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CHRISTOPHER VITALE

NETWORKOLOGIES

**A PHILOSOPHY OF NETWORKS
FOR A HYPERCONNECTED AGE
– A MANIFESTO**

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A Philosophy of Networks for a
Hyperconnected Age – A Manifesto

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Reference Matter

Note to the Reader

This book is a short introduction to the task of producing a philosophy of networks for our hyperconnected age. The book has two primary parts. The *Introduction* explains why we might want a philosophy of networks, and the basics of what this could mean. This is done by sketching the technological, cultural, and historical contexts of this project, including the scientific and philosophical sources of its inspiration, while articulating many of the project's primary concerns in the process. The *Manifesto* which follows then presents, in a hypercondensed and programmatic form, the project as a whole, describing in microcosm what it might mean to view the world and everything in it as composed of networks of networks, and the implications this can have for a wide variety of fields.

While the *Introduction* emphasizes accessibility and explanation, the *Manifesto* emphasizes compactness, intensity, and scope. Minor repetitions of core notions between these texts allow each to be comprehensive in what it sets out to do, such that the *Introduction* and *Manifesto* can be read either together or separately, and the notes are designed to be separable for each part for this reason. Those who wish to read the book from front to back, however, will find that any topic explained in the *Introduction* is always, after a brief recap, dealt with in greater depth and breadth in the *Manifesto*. In addition, the notes for both sections emphasize, whenever possible, sources which, like this book, aim to speak to both general readers and specialists, in the hope that readers who are new to any of the topics mentioned can learn about them for themselves.

Because of the brevity of this book, the task of grounding, explaining, and describing the ramifications of many of the claims made are necessarily left to future texts of what I have come to call “the networkological project.” At present, three additional books in the *Networkologies* series are nearly complete, and more are already in progress. While it is unusual to work on several books at once rather than publish them in series, I found that this fit the networked nature of the subject matter, allowing me to keep the form as well as the content of these texts refractively networking between the volumes. As this network of texts was coming to completion, however, I wrote some brief introductory texts which took on a life of their own, a dense and wide-ranging *Manifesto*, and its more user-friendly *Introduction*, and this book is the result.

The wider networks of which this book is only a part, however, are not limited to the printed page. The ideas presented here are crystallizations of notions I have worked to produce by means of an extensive set of writings on a wide variety of topics, which are available on my website at <http://networkologies.wordpress.com>.

Brooklyn, NY
Spring 2014

Acknowledgments

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Finally, I'd like to dedicate this book to my dear Grandma Netta, who passed away as I was nearing completion. You lived with this book project's development almost as much as I did. Your love for me knew no bounds, and you always wanted the best for me. I will never forget. The gift of love you gave me is something I will carry with me all my days, and try to learn from. I will always love you. My soul is with you always, and yours with mine.

Brooklyn, New York
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Part One

Introduction to a Philosophy of Networks

Living in a Networked Age

“Everything is connected.” “All is One.” “The One in the Many, the Many in the One.” In today’s digital hypermodernity, these insights, found in many ancient traditions around the world, are often reduced to sound-bite mantras. And yet, defying the seeming linearity of time and history, these notions now seem to haunt us, uncannily, not merely from the past but also from the future. For our world today really is more connected, and more so by the day.

While few would deny this, it also seems clear that this new connectedness is happening in a manner quite different from what many had predicted. In place of yesterday’s futures, so many visions of a triumphant “end of history,” or a smoothing out of differences in a world full of discrete atoms, binary switches, orderly grids, frictionless precision, synchronized simplicity, or tidy certainties, things have taken a turn for the strange. Today’s world is full of distributed agencies and virtual potentials, rippling deconstructions and flash-point emergences, all eluding easy categorization or comprehension, at least by means of yesterday’s models. The future is not what it used to be: it is much more unpredictable, dangerous, sly, and interesting.

Although all truly *is* becoming one, this new connectedness is far from unitary. Rather, it is fractal, multiplying in layers within layers of burgeoning complexity. We live in an age of radical differentiations, cascades and crashes, decentralized affiliations and baroque complexifications, all of which shatter as they recombine and destroy as they create. It is as if we woke up one day, and suddenly all the points in the world had burst into webs, all the straight lines into nets of wires, and all the planes and volumes revealed textured layerings of branchings within branchings. Nothing is what it seemed it would be.

