TECHNOLOGY AS AN OBSERVING SYSTEM: A 2ND ORDER CYBERNETICS APPROACH

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ABSTRACT

The role of technology in modern society is becoming fundamental to society itself as the boundary between technological utilization and technological interference narrows. Technology penetrates the core of an ever-increasing number of application domains. It exerts considerable influence over institutions, often in subtle ways that cannot be fully understood, and the effects of which, cannot be easily demarcated. Also, the ever-expanding ecosystem of Information and Communication Technologies (ICTs) results in an emergent complexity with unpredictable consequences. Over the past decades this has created a tension that has led to a heated debate concerning the relationship between the technical and the social. Some theorists subsume the technical into the social, others proclaim its domination, others its autonomy, while yet others suggest that it is a derivative of the social. Starting with Luhmann's remark that technology determines what we observe and what we do not observe, this paper takes the approach that infers there are multiple benefits by looking into how Systems Theory can provide a coherent theoretical platform upon which these interactions can be further explored. It provides a theoretical treatise that examines the conditions through which the systemic nature of technology can be inspected. Also, the paper raises a series of questions that probe the nature of technological interference in other 'function-systems' of society (such as the economy, science, politics, etc). To achieve this goal, a 2nd order cybernetics approach is employed (mostly influenced by the works of Niklas Luhmann), in order to both investigate and delineate the impact of technology as system. Toward that end, a variety of influences of Information Systems (IS) are used as examples, opening the door to a complexity that emerges out of the interaction of technology with its socio-economic and political context. The paper describes technology as an observing system within the context of 2nd order cybernetics, and looks into what could be the different possibilities for a binary code for that system. Finally, the paper presents a framework that synthesizes relevant systems theoretical concepts in the context of the systemic character of technology.

Keywords: information technology, Niklas Luhmann, second-order cybernetics

INTRODUCTION

Technology is, without doubt, a dominant influence on modern society. Unfortunately, despite this, we usually insist on treating technology as if it is a multi-purpose 'tool' that can be simply implemented in different domains of society. This attitude, usually accompanied by the delusion that technology solves problems, ignores the more serious effects that technology inflicts on other societal subsystems (Angell, 1993). While there is no denying the positive side of technology, or the negative for that matter, the second order effects are usually ignored because of an unshakeable belief in the largely controllable instrumentality with which technology can be deployed (Angell & Demetis, 2010). This paper argues for the need to develop a systemic description of technology that revolves around its autonomous character.

In order to consider the forcefulness with which technology has come to occupy an ever-larger number of societal subsystems, an appropriate theoretical language is needed to describe the notable changes that technology creates. This remains a difficult task for a number of interconnected reasons. First, technological implementations exhibit considerable variety, and therefore, to be all-inclusive any theoretical treatise that sets out to describe the role of technology, will have to deploy a highly abstract lexicon to describe different contingencies. Second, the description of the role of technology within society remains a complex endeavor (Kallinikos, 2002). To attempt a coherent description of that role means to ponder the 'character' of technology itself. More importantly, it means being able to describe the mechanism with which technological interference is manifested. Third, while some scholars have attempted to portray technology as occupying a distinct role within modern life, thereby granting it some degree of autonomy, these approaches usually fail to deliver the more subtle technological interference that propagates across the boundaries of other systems (Demetis, 2010). So there is a need to be able to describe the foundation of any systemic interactivity between technology and other societal systems.

Of course, for systems theorists, all these aspects are not an issue, in the sense that they are all characteristics of what they could broadly call *a system.* Needless to say, systems theory is a significant candidate for the role, as it is no stranger to multidisciplinary analysis (in fact it has always pursued it). Furthermore, with second-order cybernetics applied to society (arguably one of the very latest steps in the long line of advancing systems theoretical concepts), the lexicon of systems theory itself has advanced, albeit with its description of social systems gaining in complexity (Luhmann, 1993, 1995, 2002b). With this development, there is opportunity not only to describe complex social systems, but also to show how other systems (such as technology) interact with society.

