call them DGCF, which stands for "digital genre communication forms".

It is especially important to consider them from the perspective of the last 20 years of the emergence and subsequent mutating of network communication forms. All the modern genre research into the Internet conducted so far has shown the difficulty of connecting different aspects of present-day knowledge about genres with network communication practices. Researchers dealing with multimedia issues often struggle with the definitions of genres, their implementations, and classifications. To describe the difficult nature of the web, genre researchers usually rely on the concept of remediation proposed by the media experts Jay Bolter and Richard Grusin. Remediation is the logic "according to which new media are transforming the earlier media forms" (Bolter, Grusin 2000: 273). No new media form is born from scratch, the researchers say, all new media technologies rely on old technology transformation, modernisation and addition of the newest media technologies. Each new form is therefore "a representation of one medium in another".

In addition, genres may be mostly understood from their social aspects (Hare Trammel et al. 2006; Wojcik, Dryll 2008; Gill, Nowson, Oberlander 2009; Cywińska-Milonas 2002; Marecki 2002).

Network users, unfortunately without much success, also have spirited discussions about web genres. Definitions generated by them in American literature on the subject are referred to as Meta-Genre (Giltrow 2001). However, from the point of view of literary experts, it does not seem right to use the term "Meta-Genre" in this meaning, nor does defining genres only through user awareness. This is because there are usually standard rules operating as a collection of unwritten and even unconscious rules and regulations, to which text is subordinated. Also, some research is being conducted in the area of sociology (Santini 2014). Its aim is to determine which new online genres are identified in reception. There have been three types of web recognisability distinguished: (1) recognisable, although in a vague way (*ambiguous web genres*; blogs belong to this category), (2) transparent or easily discerned (*easy web genres*), and (3) unrecognisable (*difficult web pages*).

In the traditional meaning, genre science (genre studies) is defined as a section of poetics dealing with the types of literary genres, examining the definitions of these concepts, ways of their existence, descriptions of the structure, typology or systematisation of literary material, as well as the historical development of genres, historical systems of genres and layers of genre awareness, the use of names, and genre concepts

(Cudak 2007). The origins of Polish genre studies, which has had a significant contribution to the development of the discipline (conferences, symposia, collections of essays), are associated with the scholarly activities of Stefania Skwarczyńska. Further findings in the so-called New Genre Theory (Balcerzan 2007) have been made pointing to parallel and different directions, leading, on the one hand, to research into new literary forms (Grochowski 2000) and indicating, on the other, a need to study non-literary texts that are of interest to genre researchers.

Thus, modern Genre Theory is a discipline understood more broadly than traditional genre studies limited to literary genres. Proponents of the New Genre Theory postulate stretching the concept of "genre" into the whole sphere of social communication situations. Following Bakhtin, they argue that "We speak using only certain genres of speech ... Genres of speech are given to us in almost the same way as the native language, which we use without difficulty even before the theoretical mastery of grammar" (Bakhtin 1986: 373). In this sense, modern genre science deals with every utterance, printed at a prestigious publishing house and written on the Internet by an anonymous user. As Bolecki wrote, understanding of the genres as solid forms referring to the new media must turn into situational genres (Bolecki 2007: 217). As can be easily seen, the term "genre" is intertwined with many historical, terminological, and ideological complications.

New forms of genre studies have also been created, for example media genre studies and intersemiotic genre studies. Researchers of linguistic genre studies take slightly different positions (Witosz 2002). According to linguistic genre studies, "genre" is to a large extent a notion generating a notion: "Genre—today most often understood after Bakhtin as the type of text—is treated as a theoretical construct (*conceptus mentis*), placed at the level of abstraction; a text model containing both unchanging and variable features, regulated by practice (convention, habit, norm). The concept is also often placed in an intermediate realm between the system (abstract model) and its textual actualisation—at the level of norm. Then the genre is treated as a pattern existing intersubjectively in the communicative competence of the members of a given community in a given culture, which—despite being transformed along with the historical-cultural changes—operates as a systematizing force" (Witosz 2004: 42).

New DGCFs require new skills from those users who would like to be engaged in communication using genres. In Table 1, we show two levels of creating and receiving DGCFs.

**Table 1.** Technology-related and meaning-related levels of creating and receiving DGCFs

<b>Creation and reception can have two levels:</b>		
	<b>Creating DGCF</b>	<b>Receiving DGCF</b>
Level 1. Outside the text (technology-related)	<ul style="list-style-type: none"> <li>• Formal organisation (a publishing frame, which allows for a specific visual organisation of the content)</li> <li>• Organisation of social circulation that enables a dialogue between the senders and their audiences</li> </ul>	
Level 2. Inside the text (meaning-related)	<ul style="list-style-type: none"> <li>• Strictly connected to semantic comprehension of logo-visual texts</li> </ul>	

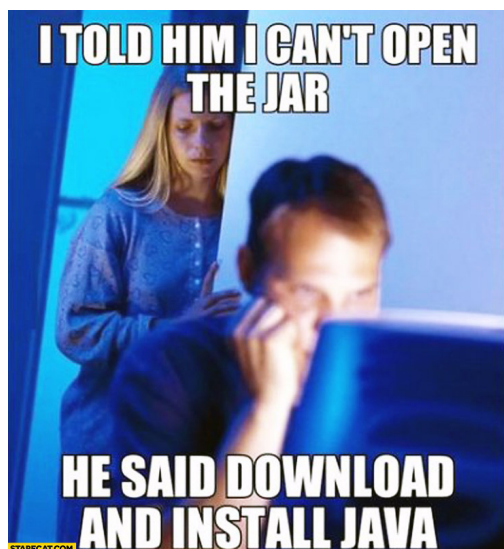
Factors found inside the text are also connected to the six communication functions distinguished by Roman Jakobson (Jakobson 1989). They are the referential, poetic, emotive, conative, phatic, and metalingual function, each associated with a dimension or factor of the communication process, which includes the sender, the receiver, the message, the context, the channel, the code.

The consequence of two-level DGCF creation and reception is a proof that we need both technology-related and meaning-related competences in order to be a competent DGCF user (one either actively creating or actively receiving them).

DGCF enable effective communication, i.e., they help in creating social bonds, in implying an agreement and sometimes even in encouraging participation in community actions. To put it simply: DGCF allow for a correct understanding of the message.

Let us see this by looking at a concrete example of the selected meme. Participation in the circulation of memes is associated with getting to know the code, which is used by a given community. The point is to know the context, be able to read the message, react to it in the right way, aptly pick up the style (parodistic, for example), get the hint, understand semantically the combination of a picture and a verbal comment. In a word, to have the competence for receiving DGCF properly and advantageously.

In such a case, understanding the message and, by the same token, participating in a social networking game of creating or sharing memes does not require any additional comment or introduction, which in turn demonstrates a high competence in navigating the net. It also determines the opportunity for a recipient to participate in the community.



**Illustration 1.** <http://www.memecenter.com/fun/444562/no-title> [access: July 2014]

The illustrated meme is entertaining and comprehensible, but on two conditions. The first is to have a competence of DGCF, that is, the knowledge of (1) the meme's publishing framework, i.e., of the visual shaping of the message specific to this genre (memes usually operate anonymously, apart from the concrete author, and are not linked with just one internet platform, and so they appear on different web sites or services, for example, they may be recommended by e-mail or on Facebook.com); (2) an understanding of how the meme exists in social circulation (in the case of memes, it is a mechanism of viral content, a content recommendation system); and (3) the ability to receive semantically the message connected directly with the poetics inherent in a given genre (the meme is based on irony, comic qualities, a juxtaposition of contradictory meanings, and the semantic whole of the message is formed at the interface between an image and a word; the meaning of a message cannot be reduced only to the image or only to the word). Thus, we speak of the external and internal factors of DGCF.

The second prerequisite for the full communication process to occur is the knowledge of the homonymous definitions of the word "jar". For the presented meme is based on the semantic play between homonyms.

What is going on here? The situation illustrated in the above meme reminds one of a typical situation between spouses seeing each other at home in the evening. She moves around the kitchen in her pajamas and he sits in front of the monitor. Thus, we have two heroes of the story, the narrator, however, is the woman and it is from her perspective that we are seeing the situation. The heroine asks the man for help in opening the jar (the first meaning of the word "jar"). But the man who is completely absorbed

in surfing the web responds by saying that she should download and install Java. The joke refers to the second meaning of the term "jar", that is, JAR in the language of programmers (ang. Java Archive) is a ZIP archive used to structure and compress Java class files and the metadata linked with them.

The meme plays on the opposition of what is male and what is female, as well as on the diversity of languages and the impossibility of good communication. This is one of the frequently recurring themes of universal culture: "Women are from Venus, and men are from Mars". The woman wants to open a jar but the man gives her instructions on how to cope in a situation when one has a problem with opening a Java archive.

The kind of the font is also important. The font in the illustration is simple, sans serif, revealing unprofessional preparation of this material. Even at first glance, it is to be visible that an unprofessional graphic designer worked on the message, he did not refine the colours and fonts, he did not devote too much time to the finishing of the photo. Here we find ourselves in a genre world of rapid home-made "production" which is based on the instantaneous creativity and a simple concept, and not on the quality of the work. The meme stands in opposition to the quality understood as the fine-tuning of every detail: just like children we are to play on the net spontaneously, in every respect the rule is: it is a work-in-progress. For memes represent a social game on the web. To participate in it, you must know the existing rules of DGCF.

In order to understand the concept, the knowledge of the functioning of DGCF is needed. One of its elements is the meme (in this case, the meme that functions in the community of Java developers) and another is the meaning of a specific term. This is not a drama of communication between people but a slightly ironic commentary with an addition of humour. It refers to the situation well known from real life and is addressed to a given social community. It also aims at encouraging people to create their own memes. A good meme makes subsequent communication participants join in the fun and further messages are created within the framework of the series which was once started.

DGCF are not only logo-visual but also social phenomena. The new genres are not just objects of aesthetic perception, but they are also a significant mass social occurrence (cf. Bakhtin). As such, they are a means of intergenerational and also, potentially, intergenerational communication. To make the intergenerational exchange of messages possible, we need to provide skills that could be used at both levels: the technology-related and meaning-related levels of creating and receiving DGCF. This is the challenge for a digital inclusion work.

## Conclusion

We need to speak of DGCF in order to truly grasp the concept of digital competences (thus: DGCFs → DCs). Creation and reception of digital genre communication forms reveal digital competences.

The next step is to move from digital competences (DCs) to social actions, as digital competences are relevant to mutual understanding between people, as well as to taking action.

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# Data visualisation as a tool for preventing information overload

Until recently, data visualisation remained of interest to a small group of analysts, researchers and information design specialists. Painstakingly developed diagrams, which took some practice to read and understand, filled the pages of expert reports, papers and research publications. This situation has changed dramatically over the last several years, as formerly niche information design made inroads into mainstream media, e.g. journalism and advertising, and information designers became celebrities at conferences bringing together trendsetters from the world of new technologies.

One reason for the extraordinary popularity of data visualisation is the accelerating datafication process, namely the production and collection of numerical data for almost all phenomena and areas of life, in particular those which are still not seen as interesting sources of information (Mayer-Schönberger, Cukier 2013: 73–83). Content saved in digital form can be easily processed and subjected to automatic visualisation, aided by the many, increasingly easy-to-use applications available. Datafication, as part of the algorithmisation process, is becoming a new cultural paradigm thanks to accessible data storage tool prices, large-scale analogue content digitisation programmes, the rise of the "Internet of Things" (in the form of data produced by objects of everyday use) and, above all, huge quantities of content produced each day by the users of social networking sites.

In this article the practice of data visualisation is considered in the context of information overload, assuming that it is not characteristic only of information society,

but a regular phenomenon in the history of culture, occurring at the key moments of change in media environment. It is assumed that with the development of infosphere, societies produce the necessary strategies to counteract this overload. In addition to the aforementioned design solutions (information design and data visualisation), these include technological tools (algorithms, automatic filters, data processing systems) as well as mechanisms for social content management (curatorial practices, social tagging, etc.) which are basically adaptations of existing mechanisms for information processing to the current challenges and social conditions (Piekarski 2014).

I see data visualisation as one of the basic tools for mitigating the negative effects of the information chaos, while many communication researchers consider these visualisation practices to be yet another proof of the dominance of image culture and evidence of the crisis or even the demise of our civilisation. This misunderstanding is the result of a superficial interpretation of the essence and functions of digital visual messages. Data visualisation does not belong to the same image universe as classic reportage photography, primarily because it has no claims to direct representation of reality<sup>1</sup>. Its potential for clear presentation of large data sets and storytelling comes from combining the numeric language of computers with the tailor-made synthetic visual language.

For a better understanding of the relationship between the world of numbers and imaging techniques, let us go back to the late nineteenth and early twentieth centuries and look at the social context of the then emerging cinema and the Herman Hollerith's electric calculating machine. Both inventions, eventually synthesised into the modern computer (Manovich 2001), developed in response to the rise of mass society and a need for a new, more democratic model of knowledge, breaking with the hierarchical model of the world and the linear structure of the book. Round about the same time, attempts were made to create universal information management systems that could use the intellectual capital of various social groups to eliminate the consequences of globalisation and the associated defragmentation and dispersion of knowledge. The first decades of the twentieth century brought the theory of a universal knowledge system by Paul Otlet, the idea of the World Mind by Herbert G. Wells, as well as the Isotype universal visual language—the subject of my particular interest.

Like the modern computer, the Isotype visual language positions itself at the intersection of the development of computational techniques and modern media. While the former helped society cope with information overload and the second created an

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1 Compare it with Lupton (1986) and Gitelman (2013).

alternative model of perception, Isotype combined the two trends to offer a promise of a universal tool for describing reality. Isotype's most important legacy is the transformation mechanism of converting figures into images using a specially developed visual language. The person responsible for such transformations acts as a gatekeeper, and sometimes a curator, whose task is not so much to find a neutral way from the data to the image, but mainly to endow the facts with meaning.

"It is the responsibility of the 'transformer' to understand the data, to get all necessary information from the expert, to decide what is worth transmitting to the public, how to make it understandable, how to link it with general knowledge or with information already given in other charts. In this sense, the transformer is the trustee of the public" (Neurath 2009: 77–78).

In a narrower sense, transformation is a design process which involves defining the relationship between data and image. It is an attempt to use figurative language to present abstract relationships and concepts. It is often based on the search for synthesis and even breaking the Western culture's traditional opposition between image and natural language, between quantitative and qualitative values, between the tangible and the abstract as well as what is individual and what is collective. Using the language of new media, transformation is a creative use of the tension between the traditional linear narrative and database logic. It is in the context of such rhetorical devices, that the author of this study considers data visualisation a potent tool for dealing with the negative consequences of information overload.

Among the ample legacy of Isotype books, I find the *Modern Man in the Making* (Neurath 1939) of special interest. A proposal to describe the history of mankind in a publication which size and format are more akin to a geographical atlas, than an academic monograph, reveals a typical modernist ambition—if not conceit—that synthesising vast historical knowledge is a feasible task. Importantly, the authors are not interested in traditional historical narrative focusing on political events or wars. Instead, they give their utmost attention to social and economic issues and their impact on human emancipation. Even the type of content presented, e.g. statistical data on economic output, demographics and quality of life, forces the use of a data-driven approach to storytelling. In one of the visualisations authors try to capture the essence of the industrial revolution by showing the way textile production changed between 1820 and 1880. Arranged in neat rows, the pictograms present both the volumes of fabrics produced and the numbers of workers employed respectively in family workshops and industrial plants. The subsequent years show an increase in productivity, as production shifts to large factories. After 70 years, the same number of weavers is able to produce over 20-fold more cloth (53). Other

visualisations in this publication use data on working times, fertility rates, or average incomes to show how people's living standards changed in the most industrialised countries.

These methods of presenting the relationships between data sets have since entered the canon of information design and are now creatively adapted to the new technologies environment. *The Fallen of World War II* (Halloran 2015) is a recently published project which efficiently combines a linear narrative with database logic and a way of presenting the figures using the pictogram multiplication method developed by Isotype creators. It is a several minutes' long animation on the number of people who died in armed conflicts with particular emphasis on WWII. There are interactive elements woven into the story which enable the viewer to explore and compare the presented figures. The finale of the presentation is personalised by introducing the current time at which the animation is viewed. The authors describe it as a data-driven documentary, but can be easily classified as part of recently popular genre of data storytelling.

Both Neurath's *Modern Man in the Making* and the above animation fit into a trend present in data visualisation projects which aspires to create a synthesis offering a broad picture of the presented issues (so-called big picture). Interactive tools allow users to start navigation from the general, introductory plan, and then explore the issues in a manner appropriate to their own individual preferences and interests. The advantage of this type of narrative is the fact that the subsequently reported information items already have a context, which makes it easier to put them in a wider field of view. This practice is of course susceptible to the threat of undesirable intellectual shortcuts and simplifications, but it clearly shows the need to restore a coherent picture of reality which lost in the chaos of multiple viewpoints and variety of data sources.

The previously mentioned tensions between the concrete/individual and the abstract/collective opposition are efficiently used to create organisational principles for interactive digital database interfaces. This is clearly confirmed by the evolution of large statistical data repositories, such as European Commission's Eurostat (2015) or the Internet service run by the Organisation for Economic Cooperation and Development (2015b), as they are transformed from typical storages of different kinds of statistical data files into sophisticated tools which present information in the form of diagrams, charts and maps, providing an easy way to read and compare various parameters<sup>2</sup>. In terms of design solutions and functionality, the OECD service stands

2 OECD Better Life Index (OECD 2015a) is a particularly interesting example.

out above all others. Available to the user are not only efficient search tools with which to find relevant information, but first and foremost the functionality to generate their own charts which they can share with other users or embed directly in their online projects. Thanks to automatic visualisation and sharing tools, the otherwise inaccessible statistical data resources are endowed with context and human dimension, while preserving measurability and precision of numerical data.

Another example of personalisation in projects that use large statistical databases on demographics is an application *The world at seven billion* created by journalists from the BBC (2011). After entering their date of birth and place of residence, it provides the user with information (presented in a captivating manner) about which in turn inhabitant of planet Earth they are, how many people actually inhabit our planet, and what the demographic forecasts for a given country are. The application shows the position of a given person and country in the context of global demographic changes. The user gets an opportunity to grasp the idea of historical change, learn about the population growth rate and observe development directions for individual countries. This simple application, built with the help of readily available data, is very successful in providing an instantly accessible and interesting account of an issue that would be very difficult to present in the form of a traditional linear newspaper article.

One of the tasks of data journalism is the search for stories in large sets of unstructured content. Interdisciplinary teams of journalists, programmers and designers have the analytical and development tools enabling new kinds of journalistic investigations as well as new ways of communicating with their audiences. Data journalism is particularly important in a culture of openness, as more and more information is available in the open data model. What is the actual use of hundreds of gigabytes of public data if they are not arranged in a legible for the potential audience? Is open data, unless someone supplies a proper context and arranges it into a digestible "story", capable of improving the functioning of democracy? In an environment of information excess, it is the journalist's duty to peer beneath the surface of this jumbled flow of information, search for their new relationships and giving them meanings, but primarily to assist users by preventing them from getting lost in the information-overloaded environment<sup>3</sup>.

It is no coincidence that data journalism has rapidly risen in popularity since the release by WikiLeaks of US diplomatic cables and classified documents concerning the wars in Afghanistan and Iran. The content then published comprised many inter-

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<sup>3</sup> For more information on data journalism go to (European Journalism Centre and Open Knowledge Foundation 2012).

esting, if not shocking, stories, but first they had to be "found" in large databases and arranged in an appropriate form to be of interest to the general public. As a result, some important projects were completed, mapping killings during the Afghanistan and Iraq wars. For example, interactive projects by the Guardian provide a detailed account of the locations and nature of the clashes and the number of casualties among military and civilians (McCormick, Allen, Dant 2010). Similarly to the previously mentioned implementations, objectified report-based data records become much more meaningful when we see them on the map and "pin" them in a particular location.

A successful combination of the intangible character of the database with the tangibility of specific deaths is even more evident in *The Deaths of Afghans. Civilian Fatalities in Afghanistan, 2001–2012* (The Nation 2015) and *Out of Sight, Out of Mind*, projects delivered by the Pitch Interactive (2015) design studio from Oakland, US. The former, created for *The Nation* magazine, provides us not only with the number of people, split into military and civilians, who were killed in various incidents, but also the place and type of attack (land or air) and the name of the responsible general. The second project is intended to draw America's attention to the consequences of the seemingly precise, drone raids on Pakistan, in which relatively few military targets are hit and the victims are usually civilians, including children. While statistics often reduce human lives to relatively insignificant numbers, both the project provide the much needed context to convert abstract figures into real tragedies, thus drawing attention to the fate of civilian victims of military actions. Thanks to this kind of productions, WikiLeaks vast database repositories, rather than adding to the information chaos on the Web as another source of often unverified content, become a tool for a critical review of the mainstream media coverage battlefield stories, which often ignore inconvenient facts<sup>4</sup>.

For this reason, data journalism may be perceived as an interesting example of convergence and one of the few constructive responses of the industry to the crisis of traditional media. Though it is often referred to as "visual journalism", the essence of data journalism must not be reduced just to creating visualisations, since in terms of means of expression, it places itself at the intersection of image, computer language and natural language. In extreme cases, data journalism may be considered an example of media tabloidisation, although it is a very superficial and in fact false view (although both phenomena can have a similar source in the ongoing crisis of natural language as a crucial tool for the production of meanings in culture). As a matter of fact, images used by data journalists belong to the realm of technical images—in

4 For other examples go to: (Rogers 2010), (Rogers 2015b) and (Rogers 2011).

Vilem Flusser's (2013) terms—in that they contain no claims to any direct representation of reality as is the case in photojournalism. This does not mean, however, that they do not attempt to describe this reality. They definitely do, but using other means.