While the Internet and its new virtual worlds on the Web nevertheless function as epitome and guide, mirror and engine, even these often appear to be mere refractions of some newer, deeper, and profoundly discomfiting logics. In place of the euphorias of the early computer age, so many hopes of a borderless, post-Cold War techno-utopia, our world now dances to the rhythms of neo-religiosities and digital protests, video-game wars and financial weapons of mass destruction, invisible labor and long distance oppression, all coordinated by new agencies which are always beyond reach, everywhere and anywhere but where they appear to be. As space contracts, distances only increase, filling in with firewalls against cyber-feints, security checkpoints and walls both virtual and concrete, even as wormholes seem to continually arise in front of ever more obscurely distributed agencies.

We need to try to understand what these new forms of inter-connectedness could come to mean, and on their own radically new terms. But where to start? If there is one word which brings together the multiform new logics which are so rapidly changing the structure of our world, a word which describes the ways in which everything is fracturing so as to reconnect more intensely, it is the term “network.” Whatever is changing our world seems to be indicated by this term, even as it all seems to mutate by the minute. And so it seems almost

truism to say at this point what seems so obvious: ours is a networked age, and seeming more so by the day.

What this could mean for us, however, is much more difficult to determine, for it is not even easy to say how we got here. While the Internet clearly was an essential catalyst which helped bring this all about, that which brought these changes to critical mass, it is also perhaps merely a symptom. For long before we began to link computers together the world was growing networked, knitting itself together by means of satellite communications and television signals, flows of products and currencies, telephone wires and railroad tracks before this, even if we would never have thought to call these changes networked at the time.¹ What is more, scientists are increasingly showing that the physical and biological world from which we evolved was already networked to the core.² Perhaps then we have only begun to see the ways in which the world was always already networked, as if waiting for us to remove the blinders of our more orderly, modernist inspired dreams. If so, the Internet itself could then simply be a messenger of things to come, or a strange sort of return home, even if one which clearly developed the networks in the world to both quantitative and qualitatively new levels of possibility.

Whether or not the past was always already networked, or we are just learning to see this it seems clear that the rules of the games which dominated humankind for millennia are changing in dramatic ways. With each passing year, space appears less like a grid, and time less like a linear progression, even as neither seems to be returning to the simple bordered terrains or cyclical seasonal patterns of old. Notions like before and after, cause and effect, ancient and modern all seem to shift relative to changes in the gravity of our new spatial-temporal intertwinings, with so many crystalline webs of potential pasts and plural futures continually reworking our positionality even if we stand still. Nettime and netspace are now distributed in webs which continually re-update, shimmering and flickering in relation to each other.³ producing new landscapes which transform, deepen, and layer without necessarily progressing or pointing out a privileged direction or orienting trajectory. Compressing and decompressing, the spacetime of networks loops back into itself, creating new rhythms within and between its locations, shattering and recomposing what was solid into dynamic symmetries in fluid fabrics with new habits and structures all of their own. Futureshock turns to whiplash quite quickly in today's virtual kaleidoscopy, where morphing planes and crenellated surfaces seem to enjoy swallowing histories in their wake.

In such a world it is hard to even know who, never mind what, we are becoming. For we are increasingly composed of so many quasi-living distributed intelligences, meshes of data, images, and commodities, all of which seem to increasingly manipulate us according to their own suband supra-human desires, fears, hopes, and dreams. Assemblages of screens and avatars, interfaces and software platforms, digital communities and semi-anonymous agencies, we now find fibers and channels, flows and feedbacks, patterns and prostheses where we once thought there were human beings. And yet, within all this, all of our selves still seem to need to find some form of orientation, some way to gain a hold on the changes we clearly unleashed on the world, but which seem to be quickly redefining anything and everything in and between whatever, wherever, and whoever we thought we used to be.

No matter how things got this way, no matter what we thought the future would be, it seems clear that the time to understand networks, and what they can mean for us, is now.

And there is definitely an urgency to this. For our world is increasingly shaken by crises which seem to be describable only in networked terms, from financial crashes to terrorist organizations and digitized militaries, to changes in modes of organizing protests and revolutions, to shifts in how we relate to our everyday work, leisure, and socialization. And this is only the start. For our networks are on the cusp of producing revolutions in bio- and nanotech, and when this comes about, they will truly have the power to rework the very foundations of the biological and physical worlds which made all this possible, and in ways which are likely to further synergize with our increasingly webbed hyper-virtual realities.