In this paper, I argue that we need a systems theory for technology, built on the tradition of social second-order cybernetics, so that we can develop an ability to describe the mechanism through which technology has discernible but non-causal effects in society (in the sense technology's effects cannot be attributed to specific causes). In other words, we need to be able to describe technology as *system* (or to be more specific, as a functionally differentiated system within society). Ironically, despite all the signs that modern technology is becoming indispensable, this endeavor is almost non-existent even within the discipline of Information Systems (Lee, 2010), where applications of systems theory are extremely scarce. It is important to consider the systemic fabric of technology because the effects of technology are not restricted to just the strict confines of the domains within which technological implementations can be found. Instead, technology interferes in a profound way with other core functions systems across society, like the economic, the political, or the legal systems. On a number of occasions, this interference distorts the very function of these systems, which are supposedly adopting technology to serve their own purposes. By extension, unpredictable consequences cannot be restricted solely to those systems themselves, but have knock-on effects for society at large.

This paper is structured as follows: First, there is a review of the functional differentiation of society, and the role of technology reflected in it; second, Niklas Luhmann's perspective on technology is discussed through his concepts of 'functioning simplification' and 'closure'; third, a theoretical model is developed in order to consolidate some observations and reflect on their interactions. Of course, the description of technology as a system through second-order cybernetics must be viewed as a substantial research programme. This paper is a small step towards an initial theoretical framework, at the same time recognizing the limitations of doing so in this form.

THE FUNCTIONAL DIFFERENTIATION OF SOCIETY AND THE ROLE OF TECHNOLOGY

Even if we are to describe technology as a system in its own right, we need to accept that no system exists in a void. Technology can be perceived as structurally coupled with other systems, with their co-evolution exceeding any conventional descriptions of cause-and-effect. In order to establish some ground upon which technology can be perceived as maintaining a systemic hypostasis, it is critical that we look into the functional differentiation of society (Luhmann, 1995; Moeller, 2006). This will be helpful in order to examine the functional differentiation of technology itself.

The functional differentiation of society into subsystems is informed by four essential assumptions:

i) the functions that characterise the subsystems of society (e.g. law, economy religion, science, etc), are constitutive of a subsystem's internal operations. Functions are different from hierarchies in that functions always synthesise a multitude of possibilities within the subsystems, and become an alternative form for expressing unity and difference.

ii) Within Niklas Luhmann's description of social systems (Luhmann, 1995), the system of society is considered to be the predominant system to which all others refer; only the system of society is operationally closed, by the function of communication that is central for any societal aspect.

iii) Differentiations within society are those that give rise to the constitution of subsystems within it (what we would call function-systems). The autopoiesis of the subsystems is intertwined with, and supported by, communication. Without communication, it becomes impossible to achieve any coordination of the subsystems' elements against positive (that is destabilizing) feedback generated by the environment. The centrality of communication in this regard, elevates the informational value of communication as a shield against what would ultimately threaten a system's survival. Also, communication transcends the boundaries of different subsystems of society such as the political, the legal, or the economic systems.

iv) Autopoiesis then becomes a critical characteristic within the functional differentiation of society into subsystems. Without autopoiesis the subsystems lose their ability to 're-make themselves' and reconstitute their elements (Von Foerster, Zopf, & United States. Office of Naval Research., 1962), as they face the ambiguities of the environment with which they are coupled. Autopoietic systems are operationally closed, and in this sense they are autonomous systems (Luhmann 2005). In this sense, a system cannot be more or less autopoietic; but it can be more or less complex. Thus the distinction between open/closed systems becomes obsolete; it is replaced by the question of 'how self-referential closure can create openness' (ibid).

With these initial comments regarding the functional differentiation of society into different subsystems, one can proceed by consolidating these above aspects in a definition for such a differentiation. According to Luhmann,

" 'Differentiation' means the emergence of a particular subsystem of society by which the characteristics of system formation, especially autopoietic self-reproduction, self-organization, structural determination and, along with all these, operational closure itself are realized" (Luhmann, 2000).

Perhaps the most critical aspect in differentiation that needs to be emphasised here is the unique directionality with which it occurs. Differentiation of society into subsystems is not a process that is imposed top down. On the contrary, it is spawned by particular inventions that generate the differentiation, and hence make the constitution of subsystems necessary. In other words, such inventions spawn the conditions for the emergence of subsystems that the rest of society cannot subsume, eliminate, or ignore. In fact, the only thing that a society can do in the face of such powerful inventions is attempt to regulate the effects these subsystems will have, and develop strategies for handling their destabilising effects. In this manner, function-systems assimilate critical advances and inventions. They become resilient and indispensable for society, but at the same time, they open the door for an ever expanding complexity within themselves, which feeds back to other function-systems in unexpected ways.

