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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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Winchester, UK
Washington, USA

First published by Zero Books, 2014
Zero Books is an imprint of John Hunt Publishing Ltd., Laurel House, Station Approach,
Alresford, Hants, SO24 9JH, UK
office1@jhpbooks.net
www.johnhuntpublishing.com
www.zero-books.net

For distributor details and how to order please visit the 'Ordering' section on our website.

ISBN: 978 1 78099 238 9

A CIP catalogue record for this book is available from the British Library.

Design: Lee Nash

Printed and bound by CPI Group (UK) Ltd, Croydon, CR0 4YY

CONTENTS

Note to the Reader
Acknowledgments

Part One – Introduction to a Philosophy of Networks
Living in a Networked Age
Networks – and Philosophy?
Building on the Science and Mathematics of Networks
What is a Network? A Brief Primer
Complexity, Emergence, and Robustness
The Brain as a Model for Philosophy: Artificial Neural Networks and Beyond
Network Dynamics: States, Processes, and Tendencies
Networkological Description: Immanence, Relation, Refraction, Emergence, and Robustness
Network Economies: Networked Models of Value, Meaning, and Experience
Sync: Understanding, Knowledge, and Thinking
Evolving Robustness: From Evolution to Liberation
Beyond the So-Called "Death of Philosophy"
Networkological Critique: Networks Beyond Overreification and Cancerous Reproduction
From Networks to Netlogics: Diagramming the World
Radical Relational Emergentism: Philosophy as Refractive Crystallography

Part Two – Networkologies: A Manifesto
nodes: *access, science, mathematics, image of thought, process, complexity, emergence, relation, fractality, holography, spacetime, immanence, principles, experience, realities, (un)limits, semiotics, mediology, machinology, value, symbolic economies, robustness, practics, metaleptics, sync, understanding, evolution, meta-evolution, hyper-evolution, thinking, critique, deconstruction, reconstruction, post-foundation, refraction, diagram, difference, distributedness, histriography, psychology, panpsychism, liberation, commons, oppression, economics, political economy, politics, transviduality, post-anarchism, pantheism, theophanic post-theology, erotics, praxis, aesthetics, nothing, philosophy, meta-philosophy, history of philosophy, beginning, dream*

Reference Matter

Note to the Reader

This book is a short introduction to the task of producing a philosophy of networks for ou hyperconnected age. The book has two primary parts. The *Introduction* explains why w might want a philosophy of networks, and the basics of what this could mean. This is done b sketching the technological, cultural, and historical contexts of this project, including th scientific and philosophical sources of its inspiration, while articulating many of the project primary concerns in the process. The *Manifesto* which follows then presents, 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 networks, and the implications this can have for a wide variety of fields.

While the *Introduction* emphasizes accessibility and explanation, the *Manifesto* emphasize compactness, intensity, and scope. Minor repetitions of core notions between these tex allow each to be comprehensive in what it sets out to do, such that the *Introduction* an *Manifesto* can be read either together or separately, and the notes are designed to b 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 bo sections emphasize, whenever possible, sources which, like this book, aim to speak to bo general readers and specialists, in the hope that readers who are new to any of the topi mentioned can learn about them for themselves.

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

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

Brooklyn, NY
Spring 2014

Acknowledgments

Writing several volumes worth of interconnected books before publishing the first wou never have been possible without the amazingly supportive and creative environme provided by the School of Liberal Arts and Sciences at Pratt Institute in Brooklyn, New Yor My department chair Ira Livingston was an incredible mentor through the process of givi birth to a first book, and it was his encouragement to follow my passions freely that reall gave me permission to pursue this fully. Dean Toni Oliviero took the risk of hiring such young teacher, giving me the freedom to develop and publish as I chose. And my amazi colleagues have provided the ideal creative environment. Jonathan Beller and Ethan Spigla were perfect partners in serious intellectual and political games, I have learned so much fro both of you. Gregg Horowitz, Lisabeth During, and Jeffrey Hogrefe, along with Jon, Etha and Ira, read parts of the manuscript and gave crucial feedback. And my other amazi colleagues, including Stephanie, Ann, Mendi, Uzma, Jennifer, Danny, Tracie, Suzie, Nelso and Christian, along with Gloriana and Danielle, all the amazing students, and our new Dea Andrew Barnes and new Chair Maria Damon, have made Pratt a wonderful place to grow.