The potential of data visualisation as a tool for filtering information can yield even better results thanks to the simultaneous use of several different content processing strategies. The most obvious examples are tools for automating data processing, but the most interesting results can be achieved by expanding the scope of activities to include social networking strategies. An excellent example of combining several data filtering mechanisms were the steps taken by the Guardian's (Rogers 2015a) data journalism department in connection with the illegitimate expenditure by some of the UK's Members of Parliament. A five years' worth of data on expenses reimbursed by the state was made available in the form 5500 PDF files containing scans of hundreds of thousands of receipts and invoices. An internal Guardian team created a crowdsourcing application which enabled volunteers to easily view and describe the scanned documents. Thanks to the work of more than twenty thousand volunteers, a relevant online database was quickly compiled. This, in turn, provided the basis for clear visualisations allowing easy and quick comparison of spending by MPs representing various political parties.

This story shows how important transparency and citizen involvement in the process of data processing and visualisation is. Granted, today the Isotype philosophy may be seem objectionable with the patronising attitude of the information designer (transformer) towards the general public, which was so typical of the twentieth century mass media. In order to balance the relationship between the specialist creator and the education-hungry recipient of visual content, users need to acquire basic competencies in working with data. The hundreds of courses, tutorials and easy-to-use tools already available on the Web are a clear testament to the rapid democratisation of the field so far reserved for a small group of analysts. If indeed the language of data is replacing natural language in the process of knowledge creation, people need to acquire certain data processing skills with which to form the foundations of a new literacy, just as more and more social groups before them learned to read and write, creating a modern society.

"The history of previous information overload panics and the tools that were devised to cope with them suggests that a period of info overwhelm after the invention of every radically more efficient means of communication tends to be greeted by alarm, followed by new info tools and the growth of newly literate populations" (Rheingold 2012: 100).



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# Beyond laboratories...

## Selected results from the ethnography of Polish hackers

This working paper discusses the results of exploratory study of hacking communities in Poland, done by the Author from 2013 until 2015 In five Polish cities. By using ethnographical methods and Science and Technology Studies (STS) framework, it discusses potential importance of non-formal IT and electronic groups for education, business and research social worlds.

The paper builds on microsociological approach, mainly on educational biographies of hackers and description of everyday transactions done in the hackerspace. Following this route, I also describe how hackerspace is constructed by different actors—by its founders, by latecomers, by officials, by business and by academia.

Second route of analysis is the study of hackerspace as a laboratory; a place where knowledge, science and technology is created, exchanged or reproduced. The notion of laboratory is well stated in STS, from which it could be translated into non-academic applications (e.g. social innovations theory, education studies).

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<sup>1</sup> Work was funded by University of Warsaw Digital Economy Lab Research Grant (March-April 2015). Research continuation (from April 2015) is being funded by National Science Centre Preludium Grant 2014/13/N/HS6/04113.

Last parts of the paper are recommendations for policymakers. I also outline applied research perspectives for social sciences that could be explored in future research of hackers and misusers.

## Introduction

Technology always existed as a half-way between formalism and informal practice. Regardless of whether or not it was technological research laboratories, industrial design bureaus or factory-shop floors, formal knowledge structures were also supplied by informal transfers.

Several historical accounts of the technology in the twentieth century were aware about this characteristics. This line of thinking was also taken by sociologists of technology, especially from the field of science and technology studies. For example: Walter Vincenti showed that aircraft engineering benefitted from formal aerodynamics as much as the later learnt from the field test procedures (Vincenti 1990). This historical claim is also supported by biography of Clarence "Kelly" Johnson, a chief of Lockheed experimental air engineering laboratory "Skunk Works" (Johnson, Smith 1985). Louis Bucciarelli and Dominique Vinck showed that engineering should be regarded as a different field, only partially connected with formal knowledge institutions (Bucciarelli 1996; Vinck 2009).

Similar discrepancy between different groups creating knowledge could be found in the history of computing (Juza 2009; Aker 2007). Openness of the mathematics community was less evident for the engineers, especially for those closely collaborating with military. This controversy revolved around access to knowledge (publicly available vs. industrial patent/political secret) rather than on formal/informal practice, but one key issue remains—science, engineering and technology are not homogenous, neither uniform areas of social life. Different scientific disciplines or branches of engineering use slightly different approaches to truth, stability or usefulness. Differences in language, symbols, attention to mathematics or practicality or even different ontologies result in formation of different "epistemic cultures" (Knorr-Cetina 1999).

Garage inventors, "do-it-yourself" (DIY) tinkerers and hackers could be seen as an end of the whole continuum rather than direct oppositions to existing formal academic, civic or business institutions (Juza 2011). As it will be shown later, hacking

communities could also act as a meeting places for different epistemic cultures, establishing what was called "trading zones", where different purposes or knowledge systems might interact or be exchanged (Zaród 2015).

Empirical research presented in this paper, was focused on the hacker / maker community in Poland. Hackers (defined by themselves) are tinkerers, IT enthusiasts, programmers and electronic DIY communities (Coleman 2009). Makers are more connected with material engineering, especially with 3D printing, CNC machines etc. Hackers organise themselves in hackerspaces, term that describes both community and physical space (Maxigas 2012). Makers group themselves in makerspaces or fabrication laboratories (Fab-Labs). Difference in names are more likely to be a PR tools rather than sign of differences. "Maker" associations are likely signals of openness and general-DIY approach, whereas "hacker" might signal underground or subculture style. In everyday operations, difference is vague, as both types of activities blend together (Gershenfeld 2007).

Depending on the particular case, places could be organised as a NGO, academic spin-off, commercial place (machines for rent) or informal group (Zaród 2013b). Common issue for all those initiatives is a commitment into open-source / open-hardware projects and references to hackers' ethics (Coleman, Golub 2008). All of those spaces do not endorse illegal activities, such as cracking, password stealing or internet scamming.

Introduction of Raspberry Pi and Arduino (cheap and open-license) electronic circuits together with lowering costs of 3D printers started "third wave of hackerspaces", connected with classical DIY (e.g. woodwork, plastic), education and public engagement (Gershenfeld 2007). Previous generations of hackerspaces concentrated on computer DIY (homebrew computing) and Linux / Unix systems. This typology is based on the classification developed within hacking community (Maxigas 2012; Farr 2009).

Organised and formalised institution, known as "[City] Hackerspace Association", has existed from 2012, so it could be placed within "third wave of hackerspaces" (Maxigas 2012). It was one of the first hackerspaces in the East-Central Europe. Due to short history, unusual place and rapid changes of IT, one may suspect that hackerspaces in Poland might be somewhat different than groups researched previously in western countries.

Introduction of the new hardware and rising number of hackerspaces created opportunity to study them during development phase, enabling to see how local characteristics shape up forms of these groups. If we take together humans, their computers, web image, fabrication machines and communication channels, the result is a hacking collective, where digital, social and technical actors are indistinguishable.

## Theoretical foundations

Hacking ethics and community processes were researched within cultural anthropology (Coleman, Golub 2008). Still, this issue is an important research topic within IT research community (Raymond 2001). Research by Gabriella Coleman focused on the hackers' ethics and followed methodology developed within cultural anthropology (Coleman 2013). Hacking was described as a applied liberalism, where different political, professional and lifestyle choice both co-exist and are subject of constant renegotiations (Coleman, Golub 2008). This approach aims to explain dichotomies such as:

- Between collective production of open-source software knowledge and individualism of the hackers;
- Between different political choices of the hackers (from anarchist-left to free market right);
- Between openness of the knowledge ("Information wants to be free") and attention for the privacy and individual rights.

Coleman's and Golub's argument focuses not on the exact results of these choices ("Who is the real hacker?") but on the ability of the hacking culture to include nearly full spectrum of the possible answers and their different interactions.

IT studies concentrated on computer security issues ("Human factor" as a possible weakness), but due to rising complexity of problems even computer sciences consider human actors as an important issue in the seemingly "purely technical" security research.

Tinkering and DIY practice research has a long history in STS studies. The issues of knowledge transfer, tacit knowledge and epistemic cultures are still being researched and discussed in contemporary research (Collins 2013, c2010). Introduction of low-cost, popular programmable microcontrollers provides opportunity for studying tinkering and DIY in the newly set collectives.

The Author's idea is to supplement existing approaches with findings from the STS and history of technology, focusing on hackers not as a subculture or a liberal practitioners, but as knowledge makers. The object of the study is not a virtual community, or a number of individuals, but a group meeting in physical basement in a regular manner. The virtual presence is also maintained in forms of webpages, chats and discussion lists, but physical world act as a meeting, tinkering or hacking place as well.

## Research methods

At the beginning the study operated within classical sociology, as the PhD supervisor was working within symbolic interactionism. Despite knowing basic concepts of STS (Sismondo 2010) I decided to learn observation and interview conduct from classical methodology (Babbie 2008) books before moving into Actor-Network Theory approach (Latour 2005).

Being trained as an applied physics engineer, I had less problems with examining the role of the objects in the collective. Before starting PhD track in sociology, I was involved in creating fab-lab in the other city (Zaród 2013a). I also had experience in science-tech-engineering-mathematics education (STEM) research and didactics.

The initial aim of the study was the description the epistemic culture of the hackers and comparison with the counterpart existing in the local academic research community in the field of electronics, automatics or computer sciences. Another object of comparison was local students' science club at the technical university. The aim was to observe how different degrees of formality affect research and development. Hackerspace was considered least formalised, science clubs and construction groups as semi-formal and academic laboratories as most formalised.

During the research, the study evolved from ethnographical comparison into a case study development. Additional field research (e.g. in the academic laboratories) was gradually limited toward sensitising role—major part of the ethnography (hackerspace research) is a time consuming process, especially in non-formalised organisation without regular schedules. I decided to use shorter visits in other hackerspaces, laboratories and software companies not as full-scale comparisons but as a sensitising tool (Blumer 2007) and devoting myself into ethnographical study of the hackerspace.

The empirical part of the paper is based on the ethnographical observations being made from October 2013 until June 2015. During the first half of this period (until March), observations were less frequent (once per week or fortnight). From November 2014 until February 2015, regular observations were conducted in [City A] Hackerspace. Observations covered from 10 to 20 days of activities each month. Typical observation started from 4 P.M. or 6 P.M. and lasted until 11 or 1 A.M. This time window was selected basing on the initial observations, showing that evenings are periods of increased activity. Hackerspace is open 24/7 basis, but most of the participants have full time jobs, so evenings are natural time for social activities.

Before the observations, information about the research was posted on the hackerspace mailing list. After that, informed consent was taken from each of the hackerspace guests present during any observation. Following the interest of the observed community, research was posted on the internal hackerspace Wikipedia (same as other hackerspace projects). During the general assembly of the "[City A] Hackerspace Association", formal petition for research consent was put under the public vote. 29 persons voted for the consent, with no votes against it or abstaining. Before the assembly, the Author was accepted among the ranks of the association and was given access to all internal documents. Not all of the documents could be discussed publicly, but all data gathered personally from observations and interviews do not have this restriction.

As a supplementary data, 15 interviews were also conducted. Initial 5 interviews focused on broader DIY/academic tinkering, whereas following 10 were connected with hacking community. Interviews were openly recorded and partially transcribed. Interviews were semi-structured and focused on the educational history of the participants.

Scope of observations and transcriptions were limited by two factors. The Author was educated as an engineer and had to learn the basis of the observation and interviews during the first half of the discussed period. It was also the first year of the PhD course at the University. Second issue was that the research did not receive funding from the university, which limited amount of time that could be devoted for research time. From December until July, Author received scholarship from PBIS Stocznia (do-tank and NGO in Warsaw).

## Selected results

This study is a part of ongoing larger project, focused on the same topic, but focused on theoretical issues. The paper builds on larger base of results from the study, encompassing over 200 observations, 20 interviews and numerous informal talks, emails and personal contributions. Rather than conducting a new study, it used existing data to shift perspective from theoretical STS considerations to case study, with practical outreach.

## Becoming a hacker

Most people observed in the collective are male, aged 16 to 35 years old. The hackerspace has about 30–50 members (criterion: paying the regular fee, activity on the mailing list and spotted during the observation). During special meetings up to 40 of them meet in person. Basing on the short information on age, professions, education and interest, I would say that hackers from the observed hackerspaces are likely to be male, from middle-class families (from state servants to small entrepreneurs families). This is based on approximately 80 records from 4 sites in Poland. I do not claim that it could be representative for all hackerspaces in Poland, but majority of data (about 50 records) is from the location that is the main focus of the observation. In other words: these findings are representative for the studied hackerspace and do not differ from smaller scale, irregular tests in other Polish collectives.

More detailed biographical data is based on 5 in-depth interviews done in Polish, and 10 supplementary ones done in Polish or English. Interviewees say that their tinkering start with misusing the computer, the fascination about empowerment it gives. Installation of Linux or participation in open-source community was sometimes facilitated by teachers, but more commonly they say: "I found something on the Internet". Some of the hackers had DIY role-models (sharing the work with uncle, father or brother), but this is not a general rule.

Shared experience is their take on education. While all of them finished general education track, resulting in "matura" state final exam, most of them went on to study computer sciences at university or engineering university and dropped out during the studies. Some of the participants participated in extra-curricular classes on computer sciences, but they did not like to participate in "mathletes" or "computer science competition". As one of them explained: "I do not like algorithmics. I prefer hands-on, trial-and-error approach".

Dropping out of the university is also recognised by whole collective as typical experience. Several informal talks during the observation claimed that "You entered the hackerspace. Forget about finishing the degree". Several hackers shared their negative stance on formal education during the observations, especially on the outdated equipment and "antique teaching model". Similar notes on the technical education in Poland is proposed by some researchers (Kostyszak et al.; Mucha 2009).

During the interviews, some participants created opposition within computer sciences. They confronted algorithmics with material, silicon based approach. The interviewed hackers declared themselves rather for the second approach, emphasising following aspects:

- Materiality. Interviewed hackers emphasised interest on low-level programming (e.g. embedded systems, programmable electronics) or server architecture. In both cases, computers are treated as material objects, connected with physical issues like heat, power usage, stability.
- Practicality. Default road to solution are fast iterations of trial and error cycles. Theoretical models and algorithms have limited use (classical cases of search algorithms, queuing etc.).
- Quick feedback loops. During the observations and interviews, hackerspace and hackers seem to be operating on many issues on the same time. Some of the admitted having "extremely low attention-span".

It should be noted that hackers from the researched group are aware of such traits. Some of the consciously try to rework them, while others adjust their work according to individual tempers and learning habits. In a hackerspace, I have spotted several people, working as programmers, who declared disinterest on "material" or "technical side", and they were minority in the observed population. Almost all members of this minority were students or graduates of higher years of computer studies, who came to the hackerspace slightly later than other members. In other words: one could become a hacker (or a member of the collective) if one is interested in mathematics, algorithmics and programming theory, but one will not rather develop this approach in the hackerspace.

Regardless of their approach, hackers share some biographical features:

- Power-user experience. Even when using popular operating systems, hackers early (during adolescence) try experiments with non-standard plug-ins and modifications. During the interviews, some of them emphasise the empowering effect of the technology ("I could do everything with the computer"). This experience is also noted in other studies (Söderberg 2010).
- Setting-up a Linux system. Some interviewees mentioned that setting up a Linux systems (e.g. Ubuntu distribution) or setting up a small home server. After that, while searching for information online, they became members of the Linux users groups, internet forums etc. One of such groups meet in person and laid foundations for the hackerspace.



- Self-learning. During the interviews, participants emphasise "learning on their own" or experience of being misfit to school. What should be noted, is that not all hackers criticise the concept of formal education systems. Point of critique is rather on teaching methods or curriculum. Some of them regret not learning more at school, or regret having insufficient basic knowledge (e.g. in physics). Regardless of such declarations, nearly all biographical constructions (grammatical forms, verbs etc.) emphasise self-reliance and self-creation.

## Founding a hackerspace

Hacker movement has been connected to ideas of open source software, especially with Linux operating systems. During the interviews, participants told about series of meetings on the Linux administration held in the telecom laboratory in the local technical university, partially funded by one of the telecom companies. It operated for a few years, achieving in semi-independent status. Because it was an educational facility, it could concentrate on the community building and problem solving, rather than on publishing or advancing academic careers. Due to its contingency, most of the staff did not have the formal academic credentials. Some students "hang-out" near the lab, and became technical staff on their own. Then they started series of technical talks and workshops, which extended interest even more broader.

Other founders of the Hackerspace came from a local IT discussion group that had been established in one of the local pubs. Pub meetings had been gathering for at least 6 months, eventually linking with people from the laboratory. After some time, the cooperation between telecom lab and technical university dissolved and laboratory staff found work in other places, but the idea of the meeting place remained and place for the hackerspace was searched. One of the founders worked in the company that rented place in the building with free spaces and suggested to place hackerspace there.

After inspecting the place, vote was held on the Wikipedia about destination. Building is operated by government research laboratory founded post-war, but due to budget cuts it is forced to rent places for companies and organisations. Once a hallmark for Soviet modernisation (it was one of the first research institutions in this field in post-war Poland), it was reduced to a role of a landlord. But even "skeleton crew" of the research division from the institution had eventually found the hackers and visited the hackerspace from time to time.

Refurbishing the place was done on the volunteering principle, which was also the case for other two observed initiatives in Poland. Most of the furnishing were brought from private resources.

Hackerspace is located in the basement, but there is an informal circulation of gossip, materials and social issues between the staff of government research laboratory, employees in companies and members of the hackerspaces. Example of such circulation might be: social meeting on Friday evening in the hackerspace, meeting on the programming events or talks in the hackerspace or taking obsolete equipment from the laboratory. At least five cases of such circulation were observed. At least three of the hackers also researched history of the institute and contacted its staff in order to learn details about electric network output and maintenance.

Basing on the observations and interviews from hackerspace in other city (that was relocating during the visit), key issues for locating the hackerspace are:

- Stable and broadband internet connection. Reliable, high output electrical network;
- Localisation and accessible area. Neighbours should not complain about loud workshops and nightlife;
- Autonomy of decisions. Some of the hackers declare against any kind of submission into academic or business structures. Some accept support (money or equipment), but all of the agree on autonomy of decisions inside the hackerspace.

Interviewees did not mention financial aspect as an important factor, although it was important aspect in founding the hackerspace in other cities (Schlesinger, Islam et al. 2010). At this moment, observed hackerspace is financially stable and based on the monthly payments. Payments range from 50 to 200 zlotys (less than 10% of average monthly payment according to the Polish Ministry of Finance financial statistics). There are about 30 + members paying fees, some of the voluntarily pay more. At least 5–10 members achieved the rank of senior programmer / project manager, which places them among well paid group in the society.

Regular payments are basis for the membership and unlimited access. After paying first monthly rate, persons receives access card. Thursdays are the only days officially open for the outsiders, but in practice this division is not enforced strictly. E.g. I have never been denied access to hackerspace, regardless of the day I came to observation. No one urged me to start paying the monthly fees.

## Experiments in the hackerspace

Various STS-related theories (e.g. Actor-Network Theory) point out that reliable, stable sociotechnical compositions become "black boxes" in the society—things that are defined mainly by input and output (Latour 1988, 1999). Inside mechanisms became so standard and routinised, so they are forgotten or practically invisible. One example could be a city card system, for transport fees payment. After testing and introductory phase, most people do not think about coding system, privacy issues or security. Even for specialists (traffic engineers), many of the details (e.g. data management systems or circuit architecture) are fixed for good.

Similar black boxes are spotted nearly everywhere in modern technology. For example: Solid state physics describe mechanism of the transistor. Electronics engineer design the card, but treat the transistor as a simple item not as a complex mix of quantum physics, semiconductor chemistry and materials engineering. When the card is manufactured, the telecommunication engineer and system architect forget about details of the amplifiers, coils and passive elements. Only when something breaks down, the layered structure of the card is uncovered and disputed in the laboratory. Sometimes the circuits need to be re-arranged, sometimes it is a matter of telecommunication or a solid state physics of the transistor (Gertner 2012).

The description of the public transportation system is not an incident, nor just a hypothetic illustration for a theory. Students from University of Amsterdam found weak spots on different parts of the city card and computers of the public transport system (Cho 2008). Interest in everyday electronics and computer usage seems to be shared also in the studied collectives. Hackers from one of the Polish hackerspaces also analysed vulnerabilities in public city card system and handed the security report to the transport operator. Computer security issues are present in forms of regular cryptoparties (free and open courses on protection of personal Internet communication, e.g. encoding emails and maintaining privacy in webpage browsing). As it was observed, guests of such events were laypeople (not calling themselves as hackers) and received some basic security instructions about PGP, privacy setting and so on. Similar events were made outside the hackerspace, for example during art events connected with privacy issues.

Another argument for the laboratory approach could be found in the interviews with hackers-administrators, interested in servers. Answers to the general question (What do you do in the hackerspace?), interviewees answered about "tinkering with servers", "testing different concepts". When the follow-up question was asked (Could you tell me more about this tinkering / testing?), given answers put emphasis on the possibility of free-range experiments but on "living infrastructure". Hackerspace servers provide services for the community, but their potential failure (which never happened due to experiments) would not have as dire consequences as failure in hacker's workspace. During the observations and interviews I encountered some server administrators or security specialists, who work in banking or telecommunications. Due to their legal obligations (non-disclosure agreements) they did not talk about their professional life in details, but they admitted learning some of their trade experimenting with "hackerspace infrastructure".

The mutual relationship with business security and hacking collectives is a two-way one. When companies are changing the computers or modernising the servers, hackers bring obsolete equipment to the space. This equipment is sometimes bought as a discount by the whole community or it remains a personal property only temporarily leased to the collective.

One possible problem with treating the hackerspaces as laboratories could be the mechanisms of the knowledge standardisation, enabling larger-scale influences. While hackers store their work in forms of repositories (likely GitHub or local Wikis), not all outputs are mobile and standardised enough to become inscriptions. Within STS inscription is well defined category, covering transformations of statistical data, maps, schematics and equations. Inscriptions are standardised and mobile, so they could be easily scaled, transformed or repacked into other forms (tables into graphs, graphs into publications, publications into reviews...). While code is obviously a very mobile and easily transformable form of engineering output, some hackers employ non-standard notations, libraries and personal quirks (as inside jokes). Even those hackers who are more open to sharing and standardising knowledge, admit that lack of documentation limit the scope of replication of hacking practices.