Then, one can observe that,

"Unlike in the ancient European description of society, such as Plato's theory of the politically ordered society (politeia, republic), this does not happen in the form of the division of a whole on the basis of essential differences between the parts. Indeed, differentiations in social evolution do not arise in this way, from above, as it were, but rather on the basis of very specific evolutionary achievements, such as the invention of coins, resulting in the differentiation of an economic system, or the invention of the concentration of power in political offices, resulting in the differentiation of a political system. In other words, what is needed is a productive differentiation which, in favourable conditions, leads to the emergence of systems to which the rest of society can only adapt" (ibid).

Within Luhmann's description of functional differentiation of society, the question that arises almost immediately is how 'technology as a system' can be viewed within society (Demetis, 2010). One can begin to suspect that technology is related to the system of science and can be described as just another subsystem within the system of science. But the system of science can also be viewed as the platform that delivered a series of technology-related inventions. On the basis of bottom-to-top productive differentiations, it could be said that a series of inventions, most notably the Integrated Circuit (microchip), have led to the development and evolution of computing, thereby creating those favourable and necessary conditions for the differentiation of the system of (information) technology. With the evolution in computation, and more importantly, the invention of the Internet and the World Wide Web, the black-boxes of isolated computing devices have mutated into the elements of a very complex and resilient network (Dertouzos, 1997). However, they are not independent of the users and the society around them. This has created a new complex system that *also has communication at its very core*. Effectively it has created a 2nd order society, or a meta-society where communication becomes computationally structured, and where the exchange of positive/negative feedback becomes contingent on how data are being manipulated (e.g. through techniques like profiling, data mining, and so on). This creates a structural coupling between society and the computationally structured 2nd order society, with effects that dynamically affect both. This transition in computation and the creation of a 2nd order society needs to be highlighted repeatedly; because it is through this transition that modern technology re-structures the communication that is required for the new system itself. Even more importantly, the transition into modern technology sets new conditions and limitations for the operational closure of society. Ultimately, communication is the common factor of both society and technology in a similar (but different) type of operative closure.

The concept of communication in this context cannot be stressed enough. As Luhmann remarks, "the concept of communication can be built into a theory of complex systems only if one gives up the long-established idea that systems exist as elements *and* relations among these elements. It is replaced by the thesis that, because of complexity, carrying out the process of relating elements requires selections, and thus relationship cannot be simply added onto the elements. With those selections, the process of relating qualifies elements by cutting off some of their possibilities. In other words, the system contains, as complexity, a surplus of possibilities, which it self-selectively reduces." (Luhmann, 1995). In this mode, communication means limitation. More crucially, technology then can be perceived to pose an additional limitation into the stream of societal communication itself. Under the aegis of technology, the process of relating elements and establishing connections between them is realized through automation. Algorithms are the carriers of the logic that constructs these relations. However, this comes at a price of creating further observable/unobservable distinctions that are streamlined into technology. How else could an algorithm even work, if not by determining what is to be automated and what is to be left unautomated as a prerequisite for automation?

Now, if technology is to be treated as a system, then what would be required in order to establish its systemic identity? A 'hard-line approach' would be to acknowledge that defining any system is an observer-relative act. So anything can be a system. However, in the context of the subsystems of society, what we could label as function systems, are established upon firm binary codes. While binary codes (the distinction-making identities of systems) are well known in the systems community, it is still useful to reflect on coding from a second-order cybernetics perspective and stress the importance of the observer.

CODING

In the context of the functional differentiation of society, technology can only be characterised as a system if the conditions discussed previously are fulfilled. However, how systemic differentiation are carried out, also implies an observer-relative positioning; ultimately, that remains an act of choice. Nevertheless, whether and to what extent different observers perceive, construct, and analyse a different technological system is one thing; but to deny the presuppositions that give rise to the system of technology itself, including the consequences of specific bottom-to-top inventions that led to advances in computing and networking, underestimates the implications of these phenomena.