Many teachers and advisors were also a great inspiration. Emily Apter was an amazi dissertation advisor who had faith in me and was a crucial influence. Three addition mentors had a profound impact on the way I think: Eva Geulen taught me how to read, Ka Silverman taught me how to see, and DorisAnn Markowitz taught me how to create. addition, Richard Sieburth and José Esteban Muñoz were wonderful mentors and teache And I will never forget the amazing experience of studying in truly inspirational class taught by Fred Moten, Avital Ronnell, Carolyn Dinshaw, Patrick Deer, Barbara Spackma Rachel Newcombe, Robert Cohen, Lisa Duggan, Michael Schultz, Max Pensky, Martin Dillo Donald Weiss, Hubert Farnsworth, and Tom Carter. I also learned so much having the chan to study during summer 2008 at the Complex Systems Summer Program at the Santa F Institute in Santa Fe, New Mexico. On the editorial side, Paul Ennis, Liam Sprod, Jul Steinmetz, and above all Dave Kim and Zach Slanger went above and beyond the call of du in providing detailed commentary on the manuscript, especially Paul and Julia early on, a Dave and Zach at later stages. Extensive feedback from Jason Frenkel and Aaron Holland was also incredibly helpful at various points along the way. And many thanks to Tar Goddard and Trevor Greenfield at Zer0 Books for being so flexible with deadlines.

Family and friends have been an incredible support. My friends who became academic including Ronit Fainman, John Hartman, Daniel Just, Caitlin Benson-Allot, Thomas Phili Jason Hoffman, Dave Kim, and Aaron Hollander never cease to inspire me. Special thanks Sam Albright and Jonathan Root for helping to keep me sane during periods of hard wo (and to Jon for doing the diagrams). Many other friends have been a wonderful source support, learning, and joy, including Stan, Tuck, Craig, Kristin, Brent, Steph, Donn, Jes Shane, Ian, Ray, Geoff, Paul, Adam, Lisa, Dayna, Shay, Ersin, Ralph Parilla, and all th amazing folks of RBN, including Gerrit, Meika, Alan, Sydney, Nan, Candice, Dana, Marsha

Sam, and Jen. To my family, thank you so much for everything!: Dad (with his amazin meteor protection abilities), Grandpa Frank (our rock), Mike, Matt, Joseph, Ricky, Ashle Adam, Marcella, Steve, Maria, and Carl. My dear doggie, Puggle, was my constant companio for many long hours spent researching and writing. Mimi Spiro was a steadfast source inspiration and caring. My Mom and Aunt Barbara, as always, are my center in this world.

Finally, I'd like to dedicate this book to my dear Grandma Netta, who passed away as was nearing completion. You lived with this book project's development almost as much as did. Your love for me knew no bounds, and you always wanted the best for me. I will nev forget. The gift of love you gave me is something I will carry with me all my days, and try learn from. I will always love you. My soul is with you always, and yours with mine.

Brooklyn, New York
Spring 2014

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." I today's digital hypermodernity, these insights, found in many ancient traditions around th world, are often reduced to sound-bite mantras. And yet, defying the seeming linearity time and history, these notions now seem to haunt us, uncannily, not merely from the pas but also from the future. For our world today really is more connected, and more so by th day.