If we want to intervene in these processes, to partake in these new interweavings rather than simply be recreated by forces of our making but increasingly beyond our control, we need to begin to be able to think and act on these new terms. Static territories, rigid boundaries, linear trajectories, flat surfaces, and unitary individuals, all the basic components of the world of yesterday need to be recast. In order to truly deal with the challenges of our age, we will need to learn how to think, act, experiment, learn, value, and perhaps even dream networkedly. We need a new worldview: a philosophy of networks for our hyperconnected age.

Networks – and Philosophy?

But what exactly does the notion of a “network” even mean? Certainly the term is everywhere today. And yet, the meanings attached to this notion, at least in everyday speech, are far from clear. It is as if the term were designed to proliferate and slip away from us, to multiply and increase in intensity, functioning differently in ever more situations, moving from tired and hackneyed to surprisingly different and back again, giving rise to new possibilities in the circuits of flight in between. Hypervisible and so obvious as to be often taken for granted, networks have become such a part of the fabric of daily life that they are like the air our techno-bodies breathe, even as it is often unclear precisely what they are, or could be. Trying to pin down the essence of networking can be an experience of vertigo, of an oddly centerless centrality, as if the sense of networking is continually dematerializing and recrystallizing in ever shifting prisms of color which give us back reworked versions of who we used to be. Perhaps the trick then is to learn to ride the waves of networking first, and from there figure out what there is to be seen.

All of what I have been describing managed to manifest itself in the process of writing this book. Whenever people asked me what I was working on, I responded by saying a philosophy of networks, and was then almost always asked if this was some sort of study of the impact of social networking. That is, the idea that philosophy and networks could have anything in common seemed strange to most. But rather than something like a sociology of networks, this project aims to truly be a *philosophy* of networks, an attempt to think what networks and our networked age could come to mean in the widest possible sense. And so I would reply to my questioners by saying that while this project is not unrelated to technologies like the Internet or social networking, it is more about networks and networking as such, about how anything and everything we have ever experienced can be thought of as networked, and why anyone would want to view the world this way. My questioners then usually expressed a mixture of confusion and curiosity. When I pushed this, I found that while anyone I spoke to could give examples of networks all around them, few could really say exactly what a network itself might mean. This project finds one of its points of entry into the pressing social issues of our times in this productive ambiguity.

None of which is to say, however, that popular notions of networking are all there is on the subject, for in fact, the science and mathematics of networks have some rather precise notions of what it means to network, and this project will draw extensively upon these, expanding them so that they can be applied beyond the traditional domains of mathematics and science. Nevertheless, I found that as I began to rework scientific and mathematical notions of networking to make them more flexible, pushing them to their limits so that they could be applied to new types of situations, the terms would often mutate ever so slightly, or even fracture, until they gave rise to more branching networks of terms and concepts. Each time I thought I had finally managed to grasp what was really at stake with networking themselves, they seemed to slip away, as if trying to defy any attempt at grasping them.

conceptually. There was an unsettling multiplicity at work, one which I increasingly began to feel pertained to the very attempt to conceptualize networks, with implications for how networks are transforming the world around us, and what our potentials for networked futures could be.

And so, while what follows will draw extensively upon contemporary mathematics and science, and will be careful not to conflict with any of the findings in these fields, it will rework many of the often pre-networked aspects related to these. And it will do so in a way which also goes beyond the manner in which science and mathematics traditionally limit themselves to issues of quantity, such that it becomes possible to speak about how networks relate to issues of interpretation, value, culture, ethics, politics, and more. While the sciences and mathematics of networks will remain crucial sources, this will ultimately be a work of philosophy. But it will hardly be a traditional one, for it will also attempt to rethink what is meant by philosophy in light of networking.

Nevertheless, many seem to feel today that we are no longer living in a time in which philosophy can really say anything worthwhile at all, and certainly philosophy seems hardly relevant to most people in our world today. To most, philosophy seems to be something that specialists do in universities, far from the concerns of the everyday. But the general skepticism about philosophy today can be seen as the result of some very constricted notions about what it means to do philosophy, and the prevalence of these ideas not only in “mainstream” culture, but amongst those who “do” philosophy for a living. This lack of imagination limits not only philosophy, but also the role it plays in culture, even when it is most needed. For perhaps philosophy is simply what happens whenever we try to describe how the world looks to us as a whole, here and now,⁴ in a way which can help us map our potentials for thought and action. Philosophy then would not need to try to be beyond time and place, and culture, but rather, speak from and to these, such that perhaps every culture engages in philosophy, even when it seems to be doing other things.