Certainly, hackerspaces do participate in knowledge sharing, as places or organisers of workshops on cryptography, synthetic biology or mesh modelling. Such meetings are organised in many collectives and remain possible recruitment opportunities for a new members. Some hackers also produced manuals for such workshops (e.g. Cryptoparty handbook). On many occasions, I also spotted hackers reading academic manuals or taking online courses.

The paradox between openness of hackers workshops and localised character of their inscriptions could be rewritten in the following summary: Hacking collectives are more effective in localising general knowledge, providing context for the general engineering sciences or sharing the tacit knowledge. Hacking collectives are less effective in producing general knowledge or providing universal solutions. In other words: hacking collective rather acts as a local, end stage or final development part of the knowledge transfers than as a source of formal, stabilised knowledge.

## Hackerspace as a trading zone

As it was discussed elsewhere (Zaród 2015), hackerspace could not only be observed as a localisation of hackers' culture, but also as a "trading zone", where different cultures exchange money, experience or knowledge. Within this framework, a closer analysis of transactions and interactions on-site could follow.

One example could be a female student of bio-engineering, who could not find suitable help with her master's thesis laboratory equipment. Her university did not have resources or administrative flexibility to provide her assistance on some electronics or signal processing issues. She joined the hackerspace for the short period, receiving basic tutoring on hardware issues and managed to finish her work. She managed to defend her Master's thesis successfully. Similar case occurred when one of the professional researchers from the biological laboratory asked members of the hackerspace to design small upgrade to the existing equipment.

This case (discussed in details in Zaród 2015) highlights two features of the hackerspace. Firstly: It might act as a temporary ally in obtaining specific knowledge, giving local community some abilities to by-pass insufficiencies of larger institutions. Witnessing similar collaboration with non-government or business partners with a hacking collective, it could be argued that such trading zones are not universally set, as the hackerspace is not always fully accessible for newcomers. At the same time, such collaborations were too numerous to be treated as unique or one-time only. As many participants reported: the collaboration with hackerspace requires specific mind-set. "Basement aesthetics", occurrence of technological sexism (in spoken or unspoken versions), specific type of humour might, lack of self-confidence—all of such cultural traits could result in failure of establishment of trading zone.

After fulfilling such conditions, one still may notice that knowledge created with a hacking collective still needs validation and stabilisation from other institutions. Such processing is not only connected with formal issues (formal sign of a university on the master's thesis), but also with more epistemic details (error assessment, formal drawing of research schematics, discussion of approximations), which make inscriptions more suitable for general use and transport on non-hacking communication networks (e.g. academic or business circulations).

But trading zone framework is also valid for exchanges between permanent community members. Workshops organised inside the hackerspace allow for an exchange of interactional expertise. This type of expertise is a spoken knowledge about professional community as witnessed from the perspective of participant—e.g. about reliability and security of certain technical solutions. Similar professional exchanges were observed in IT technician communities in Silicon Valley by Julian E. Orr (Orr 1996). Hackerspace conversations fulfil similar role, at least when the administrators and 3D Printing specialists are concerned.

## Conclusions

The study of the hackers proves that well known social effects achieve new dynamics. The rise of open-hardware together with the issue of surveillance brought a new dawn to existing hacking collectives. This shift could be observed in Chaos Communication Congress yearly hosted (the largest hacking convention in Europe), from declaration of disinterest (2012: Not my department) toward screening Citizen Four, hosting Laura Poitras (2014: A new dawn).

Polish hackerspaces, albeit newer than German counterparts, participate in such movements, serving as trading zones for the distribution of digital tools toward wider social areas. At the same time, such trading zones link local businesses, academia and non-government sectors.

If some global thinking frameworks will be adopted, such as Saskia Sassen's concept of systemic edge and applying it to the scale of the region, it could be seen that localisation of a trading zone is not a trivial issue. For example: some of the Polish hackerspaces help individuals to bypass structural problems of academia. The aforementioned female student might get technical help with her education, researchers

could upgrade their tools without significant funding. The work remains done, and some structural problems (perhaps sexism in technical education?, perhaps lack of support staff or poor funding for student's work?) remain unanswered.

Some elements of hacking practice are being integrated into business or academic practice (hackaton as a form of recruitment or PR event, hackers presenting papers during academic security conferences), but not all institutions have capacity of such inclusion. Observing interactions between collectives and institutions might act as a systemic edge, enabling to study the business or academic systems on their boundaries, emergencies or controversies. Various sociological traditions (Chicago School, foucaultian, wallersteinian) suggest that margins and peripheries are not failure of the society (or culture, politics, economy), but its irreplaceable parts. Hacking collectives should be looked at no differently.

Hacking collectives should be studied not only as a signs of hacking culture, but as places where certain concepts of modernity are proposed, crossed to each other or abandoned. Issues such as privacy, connectivity, openness of knowledge or self-reliability are distinguishable from electronics, 3D-printers and server. In this sense, hackerspace are as well technical as social laboratories.

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# The role of digital tools in the development of citizen-centred politics

## Who do the digital media serve? Between cyber-optimism and cyber-scepticism

The fast development of new, digital technologies and their omnipresent use over the past few decades are sources of both many hopes and new challenges for contemporary societies. Not only political theorists, philosophers and sociologists but also social and political activists as well as common citizens keep reflecting and discussing on the potential of the Internet, which is considered to be the most interactive, direct, flexible and "multi-functional medium in history" (van Dijk 2012: 228). World leaders in the field of management and social sciences draw attention to the irreversible psychosocial and economic changes taking place in contemporary western societies under the influence of network technology. Informational and communicational technologies (ICTs) change the ways we work and organise our everyday life. They open up new possibilities for online community building and Internet-based management in the public sphere. However, the relatively recent introduction of digital tools into political and social spheres gives also a rise of conflicting visions of the Internet's impact on the future functioning of contemporary democratic regimes. The controversy is over whether ICTs can truly reinforce citizen participation, increase transparency in governance and release egalitarian trends or, rather

on the contrary, strengthen class divisions, give only appearance of co-decision-making, flood people with useless information and reduce their participation to mere *clicktivism* and *slacktivism*.

While evaluating social significance of the Internet, the so called cyber optimists focus on the potential advantages deriving from the supposed pro-democratic properties of the World Wide Web. Thus, they stress the Internet's potential to support collaboration, horizontal management, freedom of expression, collective action and bi-directional communication. In their view, the wireless communication on mass scale enables, first and foremost, the immediate and limitless flow of information, creative exchange of opinions and ideas as well as free peer-to-peer decentralised networking. Manuel Castells—one of the most known network theorists—clearly perceives the revolutionary and emancipatory effect of ICTs on modern societies: "Internet and mobile phone networks are not simply tools, but organisational forms, cultural expressions and specific platforms for political autonomy" (Castells 2012: 103). According to him, the possibility of Internet networking plays particularly positive role in developing bottom-up initiatives and fostering democratisation. Digital platforms that enable mass social mobilisation, deliberation, organisation and coordination, empower social activists and they are sources of new forms of political participation. Castells views new technologies as tools working particularly for the advantage of civil society, supporting leaderless political actions, enforcing the feeling of togetherness and accelerating social change. In his cyber-utopian vision, free voices "spread on the Internet in spite of censorship and repression" (Castells 2012: 27) and unite in order to create a networked society fighting against injustice and arrogance of power elites. From this perspective, horizontally organised social movements, supported by multidimensional, interactive communication via Internet, create a *networked crowd*—a new resource of power.

Also according to Dan Tapscott and Anthony Williams, the authors of *Wikinomics. How Mass Collaboration Changes Everything*, the way we work in cyberspace seems to trigger off egalitarian trends in the real world. In their opinion, the commons-based peer productions and online *open source* and *open access* projects, provide not only low-cost digital goods, but they also shape particular attitudes and values among their participants, such as collaboration, openness, transparency and sharing. Instead of imposing traditional hierarchical management structures, this kind of collaborative enterprises are managed on the basis of the principles of partnership, self-organisation, open discourse and consensual decision-making. Tapscott and Williams perceive "the Internet's democratizing tendencies as a positive source that is broadening access to knowledge, power, and economic opportunity" (Tapscott and Williams 2008: 271). In their view, practices such as *crowdsourcing* or other success-

ful projects founded on the idea of co-creation and sharing highlight the enormous potential of ICTs to integrate and engage people across geographical and political borders. The shift to more collaborative models of the Web 2.0 and the phenomenon of networked prosumption inspired Tapscott and Williams to ask a question: "why not open source government?" (Tapscott, Williams 2008: 25). But is online collaboration together with the provision of free access, peering, communicating and opening resources enough to democratise current political systems?

Notwithstanding the propagated features of communication via Internet and its supposedly "free" and "democratic" networks, in which "everyone can participate, and no one can control the result" (Rosanvallon 2011: 68), several theorists and scholars warn against the serious risks and threats related to the Internet use and its pervasive impact on contemporary societies. According to Evgeny Morozov, the social networking perspective is largely naïve and the democratising potential of the Web is widely exaggerated. In *The Net Delusion*, Morozov presents the inherently contradictory nature of the Internet, showing that its mechanisms and tools are like a double-edged weapon. On one hand, ICT tools enable mass free communication and unlimited flow of information. A special role is often attributed to social media. They are commonly perceived as tools empowering citizen's grass-roots initiatives, civic participation and critical debates. *The Arab Spring*, *Indignados* and *Occupy Movement* have become the leading examples of how the social media can help in rising consciousness and mobilising collective actions of common citizens against the unwanted regimes or political orders. One could get the impression from the reports of many mainstream journalists on these events, that new technologies and social media played the crucial role in evoking these mass protests and that they significantly contributed to abolishing dictatorships. On the other hand, Morozov observes that *Facebook revolution* and *Twitter revolution* were the slogans coined just in order to prioritise Internet tools over the human, socio-cultural, political and economic factors, which is the symptom of *Internet-centrism* (Morozov 2011: xvi)—an ideology of technological progress in the new, revolutionary digital age. He points out that the widespread cyber-utopian fascination for the Internet technologies is clearly premature and inappropriate. According to Morozov, cyber utopians do not take into consideration that the "weapons of mass collaboration" (Tapscott, Williams 2008: 11), apart from having the potential to enrich democratic attitudes and practices, may be also used as weapons of mass propaganda and developed systems of Internet surveillance. Morozov's pessimistic and dystopian point of view focuses on questioning the presumed net neutrality. Google, together with other Internet-based companies such as Microsoft, Facebook and Twitter, have a dominant position of Internet monopolies. Such a "centralization of information under one roof" (Morozov 2011: 173) imposes extreme threat to the issues connected with the Internet users' security and privacy. Because of the advanced tracking tech-

nologies, which constantly collect our digital footprints, whatever is being placed "in the cloud" stops being personal and private—it can be accessed at any time, even without our consent and knowledge. Cyber utopians tend to forget that, besides being used by social activists and common citizens, the web is also a tool which can serve both "democratic" and "authoritarian" state governments. Conversely to Castells assumption that "governments are afraid of the Internet" (Castells 2012: 7) many government and political leaders have learned how to effectively use modern technologies for their own scopes. Apart from conducting online election campaigns and spreading political propaganda, the use of ICTs gives possibilities of individual and mass surveillance of digital communication and all other online activities, what makes them perfect instruments of invisible social control. Edward Snowden's revelations and controversies about mass surveillance programs such as PRISM and Tempora, clearly showed that our personal data—constantly collected and stored on servers belonging to large corporations—can be easily achieved by government representatives on the pretext of "war on terrorism", "security" or "law enforcement" (Lyon 2014). Internet censorship (such as Golden Shield Project in China) and bloggers paid by state governments in order to praise the current *status quo*, are, in turn, examples of how ICTs can be used by authoritarian regimes.

Christian Fuchs, in his critical analysis of social media, questions the popular claim that modern technologies can make culture and society more democratic (Fuchs 2014: 53). Contrary to the simplistic theory of technological determinism, he pays particular attention to the complex social, political, ideological and economical context in which ICT tools are being used. His multidimensional attitude excludes ascribing only positive or only negative associations to the Internet communication. According to Fuchs: "communication is not automatically progressive" (Fuchs 2014: 19). Although Internet has made mass communication possible and easy like never before, the online visibility is still centralised and the inequality of actors makes the potential benefits of Internet use distributed asymmetrically (Fuchs 2012: 15). Powerful mass media, big companies, celebrities and other well-known people can attract much more attention than alternative information services or single political bloggers. Instead of empowering "the weak", the online world merely mirrors the offline reality with its increasing inequalities and asymmetric economic power relations. Fuchs argues that the "participatory culture" promoted through social media is just a part of Web 2.0 ideology, which serves Internet-based corporations for their own marketing purposes and for raising their own profits. Fuchs study demonstrates that the popular trends of "sharing", "co-creation" and "prosumerism" are in many cases just covers for exploiting mechanisms of mass, spontaneous collaboration in business. Such a use of skills, knowledge and collective work of Internet users by large corporations without pay, can be perceived as another form of general *outsourcing* trend.

While the common knowledge about the Internet surveillance mechanisms is very poor and the privacy policies of commercial Internet services are often very complex, companies like Facebook can easily profit from "millions of users, who upload and share personal information that provides data about their consumption preferences" (Fuchs 2012: 31). Fuchs claims that, apart from the name, social networking platforms in their roots often do not have much in common with "prosocial attitude"—they are rather "primarily about profit-generation by advertising" (Fuchs 2012: 36). Reducing humans to the status of consumers bringing profit is especially evident in the case of targeted, personalised online-advertisement, which is based on the close surveillance of users through tracking their consumption habits and consumer profiling. The dominant popularity of entertainment and pop-culture oriented topics among Internet users gives the impression that the precarious free-labouring raising profits of Internet companies is a form of entertainment<sup>1</sup>. Referring to Marxist's critique of political economy, Fuchs uses the term *commodification*, which according to him, perfectly describes the attitude of big Internet companies (like Google or Facebook) towards the data obtained from the Internet users. His caution is worth heeding: "the category of the prosumer commodity does not signify the democratisation of the media towards a participatory or democratic system, but the total commodification of human creativity" (Fuchs 2012: 56).

## The use of digital tools in the context of political crisis—turn towards citizens?

The current world situation is often described in terms of the simultaneous economic, political, social and environmental crises, which demand immediate, decisive and practical solutions. At the same time, it seems that political systems based on representative governments, no longer respond to the most basic concerns, needs, and rights of ordinary citizens and they are not able to develop effective remedial policies. The growing number of citizens in established democracies do not feel that they have any influence in political decision making (Gilens, Page 2014; Della Porta 2013: 114). While fewer citizens tend to participate in general elections<sup>2</sup> and to trust public institutions, political parties and politicians (Della Porta 2013: 25), more and more political and social analysts describe the growing alienation of political

<sup>1</sup> The term "playbour" has been coined in order to name this phenomenon.

<sup>2</sup> A collection of global voter turnout statistics are available on the official website of The International Institute for Democracy and Electoral Assistance: <http://www.idea.int/vt/>.

elites and citizens' political apathy in terms of the irreversible crisis of representative democracy. In response, politicians from the mainstream, governing parties started to promote new technologies and some participatory tools as remedies for diagnosed deficiencies in traditional mechanisms of representative democracies. Numerous *e-consultations* and participatory budgeting projects have been launched in the last decade. However, the character of consultations is often non-binding and the allocated funds for citizens' projects usually represent less than one percent of total annual spending<sup>3</sup>, not allowing for the bottom-up decision making on key investments. Many crucial decisions and large investments remain without even consultations. Participation without the possibility of taking binding decisions becomes a mere "pseudo-participation" (Schafer 1974: 499). Although the idea of *open source government* is getting implemented on a wide scale and is progressively imposing transparency in public administration, it is still far away from the ideal of *open source governance*<sup>4</sup>. The analysis of numerous cases of participatory processes shows that without the true will of politicians to share their decision-making power, the participatory slogans become empty and can discourage citizens even more (Font et al. 2014: 186). *Partitocracy*<sup>5</sup>, meaning the bureaucratic rules of political parties and the oligarchization of political life in democratic countries, remains an adequate term to describe the predominant tendencies in the systems of representative democracies.

Nevertheless, the current political crisis affecting the system of representative democracy manifests itself not only in a constant decline in electoral turnout, general political withdrawal or helplessness. While people in established democracies often do not know who might really represent their views and they are fed up with "choosing the lesser of two evils", new constructive responses start to appear in the public sphere. Although the "networked democracy based on local communities and virtual communities in interaction" (Castells 2012: 228) advocated by Castells may seem to many rather an idealistic and utopian project, we can currently observe thousands of directly involved ordinary citizens and social activists, who build increasingly powerful, grassroots political structures, alternative to the mainstream, traditional parties. One of such cases is The Pirate Party International—a transnational organisation, whose formalisation and diffusion started with the registration of its Swedish

3 For example, in Poland the ratio in relation to the total expenses varied from 0,08% to 3,96% (Aleksandrowicz 2013).

4 For more detailed description of differences between "governance" and "government" see Table 2 on The Open University website, available at: <http://www.open.edu/openlearn/nature-environment/the-environment/environmental-science/climate-change/content-section-3.2.1>.

5 The concept of *partitocracy* has been widely described by Deschouwer, de Winter and della Porta (1996).



branch as a political party in 2006. In Germany, fifteen Pirate Party members got elected in 2011 to the House of Deputies of Berlin receiving 8,9% of the total votes. The German Pirate Party, associated with the global social movement opposing internet censorship and surveillance, prioritizes protecting civil rights, supporting citizen direct participation in decision-making, increasing transparency and accountability in public governance, as well as promoting neutral and open Internet<sup>6</sup>. With its 24,438 members, German Pirate Party is the largest of all pirate parties (Kling et al. 2015: 2). The Pirate Party is becoming very popular also in Iceland, where it was formed in the wake of financial crisis and it mobilised against the Icelandic government, compromised by banking and political scandals. At the moment, it has around 30% support, what makes it the most popular political party in Iceland<sup>7</sup>.

Another example is Podemos—a new Spanish party, established after the 2011–2012 *Indignados* mass street protests against the traditional party politics, disgraced politicians, corruption and increasing inequalities in Spain. While thousands of protesters under the slogan "*¡Democracia Real YA!*" ("Real Democracy NOW!"), were calling for citizen-based democracy and transparent, bottom up decision-making, many politicians and experts in mainstream media were accusing grassroots movements of spreading too idealistic visions of unachievable or even undesirable changes. In contrast, the leaders of Podemos party, made the inclusive and transparent decision-making their main asset and indicator of their progressive politics. The basic claim among Podemos supporters is that the direct participation of citizens is indispensable for a system to be called democratic and legitimate. Therefore, Podemos party structures are based on the so-called *circles*. This network of over 800 local groups<sup>8</sup> set up across the country, support direct citizen participation and they are open to all who share the party's main objective, that is: "to open a political space to the social majorities excluded from the real decision-making processes" (Zelik 2015). Only four months after it had been founded in January 2014, Podemos received 8% of the national vote in the European Parliament Elections and brought in the EU Parliament five of its members (Table 1 in De Sio et al. 2014: 259), including its main 35-year-old leader—Pablo Iglesias. Recently, in the regional elections in May 2015, Podemos came third

6 German Pirate Party postulates described in *The European Manifesto of the German Pirate Party* are available at: <http://piratetimes.net/the-european-manifesto-of-the-german-pirate-party/>.

7 According to the Icelandic National Broadcasting Service (RUV) reports, published 30.04.2015 and available at: <http://www.ruv.is/frett/piratar-med-30-prosent-i-thjodarpulsi>.

8 The number of circles is estimated as to March 2015 and it is still growing. More information on the *circles* is available at: <https://www.opendemocracy.net/can-europe-make-it/tim-baster-isabelle-merminod/podemos-new-type-of-resistance>.

overall in the vote in 13 Spanish regions and the grassroots local candidates, supported by the party, got elected as mayors in the biggest Spanish cities—Madrid and Barcelona<sup>9</sup>. Along with the unexpected, spectacular success of Podemos party, the authors of analysis "The European Parliament Elections of 2014" announced the possibility of the end of bipartisan rule in Spain. According to them: "the capacity of new parties to address the demands of the average citizen through a new style of politics implies a great challenge for mainstream parties" (De Sio et al. 2014: 260).

The leaders of Podemos and Pirate Parties do not refer to any specific left-wing nor right-wing ideologies, instead they emphasise the role of ordinary citizens' participation in decision-making. Speaking out against demagoguery and authoritarianism, they want to reinforce the voice of "the common people" in public discourse and empower citizens through political education and direct means of participation. In the face of these new, progressive social and political movements, the old ideological framework based on Schumpeter's proceduralist and elitist vision of democracy, as well as the hierarchical structures of traditional political parties, seem extremely obsolete. The gap is widening even more when considering the differences in use of digital technologies between the traditional, mainstream parties and these new, grassroots' political movements. While the major parties use their websites mainly for the unilateral, top-down communication, the interactive websites and multifunctional on-line platforms of anti-establishment parties are designed in order to facilitate bidirectional communication, mass social mobilization and horizontal coordination. Employing ICTs in order to provide citizen-based discussions as well as respond to citizens proposals and needs, is a real standout among other parties which use digital tools mainly to promote their own opinions and propagate their own solutions.

Many decisions taken by Pirates are first discussed among their members via PiratePad online platform, whereas their collaborative work is facilitated by chatrooms, wikis and mailing lists. Additionally, Berlin's Pirate deputies experiment with the open-source LiquidFeedback software, enabling every interested individual to put proposals to the vote and get a constructive feedback. The LiquidFeedback mechanism<sup>10</sup> is based on proxy voting system which allows citizens' to vote directly or delegate their votes to someone else whom they trust. Thanks to the LiquidFeedback system used

9 Based on the analysis by Professor Laura Morales and Dr Luis Ramiro from the University of Leicester, available at: <http://www2.le.ac.uk/offices/press/think-leicester/politics-and-international-relations/2015/the-spanish-local-and-regional-elections-of-24-may-2015>.