Consider the political system, which refers to its own operations, and hence is able to refer to its elements for the constitution of any subsystem within it. In this manner, it is self-referential, as are the legal and economic systems (Luhmann, 2004). By the ability of all these systems to refer to themselves (the primary concept of self-reference), they gain the capacity to carry out internal differentiations, and hence allow for the creation of other systems within themselves (Luhmann, 1990). Self-reference implies that an emergent system acquires the property of self-reference out of the systems that communicate for the act of its systemic formation. This autopoietic transcendence from systems to systems implies that the code of a system solidifies the autonomy of a subsystem within a function-system (Demetis, 2010). This is certainly the case for what Luhmann calls 'high technology' (Luhmann, 1993) where the boundaries of the 'technical regulation of technology' are transcended. Technology 'controlling' other technology is nothing new as a concept, however, the regulative character of this association exhibits self-organization.

With the hope of not stating the obvious, the issue of 'coding' has got absolutely nothing to do with computer coding. As it has already been discussed, in the systems community, the ideas represented in the concept of 'codes' or 'binaries' are well known, however, it is still useful to view the function of coding in the context of second order cybernetics. A code within a system has a primary utility: communication. Communication takes two distinct forms based on the codes: the code serves (1) to communicate the function of the system amongst its subsystems, and (2) to ensure that there is something that constitutes the fundamental difference being communicated between subsystems. Regardless of the variety or complexity that subsystems may exhibit, they always have to refer to the code in one way or another (ibid). An example might help in clarifying this issue.

For instance, the code of the legal system is determined by the distinction of legal/illegal (Luhmann, 2004). The code can only be established as the unity of the distinction being systemically used in order to communicate the system's goals throughout all of its subsystems and as a reference point to itself. This means that whatever subsystems may exist within the system of law – functionally differentiated from society –, such subsystems always communicate within the constraints of, and by the use of, the fundamental distinction between legal/illegal.

This distinction between legal/illegal that serves as the code of the legal system has considerable systemic implications, because 'while the distinction between legal and illegal can be maintained for individual coding, the system as a unity can never decide the basis of what is legal or illegal. It can never apply the code to itself as a system. There is no foundational value establishing what is legal or illegal, only operations' (Luhmann 2004). Therefore the code itself is foundational in system formations that are functionally-differentiated from society. As the code in itself characterises the primary function of differentiation of the system, it is impossible for the system to use the code to describe itself. This means for example that the distinction being used 'enables the legal system to operate legally (!) by declaring that something is legal or against the law' (Luhmann 2000). The code exposed in this way becomes the first expression of self-reference within the system, and also the foundational representation of all autopoietic functioning without which the legal system would not be able to sustain itself, let alone become differentiated.Within five major functionally-differentiated systems of society, the code in respect to each system is portrayed in the table below (Moeller, 2006):

TABLE 1

System	**Code**
Law	Legal/Illegal
Politics	Government/Opposition
Science	True/False
Religion	Immanence/Transcendence
Economy	Payment/Non-Payment

CODES AND SYSTEMS: FUNDAMENTAL UNITIES OF DISTINCTIONS

The fact that the code cannot be applied by the system to itself is something that should place the concept of the code at the centrepiece of systemic formation (the act of formation of any system designated by an observer). If the system was able to apply the code that is constitutive of the system's differentiation, then that would mean that the system would be able to describe itself fully. However, that possibility of a system describing itself fully can only arise if the system uses its whole self for the description. That is tautological. It creates an entity with no connecting value, an entity that cannot be connected to any other. In recognising the importance of this problem, Luhmann remarks the following:

"If one tries to observe both sides of the distinction one uses at the same time, one sees a paradox – that is to say, an entity without connective value. The different is the same, the same is different. So what? First of all, this means that all knowledge and all action have to be founded on paradoxes and not on principles; on the self-referential unity of the positive and the negative – that is, on an ontologically unqualifiable world. And if one splits the world into two marked and unmarked parts to be able to observe something, its unity becomes unobservable. The paradox is the visible indicator of invisibility. And since it represents the unity of the distinction required for the operation called observation, the operation itself remains invisible" (Luhmann 2002).