In this sense, the so-called “death of philosophy” in our world today can then be seen as an opportunity.⁵ For it is only when past forms of thinking seem naïve or less relevant than before that we can begin to question anything and everything, including what we mean by thinking. Each age needs to reinvent philosophy, to learn to dream anew about what it might mean to think in regard to the challenges of the times, and hopefully, point towards ways to help make the world a slightly less oppressive place. And if philosophy is viewed as the manner in which we try to make sense of the big picture in regard to how it appears from here and now, then this would mean that since networks are changing our world they need to be considered a proper subject for philosophy.

That said, to think that it might be possible to truly philosophize about networks in the manner of the past, particularly when networked approaches to neuroscience and artificial intelligence present some radically new notions of precisely what is meant by thought and thinking, would be some creative imagi-neering indeed. Networked times call for networked means. This project therefore will not simply philosophize *about* networking, or apply traditional notions of what philosophy might mean to networking. Rather, it will work to rethink philosophy as networking, to produce a philosophy *of* networks, in all senses of the terms. For by reimagining everything in the world as forms of networking, it may become possible to get a sense of what networks have to show us, not only about science and

technology, but about what our world and even ourselves could become. And in doing so, may even be possible to return philosophy to something that can matter to everyone, as lived practice beyond universities, more in sync with our contemporary and potential future forms of networking.⁶

This is the task that what I have come to call “the networko-logical project” sets for itself. What follows is a thought experiment. Its goal is to see if everything in the world, from matter to markets, organisms to molecules, brains to societies, languages to love, can be seen as composed of networks of networks. The hope is that this can help reframe some of the impasses that dominate our world today, so as to indicate pathways towards new and potentially better ways of navigating the challenges of our increasingly complex networked realities. Welcome to the world of networkologies.

Building on the Science and Mathematics of Networks

The project to develop an entire worldview based on networks luckily does not have to start from scratch. During the second half of the twentieth century, the science and mathematics of networks, a major component of what is often called “complex systems science,” began to revolutionize a variety of fields of study in a manner which continues today, and which can provide a starting point for this project. Developing from cybernetic, chaos, information theory, graph, and systems theories, complex systems approaches bring together a variety of research modalities. What unites them is the notion that in order to understand many of the most difficult and interesting aspects of our world, it is necessary to not only get a sense of how the parts of a system function individually as isolated units, but also in regard to how they interact with each other and their environments as wholes.⁷ By showing how the intertwining of entities in dynamic webs can lead to effects which were not predictable from the distinct form of the parts involved, this more holistic approach has led to an ability to understand many phenomena in the world which often previously defied scientific modeling.

Complex systems science is a relational and network-oriented approach to scientific thinking. Opposed to various forms of “reductionism,”⁸ complex systems research shows how modes of interaction between relatively simple parts can give rise to highly complex behaviors. For example, individual ants have limited brain capacity, yet colonies of ants can build massively complex dens, just as individual birds or fish can flock, molecules of water can form a whirlpool, or investors in a financial market can start following each other into a cycle of bubble and crash. Using models which do not isolate individuals from each other, but look at how they interact in systems, researchers have increasingly been able to simulate and better predict the behaviors of such systems, often using explicitly networked models. While the field began by modeling relatively simple systems, such as flocks of birds and ant colonies, these were only the beginning. Artificial neural networks, for example, have revolutionized artificial intelligence, giving rise to simulations which model the basic components of living brains and which, unlike more traditional forms of artificial intelligence, can learn, forget, associate, and even guess in ways shockingly similar to the thinking styles of highly developed organisms. Insights from this work are increasingly helping to guide the study of the human brain, as well as exerting a profound impact on what computation and intelligence have come to mean in a variety of fields.⁹

All of these developments have occurred, however, by means of software run on non-networked, binary, “serial” computers, like the type normally seen on desktops. And so while the software simulates networks, it runs on non-networked hardware. Though the development of non-binary, “parallel,” networked computer chips is still only in the realm of technological fantasy, and will likely have to wait for advances in genetic, nano, or quantum computing, software simulations have provided the first glimpses of what is likely to come even as the Web’s virtual networks continue to pave the way. Even with our limited hardware, however, much has already been accomplished simply by starting to think and

model the world by means of networks. Network models have been used to map the Internet, better understand social networks, predict crashes in markets and electrical grids, simulate crowd behavior, and design roadways to decrease congestion.¹⁰ All that was needed, in this sense, was a change in perspective.