10 The detailed description is available at *LiquidFeedback's* official website: <http://liquidfeedback.org/>.

by German Pirate Party<sup>11</sup>, its members can create initiatives within specific areas (e.g. environmental policies, education, economy etc.). Each topic needs first a minimum quorum of supporters in order to be voted upon. The votes can be delegated on three levels: on the global level–i.e. in all areas; on the level of particular areas; and on the level of singular issues. The crucial principle of this continuous process of decision-making, based on the concept of "liquid democracy", is that the delegated votes can be reclaimed at any time, while actions of every voter are registered and public. The LiquidFeedback system was adopted by German Pirate Party in May 2010 and with its 13,836 users (as of January 2015) it is the largest online community implementing delegative democracy (Kling et al. 2015: 3). Similarly, the leaders of Podemos developed various forms of direct digital democratic involvement of citizens, which provide unmediated ways of representation and close relationship between the party members, political activists, and other supporters. One of the main channels for popular participation is the official Podemos interactive website<sup>12</sup> enabling online voting and decision-making. Podemos also launched several online platforms based on open-source software such as Reddit (adapted by Podemos party under the name Plaza Podemos), Agora Voting, Loomio or TitanPad, which enable online deliberation and collaborative work of their supporters<sup>13</sup>. Digital tools also allow Podemos to get bottom-up support and collect money on-line. The main sources of Podemos' funding are regular citizen's donations and crowdfunding for specific projects. Since transparency and corruption-free politics is one of the party's primary postulates, all the accounts and balances of the party are published online.

The use of social media and digital participatory tools by tech-savvy leaders of Podemos and Pirate Parties enables implementation of new models of networked political organisation and collaboration. The introduction and internalisation of technological innovations into everyday political activity correspond to the growing expectations of citizens for greater democratisation, participation, accountability and transparency in public decision-making and governance (Font 2014; Khagram et al. 2014). Nevertheless, the ICT-tools used by Podemos and Pirate Party must be adapted and customised to conditions of the established political systems based on representative government. The adopted innovative, hybrid models of off-line representation and on-line direct decision-making give rise both to a great number of expectations and

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11 The following description is based on Kling 2015.

12 <http://podemos.info/>.

13 Podemos platforms are based on open-source software such as Reddit (adapted by Podemos party under the name Plaza Podemos), Agora Voting, Loomio or TitanPad. More details on the official Podemos Party website: <https://podemos.info/participa/herramientas/>.

serious doubts. What are the actual advantages and potential threats deriving from the use of digital participatory tools in politics on the example of multifunctional on-line platforms used by Podemos and Pirate Parties? One of the objections against the use of Online Delegative Democracy platforms, such as Pirates' LiquidFeedback, is that in fact they are not so much democratic. The controversy regards especially the so called *super voters*—i.e. "users with a large share of incoming delegations" (Kling et al. 2015: 3). However, as it has been demonstrated in a multiannual, detailed study of the Pirate Party LiquidFeedback platform, the risk of abuse of voting power by super-voters is highly limited by the continuous social control, recall mechanism and responsible selection of delegates (ibid.: 9). Another objection is that supposedly inclusive tools can also cause new kinds of exclusion. Although certain groups can benefit from the new e-voting opportunities (Caarls 2010: 15–16), not everyone has the access and adequate skills to use new technologies. Apart from the broad problem of *digital divide*, other challenges usually associated with e-participation and Internet voting include transparency, security and privacy issues. How to guarantee that the results of the online voting and debates are not manipulated by some powerful interest groups? Although the management of Podemos' online platforms is assigned to professional external companies (Pucciarelli and Russo Spena 2014: 87), the possibility of corruption or hacking attack still cannot be totally excluded. Furthermore, some researchers stress that "the movement of political activity to the Internet is generating massive amounts of data, as individuals' political conversations, donations, and forms of political organising leave electronic traces" (Farrell 2012: 47). The way these sensitive data could be potentially used causes serious ethical concerns. Other doubts regard the competences of citizens to deliberate and to make responsible decisions as well as the quality of their online activity. Group polarization, homophily and preference falsification pose particularly vexing problems (Farrell 2012), putting into question whether the online deliberation is possible at all. However, the study of numerous cases of political web-based forums reveals that:

Generally, the opinions expressed in the forums are justified (even if just superficially), that the debates do generally not lead to a polarization of opinions even if the participants share similar interests and have similar political ideologies, that the debates are generally not invaded by disrespectful behaviors, that the online debates can contribute to enlightening the opinion of its active and passive users, and that some of them have concrete political outcomes (Kies 2010: 165).

Additionally, the same study confirms that "if ordinary citizens believe that their writings might have an impact on the decision-making process, they will be more motivated to adopt a deliberative attitude" (ibid.).

## Online and offline interdependencies, paradigm shift and participatory democracy

It is noteworthy that the above-mentioned problems and controversies are not particularly new. They did not arise together with the attempts to implement innovative projects testing the idea of digital democracy. In view of the current political crisis in established liberal democracies, the functioning and legitimacy of contemporary traditional, off-line political decision-making processes can be similarly questioned, just as their new, on-line versions. While answering the question whether the use of digital tools can reinforce democratising processes or rather undermine them, it is crucial to acknowledge that digital technologies are just "tools". They should not be treated as magic solutions nor as threats *per se*. Their role in politics depends on the will of those who design, use and have control over them. In essence: "The new electronic agoras offer interesting opportunities to promote deliberative practices, but the question is whether these will be coherently exploited by the different public and private actors" (Kies 2010: 166).

Since a large part of the participatory infrastructure of the newly established parties is still in experimental and development phase, it faces many yet unresolved challenges and its evaluation is limited only to the current state of affairs. Accordingly, the dynamic progress of digital participatory tools and other technological advancements require deep reflection and strategic analysis how should they relate to the traditional mechanisms of representative democracy. Are they complementary or rather contradictory? How can they be integrated or transformed? The key problem is not just settling disputes between naïve "utopian fools" and rational "cyberrejectionists". These conflicting forces indicate rather a more complex problem, namely, the shift from the gradually outdated paradigm of political power based on delegated representatives and privileged political elites to the new paradigm of citizen-based power and participatory politics. Participatory democracy with its aspiration for "citizens doing politics"<sup>14</sup> and collective public problem-solving, excludes the highly centralised, hierarchical model of representative party system with the corporate lobbying power. Even if traditional politicians more and more often introduce fashionable concepts of *electronic democracy*, *e-government*, or *e-administration* in their vocabulary, they "all miss a crucial point, because all focus exclusively on applying the Internet to the electoral-representative dimension of public life" (Rosanvallon 2008: 70). Introducing "strategies for decentralised decision-making and the participation

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14 Phrase attributed to Pablo Iglesias (Kassam 2014).

of citizens as 'co-producers' in governance" (Davies and Imbroscio 2008: 225) indeed requires an overall paradigm shift. Technological tools themselves will not make any difference—"the impact of technologies is in fact filtered through normative conceptions of democracy" (della Porta 2013: 103).

Since we are living in "the hybrid world of real virtuality" (Castells 2012: 233), online activism cannot be separated from offline activism. In case of Podemos, its success would not be possible without the widespread network of local *circles* and without "Iglesias' ubiquitous presence as a talking head on Spanish television" (see Kassam 2014). In confronting and transforming the structures of social, political and economic power, ICT tools are useless without highly motivated individuals, shared purpose, face-to-face political mobilisation, offline meetings as well as personal, direct engagement in long-term collective actions. Following Christian Fuchs: "a commons-based Internet requires a commons-oriented society" (Fuchs 2012: 67). Evidently, social protests do not arise nor authoritarian regimes do not fall only because of "blogging", "tweeting", "Googling" and "YouTubing"—in confrontation with the complexity and multidimensionality of socio-political relations such technocentric and technodeterministic claims expose only their extreme simplification. Yet, just like we cannot overrate the role of technologies, nor we cannot deny that some Internet tools have already proved to be helpful and their use has a potential in further turning the ideals of collective decision-making and direct civic participation into practice. Although the revolutionary role of ICTs in democratising democracy remains more a wish than a reality, Peter Dahlgreen observes that:

It is difficult to imagine that the current manifestation of alternative politics and oppositional world-views could have spread so extensively in the absence of the Internet. Both technologically and economically access to the net (and other ICTs, such as mobile phones) has helped facilitate the growth of massive, coordinated digital networks of engaged activists (Dahlgreen 2009, 190).

International mass protest movements, such as *Occupy Movement* and *Indignados*, show that many people all over the world start to understand that instead of waiting for the change from the top, they themselves can be catalysts for change from the bottom. Yet, the problem remains that the counter-power of ordinary people is much weaker than power of corporations and political elites. Keeping "people occupied with struggling for survival so that they have no time, energy or thoughts for counter-power struggles" (Fuchs 2014: 77) is an effective strategy of those who do not want to lose their privileged position. Nevertheless, the world in which we are living is not a necessity and the change of *status quo* is not only necessary but also possible. Proponents of participatory democracy are often pictured as utopian dreamers obsessed



with the questions of how things should be, rather than how things can be in real world settings (Zittel and Fuchs 2007: 10), but "most modern political ideologies at the roots of political systems (liberalism, socialism, communism) originated from utopias" (Castells 2012: 228). The struggle may be long and the changes evolutionary and gradual rather than revolutionary, however it is important to know and define the goals for which we can strive, such as: "overcoming the corporate character of social media and (...) establishing a truly participatory Internet within the context of a participatory democracy" (Fuchs 2014: 24).

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# Symbionts and parasites—digital ecosystems

## Introduction

"Digital ecosystems" have been attracting a considerable amount of attention from both business and the academia for some time now. Interactions inside and between companies, social media and IT systems are all being looked at as if they were biological ecosystems<sup>1</sup>. In biology the ecosystemic approach irreducibly implies that there exists a network of links and interdependencies amongst all the elements of the given system—animals, plants, microbes, but also water, rock formations all sunlight. These elements form an ecosystem, a network, and constantly influence one another. When applied to other fields, like IT systems in companies, the concepts borrowed from evolutionary ecology allow to bring out the interrelationships between various elements of the system and look at how the whole network grows and evolves. Currently, the ecosystemic approach is being applied in a growing number of research fields<sup>2</sup>. It has repeatedly proved its potential to make certain aspects of analysed phenomena visible that may otherwise be obscured when looked at through more selective optics, particularly in the fields like economics, sociology, and IT. This article will focus

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1 See for example: <http://www.forbes.com/sites/fredcavazza/2012/03/12/an-overview-of-the-social-media-ecosystem/>.

2 Look, for example, at Bronfenbrenner's Ecological Systems Theory of Development—an ecosystemic theory of child development.

on the potential that chosen conceptual tools borrowed from evolutionary ecology offer to interdisciplinary philosophical analysis of contemporary social and cultural phenomena.

In this paper I apply concepts used in evolutionary ecology to the framework of Actor-Network Theory (ANT), particularly the writings of Bruno Latour. ANT is a very influential contemporary theory used in many fields of social sciences and humanities. It takes a non-essentialist perspective and looks at how actors (all that acts can be an actor—people, animals, objects, theories etc.) influence one another, creating networks of interactions. What is worth mentioning—actors can also be networks themselves, thus Actor-Network Theory.

The proposed borrowing of concepts and approaches from the field of evolutionary ecology into the domain of Actor-Network Theory aims to create conceptual tools allowing a broadened philosophical analysis of many aspects of the contemporary world. ANT helps problematize various important issues that arise today. It does, however, as I will attempt to show, have a set of assumptions at its core that close off certain modes of inquiry—particularly those intending to look at the specific characteristics of individual relationships between elements of the "network". This article aims to propose an approach for a more nuanced understanding of the character of the shifts in modes of coexistence between human and non-human actors that are fostered by new technologies. These, it will be argued, can be looked at as elements of an ecosystem. They form hierarchies, symbioses, chains and balances. A conflict of interests will often appear and some will perish.

## Method ANT

The actor-network can be reduced neither to an actor nor to a network. It is, at the same time, the actor forming relationships with other actors and the network of these relationships that has a power to change its elements (Callon 1987). "Nodes" of this network do not precede it. Actants, or actors, are those that act, action is what constitutes them (Latour 1999a)—and relations between them can be described as inter-actions—mutual influencing (Konecki 2011: 115–136). This is warranted, among others, by the symmetrical character of these relations, which means no action remains isolated. Like in the case of "translation" (Latour 1994: 29–64)—a process described by Latour, where as a result both sides are transformed (though the change might be more significant to one actor than the other).

It has been pointed out by many readers that ANT neglects, or even openly rejects analysis of the relations themselves. In such a critique, Olga Amsterdamska writes "Latour argues that it is unimportant to examine either the characteristics of the nodes of the network or the nature of the alliances; 'the only question that really matters,' according to Latour, is 'is this new association weaker or stronger than that one'" (Amsterdamska 1990: 499; Latour 1987: 127). If taken radically, this is a serious hindrance to our understanding of contemporary phenomena through ANT.

However, as Latour himself admits, actants do have goals and functions (Latour 1999a). These are sometimes mutually exclusive. When an actant interacts with another one on a path to its goal, it may either go on practically undisturbed, or, more likely, be helped or hindered as a result. These interactions possess a certain "charge"—meaning they can be mutually beneficial, or one of the actants may be taken advantage of. It may also be more complicated.

In order to account for these different variations of interactions an approach is proposed that allows an insight into the characteristics of the relations forming the actor-networks—using a conceptual frame taken from the field of evolutionary ecology. A resulting "hybrid" can be used to analyse the human-technology relations—"digital ecosystems".

Working within the framework of ANT I take on most of its assumptions. A particularly important one is the revocation of the subject-object dichotomy. This revocation is radical, as ANT is not merely about giving subjectivity to objects through a dialectic transformation, but a wholly different approach: "essence is existence and existence is action" (Latour 1999a: 179). For this reason throughout this text terms *actant* and *actor*—entities constituted by action—will be used, not *subject*. Furthermore, not only humans, but also non-humans can be actors equally (Latour 1999a: 179). Non-humans include physical objects, technologies, animals etc.—anything possessing *actantiality*, i.e. a potential to act.

The intention of this article is not a metaphor, or a parallel, saying that the Actor-Network Theory is like an ecosystem. The aim is to take a closer look at the relations between actor-networks. The justification supporting this choice of paradigm will be evaluated on further in the article. What is, however, worth mentioning at this point is that evolutionary ecology is mainly preoccupied with how certain organisms change over time, how they evolve and transform as part of an ecosystem, which keeps changing with them. The ontological aspect is also very significant to ANT, as Latour points out (Latour 1999b: 15–25), it is concerned with the formative relations rather than stable entities.

As John Law, an ANT theorist, points out "entities take their form and acquire their attributes as a result of their relations with other entities" (Law 1999: 1–14)—actors do not precede their relations, they only gain their form and characteristics as a consequence of these relations, of being (in) the network (Cordella, Shaikh 2003). One should not, however, haste and call ANT radically relativist—some parts of the actor-networks are more rigid than others. Arguably, genes would belong to this category. Therefore, usually, a cat will feel inclined to eat a mouse—genes constitute part of its network—but some cats choose to be vegetarians.

Latour's discouraging of analyses of individual relations and "nodes" of the networks has a reason. ANT depends heavily on its ontological assumptions. As the actor-networks are by definition a mesh of interactions and influences, it is not possible to separate element "A" and analyse it outside of the network. It is not possible to precisely distinguish and identify individual interactions. One may also mistakenly take something as specific to an actor and not see it was a result of its positioning within the wider network and influence of other actors. Michel Callon shares Latour's reservations and argues the relationships between entities, just as the entities themselves are unspecified (Callon 1993: 232–268). Nonetheless, one needs a certain level of separation, in order to get any grasp of the network being analysed, even though the results do not possess the weight they could have in other paradigms and are, by definition, only temporary—the network can change and everything changes with it (Akrich, Latour 1992: 259–264).

In the following sections some of the benefits resulting from the proposed approach will be reviewed, the more significant reservations it may cause will be discussed and several application examples presented.

## Evolutionary ecology

Evolutionary ecology is an interdisciplinary field where ecology and evolutionary biology overlap (Pianka 2011). The main area of interest for evolutionary ecology is how ecosystems evolve, both as wholes and as networks of relations, and how different species behave in relation to their changing environment over time. In this field, various forms of relationships, or interactions between organisms, have been distinguished according to outcome, mechanism etc. These include competition and various forms of symbiosis. Many other sub-domains of biology also use these terms,

but evolutionary ecology looks simultaneously at how whole networks and their elements interact and change one another. As this is a preliminary phase of research I propose to look at two categories—competition and symbiosis.

What is worth mentioning—for many biologists symbiosis has a broad meaning, signifying any persistent interspecific biological interaction (Douglas 2010; Margulis 2008), not necessarily one that is mutually beneficial, as the everyday use of the word would suggest. Symbiosis therefore includes relations such as mutualism (which is a mutually beneficial interaction) and parasitism. In this paper both meanings are employed, with the narrower one distinguished as "mutualistic symbiosis", for the sake of clarity.

The main difference between symbiosis and competition would therefore be constituted by the fact that in the case of competition the actors compete for a limited resource, and in the case of symbiosis they take at least part of what they need directly from the other actor<sup>3</sup>. This does not need to be food, but also, for example, safety, as will be shown in the next paragraph.

A very interesting example of mutualistic symbiosis is the relationship between a goby fish and an Alpheidae shrimp, which sometimes live together. The shrimp digs and maintains a burrow in which both the shrimp and the goby live and where the fish can lay its eggs. The fish has a much better eyesight than its "partner", so it can spot danger much faster. The two stay in close physical contact a lot of the time—to do so, the shrimp uses its tentacles and the fish its tail. When the goby sees a predator, it will warn the shrimp, brushing its tail against the shrimp's body and the two rush back into the burrow.

Introducing categories from evolutionary ecology allows a more nuanced analysis of the actor-networks, as they provide the instrumentation to look at the characteristics of particular relations. At the same time, these categories are not tainted by unwanted meanings and long philosophical tradition that some more established terms possess. Evolutionary ecology resembles ANT in many of its assumptions. Bruno Latour took ecology as an object of study at one point, although his interest was more in the subject than methodology. The choice is not in any way revolutionary, many thinkers in the field of social sciences and humanities have used conceptual tools from other domains. Gilles Deleuze and Felix Guattari appropriated concepts (e.g. rhizome) used in biology (Deleuze, Guattari 1987), though with a much more radical consequences than what is proposed here.

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3 This is of course a simplification when compared to the strict meaning used by biologists.

Borrowing concepts between different fields bears the risk of transferring also the criticisms associated with them. In the case of applying concepts from evolutionary ecology to ANT, this risk is minimal, as these concepts do not require a broad theoretical background to be transferred with them, as the mechanisms themselves are the most useful. In this article, from a philosophical perspective, the most important postulate is that relations between actor-networks are not neutral, they require a more thorough problematization, and using conceptual tools from evolutionary biology could be a way of doing so. Concepts like symbiosis, coevolution or parasitism do not carry with them an excess of meaning in the field of philosophy. They bring assumptions of an ontologically relational and dynamic character from their original domain, but these are shared with the Actor-Network Theory and need not be separately defended.

## A more nuanced approach

The proposed approach retains the structure of ANT and aims to look deeper inside chosen contemporary phenomena. Evolutionary ecology focuses on how species, as collectives, change, transform and interact together with their environment—that is, other species and beings of various other character—the network. The scope of this preliminary research did not allow time to work out a perfectly consistent vocabulary, therefore some of the terms used here will need revisiting at later stages. In *Pandora's Hope* Latour emphasises the importance of the collective and that the subject-object dichotomy obscures the understanding of them. Evolutionary ecology allows to look at an asteroid hitting Earth like it would at humans dumping toxic waste into rivers. Actions and inter-actions are a result of many factors, and the responsibility for them must be shared between various actants.

Evolutionary ecology operates under the assumption that nothing in the world around us was formed, or could even exist, in separation from other elements. This includes other organisms—plants and animals, microbes, but also rain and volcanos. Evolutionary ecology elements employed into ANT allow us to look into networks of co-determinations that otherwise would not be noticeable, to really see the actor-network. Even though Latour disagrees with looking at individual relations. There are about ten times more non-human cells that live in and on the human body than there are human cells, albeit they are much smaller and constitute only a few percent of our overall weight. Without all these organisms—the microbiome—the human body would not function properly and fall ill very quickly. One could therefore say that human body is a hybrid actor, or, that it is a "black box"—an actor-network that, though built of many smaller ones, "behaves" like a relatively separate entity (Latour 1999a: 315).

The apparatus of evolutionary ecology allows us to look at modes of coexistence and mutual constitution of various actors. These sometimes are detrimental to one (or both) of the actors, but can also take the shape of mutualistic symbiosis. That means two species coexist, inter-dependently of each other. Like humans, who, at this stage of our evolution, require an army of bacteria in order to live. There are many kinds of conceptual frameworks, depending on the employed perspective. The relationship between a human and their biome could therefore also be called a coevolution, an interdependent evolution, where two species evolve together, adapting "in relation to one another". This notion, however, comes from a different "set", and, for the sake of clarity, in this article the symbiosis paradigm will be used.

One of the common points of attack at ANT is that it neglects intentionality, which seems to also be suggested by the, much criticised by Latour, "common sense". Let us, however, remember here that ANT does not mean objects became subjects possessing intentions in some dialectic process—it forsakes this dualism entirely. The major role is therefore played by the network of associations, not the intentions of individual actors. As Latour writes, intentionality is a property of neither humans nor non-humans, but "of institutions, of apparatuses, of what Foucault called *dispositifs*" (Latour 1999a: 192).

Using the conceptual framework from evolutionary ecology makes it possible to disregard, or temporarily set aside, the question of intentionality, as it mainly looks at formative interactions, which is one of the main advantages of the proposed approach. When analysing evolutionary processes there is no point asking whether the goby fish intentionally lives with the shrimp—it is a result of interspecific relations taking place over long periods of time. It is, however, important to remember that ANT is not a constructivist theory (Latour 1999a; Law 1999), even though some of its critics might suggest so (e.g. Amsterdamska 1990).