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

Although all truly *is* becoming one, this new connectedness is far from unitary. Rather, it fractal, multiplying in layers within layers of burgeoning complexity. We live in an age radical differentiations, cascades and crashes, decentralized affiliations and baroqu complexifications, all of which shatter as they recompose and destroy as they create. It is if we woke up one day, and suddenly all the points in the world had burst into webs, all th straight lines into nets of wires, and all the planes and volumes revealed textured layerings 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 epitom and guide, mirror and engine, even these often appear to be mere refractions of some new deeper, and profoundly discomfiting logics. In place of the euphorias of the early comput age, so many hopes of a borderless, post-Cold War techno-utopia, our world now dances the rhythms of neo-religiosities and digital protests, video-game wars and financial weapo of mass destruction, invisible labor and long distance oppression, all coordinated by ne agencies which are always beyond reach, everywhere and anywhere but where they appe to be. As space contracts, distances only increase, filling in with firewalls against cyber-feint security checkpoints and walls both virtual and concrete, even as wormholes seem 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 mean, and on their own radically new terms. But where to start? If there is one word whic brings together the multiform new logics which are so rapidly changing the structure of ou world, a word which describes the ways in which everything is fracturing so as to reconne more intensely, it is the term "network." Whatever is changing our world seems to b 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 no even easy to say how we got here. While the Internet clearly was an essential catalyst whic helped bring this all about, that which brought these changes to critical mass, it is als perhaps merely a symptom. For long before we began to link computers together the wor was growing networked, knitting itself together by means of satellite communications an television signals, flows of products and currencies, telephone wires and railroad tracl before this, even if we would never have thought to call these changes networked at th time.[1] What is more, scientists are increasingly showing that the physical and biologic world from which we evolved was already networked to the core.[2] Perhaps then we hav only begun to see the ways in which the world was always already networked, as if waitin for us to remove the blinders of our more orderly, modernist inspired dreams. If so, th Internet itself could then simply be a messenger of things to come, or a strange sort of retur home, even if one which clearly developed the networks in the world to both quantitativel and qualitatively new levels of possibility.

Whether or not the past was always already networked, or we are just learning to see thi it seems clear that the rules of the games which dominated humankind for millennia ar changing in dramatic ways. With each passing year, space appears less like a grid, and tim less like a linear progression, even as neither seems to be returning to the simple bordere terrains or cyclical seasonal patterns of old. Notions like before and after, cause and effec ancient and modern all seem to shift relative to changes in the gravity of our new spati temporal intertwinings, with so many crystalline webs of potential pasts and plural futur continually reworking our positionality even if we stand still. Nettime and netspace are no distributed in webs which continually re-update, shimmering and flickering in relation to eac other.[3] producing new landscapes which transform, deepen, and layer without necessaril progressing or pointing out a privileged direction or orienting trajectory. Compressing an decompressing, the spacetime of networks loops back into itself, creating new rhythms with and between its locations, shattering and recomposing what was solid into dynam symmetries in fluid fabrics with new habits and structures all of their own. Futureshock turn to whiplash quite quickly in today's virtual kaleidoscopy, where morphing planes an 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 w are increasingly composed of so many quasi-living distributed intelligences, meshes of dat images, and commodities, all of which seem to increasingly manipulate us according to the own suband supra-human desires, fears, hopes, and dreams. Assemblages of screens an avatars, interfaces and software platforms, digital communities and semi-anonymou agencies, we now find fibers and channels, flows and feedbacks, patterns and prosthese where we once thought there were human beings. And yet, within all this, all of our selv still seem to need to find some form of orientation, some way to gain a hold on the chang we clearly unleashed on the world, but which seem to be quickly redefining anything an 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, 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 cris which seem to be describable only in networked terms, from financial crashes to terrori organizations and digitized militaries, to changes in modes of organizing protests an revolutions, to shifts in how we relate to our everyday work, leisure, and socialization. An this is only the start. For our networks are on the cusp of producing revolutions in bio-an nanotech, and when this comes about, they will truly have the power to rework the ver foundations of the biological and physical worlds which made all this possible, and in way 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 rath than simply be recreated by forces of our making but increasingly beyond our control, w need to begin to be able to think and act on these new terms. Static territories, rig boundaries, linear trajectories, flat surfaces, and unitary individuals, all the basic componen of the world of yesterday need to be recast. In order to truly deal with the challenges of ou age, we will need to learn how to think, act, experiment, learn, value, and perhaps eve dream networkedly. We need a new worldview: a philosophy of networks for ou hyperconnected age.