Complex systems science has led the way in all this, and can be seen as a complement to the networked technologies and ways of thinking which made the Internet and related developments so powerful. Nevertheless, complex systems science alone does not provide a full worldview based on networks. For while various branches of research in science and technology have been revolutionized by network thinking, there is more to life than science and these new approaches have only begun to impact the way the world is thought of beyond the quantitative. And yet, networks are changing nearly everything about our world, with ramifications for how we raise our children, study, communicate, organize politically and socially, and so much more. If we are increasingly becoming networks, we still are networks which love and hate, produce art and war, hope and even dream. Unless our attempts to understand our increasingly networked world goes beyond science, technology, and the quantitative, all we will ever do is produce measurements and models which lead to faster and bigger versions of the status quo.

To produce a philosophy of networks, it will therefore be necessary to intertwine the study of science and technology with concerns of meaning and value. While it may seem strange to do so, we may soon have no choice. For as mentioned earlier, as we increase our ability to rework the physical and biological fabrics of who and what we are as individuals and species, as well as the physical, biological, and cultural contexts in which we evolve, the discussion of meanings and values in relation to science and technology will become impossible to avoid. All of which lends credence to what many historians and theorists of science have long argued, namely, that interpretation and value are always at work with scientific and mathematical practices, even if these are often difficult to see except from the perspective of a different culture, or in relation to the past.¹¹ And yet, even from here and now, it seems ever more clear that from the drive to profit in relation to industry, to the government's desires to shape social policy or gain advantage in wars, our society is permeated by attempts to control teaching and research, and in ways which have enormous impact upon the way these describe the world.

While many argue that these exceptions prove the need for freedom from bias, it seems naïve to think we will ever be in a situation in which those who pay the bills and establish the rules will not impact the form of our inquiries. The claim of freedom from bias is perhaps simply one of its more concerning forms, one which assumes a "common-sense" standard which tends to support whatever structure is currently dominant in society, and which attempts to close down the possibility of questioning before it even starts. Rather than eliminate values from research, in whatever field, perhaps we should try to relate to them in a more substantive way, by asking what sort of values we want to have, and why. Arguably a more honest approach, this would certainly also be less reductionist, more relational, and more networked. And as will become clear in what follows, such an approach is also in resonance with some of the more radical advances in twentieth century science, mathematics, social theory, and, in many ways, the structure of networks themselves.

The rise of network thinking, then, can be an opportunity in more senses than one. Since

networks make it much more difficult to see the world in isolated and restricted ways, the growing networking of the sciences, not only with the world beyond the lab, but by means of complex systems science itself, indicates a potential opportunity to imagine new ways of thinking the relation between these. For only if we can find ways to talk about how power and money, interpretation and values, quantity and quality, and hopes and fears impact a modes of inquiry and practice can we get beyond the fantasy that we can ever be truly objective, or that we should at least strive for what is often simply another way of reinforcing the way things currently are. A more networked, relational approach would be to try to understand how our values always do this anyway, whether we admit this or not, and to try to question what sort of values we might want, and how this could help guide our practices towards better futures. The hope is that perhaps this can help produce futures which are not merely efficient or complicated, but potentially liberating as well.

What is a Network? A Brief Primer

Before going further, however, it is worth saying a little more about networks themselves beyond their applications. When most people think of networks today, they often think of social networking, or the Internet, or networks for mobile devices. Ask scientists or mathematicians, however, and they are likely to think of network diagrams, specialized pictures which describe how aspects of the world hold their parts together.¹² Nevertheless, these same scientists often refer to the aspects of the world being diagrammed as networks themselves, simply because they can be represented by networks. What could it mean, then, for something to be networked, whether as an aspect of the world being diagrammed, or as a diagram itself?

At its simplest, a network is any whole, composed of parts, distinguished from a background, and composed of other parts and wholes, layered into each other at multiple levels of scale. Anything which can be thought of in this way can be seen as a network, which is a general way of thinking about how things intertwine, interact, and hold together. For example, a tree in the park can be seen as a network of branches and roots. This network is distinguished from a background, which includes the soil in which it grows, the air around it, and the rest of the park, and all of these composed of more networks in turn. There are cells in the roots and branches, and these are also networks, just as the tree is part of the park as a whole, both of which can also be seen as networks.