Though Latour refuses to take interest in the actors' intentionality, he points out the fact that they do have their own goals and functions, which influence their actions and interactions. The perspective, from which not a traditionally understood subject is being analysed, but an actor-network, surpasses the issue of a singular, situated will. Still, Latour mentions that there can be a "prime mover", who, though herself could be picked apart into a whole network, makes the perspective more comprehensible and intuitive. A similar observation can be made about organisms in an ecosystem—most of them set their goals to be eating and reproduction, and most of their actions will be attempts to reach those goals, and some other, smaller ones. ANT assumes a "consensus" can be reached between actors articulating themselves, therefore creating a balance of goals and "power potentials" (Abriszewski 2012: 122).

The issue of power is a consequence of the internal logic of the proposed approach—if one actor can cause the demise of another, then a relation of power, in Foucauldian terms, occurs. The more influence one actant has over others, the more powerful it is. In *Pandora's Hope*, Latour writes that one actant will be influenced by another only to the extent allowed by its other associations (Latour 1999a: 179). Therefore, these associations, the network, constitute power in this paradigm. A strong actor causes the network to change, just like the whole Australian ecosystem was transformed when rabbits were first brought there on ships. Power reveals itself through action, in line with the mentioned rule: *essence is existence, existence is action* (Latour 1999a: 123, 179).

The proposed approach also allows to analyse forms of power relations that classic power theory could not distinguish. For example, an apex predator, like a lion, holds a certain significant position as part of the network and can erase and rewrite existing ontologies (Latour 1999a: 179). But so can rabbits in Australia, viruses, bacteria or fungi (Latour 1999a: 179)—which, though without a defined "command centre", have a certain operational logic and can change the ecosystem. Therefore, power can be seen to take a host of forms. For the scope of this article I propose the following definition: power is the ability of an actor to influence other actors. This includes institutional and symbolic power, manipulations, dressed up as mass media fun and lifestyle gurus.

A reservation might appear at this point about the question of ethics. Neither ANT nor evolutionary ecology have a model of morality inscribed in them. However, that does not mean that they are intrinsically amoral. In her critique of Latour, Amsterdamska suggested that the question of power and morality was one of the weaknesses of his stance. "Might becomes right" says Amsterdamska, commenting on Latour's analysis of the academic world (Amsterdamska 1990: 501). This seems to be an oversimplification if only a slightly broader, perhaps Foucauldian, perspective will be employed, in which power, understood as ability to influence and form dependence is, in a way, pre-moral. ANT allows the possibility of different moralities, each dependent on the actor-networks.



## Digital ecosystem and examples

In the presented study interactions fostered by new technologies have been chosen as examples. Actor-networks change—we change—together with advancing digitisation and technicization, making the understanding of these processes one of the more pressing issues that today's social sciences and humanities have.

Technologies, particularly those involving networks and data transfers make the relational character of our world even more visible, thus rendering the Actor-Network Theory a more intuitive choice. ANT seems to reflect many of the moods apparent in contemporary Western culture—ontological disparity and instability, dissipation and crisis of the subject<sup>4</sup>. Instead of negating the dichotomy between society and technology, ANT focuses on their "coevolution". As Latour wrote: "The adjective modern does not describe an increased distance between society and technology or their alienation, but a deepened intimacy, a more intricate mesh, between the two" (Latour 1999a: 196).

Let us now look at some examples of application of the proposed method.

Competition—different organisms compete for the same limited resource. This can occur within one species or between different species. This phenomenon can be used to describe many commonly occurring relationships. A simple example could be the situation on the music market: many different musicians and whole genres compete for the attention and funds of the audience. In this analysis, however, I would like to emphasise the formative character—competing actors adapt and change according to the changing surrounding, if they are to survive. Competition fosters change<sup>5</sup>. We observe objects like computer mice taking a myriad different shapes and functions, all in order not to perish from the shelves. Through the frame of ANT combined with elements from evolutionary ecology, one can look at how a computer mouse develops in its network, growing buttons and diodes in order to eliminate competition coming from the trackball for good.

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4 Similar traces are visible in the writings of contemporary thinkers representing many different fields. See, for example, Anthony Giddens or Richard Rorty.

5 Let us remember this is not a normative analysis, at this point the proposed approach allows us to look at the relations without placing them in a particular normative context.

Mutualistic symbiosis—actors form a persistent relationship, they evolve "in sync", while benefiting<sup>6</sup> from the relation. An artificial cardiac pacemaker acts and exists in pair with a human with heart problems. The pacemaker changes, for example becomes smaller, together with the human who needs it and "evolves into a cyborg". Many such devices permanently change the ontology of a body they are implanted into. "Alive" and "dead" change meaning, and become dependent on batteries. Actually, Latour himself writes about what he calls a "crossover", a concept he borrows from genetics to describe an exchange of properties among humans and non-humans. The entities resulting these relationships are called hybrid actors (Latour 1999a: 180). Like the human-with-artificial-pacemaker. When such an actor "comes into existence", her actions (since the essence of the actor is action) are now mediated in a new way. Another interesting form of a symbiotic relationship is commensalism—one of the actors benefits while the other hardly notices at all. This can also describe scavenging, when one actor benefits from what is left of the other after it perishes (but the demise was caused by something else). A new app can form such a relationship with a big actor, like Facebook—it is not strong enough to exist without the host, but the host does not need to notice.

These nuances allow to look at differences between various kinds of formative relationships. Like in the case of competition—where both actors develop and adapt in order to survive the other—and mutualistic symbiosis where they co-evolve supporting each other.

A social media platform like Twitter in its relationship with information seem to be, at least partially, in a mutualistic symbiotic relationship, where one fosters the other. The insight we can get from the analysis will change, however, if one looks at this relationship as competition, where they both evolve in ways that are less beneficial, and more a survival strategy—information gets simplified and Twitter has to resort to more aggressive moves in order to remain on the information market. It may happen that a relationship transforms, and from commensalism becomes parasitism (one benefits at the expense of the other) or competition. Actors and actor-networks are by definition unstable, or rather metastable, that is, in a state of temporary balance that they can easily be thrown out of. Once that happens they are not likely to return into the previous state, like a pen standing upright. Certain relationships, should they prove strong, may become fixed for a longer period of time and change actors forming them—this usually happens when various kinds of symbiosis can be observed.

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6 There are also categories of symbiosis called synnecrosis and amensalism where, respectively, both organisms die or one dies and the other takes everything and does not really notice what happened.

However, sometimes the relationships can be so detrimental, or, using Latourian terms, unstable or misaligned, to one or both sides, that they end quickly, like when a bacteria is so deadly that it has no chance to spread.

## Conclusions and further possibilities of research

The proposed method of borrowing concepts from evolutionary ecology into actor-network theory allows to differentiate between various forms of relationships that may otherwise be undistinguishable. Evolutionary ecology analyses the development and formation of entire systems and the elements that form them, based on the assumption that nothing could exist or function entirely on its own.

Presented research is part of a larger project concerned with the development of relations between humans and technology. These include the cases of social media, development of technical devices, particularly ones like the artificial pacemaker. The main goal is to look at how, through these relations, humans and technology transform each other, coevolve and form new, hybrid actors. To a certain degree one should agree with Latour (Latour 1999a: 195) that these transformations follow the same patterns as any networks in the past, with their mediations, translations, blackboxing etc. However, since, within the presented paradigm, the ontology of actor-networks is dynamic by definition, it gets overwritten when the larger network changes. One could therefore say, that with the emergence of the ability to, for example, incorporate various devices into human bodies, the ontology of the human body as such has changed. To an extent, this kind of human-non-human relationship is no longer of the same order as using a stick to get fruit from a tree or even wearing glasses<sup>7</sup>. That is why it is important to look closely at various aspects of our relationships with technology, and evolutionary ecology combined with ANT is one of the ways to do that. The current moment in history is, it could be argued, comparable to the moment when the asteroid caused the demise of dinosaurs. Still, the mechanism is survival of the fittest, but the game has changed. That also goes well along the assumptions of ANT—strongest associations survive.

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<sup>7</sup> I would like to thank Matthew Gladden for this question.

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# Neural implants as gateways to digital-physical ecosystems and posthuman socioeconomic interaction

## Introduction

For many employees, "work" is no longer something performed while sitting at a computer in an office. Employees in a growing number of industries are expected to carry mobile devices and be available for work-related interactions even when beyond the workplace and outside of normal business hours. In this article it is argued that a future step will increasingly be to move work-related information and communication technology (ICT) inside the human body through the use of neuroprosthetics, to create employees who are always "online" and connected to their workplace's digital ecosystems. At present, neural implants are used primarily to restore abilities lost through injury or illness, however their use for augmentative purposes is expected to grow, resulting in populations of human beings who possess technologically altered capacities for perception, memory, imagination, and the manipulation of physical environments and virtual cyberspace. Such workers may exchange thoughts and share knowledge within posthuman cybernetic networks that are inaccessible to unaugmented human beings.

Scholars note that despite their potential benefits, such neuroprosthetic devices may create numerous problems for their users, including a sense of alienation, the threat of computer viruses and hacking, financial burdens, and legal questions surrounding ownership of intellectual property produced while using such implants. Moreover, different populations of human beings may eventually come to occupy irreconcilable digital ecosystems as some persons embrace neuroprosthetic technology, others feel coerced into augmenting their brains to compete within the economy, others might reject such technology, and still others will simply be unable to afford it.

In this text we propose a model for analysing how particular neuroprosthetic devices will either facilitate human beings' participation in new forms of socioeconomic interaction and digital workplace ecosystems—or undermine their mental and physical health, privacy, autonomy and authenticity. We then show how such a model can be used to create device ontologies and typologies that help us classify and understand different kinds of advanced neuroprosthetic devices according to the impact that they will have on individual human beings.

## **From Neuroprosthetic Devices to Posthuman Digital-Physical Ecosystems**

### **Existing Integration of the Human Brain with Work-Related Digital-Physical Ecosystems**

In recent decades the integration of the human brain with work-related digital ecosystems has grown stronger and increasingly complex. Whereas once employees were expected to use desktop computers during "working hours," for a growing number of employees it is now expected that they be available for work-related interactions at all times through their possession and mastery of mobile (and now, wearable) devices (Shih 2004; Gripsrud 2012). Along this path of ever closer human-technological integration, an emerging frontier is that of moving computing inside the human body through the use of implantable computers (Koops & Leenes 2012; Gasson 2012; McGee 2008).

## The Potential of Neuroprosthetic Implants for Human Enhancement

One particular type of implantable computer is a neuroprosthetic device (or neural implant) designed to provide a human being with some sensory, cognitive, or motor capacity (Lebedev 2014). Such neuroprostheses are currently used primarily for therapeutic purposes, to restore abilities that have been lost due to injury or illness. However, researchers have already developed experimental devices designed for purposes of human enhancement that allow an individual to exceed his or her natural biological capacities by, for example, obtaining the ability to perceive ultrasonic waves or store digitized computer files within one's body (Warwick 2014; Gasson 2012; McGee 2008).

### Toward Posthuman Digital-Physical Ecosystems

The use of neuroprosthetics for purposes of human enhancement is expected to grow over the coming decades, resulting in a segment of the population whose minds possess unique kinds of sensory perception, memory, imagination, and emotional intelligence and who participate in social relations that are mediated not through the exchange of traditional oral, written, or nonverbal communication but by neurotechnologies that allow the sharing of thoughts and volitions directly with other human minds and with computers (McGee 2008; Warwick 2014; Rao, Stocco, Bryan, Sarma, Youngquist, Wu, & Prat 2014).

Until now, communicating a thought to another mind has required the thought to be expressed physically as a social action that is audible, visible, or tangible in nature, however future neuroprosthetics may facilitate the exchange of ideas directly at the level of thought (Warwick 2014; Rao et al. 2014; Gladden 2015d), thereby allowing the creation of human networks that can be understood as either "supersocial" or "postsocial" in nature. Not only might such posthuman (Ferrando 2013) digital ecosystems be inaccessible to those who lack the appropriate form of neural augmentation, but even their very existence may be invisible to unmodified human beings.

In this text, we will often refer to such ecosystems as "digital" to emphasise the fact that they may utilize an immersive cyberspace or other artificial environment as a virtualized locus for socioeconomic interaction. However, it should be kept in mind

that any such virtual reality is always grounded in and maintained by the computational activity of electronic or biological physical substrates; thus technically, digital ecosystems should always be understood as "digital-physical" ecosystems.

## The Need to Analyse Neuroprosthetics from Cybernetic, Phenomenological, and Existentialist Perspectives

As a bidirectional gateway, a neural implant not only aids one's mind to reach out to explore the world and interact with other entities; it may also allow external agents or systems to reach into one's mind to access—and potentially manipulate or disrupt—one's most intimate mental processes (Gasson 2012: 15–16). This makes it essential that manufacturers who produce such devices, policymakers who can encourage or ban their adoption, and users in whom they will be implanted be able to understand the positive and negative impacts of particular neuroprosthetic devices on individual users. This calls for the development of device ontologies and typologies for classifying and understanding neuroprostheses that do not simply focus on the devices' technical characteristics but which also consider a user's lived experience of a neuroprosthetic device and which integrate a cybernetic analysis of "control and communication" (Wiener 1961) with phenomenological and even existentialist perspectives (Gladden 2015d).

## Existing Ontologies and Typologies of Neuroprosthetic Devices

Existing typologies for neuroprosthetics are primarily functional. For example, a neuroprosthetic device can be classified based on the nature of its interface with the brain's neural circuitry [sensory, motor, bidirectional sensorimotor, or cognitive (Lebedev 2014)], its purpose [for restoration, diagnosis, identification, or enhancement (Gasson 2012: 25)], or its location [non-invasive, partially invasive, or invasive (Gasson 2012: 14)]. Typologies have also been developed that classify a neuroprosthesis according to whether it aids its human user to interact with a real physical environment using his or her natural physical body, augments or replaces the user's natural physical body (e.g., with robotic prosthetic limbs), or allows the user to sense and manipulate some virtual environment (Gladden 2015b).



# Formulating Our Model for an Ontology of Neuroprosthetics

Here we propose a model for classifying and understanding neuroprosthetic devices especially in their role of integrating human beings into digital ecosystems, economies and information systems. The model comprises two main dimensions, of which one (impact) is further subdivided into two sub-dimensions (new capacities and detriments).

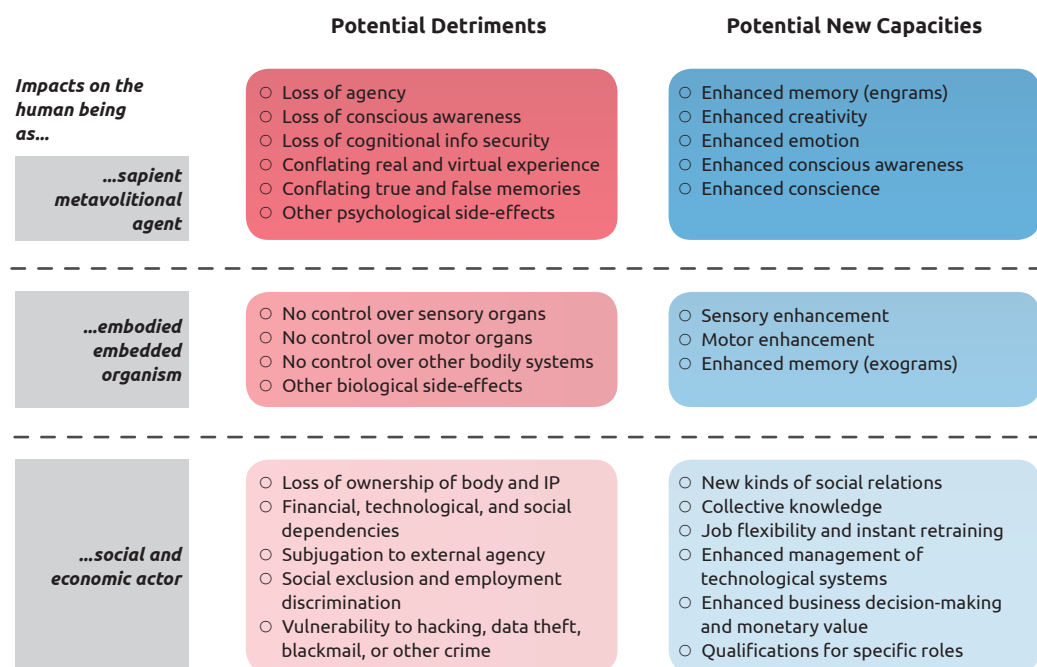
## Roles of the Human User

A neuroprosthetic device affects its human user as viewed on three levels: 1) the human being as a sapient metavolitional agent, a unitary mind that possesses its own conscious awareness, memory, volition, and conscience—or "metavolitionality" (Gladden 2015d; Calverley 2008)—2) the human being as an embodied organism that inhabits and can sense and manipulate a particular environment through the use of its body; and 3) the human being as a social and economic actor who interacts with others to form social relationships and to produce, exchange, and consume goods and services.

## Impact: Potential New Capacities and Detriments

At each of these three levels, a neuroprosthetic device can create for its user either new opportunities and advantages, new threats and disadvantages, or both. Typically a neuroprosthetic device creates new opportunities for its user to participate in socioeconomic interaction and informational ecosystems by providing some new cognitive, sensory, or motor capacity. Disadvantages may take the form of a new dependency on some external resource, the loss of a previously existing capability, a security vulnerability, or some other detriment. Because a neuroprosthetic device's creation of new capacities can be independent of its creation of detriments, these elements comprise two different dimensions; however, it is simpler to treat them as two sub-dimensions of a single larger dimension, the device's "impact".

**Figure 1.** A multidimensional model of the impacts of neuroprosthetic devices on individual users



## Impacts Captured by Our Model

Below we present specific capacities and detriments that neuroprosthetics are expected to create for their users at the three levels of the human being as 1) sapient metavolitional agent, 2) embodied embedded organism, and 3) social and economic actor. These items constitute a broad universe of expected possible impacts identified by scholars; any one neuroprosthesis may generate only a small number of these effects, if any.

### Impacts on the User as Sapient Metavolitional Agent

Neuroprosthetic devices may affect their users' cognitive processes in ways that positively or negatively impact the ability of such persons to participate in socioeconomic interaction and informational ecosystems.

New capacities provided by neuroprosthetics may include:

- *Enhanced memory, skills, and knowledge stored within the mind (engrams).* Building on current technologies tested in mice, future neuroprosthetics may offer human users the ability to create, alter, or weaken memories stored in their brains' natural memory systems in the form of engrams (Han, Kushner, Yiu, Hsiang, Buch, Waisman, Bontempi, Neve, Frankland, & Jossely 2009; Ramirez, Liu, Lin, Suh, Pignatelli, Redondo, Ryan, & Tonegawa 2013; McGee 2008; Warwick 2014: 267). This could potentially be used not only to affect a user's declarative knowledge but also to enhance motor skills or reduce learned fears.
- *Enhanced creativity.* A neuroprosthetic device may be able to enhance a mind's powers of imagination and creativity (Gasson 2012: 23–24) by facilitating processes that contribute to creativity, such as stimulating mental associations between unrelated items. Anecdotal increases in creativity have been reported to result after the use of neuroprosthetics for deep brain stimulation (Cosgrove 2004; Gasson 2012).
- *Enhanced emotion.* A neuroprosthetic device might provide its user with more desirable emotional dynamics (McGee 2008: 217). Effects on emotion have already been seen in devices used, e.g., for deep brain stimulation (Kraemer 2011).
- *Enhanced conscious awareness.* Research is being undertaken to develop neuroprosthetics that would allow the human mind to, for example, extend its periods of attentiveness and limit the need for periodic reductions in consciousness (i.e., sleep) (Kourany 2013: 992–93).
- *Enhanced conscience.* One's conscience can be understood as one's set of metavolitions, or desires about the kinds of volitions that one wishes to possess (Calverley 2008; Gladden 2015d); insofar as a neural implant enhances processes of memory and emotion (Calverley 2008: 528–34) that allow for the development of the conscience, it may enhance one's ability to develop, discern, and follow one's conscience.

New impairments generated by neuroprosthetics at the level of their user's internal mental processes may include:

- *Loss of agency.* A neuroprosthetic device may damage the brain or disrupt its activity in a way that reduces or eliminates the ability of its human user to possess and exercise agency (McGee 2008: 217). Moreover, the knowledge that this can occur may lead users to doubt whether their volitions are really "their own"—an effect that has been seen with neuroprosthetics used for deep brain stimulation (Kraemer: 2011).
- *Loss of conscious awareness.* A neuroprosthetic device may diminish the quality or extent of its user's conscious awareness, e.g., by inducing daydreaming or increasing the required amount of sleep. A neuroprosthesis could potentially even destroy its user's capacity for conscious awareness (e.g., by inducing a coma) but

without causing the death of his or her biological organism (Gladden 2015d).

- *Loss of information security for internal cognitive processes.* A neuroprosthetic device may compromise the confidentiality, integrity, or availability of information contained within its user's mental activities (such as perception, memory, volition or imagination), either by altering or destroying information, making it inaccessible to the user, or making it accessible to unauthorized parties (McGee 2008: 217; Gladden 2015d; Gladden 2015c).
- *Inability to distinguish a real from a virtual ongoing experience.* If a neuroprosthesis alters or replaces its user's sensory perceptions, it may make it impossible for the user to know which (if any) of the sense data that he or she is experiencing correspond to some actual element of an external physical environment and which are "virtual" or simply "false" (McGee 2008: 221; Gladden 2015d).
- *Inability to distinguish true from false memories.* If a neuroprosthetic device is able to create, alter, or destroy engrams within its user's brain, it may be impossible for a user to know which of his or her apparent memories are "true" and which are "false" (i.e., distorted or purposefully fabricated) (Ramirez et al. 2013).
- *Other psychological side effects.* The brain may undergo potentially harmful and unpredictable structural and behavioral changes as it adapts to the presence, capacities, and activities of a neuroprosthesis (McGee 2008: 215–16; Koops & Leenes 2012: 125, 130). These effects may include new kinds of neuroses, psychoses, and other disorders unique to users of neuroprosthetics.