This makes the point of the primacy of a code for a function-system even more crucial. The code is not only a necessary paradox that cannot resolve itself (in being utilised by the system that incorporates it), but also a foundational aspect of the constitution of any system of knowledge and all action. Without this necessary initial asymmetry exposed by the fact that the code cannot be defined by the system, an asymmetry that takes the form of a paradox, the system would not have been able to expand itself or even communicate within its internal differentiations. The asymmetry induced by the introduction of the code within a system is a necessary prerequisite for the evolutionary steps the system will take in re-defining itself and exploiting its environment. In other words, asymmetry becomes a necessary pre-requisite for self-reference, and for autopoiesis. The very fact that asymmetry is a foundational prerequisite for self-reference places asymmetry at the very core of scientific evolution, and even more so, infers that approximation is an unavoidable consequence of this asymmetry.

The second most important role that the code helps to establish is that of communication between subsystems within the system. But that is not the only form of communication possible. The system, and any system, also communicates with its environment. If we again take the legal system as an example, then it becomes obvious that the legal system functionally differentiates itself from other systems in society by referring to its code (legal/non-legal). Systemic interpenetration requires that the legal system influences other functionally-differentiated systems of society (such as the economy) by 'transmitting' its code. The way in which this happens is through the depiction of the code into an instance of a notational schema that constitutes the means of communication, typically in the form of legal documents, articles, etc.

But even within the legal system, the code serves as a mode of communication between subsystems of the system itself. If we take the legal system as a whole then it becomes obvious that the subsystems within it also utilise the code legal/illegal, as a means of both establishing and perceiving themselves as subsystems of the legal system (say a law firm). In this way subsystems become autopoietic, and they also gain the means of communicating with both similar (i.e. other law firms) and different subsystems (e.g. a notary) within the system. The code of any system therefore plays a critical role. Regardless of how one may carry out internal differentiations within the legal system and hence attempt different subsystemic observations and interactions, the code remains primary to the concept of system and of any communication within that system. The code is what penetrates all subsystems within a functionally differentiated system, and is what ties together function, differentiation and autopoiesis of the system itself.

THE CODE OF THE SYSTEM OF TECHNOLOGY

In considering technology as a system within the realm of the structural yet constitutional differentiation between system and environment, a set of issues arises almost immediately. If technology is a system, then what is its environment? If technology is treated as a system within the schema of the functional differentiation of society, having emerged in a bottom-to-top fashion from particular scientific breakthroughs (like the invention of the microchip), then in the environment of technology as a system would be other function-systems like the legal system, the financial system, and the political system. But in such a scenario, wouldn't technology refer to those systems (say a computer-based system designed to operate for the financial system), and hence collapse to a subordinate form that loses much of its distinctive character? The answer to this question is no for a series of reasons. Technology resists much of its subordination by maintaining systemic characteristics. Also, the volume of data that is subjected to automation implies that there is a complexity that is chaotic (in the sense that it cannot be pre-ordered) - it can be streamlined through technology so that it can become automated, but this affects considerably the way data is being generated by users as they become subjected to technology's categorical assumptions. Of course the systemic aspect of complexity analysed in systems theory could be alluded to here, or indeed, the law of unintended consequences that stems from such a complexity. But there is something more to the phenomena that technology helps generate.

Interpenetration of other systems with the system of technology implies a fundamental consideration that should not be underestimated. It implies that technology – with its distinctive character – counteracts top-to-bottom processes of other systems that attempt to employ technology as form by generating bottom-to-top processes that display a unique set of properties and that elevate technology from form to system. The concept of form in this regard implies a subordination and control of technology by individuals and organisations that adopt technology for application in a particular problem domain. Luhmann calls this 'technicalizing the operations of (other) systems'. In contradistinction to the concept of form, the concept of system, when referring to technology, implies that technology retains all of its systemic attributes regardless of the problem domain with which it might be structurally coupled. But what makes current beliefs mostly reduce this differentiation regarding technology as form, and what is to be gained in examining the underlying processes that restructure this difference?