While this is a relatively concrete example, even dispersed aspects of the environment, such as the air surrounding the tree, the soil in which it grows, or the clouds in the sky above it are all networks, which is to say, parts connected to others, distinguished from a ground and layered at multiple levels of scale. Even more abstractly, all these networks appear to me, the one in the park observing them, even as I am also a network, composed of more networks. The manner in which I perceive the tree as a network is also itself a result of the way in which we network together in the mode of intertwining generally called “perception.” Whether considered from “inside” or “outside” a given observer, it is all networks, all the way down, simply of differing sorts.

While it might seem simple to say that everything is composed of networks, the descriptive potentials of this approach manifest in the different types of networking, and how that impacts the way networks relate to each other. Any network can *diagram*, or represent, another, though abstract ones tend to be particularly good at describing the ways other networks hold together, which is to say, the ways they network their parts. For example, a network of lines can be used to represent the structure of the branches of a tree, just as a network of points against a ground can be used to indicate the layout of trees in the forest as a whole, even if these points are only linked together as a network implicitly by the ground between them. In all these cases, when a network resembles aspects of one or more other networks in this manner, whether this is done intentionally by a human or not, it diagrams it.

Diagramming describes how networks deal with issues of representation, recasting the

notions, as networks tend to do, in more relational form. For networks can both diagram and be diagrammed, represented and representing, functioning as what linguists generally call signifier and signified.¹³ Unraveling the reductive ways in which representation has often been described in and beyond linguistic models in the past, networks provide more polymorphous ways of theorizing what has often previously been seen as rigid and dichotomous.

All of what is described above can be refined by means of terms drawn from the science and mathematics of networks.¹⁴ From such a perspective, the parts connected in a network can be recast as **nodes**, which are joined together by **links**. Nodes and links are always surrounded by backgrounds, or **grounds**, which are aspects of the more general **ground** of which they are themselves parts. While grounds may appear unified, whenever they are examined more closely, they are always composed of more networks, which then reveal their own grounds in turn. Considered together, nodes, links, and grounds give rise to networks even as each is ultimately composed of more networks in turn. The manner in which parts and wholes of networks contain each other gives rise to layers which are called **levels**, or **levels of scale**. Nodes, links, grounds, and levels are the primary **aspects** of networks in the world. In what follows, the concept of networks in their most abstract sense will be referred to as **the network diagram**, a concept composed of the sub-concepts, or **elements**, of node, link, ground, and level, all of which are abstractions from the networks which manifest in the world.

Beyond these basics, the networkological project will examine the manner in which the nodes, links, grounds, and levels are the products of various processes. From this perspective nodes can therefore be seen as produced, maintained, and transformed by processes of **nodding**, links by **linking**, grounds by **grounding**, levels by **leveling**, and networks by **networking**. For example, when a tree gives rise to buds, it produces nodes, and this is an example of nodding. When people make friends at a party and exchange contact information, they create new links, an example of linking. An ocean serves as a medium, support, container, and context for the fish within it, and in this sense, the ocean can be seen as grounding the fish. A more abstract form of grounding can be seen in the way in which descriptions of the world tend to justify themselves in relation to others, such that the contexts provided by these justifications act as grounds for the ideas in question. Grounds are intimately related to how nodes and links change, for they relate these to processes beyond them, and viceversa. Grounds, like levels, are in many ways trickier than nodes or links, for they are necessarily both inside and outside of the networks in question. Beyond nodding, linking, and grounding, there is also leveling, the manner in which networks give rise to levels, such as when an embryo divides from a mass of cells into layers of skin, bone, nerves, muscles, etc. And leveling, in turn, is intimately related to notions of the emergence of networks from each other, such as the way in which an embryo can ultimately give rise to a living human being.

The temporary solidification of processes which gives rise to particular nodes, links, grounds, and levels is what many discourses have called a form of **reification**, a term which literally means “thing-ification” (from the Latin word *res*, for “thing”).¹⁵ Reification is necessary to produce and maintain networks, even if it can come to dominate, paralyze, and stultify their ability to grow and change when taken to extremes.

While some degree of reification is not only necessary but also essential to the formation, support, change, and development of any and all networks, the term reification will generally be used in what follows to describe what happens when reification itself reifies, which is to say, when it is taken to an extreme and becomes harmful and “over”-reifies.