## Impacts on the User as Embodied Embedded Organism Interacting with an Environment

Neuroprosthetic devices may affect the ways in which their users sense, manipulate, and occupy their environment through the interface of a physical or virtual body. New capacities provided might include:

- *Sensory enhancement.* A neuroprosthetic device may allow its user to sense his or her physical or virtual environment in new ways, either by acquiring new kinds of raw sense data or new modes or abilities for processing, manipulating, and interpreting sense data (Warwick 2014: 267; McGee 2008: 214; Koops & Leenes 2012: 120, 126).
- *Motor enhancement.* A neuroprosthetic device may give users new ways of manipulating physical or virtual environments through their bodies (McGee 2008: 213; Warwick 2014: 266). It may grant enhanced control over one's existing biological body, expand one's body to incorporate new devices (such as an exoskeleton or vehicle) through body schema engineering (Gladden 2015b), or allow the user to control external networked physical systems such as drones or 3D printers or virtual systems or phenomena within an immersive cyberworld.

- *Enhanced memory, skills, and knowledge accessible through sensory organs (exog-rams).* A neuroprosthetic device may give its user access to external data-storage sites whose contents can be "played back" to the user's conscious awareness through his or her sensory organs or to real-time streams of sense data that augment or replace one's natural sense data (Koops & Leenes 2012: 115, 120, 126). The ability to record and play back one's own sense data could provide perfect audiovisual memory of one's experiences (McGee 2008: 217).

New impairments generated by neuroprosthetics at the level of their users' physical or virtual bodily interfaces with their environments might include:

- *Loss of control over sensory organs.* A neuroprosthetic device may deny a user direct control over his or her sensory organs (Koops & Leenes 2012: 130). Technologically mediated sensory systems may be subject to noise, malfunctions, and manipulation or forced sensory deprivation or overload occurring at the hands of "sense hackers" (Gladden 2015c: 201–02).
- *Loss of control over motor organs.* A neuroprosthetic device may impede a user's control over his or her motor organs (Gasson 2012: 14–16). The user's body may no longer be capable, e.g., of speech or movement, or the control over one's speech or movements may be assumed by some external agency.
- *Loss of control over other bodily systems.* A neuroprosthetic device may impact the functioning of internal bodily processes such as respiration, cardiac activity, digestion, hormonal activity, and other processes that are already affected by existing implantable medical devices (McGee 2008: 209; Gasson 2012: 12–16).
- *Other biological side effects.* A neuroprosthetic device may be constructed from components that are toxic or deteriorate in the body (McGee 2008: 213–16), may be rejected by its host, or may be subject to mechanical, electronic, or software failures that harm their host's organism.

## Impacts on the User as Social and Economic Actor

Neuroprosthetic devices may affect the ways in which their users connect to, participate in, contribute to, and are influenced by social relationships and structures and economic networks and exchange. New capacities provided might include:

- *Ability to participate in new kinds of social relations.* A neuroprosthetic device may grant the ability to participate in new kinds of technologically mediated social relations and structures that were previously impossible, perhaps including new forms of merged agency (McGee 2008: 216; Koops & Leenes 2012: 125, 132) or cybernetic networks with utopian (or dystopian) characteristics (Gladden 2015d).

- *Ability to share collective knowledge, skills, and wisdom.* Neuroprosthetics may link users in a way that forms communication and information systems (McGee 2008: 214; Koops & Leenes 2012: 128–29; Gasson 2012: 24) that can generate greater collective knowledge, skills, and wisdom than are possessed by any individual member of the system (Wiener 1961: loc. 3070ff., 3149ff.; Gladden 2015d).
- *Enhanced job flexibility and instant retraining.* By facilitating the creation, alteration, and deletion of information stored in engrams or exograms, a neuroprosthetic device may allow a user to download new knowledge or skills or instantly establish relationships for use in a new job (Koops & Leenes, 2012: 126).
- *Enhanced ability to manage complex technological systems.* By providing a direct interface to external computers and mediating its user's interaction with them (McGee 2008: 210), a neuroprosthesis may grant an enhanced ability to manage complex technological systems, e.g., for the production or provisioning of goods or services (McGee 2008: 214–15; Gladden 2015b).
- *Enhanced business decision-making and monetary value.* By performing data mining to uncover novel knowledge, executing other forms of data analysis, offering recommendations, and alerting the user to potential cognitive biases, a neuroprosthesis may enhance its user's ability to execute rapid and effective business-related decisions and transactions (Koops & Leenes 2012: 119). Moreover, by storing cryptocurrency keys, a neuroprosthesis may allow its user to store money directly within his or her brain for use on demand (Gladden 2015a).

*Qualifications for specific professions and roles.* Neuroprosthetic devices may initially provide persons with abilities that enhance job performance in particular fields (Koops & Leenes 2012: 131–32) such as computer programming, art, architecture, music, economics, medicine, information science, e-sports, information security, law enforcement, and the military; as expectations for employees' neural integration into workplace systems grow, possession of neuroprosthetic devices may become a requirement for employment in some professions (McGee 2008: 211, 214–15; Warwick 2014: 269).

New impairments generated by neuroprosthetic devices at the level of their users' socioeconomic relationships and activity might include:

- *Loss of ownership of one's body and intellectual property.* A neuroprosthetic device that is leased would not belong to its human user, and even a neuroprosthesis that has been purchased could potentially be subject to seizure in some circumstances (e.g., bankruptcy). Depending on the leasing or licensing terms, intellectual property produced by a neuroprosthetic device's user (including thoughts, memories, or speech) may be partly or wholly owned by the device's manufacturer or provider (Gladden 2015d; Gladden 2015c: 164).

- *Creation of financial, technological or social dependencies.* The user of a neuroprosthetic device may no longer be able to function effectively without the device (Koops & Leenes 2012: 125) and may become dependent on its manufacturer for hardware maintenance, software updates, and data security and on specialised medical care providers for diagnostics and treatment relating to the device (McGee 2008: 213). A user may require regular device upgrades in order to remain competitive in some jobs. High switching costs may make it impractical to shift to a competitor's device after a user has installed an implant and committed to its manufacturer's digital ecosystem.
- *Subjugation of the user to external agency.* Instead of merely impeding its user's ability to possess and exercise agency, a neuroprosthesis may subject its user to control by some external agency. This could occur, e.g., if the user's memories, emotions, or volitions were manipulated by means of the device (Gasson 2012: 15–16) or if the user joined with other minds to create a new form of social entity that possesses some shared agency (McGee, 2008: 216).
- *Social exclusion and employment discrimination.* The use of detectable neuroprosthetics may result in shunning or mistreatment of users (Koops & Leenes 2012: 124–25). Users of advanced neuroprosthetics may lose the ability or desire to communicate with human beings who lack such devices, thereby fragmenting human societies (McGee 2008: 214–16; Warwick 2014: 271) and possibly weakening users' solidarity with other human beings (Koops & Leenes 2012: 127). Possession of some kinds of neuroprosthetic devices may exclude their users from employment in roles where "natural," unmodified workers are considered desirable or even required (e.g., for liability or security reasons).
- *Vulnerability to data theft, blackmail, and extortion.* A hacker, computer virus, or other agent may be able to steal data contained in a neuroprosthesis or use it to gather personal data (potentially including the contents of thoughts, memories, or sensory experiences) (McGee 2008: 217; Koops & Leenes 2012: 117, 130; Gasson 2012: 21; Gladden 2015: 167–68) that could be used for blackmail, extortion, corporate espionage, or terrorism.

## Applying the Model: Toward a New Typology of Neuroprosthetics

As a test case, we can use this model to analyse one kind of neuroprosthetic device that is expected to become available in the future: a cochlear implant with audio recording, playback, upload, download, and live streaming capabilities (Koops & Leenes 2012; McGee 2008; Gladden 2015d). Everything that its user hears would be recorded for later playback on demand. Instead of simply conveying the "real" sounds produced



by the physical environment, those sounds can be augmented or replaced by other audio that is stored in or transmitted to the device. Potential capacities and impairments created for the user of such a device are identified in Figure 2 below.

As can be seen from this example, the model does not yield a single quantitative "impact score" for each of the three levels but rather uses qualitative descriptions to capture a complex set of impacts. This model delineates a device ontology that can form the basis of further reflection on and analysis of a neuroprosthetic device's impact from both cybernetic, phenomenological, and existentialist perspectives. By allowing neuroprosthetic devices with similar characteristics to be identified and grouped, it can also serve as the basis of new typologies for neurotechnologies.

**Figure 2.** The model applied to analyse impacts of a particular auditory neuroprosthesis

	Potential Detriments	Potential New Capacities
<i>Impacts on the human being as...</i>  ... <i>sapient metavolitional agent</i>	<ul style="list-style-type: none"><li>○ Conflation of "real" sounds from the environment, the playback of recorded audio, and live streaming of audio from a remote source</li><li>○ Psychological effects of sensory overload, deprivation, or manipulation</li></ul>	<ul style="list-style-type: none"><li>○ A continuous internal "soundtrack" of music or sounds can be created to stimulate desirable cognitive activity and suppress undesirable activity</li></ul>
... <i>embodied embedded organism</i>	<ul style="list-style-type: none"><li>○ Loss of control over auditory sense data to those directing the device</li><li>○ Disruption of sensorimotor feedback loops due to lack of real sense data</li></ul>	<ul style="list-style-type: none"><li>○ Playback ability grants perfect auditory memory</li><li>○ Extension of body by tapping into audio from remote microphones</li></ul>
... <i>social and economic actor</i>	<ul style="list-style-type: none"><li>○ Hackers can eavesdrop on live audio from the user's implant or access recorded auditory experiences</li><li>○ User could be forced to hear sounds (e.g., voices) designed to produce specific reactions or behaviors</li><li>○ Some may refuse to speak with user since all conversations are recorded</li><li>○ User will be suspected of receiving secret aid or advice through implant</li></ul>	<ul style="list-style-type: none"><li>○ Ability to receive live audio prompts may aid politicians, actors, news broadcasters, lecturers, etc.</li><li>○ Hands-free ability to play back audio notes or download reference material may aid surgeons, artists, drivers, soldiers, police, athletes, etc.</li><li>○ Two or more persons can share their inner speech for forging joint experiences and communal decisions</li></ul>



## Conclusion

Ongoing advances in neuroprosthetics are expected to yield a diverse range of new technologies with the potential to dramatically reshape a human being's internal mental life, his or her bodily existence and interaction with the environment, and his or her participation in social and economic networks and activity. The new capacities and impairments that such technologies provide may allow human beings to physically and virtually inhabit digital ecosystems and interact socially in ways so revolutionary that they can best be understood as "posthuman."

The model developed in this text for understanding these impacts of neuroprosthetic devices is already being elaborated in the specific context of information security to provide a framework for future research and practice in that field (Gladden 2015c). By further refining and applying the model in other contexts, we hope that it will be possible for engineers, ethicists, policymakers, and consumers to better understand how particular kinds of neuroprosthetic devices may contribute to the development of new digital ecosystems that can be a powerful venue for the growth, liberation, and empowerment—or oppression and dehumanization—of the human beings of the future.

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# Humans between non-humans. The colonization of the analogue by the digital

Actor-Network Theory has been used in a variety of contexts ranging from classical topics discussed within Science and Technology Studies, which ANT grew out of (Latour 1986; 1999), through modern American politics (Anderson & Kreiss 2015), to marine industry (Mort 2002) and many more. It was also employed to discuss journalism (Anderson, De Meayer 2015; Turner 2005; Braun 2014). In my argument, ANT is used for the analysis of the process of *digitisation*, in which collectives engage in relations within other collectives, resulting in shifts in culture (understanding of which is explained in the further part of the article). The case I use for the sake of the argument is a local newspaper published in Poland and undergoing gradual *digitisation*.

According to Latour's terminology, the *collective* is a term with which he replaces the term *society* (Latour 2005: 14). A collective is a collection of actors who are interrelated and influence each other, while the action is never taken simply by the subject—it is always influenced by someone or something else, it is "other-taken", as Latour writes, making a reference to his Swedish friend transcribing Hegel (Latour 2005: 45). The collective is in constant movement, continuously reassembling itself, including new actors or changing the placement of those included in earlier cycles.

There is no actor without action, and everyone and everything that acts is an actor, including non-humans such as plants, animals, rocks, computers and those without material

body (*ideomorphs*) (Latour 2005: 53), such as, for example, ideas, concepts or elements of formal logic. The actor never acts alone, he or she or it is always in relation to other actors, so "it is never clear who and what is acting when we act since an actor on stage is never alone in acting" (p. 46). Constructing new actors (in a complicated process of reacting to certain observed phenomena) influencing the actions of other actors is usually a preliminary stage to including them into collectives (Latour 2004).

My goal in this paper is to explain how changes in the composition of a particular collective related to introduction of digital non-humans, such as modern computers, software and computer networks, and economic consequences of these changes, challenged and changed the shape and placement of other actors within that collective. The case discussed in this paper is the collective surrounding journalists working for a local newspaper somewhere in Poland<sup>1</sup>. My goal is also to describe a way of understanding power through the lens of ANT and to discuss my approach to understanding digital culture as a set of partial solutions to problems which human actors (in the presented case journalists and editors) face while conducting actions related to their work within such a collective, which is being methodically colonised by the digital non-humans. I finalise my argument with the conception of colonisation of the analogue by the digital.

Latour states clearly that the researchers' job is to follow the natives in their constructions of collectives (Latour 2005: 62). I dare say that while some of the actors influencing the other actors are invisible to them, the researchers' role is to notice them and include them into the collectives even when they do not appear in the natives' accounts, and this is how I proceed in the following argument.

## Two "levels" of digital culture

There are two ways of understanding *culture* in my approach. The first one would define *culture* as simply synonym for *collective*: the whole set of humans and non-humans acting in constantly shifting interrelations. The second one is "smaller" and

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<sup>1</sup> The paper employs empirical data coming from ethnographic study of a newsroom of a local daily newspaper in medium-sized city in Poland. For the purpose of this paper the identity of the company publishing the paper and names of particular journalists and editors are kept confidential due to comfort and safety of sources. Only the supervisors of my PhD dissertation and my research conducted at the National Library of Poland know the identity of the newspaper.

has lots in common with Hutchins' (Hutchins 1996: 168–169) approach. This definition would state that culture is a set of partial solutions to problems that actors happen to face in their lives, whether it would be a proper way to hang laundry or effective way of selling the newspaper or earning money on publishing written content, commonly shared by relevant actors. In this paper the human digital culture is discussed, where only partial solutions shared by humans are taken into account, however, similar work concentrating on the culture of non-humans can be easily imagined (its elements will be included here).

It is argued that by looking into these tactics, one can observe major shifts that are correlated with changing compositions of collectives. These tactics, procedures or beliefs that were influenced or stayed the same even though the digital non-humans were introduced into the collective are what may be called the *digital culture*.

In this paper the digital culture of people working for a local newspaper is analysed. The problems to which solutions are interesting from the standpoint of this study are those connected with working in a newspaper (keeping in touch with the city, composing texts), but the focus is mostly on "broadcasting" to the outside world, and this is why the editors, especially those working on the website, are paid more attention to than journalists themselves (their work on a particular piece of information is finished when they submit it to the editors).

The same as it is with metaphysics and following the natives, it is with partial solutions—some of them are intuitive and are not necessarily perceived by the natives as solutions or are intuitive to the degree where they are virtually non-existent in the eyes of the natives. The academics' role is to find those hidden ideomorphs, shed light on them and employ them into their understandings of how collectives work<sup>2</sup>.

## Parallel publishing

A shift in partial solutions to problems related to the introduction of digital non-humans, which in case of a newspaper concentrate around broadcasting information and commentary on important local events to the widest audience possible and

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2 Spokesperson as someone representing the non-humans, look: Latour 2004: 250.

bringing profit to the publisher, is the easiest to notice in the organisation of work on the website-edition of the paper (natives call it "the internet"). This part of their digital culture is described in the following part.

During the observation and interviews conducted in and around the newsroom the attention was paid to the understanding of the essence journalists' work in the eyes of the practitioners of this profession. The most common one vocalised by the interviewees was gathering and distributing information in an understandable form. Next was about constructing the discourse on important matters by vocalising important groups. The third, almost the least common, was shaping the values, ethics and goals of the audience (didacticism). Only one of the interviewees believed the art of writing to be an important part of her<sup>3</sup> work. For the most part the written and printed form of their communication was of no importance, but some level of disregard for publishing on a website can be noticed.

## Print and digital

The paper is published both in printed and digital form. The latter is the website of the paper. Greater part of the articles published in the printed edition are at some point published on the website<sup>4</sup>, although often in a slightly different form—they may be supplemented by photo galleries or multimedia, they may be shorter and lack some parts of the texts published in print, they may be connected to other webpages through hyperlinks or may be edited in order to better adhere to SEO requirements. There is a situation when the article from the first page is not published in any form before the printed edition hits the shelves—the editors might hold it back from publishing on-line when it is an exclusive (nobody else has it) and "may increase the sales another day". On the other hand, when the story is "newsy", a journalist first writes for "the internet", and only having done so, begins working on a longer story to publish in next day's paper.

The website editors (or simply "internet workers") work shifts and besides editing and publishing the articles prepared by the journalists, they write their own short entries,

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3 The genders of interviewees might have been changed for the purpose of preserving their anonymity.

4 Except for the weekend magazine addition, which is hidden behind a paywall and includes mostly longer forms, such as interviews, op-eds, or essays, but it is irrelevant, because the process of creating this addition is very different from the daily newspaper.

mostly based on official releases made by public institutions (police, the local government) and create or assemble content specific for on-line circulation—larger photo galleries (often delivered by institutions), quizzes, or videos. The process of running the website goes parallel to publishing the printed edition of the paper.

The journalists create content and forward it to the editors. They have access to the CMS<sup>5</sup> so they can add their articles to the database while its website editors' job to edit them and hit the "publish" button in an appropriate moment. But journalists do not do that so eagerly. They had been instructed by their employers how they should write for the purpose of the website, mostly in terms of SEO, however, they do not mention it as an important factor in their work. One of the journalists said that he prefers to give his texts to the editors of the printed edition for editing and proof-reading before his article goes to "the Internet". Another one prefers sending his writing as attachments to e-mails and he does not like to use the CMS. Even though everyone obediently adds his or her writing to the application used for composing the printed newspaper<sup>6</sup>.

This may lead one to think that in terms of workflow, for journalists the website plays a bit of a supplementary role and its editors are treated much more lightly than more strict paper editors. It may be connected to the fact that paper-edition editors are older and (on average) more experienced and with the fact that the most visible exercise of power of the editors and editor-in-chief lies in accepting the proposed topics and distributing page-space for the journalists, which is limited in a different way in case of the website. Both editions, as editor-in-chief explains, "are supposed to complement each other". On-line is supposed to be more "newsy" and constantly updated. But when there is an exclusive information available, it is better to delay it and publish in printed edition on the first page—when papers appear on the shelves, it is too late for the competition to update their first pages—they can only respond on-line.

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5 *Content Management System*—an application or a set of applications used for editing and publishing content on the website. There are open-source solutions, such as WordPress or Drupal, and proprietary ones. More on CMS as software of interest through the lens of ANT, look: Rodgers, 2015.

6 The company publishing the paper uses proprietary software for distributing the process of composing the paper—the artists create the layouts for the pages co-working with the editors, while the journalists "pour" their articles in prepared boxes. Interface is based on WYSIWYG user interface representing the whole issue of the newspaper. Then editors and proof-readers can edit the texts and mark them with "edited" or "proof-read" statuses, which are signalled by colours.

## Constructing the audience

Even though the majority of the articles published on-line are those that also appear in the printed edition of the paper, these two circulations vary considerably. The most noticeable difference lies in constructing the audience. On every daily meeting, which takes place early, around 9:00 AM, all journalists gather in editor-in-chiefs office on a "collegium". There are also two people from "the Internet", whose role is to provide information about on-line edition statistics—he or she highlights the last day's highest numbers of visits paid by users to particular articles and items displayed on the website, such as photo galleries or quizzes. There is hard evidence on which materials provide best viewership, and which are paid less attention.

Website editors' experience in what brings traffic and what does not influences their decisions about what is worth attention. When a reader or someone else hints the editors about a topic they should cover through e-mail, website editors decide whether they should pursue the topic by sending someone to take a photo or a video. Their decisions are based on experience in what brings traffic, and what does not. The traffic is directly related to revenue. "As long as traffic is high, nobody bothers us", said one of the website editors when asked about the ways his work is evaluated.

When journalists are asked about the criteria used for deciding whether to pick a certain topic or not, they explained that it is all about the principle of "is it interesting". This adjective appears in almost every discussion, be it between the editor-in-chief and a journalist, or between them and the author. Different journalists understand "interesting" differently, but there are some shared elements of their definitions: one says it is something that is important for a large part of the audience; someone else argues that what is interesting depends on how it is written, not what it is about—the role of a journalist is to cover it interestingly, artfully, with a good craftsmanship; the other interviewee, who worked at the newspaper as a journalist more than ten years ago, says that back then they looked for "exclusives"—interesting was the thing that no other paper in the city had, but he also declares that he liked the tabloid-style of the paper, which changed in time into more "civil-oriented". Even now during the "collegium" the fixed part of the meeting is dedicated to comparing the day's paper with others published in town. The main point in the presentation delivered by someone appointed for a particular day is to determine "if we have missed something".

The editor-in-chief is also equipped with the results of the research on the readership of their newspaper. This is where he learns about the demographics of the audience and this is what may be of assistance when determining whether (or how) something should be covered.