In order to remain true to the core principles of 2nd order cybernetics, the issues of observation and system (whether a function-system or not) need to be treated as intrinsically related (Scott, 2004; Winter & Thurm, 2005). The constitution of any system must be, above all, an observer-relative act. Function-systems may of course be separated on the basis of purely analytical targets, but this in itself constitutes a form of simplification at the core of function-systems themselves; a paradox coming from an observational simplification that makes observation possible in the first instance. The possibility for an artificial differentiation and separation of function-systems is somewhat countered by the concept of interpenetration and observation. This affects not only the systemic character of technology, but also its code.

To start with, technology can be considered to be an observing system itself. The complexity of interrelated computing operations, even if designed by humans, cannot be broken down into their constituent components, nor can their effects in society be clearly delineated. At the level of the system, complexity shields the system itself from analytical simplification that would reduce its hypostasis at a mundane operational level. In other words, complexity shields the system from providing an accurate description of itself. Clearly, the broader effects that technology is inducing onto different social subsystems, portray a somewhat different picture from the concept of a neat-controllable technological installation.

One possibility for the code of the function-system of technology could be found within the unity of the distinction between automation/non-automation. Through that distinction, technology can be perceived to determine ‘what we observe and what we do not observe; and it also controls which causes and effects are attributed to one another and which not’. The distinction then between observable/unobservable can become structurally coupled with the distinction of automation/non-automation.

The following core considerations about technology can help us create a framework for the mechanism with which technology interferes with other functionally-differentiated systems, and how it gains its own systemic character. The reader is encouraged to look further into Luhmann (1993) where ‘The Special Case of High Technology’ is analysed from a risk perspective and where further valuable insights (or even mechanisms for technological interference) can be considered. By taking these observations into account, technology can be portrayed as:

i) a functioning simplification in the medium of causality. Functioning simplification is a term that implies a reduction of an initial complexity that is subsequently streamlined within the realm of computer-based technologies.

ii) an enabler of strict couplings. Technology simplifies complexity by insulating a stream of causal relations so that: a) processes may become controllable, b) resources can be planned, c) faults can be attributed.

iii) an enabler of the extensive causal closure of an operational area. Closure implies 'the construction of a kind of protective cocoon that is placed around the selected causal sequences or processes to safeguard undesired interference and ensure their repeatable and reliable operation' (Kallinikos, 2006).

But to what extent does functioning simplification and closure accurately describe the Geist of technology (ibid)? Here, we must consider that functioning simplification and closure only paint part of the picture in describing how technology influences other function-systems in society. While they depict the operational aspect of how technology streamlines sequences of automated actions, they are not sufficient to consider the complexity of interactivities in which technology participates. For this, a starting framework is required (i.e. a set of theoretical concepts grounded in systems theory), in order to reflect on these processes that are not only technologically supported, but also, induced and propagated.

THE SYSTEM OF TECHNOLOGY

Technology has always been perceived as something 'distinct from nature' (Bacon, 2010). But the relationship between 'reality' and how technology can be perceived to gain a distinct ontological hypostasis is more subtle. This relationship lies at the core of the second order cybernetics tradition with its emphasis in distinction-making. Furthermore, by considering second order observing as a method for the deconstruction of systems, we can look into how technology operationalises and 'technicalizes' other domains. Nevertheless, it is the relationship between 'reality' and 'technology' that appears to be the most challenging; and observation is at the centre of both.

To observe something (anything really), that thing must be distinguished, separated from its surroundings, excluded from everything but itself, so that it may be reflected upon. This unavoidable and artificial distinction is created by an observer who - in the face of complexity - needs to cut down and simplify the world as an unavoidable prerequisite for observing. In fact, the function of the observer is to create the distinction between observable/unobservable, without which observation would have stood impossible (Angell & Demetis, 2010). This has two consequences. Firstly, in performing the operations needed for a distinction, by necessity the totality of everything else is not observed; the complement of the thing to be observed, is left unobserved. It cannot be observed.

For the system of technology, the imposition of the unity of the distinction between automation/non-automation has a similar effect. Through technology, through its automated lens of observing, the distinctions that are engulfed must necessarily carve reality into automated/non-automated spaces. In effect, the distinction that carves these two spaces is a 2nd order simplification of reality. First, an observer identifies a system (from whatever reality he/she is observing), and then that system is further reduced on the basis of the distinction of automation/non-automation, otherwise the reduction cannot enjoy the operative benefits of technology (functioning simplification and closure). Through the choices of observers, technology forms another reality, a 'simplified reality' in which ‘strict couplings’ are being created between the elements chosen for automation and their interrelations.