Reification will also be used to describe the way in which relatively reified entities tend to appear solid and fixed, even if they are ultimately composed of networks from within, and are aspects of other networks from without, despite seeming appearances to the contrary. While not all reification is “over”-reification, because our world is so dominated by reification and its effect, it will often be the subject of networkological critique in what follows.

While not all of the more abstract uses of notions such as nodding, linking, grounding, leveling, and reification are explicitly referred to in complex systems science in the sense described above, these notions are nevertheless implicit in the general outlook whereby these approaches describe the formation, maintenance, and transformation of nodes, links, grounds, and levels in the world. In all these cases, the notion of a network is simply drawn from what all networks have in common. Everything in the world can be seen as a network, and in this sense, to call anything in the world a network simply means to see it relationally, as a network composed of networks, linked to others, layered in levels, against a ground, and as an aspect of various processes and reifications. Networks are then, more than anything, a way of looking at the world, a shift in perspective, a lens which makes everything appear networkedly.

Complexity, Emergence, and Robustness

While there is a lot more in the details, that is it, that is the basic model. Applying this to a variety of situations, network thinking fundamentally reworks approaches to the world based on notions of reified entities, rigid binary distinctions, linear developments, monocausal explanations, and other less relational formations, and replaces these with dynamic polyform networked models which are able to do the same work, but without the limitations of the more traditional approaches. Some of the radical implications of this set of transformations, however, only become clear when networked models are extended to deal with issues of how networks change, how they can be used to redescribe aspects of our world beyond traditional forms, and the ways this impacts the production of values and interpretations in the process. To illustrate this set of concerns, it makes sense to return to the science of complex systems, essentially the science of applied network thinking.

Complex systems, often called complex adaptive systems, are generally described by researchers as those which are “more than the sum of their parts,” for they tend to be difficult to predict from knowledge of their components.¹⁶ They are also often described as “non-linear” systems, for it is difficult to tell what they will do next by means of simple, predictable, linear modes of extrapolation or mathematical modeling. For example, when a drain is opened under a pool of water, a vortex, also known as a whirlpool, will often result. This new form of organization, which in no way resembles that of the water molecules involved or the shape of the pool in which the water sits, nevertheless draws upon all of these in interaction to take the form it does. What is more, this form shifts and adapts to its environment, such that if an obstacle is introduced into the whirlpool, it will begin to swirl around it. But the precise way in which the vortex moves around an obstacle cannot be fully predicted in advance, for minor perturbations can lead to large scale changes.

All of this happens spontaneously, such that complex adaptive systems are also often described as “self-organizing,” or “emergent.”¹⁷ According to complex systems science, self-organization is promoted by a particular set of conditions, which include: diverse components, distributed organization, meta-stability, and feedback between aspects and environment in a manner which is itself diverse, distributed, and meta-stable, thereby potentiating sync between aspects, the emerging whole, and environment. When all these conditions are met, not only will a system spontaneously self-organize to greater complexity, it will generally continue to do so, at least until one of these factors begins to fall out of sync with the others.

For example, in the case of a whirlpool, once a drain is opened in a pool of water, a stable source of energy is provided due to the pull of gravity. This pull acts unevenly on the water molecules, because it is refracted by the mild attractive and repulsive properties between the molecules, giving rise to diverse flows and currents which all compete to get down the drain first. As some flows begin to move down the drain, the increase in speed affects the water, and these forces act upon each other, with the pulls towards working together and those towards

pushing apart coming into balance. Flows begin to modulate each other in feedback, not centrally, but each molecule and flow in relation to those around them, giving rise to distributed modes of organization in which no single molecule or flow predominates, but all contribute. The result is a form of balance and sync which manifests in the novel form of a whirlpool, which could not be predicted in advance from the shapes of the molecules or the container, even as it is influenced by these.

Whirlpools do not generally remain stable or develop much further, however, because they tend to run out of energy quickly, and the relative homogeneity of their parts makes it difficult for them to develop new forms of complexity which could work to maintain or grow the system beyond this. Complicating this is the fact that while a whirlpool is much more organized than a simple mass of water molecules, and hence indicates a jump in complexity, it also goes through energy much faster, and in fact, all complex systems require energy to maintain and potentially increase in complexity. Living systems, for example, eat, and they also produce wastes, and only a steady flow of energy, such as that of the sun, can maintain and grow complexity, as well as deal with wastes produced in the process. Without developing distinct new systems to find new sources of energy and take care of wastes, the system is limited in its ability to maintain itself or grow.