As one can notice, strategies of constructing audience by the journalists and editors are different for printed edition and for the on-line edition. The audience of the website is automatically quantified, data on viewership of particular articles is collected, calculated and represented in daily rankings, whereas the readership of printed edition is more difficult to understand and lacks daily verification. "Print" editors lack precise quantitative data to verify their decisions in a short term. They can only tell how well the newspaper sold on a particular day, but they cannot determine which stories were read most frequently, which of them brought most attention etc.

For the "internet" statistics, the newspaper uses mainly Google Analytics, which does not provide demographic information to its end-users. But it does collect and analyse such information based on variety of signals about the users for the providing company's own purposes.

## Allies for the on-line

Website editors engage in alliances with variety of non-humans. They use social networks such as Facebook and Twitter; they use their CMS and try to negotiate with Google Search algorithms. They also use e-mail, web browsers, word-processors, video editing tools, and professional media platforms. Some of these applications are employed for the purpose of editing content and there will be not much attention paid to it in this text. The other ones are directly connected with earning traffic on the paper's website and the know-how about using them is indeed a set of shared partial solutions to problems faced by these editors. And employing them is a partial solution of a problem related to shifts in the distribution market.

The website editors' work is evaluated on the basis of traffic, which is directly connected with profit coming from published advertisements. They have limited power to put pressure on journalists to take possible traffic into consideration while working on their articles, although their supervisor takes part in editorial meetings and planning each day. What they can do is use the delivered content effectively (for the greatest traffic) and create content on their own.

The first part of the task concentrates on publishing particular stories in appropriate intervals, so that there is "always something new on the website". When editing articles, they sometimes tweak them to become more Google-friendly, mostly by adjusting headers and titles to preferred keywords. When discussing how they do it, they talked mostly about adjusting keywords. They pointed at some bad practices

that they try to avoid: "some websites multiply the keywords so much that the article looks terrible and makes no sense". They criticised other websites' editors for irritating habit of linking new stories to older ones with the purpose of improving their PageRank. "I like what Google does with its algorithm. It prefers good content", one of the editors said. He sees Google Search as a gatekeeper that can automatically filter out bad content—a curator of fine journalism. In running one part of the website internet editors are supported by an application that measures the text's SEO<sup>7</sup>. It provides editors with quantified feedback on how well it fits with the criteria of Google Search's algorithms reconstructed within the application.

As to the content that website editors create, it is mainly news games (Foxman 2015) or short copy—they build quizzes about politicians which users can take part in (or: solve) and doing so, click through lots of views. Such elements of the website are especially profitable in terms of generating traffic—once a user starts such a quiz, he or she clicks through many pages and watches lots of adverts, providing revenue *en route*. "In my spare time I look for inspirations on-line. I tried visualisation; it's a trendy topic in other countries. But so far with little success, although there are special tools provided by Google", one of the editors said.

Another thing they do is making videos for the website. When something happens in the city and it is interesting they take a video camera, leave to take some material on site, and then come back and edit it in a rush to put it on the website as quickly as possible. They sometimes ask journalists to write something corresponding to the video so they can put it on-line next to the embedded material.

As for Facebook, internet editors usually put something on the newspaper's wall every two hours. Mostly they link to the materials published on the website, but sometimes they add something different. One morning they posted a music video from YouTube with a comment "Time to wake up!".

"There always has to be something new", one of them explained. This is what brings the traffic. It is connected with how Facebook's wall works—it presents the posts added by followed fanpages in chronological order with algorithms filtering what is displayed, and what is not (Bucher 2012). So adding new content in regular intervals provides stronger visibility of the added content and publishing posts in intervals pre-

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7 SEO—Search Engine Optimization. The term is used colloquially by practitioners of web design, interactive agencies and other web-business related professionals, so the definition from Wikipedia seems suitable for explaining the meaning of this term: [http://en.wikipedia.org/wiki/Search\\_engine\\_optimization](http://en.wikipedia.org/wiki/Search_engine_optimization).

vents jamming their own content—the wall will not display everything what is being posted in one moment. This way Facebook's algorithms also dictate the schedule of work at the internet department of the newspaper—there always has to be something available to be posted.

Since "Internet"<sup>8</sup> editors have limited authority over what journalists cover and how they do it, they focus on strong alliances with non-humans and on creating web-specific content. This is one of the reasons why digital non-humans play such a huge part in their work—they can negotiate with them and this is what they are paid for.

As it can be easily noticed, the introduction of digital non-humans changed the partial solutions necessary for earning money on publishing a paper. The whole group of web editors works on employing these solutions and gathering necessary non-humans in alliances. Lack of authority limits their possibilities in terms of forcing journalists to engage in these alliances.

The introduction of digital actors into the collective changed readers' habits, say the natives. Journalists mostly attribute these changes to the devaluation of printed press or deflation of the news. "When one can get something for free..."—they always begin explaining the behaviours of their readers with that sentence. The decrease in sales of printed newspapers in Poland is also noticed in quantitative analyses (data gathered by ZKDP<sup>9</sup>). And so the paper had to adapt—start a website, publish its articles on-line and employ people whose task will be to bring digital non-humans on their side. And by doing so, by putting everything they write on-line for free, they feed their work to make these non-humans even stronger. Facebook and Google grow with every piece of content added to the web. They earn money and personal information about the users on every piece of content that they can distribute to their users. Even when on-line editors speak enthusiastically about the two companies' intervention in the distribution processes, it's irrevocable that the paper was forced to ally with them. The journalists perceive their newspaper going on-line almost as a historical imperative—

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8 This general term is usually used when referring to the website editors by the other people working in the newsroom or in editors' offices.

9 The institution, Związek Kontroli Dystrybucji Prasy, provides data via on-line service Teleskop. Some of the data is available free of charge here: <https://www.teleskop.org.pl/zkdp/index.jsp?p=main>

The data was widely discussed, the distribution of paid electronic content was also included in the discourse in Polish context. Look: [http://wyborcza.biz/biznes/1,101716,17469124,Przesadzone\\_pogloski\\_o\\_smierci\\_prasy.html](http://wyborcza.biz/biznes/1,101716,17469124,Przesadzone_pogloski_o_smierci_prasy.html)

<http://www.spidersweb.pl/2015/02/sprzedaz-e-wydan-gazety.html>

unavoidable and absolutely necessary, nobody mentions a scenario in which the newspaper could have avoided that and chose a different approach. And their understanding of the reasons for decrease in sales of the printed paper is limited to the basic arguments about web being free of charge and pushing printed paid papers out.

## City is a network

Interconnectedness is one of the often-vocalised features of the web. This particular technology seems to reduce the number of intermediaries between human actors, fuelling transparency and enhancing direct relations in place of those mediated by the organised distribution channels (Morozov 2012). But it is rarely noticed that in place of a couple of human intermediaries, nowadays internet provides us with even more digital non-humans, but they remain obscure (look: Chun 2005). A single query addressed to Google Search goes through physical interfaces, parts of a computer or a mobile device, complex algorithms of the search engine, which are on the other hand connected with those working for social networking, e-mail services and many more, to finally reach a website, which was also created using complex tools and works on the backbone of server-side software.

One of the older editors of the paper said that back in the day it was much easier to get straight answers from public figures. Even someone holding a high position in the local administration would pick up a phone and tell journalist most of the things he or she wanted to know. A policeman would tell a reporter, who happened to be walking the street by a car engulfed in flames, what happened and who the suspects are. "Today", she said, "they would send you to the PR department".

From his point of view the local government got much more professional and careful about what is shared with the press, taking more care about the organisation of communication with the public. People working in press relations are also much more professional and work as efficient gatekeepers—this is what journalists put emphasis on. It is difficult to determine whether this particular phenomenon was caused by technological changes or by the accelerated organisational shifts started by fairly recent regime change in Poland. But for sure it may stand as a counter-argument to the belief that the society is more interconnected now than it was before.

One of the journalists said that he thinks it is also because journalists are lazier now than before. If a public institution throws them a public announcement with an

e-mail, they are eager to use it instead of looking for a topic "when wandering the streets". They have less time to work on their articles in comparison with how it was when printed press was selling well and wages were much higher, which is related to the changes within the collective caused by the introduction of the digital non-humans. "The fixed pay was bigger, now greater part is paid for published texts". This is why journalists have to write more and have less time to pursue particular interesting topics. Press releases come in handy in such circumstances.

One of the experienced journalists, who works for the paper, finds one particular skill the most important for a journalist—talking. One who has that skill can get exclusive information, because it makes their interlocutors much more eager to talk. When attending a press conference or a briefing, he does not satisfy himself with official announcements. He tries to follow the officials after the meeting, trying to get more details and learn more about the context. This is his way of breaking the walls constructed by PR departments—by making use of his ability to dig, ask and persuade people to talk. It allows him to override the procedures. He also suggested that pursuing digital-born strategies, such as using Google Search or e-mailing with someone, brings less effect than old-fashion chatting with proper people. It sheds different light on this "laziness" of today's journalists. It might be not the wages, but partial solutions they share what determines their approach to writing the articles. Maybe they prefer to ally with non-humans instead of humans, as the know-how of digital culture suggests.

When communication is more mediated by digital non-humans, one who gets in stronger alliances with them dictates how the information is mediated—one can transform a *mediator* into an *intermediary* (Latour 2005: 37–42). A strong PR department could communicate with the public through social networks directly, without the intermediation of journalists, newspapers and other media. But it does not imply transparency—only the techno-social mediator would be someone else: an employed PR department instead of an independent newspaper. And it would be difficult to rule *innovative* (as in innovator in Latour's ANT, this term is elaborated in the next part of the text) companies from Silicon Valley out of the equation.

To sum up, the way the journalists and editors responded to the introduction of digital non-humans to their collective in terms of "broadcasting" their news, a partial remodelling of the set of solutions to the problems they face can be seen (different approach to publishing on-line in reply to changing ways of circulation, necessity of making different alliances with humans and relatively new non-humans) in order to keep bringing profit to the company by selling advertisements. It probably coincides with the far consequences of regime change in Poland (professionalization of institutions' PR departments in reply to the rise of democratic responsibility of

governments), complicating the discussion on whether the discussed technological shift did indeed make government more transparent or simply made the ability to effectively negotiate with non-humans more important.

## Power of the innovator

Latour discusses the innovation and the power it gives to the innovator in *Technology is society made durable* (Latour 1991). He uses an example of cumbersome weights attached to keys in hotel rooms. By their mere construction they make hotel guests leave their keys at the reception—just as the owner wants them to do. This is the *power* of the innovator—by installing non-humans in the collective, he or she makes other non-humans behave in some manner<sup>10</sup>. This is how Latour's terms can explain why journalists, audiences, publishing companies and newspapers have to adapt to the changed circumstances—the ingenious innovations have been installed. The most important ones were Google Search and Facebook—the great game changers in the field of distribution of online content, which is also visible when analysing the non-humans website editors pay the most attention to. In ANT's terms, they obviously have to be treated heterogeneously, as techno-social groupings of various actors (Law 1991).

The ingenuity of these particular innovations lies in the nature of digital non-humans: they are digital. This means that to let them do their work, someone (or something) has to translate the analogue into the digital. And here comes the digitisation—to make text documents searchable by algorithms, first we have to turn them into digital data. In order to do that, interfaces are built—devices enabling at least partially automatic digitisation of everything—sound, image and its semiotics, literature. And if humans want to achieve their goals in a collective infiltrated by such non-humans, they have to go digital, too. When an editor wants to reach people with his or her content, he or she has to go digital: publish the story on-line in a language understandable to the machines, so that digital non-humans will be willing to distribute it to other humans. The situation is the same for digital humanists: to do their research, they usually have to digitize the content they work on, or use some that is already digital (Kopeć 2015). And by doing so, they propel the digital non-humans even further—there is more to machine-learn from, more to rank with PageRank or EdgeRank, more to distribute, and last but not least, more to attach adverts to.

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10 These non-humans don't have to be material objects (Latour 2005: 53).

This process of digitizing everything and making everyone who wants to be effective in a reshaped collective to digitise anything he or she does—I call *colonisation of the analogue by the digital*—from now on *digitisation* may stand as an acronym. This process has its agents, whom can be called *digitants*. They use both technological improvements in the construction of non-humans and spreading of ideomorphs to fuel the process on which they grow. Widespread propaganda of enhancing productivity via digital non-humans, providing transparency with social media, letting customers have wider choice—all these ideomorphs are also used to propel this process of rewriting the culture (in "wider" understanding from the introduction to this paper) into digital. This process may have far implications, the most interesting ones being probably those coming from aesthetics and ontology of culture (Manovich 2000; 2013), and has a long history ranging from the introduction of digital machines and digital simulations of biological life (Dyson 2012), or even further into the past.

Concluding, the author of this article does not speak of this process as of something inherently evil or negative just by itself. What I want to say, is:

- that distant collectives, which are more digitised than others, may be seen as parts of the same process of digitisation together with the works of engineers building interfaces aiming at digitising other parts of the other collectives, creators of gamification applications or stock-market traders automating their transactions;
- that this process does have stakeholders who benefit from digitization;
- that my observations may provide an insight into how to understand power in the context of Latour's ANT and how it may be connected with the figure of innovator who changes the rules of achieving the aims of human actors and remodels partial solutions that are available to them.

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# From journalist to media worker: The study of embodied disruption

## Theory of disruption

According to the Oxford Dictionary verb **to disrupt** means<sup>1</sup>:

- to make it difficult for something to continue in the normal way,
- to drastically alter or destroy the structure of something.

The word has achieved tremendous success in the last couple of years. It was in fact so popular, that a coder known as *turtlehearder* has written the special plug-in for the Google's Chrome browser. Titled *Disrupt to Bullshit*, its sole purpose was to substitute the word *disruption* with *bullshit* on every web page visited by its user. Such a need was the result of a long series of media articles and expert analyses discussing various subjects from disruptive perspective. To avoid chaos following such a wide spectrum of usage, I am going to start with recollection of the term and the theory behind it.

Today's disruption starts with the Schumpeter's theory of innovation. In 1942 he briefly described the phenomenon of *Die kreative Zerstörung*. "The perennial gale of *creative destruction*" is the moving force of capitalism (Schumpeter 2003: 84). The system is operated by three basic mechanisms: *imitation*, *invention*, *innovation*. Industrial

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<sup>1</sup> *Oxford Advanced Learner's Dictionary*, retrieved online at 5/25/2015: <http://www.oxfordlearnersdictionaries.com/definition/english/disrupt>.

development is based on "combinations of the means of production". Therefore capitalism in Schumpeter's view is the system that constantly changes the methods of production and the structure of consumption in the process of innovation.

The Schumpeter's idea had significant impact on theorists and researchers studying the development and crisis of capitalist industries in the second part of the 20th century. The notion of disruption, however, was not widely expanded until its last decade. The most influential turned out to be the work of the economist Clayton Christensen, who described two basic types of innovation: sustaining and disruptive (Christensen 1997). In his later work Christensen slightly revised this typology, added the middle type and changed the terms (Christensen, van Bever 2014). From now on sustainment-disruption has rather been a continuum rather than a definitive description.

The first type in Christensen's concept is the performance-improving innovation. The character of innovation is substitutive, better products replace the worse ones. This kind of innovation does not create a new market. The second type is the efficiency innovation. The main idea of this type is producing more for less. More efficient production leads to lower prices and limits jobs numbers. This type also does not create a new market, but results in jobs outsourcing.

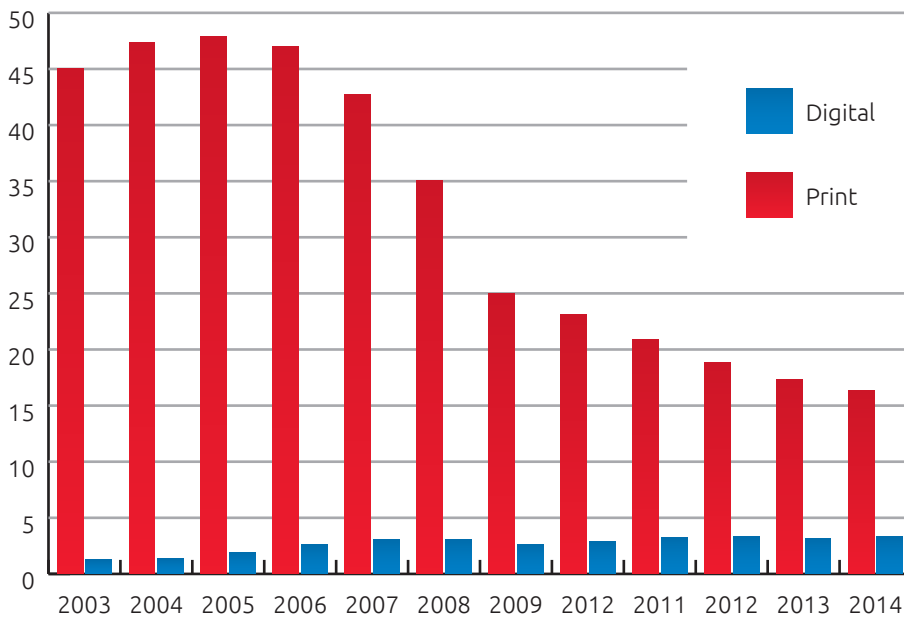
The third and most disruptive type is the market-creating innovation. It is based on non-consumption and targets it in the similar way as market niche products. It means that it transforms costly and inaccessible products so that they can reach new customers. As a consequence an innovative product is cheaper and produced at a lower cost. Typically it is also unsupported by traditional supply chains. Therefore new products need new supply networks, distribution channels and people with different skills than before. Effectively innovators have to build whole new ecosystems that also allow them for creation and targeting of more sophisticated non-consumption opportunities (cf. Callon 2006).

## Media landscape in transition

Let us take a look at media market. For the last decades researchers have been describing the crisis of the traditional media facing aggressive change following the rise and development of the Internet. As an *imperfect market* that depends supremely on the advertisement and not direct payments of the contents' receivers (Kowalski and Jung 2006), the free world wide web, declining the cost of entrance to the digital market and constantly changing patterns of media consumption have seriously impacted media's business models. The news-media market turned out to be particularly fragile.

One of the dominant descriptions of the crisis is the notion of *death of the print*. Numbers on American newspaper's advertising revenue from digital and print editions show two key trends. The revenue of print advertisement has been declining steadily for the last ten years: from 47,4 billions of dollars in 2005 to 16,4 in 2014<sup>2</sup>. In the meantime digital ad revenue has been growing but too slowly to compensate the loss in print. In 2005 digital ad revenue summed up to 2 billion dollars, while in 2014 it topped 3,5<sup>3</sup>. What happened with the 30 billion?

**Figure 1.** U.S. Newspaper Ad Revenue from Digital and Print (billions of U.S. dollars)



Source: Newspaper Association of America (through 2013), BIA/Kelsey (2014).

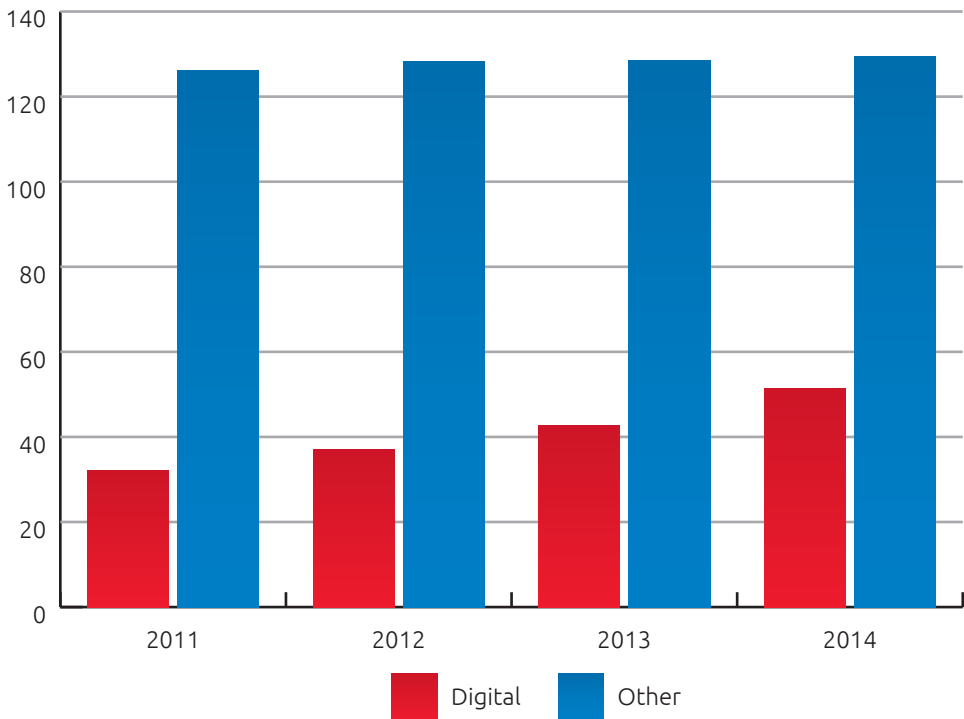
The slow growth of digital ad revenue for U.S. newspapers does not really tell the whole story. Between 2011 and 2014 advertisement spending did not fall. In fact, it raised annually from 158 to 180 billions of dollars. More surprisingly, the most of the growth accounts for digital advertisement that grew by impressive 59 per cent from

<sup>2</sup> Data: Newspaper Association of America (through 2013), BIA/Kelsey (2014).

<sup>3</sup> Data: Newspaper Association of America (through 2013), BIA/Kelsey (2014).

32 to 51 billions of dollars (source: eMarketer. "U.S. Ad Spending Forecast", October 2012, December 2013, December 2014. "Mobile Advertising Goes Mainstream", October 2011) Clearly, traditional media did not benefit much from that trend.

**Figure 2.** Total Digital Ad Revenue (billions of U.S. dollars)



Source: eMarketer. "US Ad Spending Forecast", October 2012, December 2013, December 2014. "Mobile Advertising Goes Mainstream", October 2011.