However, once the distinction has been made, the totality of that complement constitutes a residual category, which is assumed/presumed to be there, but unobserved, and the implied paradoxes from the truncated structural couplings are ignored.

Secondly, by identifying what thing is to be observed, that thing may constitute a complex entity in itself and therefore the very process of observing that thing involves observing part of its underlying complexity and the sub-things that constitute it. The very implications for observation in the latter case imply that the observer has, in observing, to oscillate between the thing identified for observation and both its constituent elements and the context in which it is sitting. This oscillation is based upon internal differences that succumb to the same principle: that the moment something is observed, something else is left unobserved.

Once the initial observation of a scene has been made, the observer has artificially isolated the observed system from its environment, but with which the system is structurally coupled. The circumstances under which the observer isolates the observed system from its environment creates several restrictions: the observed system may also act as an observing system itself, thereby observing predetermined aspects of its environment, and with which it too has become structurally coupled; at the same time, this leaves other elements within that environment unobservable, as a necessity for cutting down on the complexity of its own constitution.

And here lies the dilemma. In order to observe the whole, everything invisible must be made visible, but then nothing is distinguished from anything else, from everything else; nothing is different, and everything is different.

As Luhmann puts it:

“But in order to observe, an observer needs to ‘perform’ operations. Distinctions need to be drawn – and by drawing them, respective other sides are excluded, these exclusions being not reflected upon during observing. To put it shortly: we are dealing with a permanent production of blind spots. In order to see that which a first-order observer does not see, a second-order observer is needed who may observe how the first-order observer constructs his reality, but who, by doing so, produces blind spots just the same way – and so forth” (Luhmann, 2002a).

Thus, the observer cannot observe his act of observation (as the eye cannot see itself seeing). The observer ‘knows’ that he can observe, but ultimately ‘observing’ and ‘observing that observation’ are quite different. In the former, a distinction is being made; in the latter both that distinction, and what it is distinguished from, must be subsumed into a new distinction. Such a cognitive inference is a second-order observation.

When an observer looks at 'reality' (not in the sense of a meaningless gaze), with the purpose of 'extracting information from it' (in the non-positivist sense), or interacting with that reality, then the observer creates a distinction between observed/unobserved. The *system that is selected to be observed* gains an environment as a result of the observer's choice. Of course, the observer's choice is driven by the unavoidable need to reduce the complexity. Complexity in this sense means 'being forced to select; being forced to select means contingency; and contingency means risk'. Then, the observed system that is isolated by the observer is structurally coupled with its environment; but while some couplings between system/environment are made observable by the choice of a framework for observation (chosen by the observer), some others remain invisible (we can all those 'invisible couplings'). This does not mean however that 'invisible coupling' do not interfere with both system/environment. On the contrary; together they form a critical nexus of unobserved interferences. What the observer chooses to observe/unobserve or focus/ignore remains contingent upon how the observer changes the context of the observation.

With technology, reality turns into a 'simplified reality' where a new observing system emerges. The observing capacity of technology is on one hand passed onto the algorithms by the 1st order observer-choices being made (e.g. computer architects, designers, programmers, etc). On the other hand, algorithms that are adaptive on the basis of user feedback can change their algorithmic behaviour in a dynamic. But while the conditions with which change will occur are computationally controllable (and hence can be strictly defined), their effects can escalate and cause havoc (in a butterfly-effect-like set of contingencies). At the micro-level, small effects are normally emergent from the inability to get a grip on the sheer complexity of the computing instructions, resulting for example in the typical phenomenon of computer bugs, or the gaps that can be exploited to get unauthorised access to computer systems. The ensemble of these processes that create instabilities (either from within the system itself or from the environment) is of course an agglomeration of an incredible number of instructions that form the elements of algorithms (in computer coding). The more complex the system of technology becomes, the less straightforward it becomes to monitor interactions. The self-reference that establishes the systemic character of technology further (i.e. technology controlling technology in a non causal sense) sets the scene for even more 'strict couplings'. At an extreme level, human decision-making can be removed altogether.