The manner in which complex systems relate to energy helps explain why complex systems are often referred to as *dissipative systems*, for they consume energy and turn it into waste, dissipating potential in order to produce ordered complexity. In the process, however, they produce new forms of complexity, which can then give rise to new potentials, some of which can work to address these concerns. And so, while humans eat and produce wastes at a staggering rate, we can also farm and build sanitation systems, not to mention build computers and write novels, all things whirlpools obviously cannot do.¹⁸ What is more, complexity tends to be self-potentiating, giving rise to not only more quantity of complexity as it grows, but new qualities and intensities as well, all of which can then feed back into the process of complexification. While complex systems dissipate energetic potentials in their environments, they can give rise to whole new ways of being in the world which can enrich these environments in new ways in the process.

While complex systems describe one of the primary ways novelty enters the world, not all intricate aspects of the world are complex. Machines such as cars or laptops, while incredibly *complicated*, are not complex. These sorts of systems are only designed for specific purposes, do not come about in the world relatively spontaneously in the right conditions, are unable to adapt and change themselves in relation to their environments, and neither repair themselves nor grow, and hence, are relatively limited and rigid. While complicated systems are often very good at particular things, such as being strong or fast, they are often limited to very particular ways of relating to the world beyond them. They rarely surprise, and are simply not designed to produce novel ways of relating to the world, nor to adapt to changes or grow and evolve in the manner of organisms.

While complicated systems can be extremely powerful, it is this ability to develop in new and more intense ways, to adapt to changes and rework themselves, not only in terms of quantity but also of quality, which makes complex systems truly unique. When complex systems self-organize in ways which increase their complexity, whether in quantity or quality, this is what complex systems science calls *emergence*.¹⁹ Emergence itself comes

many degrees and forms. A whirlpool is an example of the emergence of a simple physical complex adaptive system, if one which is relatively short-lived. Living organisms are more developed forms of emergence, and they can give rise to new forms of emergence in turn, such as learning and evolution, none of which could be predicted by an examination of the structure of any particular part of the organism or its brain, but only by the relationship intertwining between these in particular sets of circumstances. Beyond physical and biological emergences, cultural advancements can also be seen as forms of emergence, from the flocking of birds to the development of language in humans, and all of these feed back into physical and biological emergences to potentiate them further.

While complex systems are dissipative of energy, they do not necessarily destroy the contexts which produce them, and in fact, most do not, or they would not be around for long. When complex systems grow and develop in sustainable relation to their environments, this is what complex systems science calls *robustness*.²⁰ While all systems ultimately steal energy and materials from their environment, such as the manner in which all life on Earth feeds off the sun, robust systems are those which are able to grow and develop in relation to their environment in the least destructive and maximally creative ways, establishing feedback relations with their environment so that they do not destroy the conditions for the emergence of themselves or their environments in the present or future.

Robustness is potentiated by the same factors as emergence, but applied not only to the system in question, but also its relations to its contexts and beyond the needs of the present moment. It can therefore be thought of as a meta-emergence which syncs up multiple emergences in and across the boundaries between entities, systems, levels of scale, time scales, and beyond. When systems are not only emergent but also robust, they emerge emergently in the future as well as the present. For example, evolutionary populations tend to be robust in relation to their environments, while whirlpools, which simply go through their energy supply and then dissolve, are not. Systems which are able to account for change over time, such as the way evolution stores memory in DNA, or humans can remember and learn by means of their complex brains, tend to potentiate the emergence of robustness, even as other aspects of these systems may tend to favor short-term benefit over long-term development.

The valuation of robustness, or the sustainable emergence of complexity, is implicit in much of complex systems science, whether in the study of physical systems, living systems, or cultural systems such as economies. Complex systems science studies the ways in which order sustainably emerges from chaos, and describes strategies for promoting this to evolve systems, particularly human systems, towards more robust conditions of sustainable growth and development.

While the implicit valuation of robustness is at work in much of complex systems science, it will be the explicit ground of the ethics of the networkological project. That is, while complex systems science views robustness as simply the common-sense way to produce more and better forms of growth, the networko-logical project will work to develop this into a fully-fledged ethics. Based on the valuation of the sustainable emergence of complexity, of robust complexification in regard to ourselves and our contexts, the networkological project sees robustness as a notion that can help develop an ethical way of thinking about a wide variety of issues beyond the more traditional and often individualistic ethics less in sync with

the needs of our rapidly mutating networked age.

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