Networks – and Philosophy?

But what exactly does the notion of a "network" even mean? Certainly the term everywhere today. And yet, the meanings attached to this notion, at least in everyday speec are far from clear. It is as if the term were designed to proliferate and slip away from us, multiply and increase in intensity, functioning differently in ever more situations, movi from tired and hackneyed to surprisingly different and back again, giving rise to ne possibilities in the circuits of flight in between. Hypervisible and so obvious as to be ofte taken for granted, networks have become such a part of the fabric of daily life that they a like the air our techno-bodies breathe, even as it is often unclear precisely what they are, could be. Trying to pin down the essence of networking can be an experience of vertigo, of a oddly centerless centricity, as if the sense of networking is continually dematerializing a recrystallizing in ever shifting prisms of color which give us back reworked versions of whe we used to be. Perhaps the trick then is to learn to ride the waves of networking first, a 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 th book. Whenever people asked me what I was working on, I responded by saying a philosoph of networks, and was then almost always asked if this was some sort of study of the impa of social networking. That is, the idea that philosophy and networks could have anything common seemed strange to most. But rather than something like a sociology of networks, th project aims to truly be a *philosophy* of networks, an attempt to think what networks and o networked age could come to mean in the widest possible sense. And so I would reply to m questioners by saying that while this project is not unrelated to technologies like the Intern or social networking, it is more about networks and networking as such, about how anythi and everything we have ever experienced can be thought of as networked, and why anyo would want to view the world this way. My questioners then usually expressed a mixture confusion and curiosity. When I pushed this, I found that while anyone I spoke to could giv examples of networks all around them, few could really say exactly what a network itse might mean. This project finds one of its points of entry into the pressing social issues of o times in this productive ambiguity.

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

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

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

Nevertheless, many seem to feel today that we are no longer living in a time in whic
philosophy can really say anything worthwhile at all, and certainly philosophy seems hardl
relevant to most people in our world today. To most, philosophy seems to be something th
specialists do in universities, far from the concerns of the everyday. But the gener
skepticism about philosophy today can be seen as the result of some very constricted notion
about what it means to do philosophy, and the prevalence of these ideas not only i
"mainstream" culture, but amongst those who "do" philosophy for a living. This lack o
imagination limits not only philosophy, but also the role it plays in culture, even when it
most needed. For perhaps philosophy is simply what happens whenever we try to describ
how the world looks to us as a whole, here and now,[4] in a way which can help us map ou
potentials for thought and action. Philosophy then would not need to try to be beyond tim
place, and culture, but rather, speak from and to these, such that perhaps every cultu
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 a
opportunity.[5] For it is only when past forms of thinking seem naïve or less relevant tha
before that we can begin to question anything and everything, including what we mean b
thinking. Each age needs to reinvent philosophy, to learn to dream anew about what it migh
mean to think in regard to the challenges of the times, and hopefully, point towards ways t
help make the world a slightly less oppressive place. And if philosophy is viewed as th
manner in which we try to make sense of the big picture in regard to how it appears fro
here and now, then this would mean that since networks are changing our world they need t
be considered a proper subject for philosophy.