A classic example in this context is financial trading. So far, we have been used to scenes where ten or more computer screens surround scores of financial analysts, as if ten pairs of eyes should be a necessary biological adaptation. But now, trading takes place without human intervention at all. It is estimated that algorithmic trading – automated execution of orders by machines without human intervention – is used by 60% of US buy-side firms. This form of 'automated execution' is manifested by the utilization of software and their incorporation into the banking industry; and outside of the control of humans, the effects of automated transacting can sometimes be surprising. As Hendershott frames it:

"…some algorithms are designed to sniff out other algorithms or otherwise identify order flow and other information patterns in the data. For example, if an algorithm identifies a sequence of buys in the data and concludes that more buys are coming, an algorithmic liquidity supplier might adjust its ask price upward. Information in newswires can even be parsed electronically in order to adjust trading algorithms.” (Hendershott, Jones, & Menkveld, 2011)

So at the level of the 2nd order society, escalation into more complex forms of communicative structures can give rise to a war between algorithms. As human processing and ultimately decision-making relies mostly on the limited capacity of humans to process and manipulate information, it becomes unavoidable that the asymmetry between the two finds resolution – in some cases – by removing human processing and decision-making altogether. These dynamics create an interesting net effect: systemic complexity is introduced by technology into other systems in society, like the economic system in this particular example. Ultimately, this may destabilize the traditional organizational structures that have been institutionally endorsed and centrally controlled. The organization of information by algorithmic means, as well as the automated execution of orders, implies that the control of organizing becomes part of algorithmic processes, and ultimately, human control is given up as a prerequisite to automation. Hence we’ve got algorithms that attempt to ‘sniff out other algorithms’, or put simply: an algorithmic war, the victims of which can be found in the unintended consequences of any complex form of automated organizing.

Another celebrated example of the systemic implications of technology is the ‘Flash Crash of 2:45’ where the Dow Jones Industrial Average had the biggest one-day decline in its history, dropping about 9%. According to the Securities and Exchange Commission (SEC) Chairman, Mary Schapiro during her testimony in US Congress, this was mostly due to ‘automated trading systems that follow their coded logic regardless of outcome, while human involvement likely would have prevented these orders from executing at absurd price’ (Schapiro, 2010).

This example on the Flash Crash of 2:45, raises another theoretical possibility for the code of technology, one that is related to the possibility for human-decision-making at different stages of the execution of computer instructions. One such code could be framed within the distinction of *autonomy/non-autonomy* that could still be structurally coupled with the code of automation/non-automation. Ultimately, this would imply autonomy in the execution of automated orders or human supervision at different stages of automated processes (resulting in non-autonomy).

CONCLUSION

On the basis of the distinction between automation/non-automation, the code of technology creates a multiplicity of observable/unobservable spaces. On one hand, algorithms express the ‘strict couplings’ of technology; they define a space for causality, but within the domain of the ‘simplified reality’ where computational observing becomes prevalent. On the other hand, the ‘strict couplings’ that are necessary for technology to function, are derailed by the complexity they help create. The predetermined automated order of the ‘strict couplings’ helps generate complexity in at least three distinct ways: a) through the emergence of incompatibilities in the domain of the 'simplified reality' itself (problems in technology or in the interoperability of technologies), b) through the interference of technology with other function-systems in society that create unpredictable phenomena (technology destabilizing other function-systems like the financial system), c) through a disruption of the structural couplings between 'reality' and 'simplified reality', where the links between the two become severed as a result of both 1st order observing and 2nd order observing.

Within the realm of 'simplified reality', automation and causality become predominant, and it is through this combination that the power of technology is usually overestimated, without accounting for the severe disruption to other function-systems. As the boundary between technological utilization and technological interference narrows, the role of technology in modern society is becoming more fundamental. Technology penetrates the core of an ever-increasing number of application domains. It exerts considerable influence over institutions, often in subtle ways that cannot be fully understood, and the effects of which, cannot be easily demarcated. More importantly, modern technology now exhibits enough systemic characteristics to be considered as a system in its own right. A systemic description of technology, informed by second-order cybernetics and taking into account the critical effects of technology in communication, will yield better and more comprehensive insights into the challenges that lie ahead.

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