Looking for the real beneficiaries one might turn to other media companies. The most eye-catching for the last couple of years is the group of publishers calling themselves digital-first media. One of the leaders of the bunch is quiz and trivia service BuzzFeed. Started in the late 2006 by The Huffington Post's co-founder Jonah Peretti, initially the site was described as "the Internet popularity contest". By 2010 its global monthly traffic reached 8 million users and skyrocketed during the next five, until it reached 200 million in February 2015<sup>4</sup>. The figures of revenue are disclosed, but according to Peretti it exceeded 100 million dol. in 2014.

<sup>4</sup> Data: Quantcast. Retrieved: 15/6/2015 <https://www.quantcast.com/buzzfeed.com>.

Facing the crisis and observing successes of unanticipated competition, the management of The New York Times decided to act. The special team of experienced reporters, editors, marketers and masthead staff-members was established with the purpose of recognition and targeting key questions significant for the newsroom's future. After a year of investigation, the team produced extensive case study, published as *The New York Times Innovation Report*. The key issues of modern journalism and media business, as well as The New York Times' failures in face of digital transition were defined precisely in the theoretical mainframe of disruptive innovation.

## Case study of disruption

According to the report's authors, The New York Times got disrupted. The process was described in the terms of Christensen's theory of types of innovation and undergone three basic phases:

1. The New York Times and other **incumbents**, leaders of the industry were focused on improving their products: invested in news-gathering, editing, attracting readers and advertisers, improving traditional distribution. This is the phase of performance or efficiency innovation.
2. New media outlets as The Huffington Post and BuzzFeed are born. Benefiting from technological transition allowing entrance to the market at low cost, **disruptors** offer products of lesser quality that at the beginning does not seem like a competition to the incumbents' offer.
3. Taking advantage of the **new technology**, disruptors improve their business in a way concealed for incumbents and improve their products. When the quality becomes acceptable for the wide range of customers, disruptors can grow by taking market share from incumbents.

The key finding of *The New York Times Innovation Report* was that the hidden element of the disruptors' development was their digital efficiency beyond reach for the traditional media. As the report concluded, filling the gap required significant change in the newsroom's organisation and additional set of skills non-existent in pre-digital editorial. The roles of journalists and editors had to change. In this way, the technological process disruptive for the industry went down from the company level, to the personal level of the employed individual. It created the new type of media employer, described by some as *media worker*.

The roots of this transformation lie in the process of media market disruption and its defined differently by disruptors and incumbents. As seen from the traditional media point of view, digital-first media companies disrupt market by offering cheaper product of lesser quality but distributed more proficiently in the digital ecosystem of social media, search engines and so on. Therefore, the traditional media see disruption as efficiency innovation.

Digital-first media point of view is that the crucial characteristic of nowadays media market is information overload. The access to typical news-readers is therefore difficult. For the media company to grow, the most important is to address non-consumption. Digital-first media noticed that Internet users not accustomed to news consumption are accessible through social media, search engines etc., but efficient addressing needs transformation of content and high skills in distribution praxis. Therefore digital-first media see disruption as market-creating innovation.

Taking into account that both traditional and digital media are dependent on the advertisers trying to reach potential customers, it becomes clear that through redefinition of news-audience and reach leverage, disruptors are creating new markets. Control over audience lies at the very centre of media industry as the stitching point of interest between publishers and advertisers (Ang 1991). When development of addressing the audience becomes its basic characteristic, the related skills are becoming substantial for the individuals.

## Disrupted journalist

The process of disruption of traditional media bears consequences on many levels. Researchers tend to focus on consequences of high-level transformation of media industry or medium-level organisation of media companies in the time of change. But there is also micro-level of the media companies' employees. How is media transformation process embodied in the individuals?

Traditional set of skills in the news-media industry makes more or less similar list:

- research,
- news-gathering,
- writing,
- editing,
- reporting,
- interviewing,

- presenting,
- filming,
- etc.

As concluded by *The New York Times Innovation Report*, to compete with the disruptors of the media market it should become (1) *digital first organisation publishing also impressive newspaper*. Among general findings the report stated also (2) closer cooperation between the newsroom and business side units, which was historically treated as a way of securing newsrooms integrity<sup>5</sup>, and hiring more digital advanced employees among leaders of organisation. More detailed suggestions stated:

- search engine optimization for every article,
- social media distribution strategy for key content,
- active social media distribution by articles' authors,
- creation of an "impact toolbox"—a set of distribution instructions for journalists,
- newsletter alerts and mailing strategy,
- influencers' relations,
- web analytics' consciousness.

Similar list of skills essential for digital journalist can be found at the website of the BBC's *Journalism Academy*<sup>6</sup>:

## Conclusion

The process of media industry's disruption have found its way to the very individual sphere of employee's skills and knowledge. As a consequence digital journalists need to learn much wider spectrum of basic skills than their colleagues from traditional media—ranging from core journalist craft to very technical knowledge of the Internet.

Digital journalism production is less a praxis of straightforward publishing and more a process of continuous development. Including both content creation and individual distribution, the process places a part of responsibility for media's perfor-

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5 Reuters-Thomson *Handbook of Journalism* <http://handbook.reuters.com/extensions/docs/pdf/handbookofjournalism.pdf>.

6 BBC *Journalism Academy* <http://www.bbc.co.uk/academy/journalism>.

mance on their employees' personal activities. This makes digital journalist as much an author, as a data-analyst, a social-network manager and a content curator and requires very different set of skills than is needed from journalist of traditional media.

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# Smart home as the Internet of Things black-box: User's agency in open and proprietary Smart Home ecosystems

## Introduction

After civilizational changes triggered by the invention of microprocessor, personal computer and the world wide web, The Internet of Things (IoT) is often considered as another disruptive phenomenon that will close the gap between the digital and the physical thanks to computing manifested by billions of automated sensors, devices and networks operating worldwide. Already there are more connected devices than people. According to various studies by 2020 dozens of billions of connected devices will operate globally (Mukhopadhyay 2014: 4) (Business Insider 2013), (Gartner 2014), (MIT Technology Review 2014).

A particular user-oriented IoT implementation (i. e. home automation system or personalized wearables) can be conceptualized as a software & hardware ecosystem. The article analyzes models of smart home IoT-based solutions currently available on the market, focusing particularly on the middleware integrator solution. By analyzing several home automation solutions, I have been able to highlight some key techno-

economic challenges concerned with smart home implementation—heterogeneity of devices and standards, degree of user control over the infrastructure and generated data, and business / monetization model. Furthermore, the study has revealed that in all analyzed models the end user is offered relative small control over the whole ecosystem. Technological complexity (multiple nodes) and the necessity to engage different stakeholders in smart home system design and implementation result in obfuscation of the IoT technology. A particular IoT ecosystem can be then conceptualized as a technological black-box. The analysis will be performed from a post-digital, critical cultural studies and technology studies' perspective.

## The Internet of Things

The Internet of Things is often considered as the next step in ubiquitous computing (Cassimally, Chichester, McEwen 2014: 10) or as Adam Greenfield calls it the "everyware"—a socio-technological condition in which the processing power is so distributed throughout the environment that computers per se effectively disappear (Greenfield 2006: 7, 26). The technology becomes more pervasive by its miniaturization but above all by integrating the computational with everyday objects and environments. From the consumer/user perspective connected and autonomous devices may be considered as magical (Cassimally, Chichester, McEwen 2014: 17) or enchanted (Rose 2011). IoT is already considered as one of the key socio-technological phenomenon we are currently dealing with. Taking into account changes in economy, society, governance and many other areas of contemporary civilization that will be introduced by the IoT, its societal impact deserves particular attention.

There is hardly any universal definition that can take into account the complexity of technologies labelled as the Internet of Things. Authors of *Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence* use the term IoT to describe set of technologies, systems, and design principles associated with the emerging wave of Internet-connected devices that operate in the physical environment. Therefore the IoT as such is a fundamentally heterogeneous set of technologies (Holler et al. 2014: 14).

An IoT-logic device is a single purpose computational device (sensor, actuator, controller) in contrast to a personal computer which is multi-purpose and thus far more powerful computational device (Cassimally, McEwen 2014: 9, 11). It enables to connect sensors and systems and real-world assets to the broader Internet. IoT can be

then described as an extension to the existing Internet, nevertheless today's Internet is still rather a virtual world of content and services, the IoT on the other hand is about interaction through the Internet with physical things (people, devices, resources etc.).

The socio-technological factors driving the evolution of networks and devices into Internet of Things ecosystems can be narrowed to three main megatrends, according to authors of the *Machine-to-Machine to the Internet of Things*:

1. An increased need for understanding the physical environment in its various forms, from industrial installations through to public spaces and consumer demands. These requirements are often driven by efficiency improvements, sustainability objectives, or improved health and safety
2. The improvement of technology and improved networking capabilities.
3. Reduced costs of components and the ability to more cheaply collect and analyze the data they produce (Holler et al. 2014: 11).

Potential areas of IoT application are practically limitless—each domain where generating contextual knowledge about the environment or enabling remote control of assets would provide added value, various models of IoT systems and architecture will be implemented. Emerging IoT applications including but are not limited to: consumer electronics, automotive transport, retail banking, agriculture, environmental issues, health and well-being, utilities, process industries.

### **Basic properties of an IoT device**

Devices labelled as IoT are fundamentally heterogeneous—in terms of hardware and software architecture, programming possibilities, power consumption and data management. However some key properties of any IoT device can be distinguished.

Each computational device / chip being an element of an Internet of Things implementation has a unique network identity (MAC, IP), built-communicational capabilities (WAN, PAN, LAN—using Wi-Fi, Bluetooth etc), is equipped with sensors, DA/AD converters and can be remotely controlled and programmed (Holler et al. 2014: 83). The IoT system can be also divided into three basic layers—a hardware ecosystem (physical devices), software layer and user layer (Corredor Pérez, Bernardos Barbolla 2014: 22–23).

Furthermore three main types of IoT use cases within the IoT industry can be distinguished—sensors, actuators and tags. The use cases determine the final hardware/software configuration of a device (Holler et al. 2014: 178; Cassimally, Chichester, McEwen 2014: 89).

**Sensors:** These are simple or complex devices that typically involve a transducer that converts physical properties such as temperature into electrical signals. They are the ways of getting information on surroundings into the device. They include the necessary conversion of analog electrical signals into digital signals.

**Actuators:** These are also simple or complex devices that involve a transducer that converts electrical signals to a change in a physical property (e.g. turn on a switch or move a motor). Actuators are the outputs for the device—the motors, lights, etc. which let the device to perform an action to the outside world.

**Tags:** Tags in general identify the physical entity that they are attached to. In reality, tags can be devices or physical entities but not both, as the domain model shows. An example of a tag as a device is a radio frequency Identification (RFID) tag, while a tag as a Physical Entity is a paper-printed immutable barcode or quick response (QR) code.

In most use cases an IoT implementation can then be narrowed to a following equation: Physical Object + Controllers / Sensors / Actuators + Internet = IoT (Cassimally, McEwen 2014: 11). As for the degree of complexity each IoT node can be either a simple AVR microcontroller chip or Arduino to a complex PC computer.

The rationale behind an IoT solution being their most important design principle at the same time is its ability to monitor and control its surrounding environment (e.g. home or city). This task can be performed as long as the framework for seamless data integration and sharing between devices can be established—both at a local network level (smart house or smart city case) and externally (cloud, remote access). A successful IoT application in any use scenario should be therefore based on a coherent software & hardware ecosystem based on standards and protocols.

## IoT implementation as an ecosystem

A particular IoT implementation (smart grid, smart house, personalised wearables) can be conceptualized as an ecosystem—both from technical perspective (standards, protocols, abilities) and from a social perspective (owner, vendor, use case etc.)

According to Jan Bosch and Petra M. Bosch-Sijtsema a software ecosystem consists of "the set of software solutions that enable, support and automate the activities and transactions by the actors in the associated social or business ecosystem and the organizations that provide these solutions" (Bosch, Bosch-Sijtsema, 2010: 77–92). Furthermore, a software ecosystem enables relationships between software, services and users. They are based on a common technological platform or market and operate through the exchange of information, resources and artifacts (Jansen, Finkelstein, Brinkkemper 2009: 187–190).

The smart house / home automation IoT-based solutions have been chosen as case study examples due to their technological heterogeneity and their market position—they are addressed to consumers understood as end users of these technologies. My pilot research has revealed that several philosophies of smart home solutions have emerged so far—based on fully open / open source software and hardware; the middleware integrator (mostly software-based) and fully proprietary / black box model. Each of them struggles to address key challenges concerned with smart home implementation—heterogeneity of devices and standards, degree of user control over the infrastructure and generated data, and business / monetization model.

## Home automation systems—case study examples

A smart house is a house that has highly advanced automatic systems for lighting, temperature control, multi-media, security, window and door operations, and many other functions. Electronic and programmable systems of a smart home can initiate timed and triggered events for lighting, shades / blinds, heating, ventilation, security, irrigation, entertainment and other systems.

A smart home connects all devices and appliances allowing them to synchronize and communicate with each other. It allows collecting information so the technology can anticipate the user's actions and habits. IoT system for smart house can be therefore characterized as a measuring and analytical ecosystem composed of sensors and actuators that is designed to automate and control living spaces.

Currently the IoT market is in flux, both from a technological and economic perspective. On one side there are completely open source DIY-friendly solutions based on Arduino, RaspBerry Pi chips and open source software, on the other side, there are proprietary, closed solutions designed with a black-box approach, that are based on custom hardware and software solutions (Cassimally, Chichester, McEwen 2014: 69–70).

Due to heterogeneity of devices and multiple application cases, an interesting implementation model has emerged—a middleware integrating software & hardware solution. It offers a unified user interface to control all home automation devices operating in a building and is designed to support as many devices and network standards as possible.

OpenHab is such a software. It enables different home automation systems and technologies to be integrated into one single solution that allows over-arching automation rules and that offers uniform user interfaces. It is designed to be absolutely vendor-neutral as well as hardware/protocol agnostic. It can be accessed as a web-app or mobile application as the whole solution is fully open source. HomeAssistant offers similar capabilities—user can control all IoT devices from an open source integrating platform. This software supports both open source Arduino-standard devices and proprietary devices delivered by vendors (Nest, Philipps etc.). OpenRemote is another automation middleware solution that integrates various open source and proprietary devices.

Next to fully-open solutions (which are inclusive at the integrator level) described above there are also hybrid solutions. They are often based on proprietary hardware and software delivered by one vendor (custom control unit, lights, thermostat etc). However, the same vendor offers also a custom control unit or power supply sockets that can integrate into the ecosystem third-party devices, giving a limited control over them (off-on, status information etc.) This is the case of Webee or more sophisticated Control 4 and Crestron Home Automation solutions. Nevertheless, this model of an IoT ecosystem implementation prevents user from modifying the user interface, devices' use cases or use another vendor's device as core nodes of the ecosystem (Webee case).

An interesting variation of this model is a subscription-based AT&T Digital Life solution. It is a home automations system equipped with security (sensors, cameras) and automation (remote control) packages. Both hardware (cameras, sensors, controllers) and software (apps, web-interface) are delivered by AT&T.

## Home automation systems—a critical analysis

Previous revolutions in consumer-oriented electronics were based on designing endless iterations of more powerful general purpose computers—PC, laptops, tablets, smartphones. However, in the era of ubiquitous computing, a user is also offered mul-

tiple interconnected devices which are scattered across the physical space in order to deliver her additional information on the environment or allow her to automate actions and remote control—this is the smart home case.

However the ultimate benefit from using IoT solutions comes from their integration (both devices and data they generate) into one ecosystem that can be easily controlled by the user. The heterogeneity of the devices that form such ecosystem introduces multitude of standards, data protocols etc (Holler et al. 2014: 76). Therefore implementation models analyzed in the study are often based on the middleware integration layer which is provided by a software / hardware solution offering a unified user interface or central control unit to connect and control all elements of the home automation ecosystem.

Despite the fact that various home automation system integrators can differ in terms of openness and degree of control that a user has over these systems, I argue that from the end user perspective any home automation system is a typical computational black-box. This situation is characteristic for the age of distributed computing where a user must operate within multiple layers of interconnected devices, networks and services.

According to David M. Berry black boxes "are the obfuscated technologies that hide what is inside, sometimes productively, sometimes not, in order to simplify systems by hiding complexity or to create abstraction layers" (Berry 2014: 183). A broad definition of black boxing considered as an approach in science and technology has been formulated also by Bruno Latour: "When a machine runs efficiently, when a matter of fact is settled, one need focus only on its inputs and outputs and not on its internal complexity. Thus, paradoxically, the more science and technology succeed, the more opaque and obscure they become" (Latour 1999: 304).

Any home automation system is a complex, networked technology that brings multiple stakeholders into account (device vendor, software producer, third parties interested in data it generates, and last but not least, its user). However, its complexity is often masked by its obfuscation. Any home automation system in order to be usable by a common user, is specifically designed using black-box approach, which puts her in a specific socio-economic position. Nevertheless, there are still some differences between middleware integrators based on the open and black-box model that will be addressed, before drawing general conclusions in the final section of the chapter.

The open source based middleware integrator gives a user more control over hardware and software. The whole home automation system is more flexible (modular

design) and transparent (the application code is publicly available). Both OpenHab and Home Assistant explicitly emphasize that the software gives a user total control over data, as a result a user-controllable and customizable data management solutions is created. The whole ecosystem can work in the intranet mode, so no data ought to ever leave the building (OpenHab example). We can conclude that in this model a user becomes a data subject (as defined by the Open Internet of Things Assembly, 2012). The open model also creates an interoperable device ecosystem—the user does need to rely on single device provider. Lastly, the open model is DIY approach friendly. A particular automation system can be developed in cooperation or solely by local actors such as companies, start-ups but also Fabrication Labs and Hackerspaces in order to address needs of local communities—blocks, neighborhoods, cities—and support local innovation economy in the process.

The middleware integrator which is designed and implemented following the black-box logic, puts the user in even more objectified position. It is based on proprietary hardware and software which is designed and maintained by its vendors and developers. The user cannot use any hardware or software that is not supported by the vendor. As a result a vendor-controllable data management solution is put into motion. This may create a silo value chain when one agent delivers not only the IoT home automation solution but also monetizes user-related data through cooperation with third parties—insurance companies (Nest example) or advertising companies. I argue that a user becomes a data object through obfuscation of the whole home automation ecosystem on many levels—hardware, data management, interface.

Notwithstanding, even the open source based middleware integrator model offers only a handful of users real control over the system and data it generates. Performing any action which has not been previously programmed by hardware/software of an IoT vendor—modifying software or user interface, adding various nodes (sensors, actuators) to the system, setting data management settings (to control privacy) is possible only to users with some level of engineering and programming skills. Therefore, the argument stating that on open source / open home automation system gives a user real agency and control over it (because of its apparent transparency and flexibility), is in most use cases just an illusion.

If a user lacks specific knowledge, there is little difference between using open source / open home automation system and closed system based on proprietary hardware software. Consequently, any unskilled user is left "at the interface level" (Berry 2011: 36, 57, 137) of a mobile application or central control unit and her control over the system and data management is limited only to options preprogrammed / made visible by its vendor. In this case, any home automation implementation may become



a source of valuable data on house-related users daily activities—from power consumption to entertainment. What is particularly dangerous is that a user of a home automation system becomes a source of data too, and has little control over it, or may not be even aware of this. Any user of a ubiquitous computing ecosystem designed following the black-box approach, can often engage unknowingly or unwillingly with its particular function of the computational system (Greenfield 2006: 46, 72).

In response to current black-box design principle in home automation systems a few interesting counterinitiatives have been established. In 2015 The IoT Design Manifesto has been formulated by a group of active professionals and designers working in the IoT industry. It outlines "10 principles to help create balanced and honest products" (IoT Manifesto 2015). It postulates a win-win strategy (that takes interests of all stakeholders into account—users, businesses, and everyone in between), promotes a culture of privacy (a culture of integrity where the norm is to handle data with care and to conscientious and deliberate identify what those data points are) and encourages to make all parties associated with an IoT solution explicit. Ultimately, according to manifesto's signatories, users of IoT solutions should be empowered to set the boundaries of how their data is accessed and how they are engaged with via the product.

Casa Jasmina is another response to obfuscation in the home automation system solutions. It is a Torino-based mansion / laboratory / FabLab coordinated by Arduino and Bruce Sterling, which focuses on designing and implementing open source solutions for housing spaces. It is envisioned as a real-world testbed for hacks, experiments and innovative IoT and digital fabrication projects, a curated space for public exposure of excellent artifacts and best practices, a guest-house for occasional visitors to Toolbox, Officine Arduino and Fablab Torino (Casa Jasmina 2015). The long-term goal of Casa Jasmina is to "encourage industries that will create tomorrow's living spaces [to follow the open source mode]".

## Conclusion

The paper aimed to analyze the end user's agency in current implementation models of an IoT-based smart home ecosystems. I have been able to highlight some key techno-economic challenges concerned with smart home implementation—heterogeneity of devices and standards, degree of user control over the infrastructure and generated data, and business / monetization models.

Initially, I assumed that there are two basic models of IoT infrastructure implementation which are based either on open / open source infrastructure or on proprietary hardware and data management solutions. However, the study revealed that because of technological heterogeneity of any IoT ecosystem (layered architecture, lack of common standards of data sharing and management) and the necessity to take different stakeholders into account (device vendor, software producer, third parties interested in data it generates) the hybrid model has emerged. This model is based on the middleware integrator which can be conceptualized as an important user-oriented operational layer of the IoT ecosystem.

Furthermore, the analysis has also proved that if we raise questions about degree of user agency and control over the system (both over the infrastructure and data it generates) there is little difference between open / open source and proprietary, black-box solutions. Current technological heterogeneity and layered architecture of any IoT ecosystem together with lack of common standards of data sharing and management, prevent any common user from building / modifying any home automation ecosystem, even if the open source approach allows it.

To fully embrace the benefits coming from open philosophy of implementing any IoT ecosystem large-scale education in the area of programming and basic engineering is needed. Provided that this aim will be achieved in a long-term perspective, today's innovation policy should encourage all interested stakeholders to participate in designing IoT ecosystems based on open standards.

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# Digital Ecosystems

## Society in the Digital Age

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ISBN: 978-83-942809-1-8

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