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

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 futu forms of networking.[6]

This is the task that what I have come to call "the networko-logical project" sets for itsel What follows is a thought experiment. Its goal is to see if everything in the world, fro matter to markets, organisms to molecules, brains to societies, languages to love, can be see as composed of networks of networks. The hope is that this can help reframe some of th impasses that dominate our world today, so as to indicate pathways towards new an potentially better ways of navigating the challenges of our increasingly complex networke 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 sta
from scratch. During the second half of the twentieth century, the science and mathematics
networks, a major component of what is often called "complex systems science," began
revolutionize a variety of fields of study in a manner which continues today, and which ca
provide a starting point for this project. Developing from cybernetic, chaos, informatio
graph, and systems theories, complex systems approaches bring together a variety of researc
modalities. What unites them is the notion that in order to understand many of the mo
difficult and interesting aspects of our world, it is necessary to not only get a sense of ho
the parts of a system function individually as isolated units, but also in regard to how the
interact with each other and their environments as wholes.[7] By showing how the intertwinin
of entities in dynamic webs can lead to effects which were not predictable from the distin
form of the parts involved, this more holistic approach has led to an ability to understan
many phenomena in the world which often previously defied scientific modeling.

Complex systems science is a relational and network-oriented approach to scientif
thinking. Opposed to various forms of "reductionism,"[8] complex systems research shows ho
modes of interaction between relatively simple parts can give rise to highly comple
behaviors. For example, individual ants have limited brain capacity, yet colonies of ants ca
build massively complex dens, just as individual birds or fish can flock, molecules of wat
can form a whirlpool, or investors in a financial market can start following each other into
cycle of bubble and crash. Using models which do not isolate individuals from each other, b
look at how they interact in systems, researchers have increasingly been able to simulate an
better predict the behaviors of such systems, often using explicitly networked models. Whi
the field began by modeling relatively simple systems, such as flocks of birds and an
colonies, these were only the beginning. Artificial neural networks, for example, hav
revolutionized artificial intelligence, giving rise to simulations which model the bas
components of living brains and which, unlike more traditional forms of artifici
intelligence, can learn, forget, associate, and even guess in ways shockingly similar to th
thinking styles of highly developed organisms. Insights from this work are increasing
helping to guide the study of the human brain, as well as exerting a profound impact on wh
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 no
networked, binary, "serial" computers, like the type normally seen on desktops. And s
while the software simulates networks, it runs on non-networked hardware. Though th
development of non-binary, "parallel," networked computer chips is still only in the realm
technological fantasy, and will likely have to wait for advances in genetic, nano, or quantu
computing, software simulations have provided the first glimpses of what is likely to com
even as the Web's virtual networks continue to pave the way. Even with our limite
hardware, however, much has already been accomplished simply by starting to think an

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

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

To produce a philosophy of networks, it will therefore be necessary to intertwine the stud of science and technology with concerns of meaning and value. While it may seem strange do so, we may soon have no choice. For as mentioned earlier, as we increase our ability 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, th discussion of meanings and values in relation to science and technology will becom impossible to avoid. All of which lends credence to what many historians and theorists 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 th perspective of a different culture, or in relation to the past.[11] And yet, even from here an now, it seems ever more clear that from the drive to profit in relation to industry, to th government's desires to shape social policy or gain advantage in wars, our society permeated by attempts to control teaching and research, and in ways which have enormou impact upon the way these describe the world.

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

networks make it much more difficult to see the world in isolated and restricted ways, th growing networking of the sciences, not only with the world beyond the lab, but by means complex systems science itself, indicates a potential opportunity to imagine new ways thinking the relation between these. For only if we can find ways to talk about how pow 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 tru objective, or that we should at least strive for what is often simply another way reinforcing the way things currently are. A more networked, relational approach would be try to understand how our values always do this anyway, whether we admit this or not, an to try to question what sort of values we might want, and how this could help guide ou practices towards better futures. The hope is that perhaps this can help produce futures whic 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 themselve beyond their applications. When most people think of networks today, they often think social networking, or the Internet, or networks for mobile devices. Ask scientists mathematicians, however, and they are likely to think of network diagrams, specialize pictures which describe how aspects of the world hold their parts together.[12] Neverthele these same scientists often refer to the aspects of the world being diagrammed as networ themselves, simply because they can be represented by networks. What could it mean, the for something to be networked, whether as an aspect of the world being diagrammed, or as diagram itself?

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

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

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

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 an be diagrammed, represented and representing, functioning as what linguists generally ca signifier and signified.[13] Unraveling the reductive ways in which representation has ofte been described in and beyond linguistic models in the past, networks provide mo polymorphous ways of theorizing what has often previously been seen as rigid dichotomous.

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

Beyond these basics, the networkological project will examine the manner in which th nodes, links, grounds, and levels are the products of various processes. From this perspectiv nodes can therefore be seen as produced, maintained, and transformed by processes o ***noding***, links by ***linking***, grounds by ***grounding***, levels by ***leveling***, and networks b ***networking***. For example, when a tree gives rise to buds, it produces nodes, and this is a example of noding. When people make friends at a party and exchange contact informatio they create new links, an example of linking. An ocean serves as a medium, suppor container, and context for the fish within it, and in this sense, the ocean can be seen a grounding the fish. A more abstract form of grounding can be seen in the way in whic descriptions of the world tend to justify themselves in relation to others, such that th contexts provided by these justifications act as grounds for the ideas in question. Grounds a intimately related to how nodes and links change, for they relate these to processes beyon them, and viceversa. Grounds, like levels, are in many ways trickier than nodes or links, fo they are necessarily both inside and outside of the networks in question. Beyond nodin linking, and grounding, there is also leveling, the manner in which networks give rise t 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 emergenc of networks from each other, such as the way in which an embryo can ultimately give rise t a living human being.

The temporary solidification of processes which gives rise to particular nodes, link grounds, and levels is what many discourses have called a form of ***reification***, a term whic literally means “thing-ification” (from the Latin word *res*, for “thing”).[15] Reification necessary to produce and maintain networks, even if it can come to dominate, paralyze, an 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 formatio support, change, and development of any and all networks, the term reification will general be used in what follows to describe what happens when reification itself reifies, which is 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 appear solid and fixed, even if they are ultimately composed of networks from within, a are aspects of other networks from without, despite seeming appearances to the contra While not all reification is “over”-reification, because our world is so dominated b reification and its effect, it will often be the subject of networkological critique in wh follows.

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

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

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

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

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

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

Whirlpools do not generally remain stable or develop much further, however, because the tend to run out of energy quickly, and the relative homogeneity of their parts makes difficult for them to develop new forms of complexity which could work to maintain or gro the system beyond this. Complicating this is the fact that while a whirlpool is much mo organized than a simple mass of water molecules, and hence indicates a jump in complexit it also goes through energy much faster, and in fact, all complex systems require energy maintain and potentially increase in complexity. Living systems, for example, eat, and the also produce wastes, and only a steady flow of energy, such as that of the sun, can maintai and grow complexity, as well as deal with wastes produced in the process. Witho developing distinct new systems to find new sources of energy and take care of wastes, th system is limited in its ability to maintain itself or grow.

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

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

While complicated systems can be extremely powerful, it is this ability to develop in ne and more intense ways, to adapt to changes and rework themselves, not only in terms quantity but also of quality, which makes complex systems truly unique. When comple systems self-organize in ways which increase their complexity, whether in quantity 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 physic complex adaptive system, if one which is relatively short-lived. Living organisms are mo developed forms of emergence, and they can give rise to new forms of emergence in tur such as learning and evolution, none of which could be predicted by an examination of th structure of any particular part of the organism or its brain, but only by the relation intertwining between these in particular sets of circumstances. Beyond physical and biologic emergences, cultural advancements can also be seen as forms of emergence, from the flockin of birds to the development of language in humans, and all of these feed back into physic and biological emergences to potentiate them further.

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

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

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

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

the needs of our rapidly mutating networked age.