vol.1

CON VERSATIONS

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cybernetics: state of the art

edited by liss c. werner

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Cybernetics is "a discipline which fills the bill insofar as the abstract concepts of cybernetics can be interpreted in architectural terms (and where appropriate, identified with real architectural systems), to form a theory (architectural cybernetics, the cybernetic theory of architecture)."

Gordon Pask, 1969

The book series 'CON-VERSATIONS' engages with pressing questions for architecture, urban planning and infrastructure; in the age of increasing connectivity, AI and robotization; in an evolutionary state of the Anthropocene, perpetuating anxiety as well as excitement and joy of a future, that we will be able to predict with less and less certainty.

Raoul Bunschoten and Liss C. Werner

'Cybernetics: state of the art'
edited by Liss C. Werner

The scientific series CON-VERSATIONS of Technische Universität Berlin is edited by
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Liss C. Werner

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CYBERNETICS: STATE OF THE ART

Edited by Liss C. Werner

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Raoul Bunschoten and Liss C. Werner

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FOREWORD

Omar Khan

It was in 1949, at the sixth Josiah Macy conference on "Circular Causal and Feedback Mechanisms in Biological and Social Systems", that newly appointed editor of the conference proceedings Heinz von Foerster, exasperated by the conference's cumbersome title, suggested that 'Cybernetics', the title of Norbert Wiener's recently published book be adopted as the conference's title. Through this simple act of renaming, von Foerster can be credited with making cybernetics into a field of study. While Wiener's book *'Cybernetics: Communication and Control in the Animal and the Machine'* (Wiener, 1948) set the scientific framework for explaining cybernetics as a subject about communication, feedback and control, it is really in the auspices of the conferences that cybernetics developed into an epistemology applicable across multiple disciplines. It was through the heated debates between scientists, mathematicians, anthropologist, linguists and psychologist that cybernetics emerged as a way of knowing our world.

Currently, cybernetics as a subject on its own isn't taught at any university in the United States. Within the engineering sciences it is reduced to the concept of 'feedback', a conceptual stepping stone for topics like informatics, system science and artificial intelligence. In the humanities it is a studied as a historical event closely tied to the development of computers and the information environment. Within the European academic context, cybernetics continues to exist in pockets but in many cases paired with informatics or robotics to make it more relevant. As to whether it as an epistemology still exists is difficult to ascertain.

Clearly there are shades of it and it is in a conference like *Cybernetics: state of the art* and the present book that we may be seeing a reemergence of this. What is it about conferences that allows for such possibilities. For one they invite conversation and sharing; open to new interpretations and disagreements. They allow one to test ideas to see whether they have staying power without the constraints of titles and structures necessary when defining a subject. And this has been cybernetics privilege and curse. There are many jokes associated with this but perhaps Claude E. Shannon's advice to Wiener-

"Use the word 'cybernetics', Norbert, because nobody knows what it means. This will always put you at an advantage in arguments"- might be positively taken for cybernetics nuance and continuing relevance for many fields. And so for the state of the art in cybernetics to be hosted at a conference in a School of Planning Building and Environment seems entirely relevant and necessary. It is in such interdisciplinary contexts that cybernetics as epistemology has the room to grow and inspire new directions of inquiry. There are many influential cyberneticist to take direct lessons from—Ross Ashby, Stafford Beer, Gordon Pask, Ranulph Glanville, and others to rediscover—Heinz von Foerster, Gregory Bateson, Humberto Maturana and Francesco Varela, and those still in our midst like Paul Pangaro who can connect us to this influential intellectual tradition. Hopefully, with this new initiative we will shed some much necessary light on understanding our increasingly cybernetic world.

Omar Khan,
Buffalo, September 05th 2017

PREFACE

Raoul Bunschoten

We have had the luck to have Liss C. Werner on board the last two years at the Technical University of Berlin, and especially in our Chair for Sustainable Urban Planning and Urban Design. Together we have been able to start up a new process of linking the state of the art of cybernetics with today's global urban developments. Her research on the work of Gordon Pask, and her tremendous energy, ingenuity—and her continuing communication with a part of the relatively small club of cybernetic specialists—have acted as a tremendous catalyst.

Gordon Pask appeared in my life standing at the bar in the Architectural Association in London, when I walked into its building on Bedford Square in London for the first time in October 1983. Alvin Boyarsky, at that time Chair of the AA, had invited me to run a unit together with Donald Bates. We had been recruited through Daniel Libeskind, who had visited the AA the year before. Libeskind had taught at the AA himself previously, before becoming, via a stint in Kentucky, the head of the Cranbrook Academy of Art in Michigan, where Donald and myself graduated with an MA in Arts. Gordon was nurturing a glass of white wine, when he caught my attention and asked me if he could help me. He could, since I needed dinner, and he duly pointed out his favourite Indian restaurant near the AA; located in a warren of streets I failed to navigate afterwards. His instructions were fairly fuzzy. Or, to be fair, I had not yet gotten used to Gordon's way of expressing things and his very particular manner of speech. During the first three years of teaching at the AA, I regularly bumped into him in the corridors and lecture hall. He was always around in crits, lectures, parties, and I started to observe him speak, interact with audiences, think aloud, and of course drink at the bar where one could approach him informally for a chat. I did not understand him, and at that early stage I had no time, since I, like all young teachers at the AA, came with hugely ambitious new programs and were fired on by Alvin Boyarsky to perform great deeds, win competitions, publish, etc. to keep the AA at the world's center of architectural education, nor

inclination to research deeper into his past. When I started a new Diploma Unit in 1986 in which my students worked on the dynamic undercurrents of urban emotions—we called them *Proto Urban Conditions*—Gordon started to get interested in our work and joined the studio on a regular basis. I realised that he had some incredibly new and fascinating thoughts to offer; provided one took the effort to listen carefully to his soft murmurings. In October 1986, we started teaching together for two years and ran a lecture series called *Order and Chaos*. By then I was well inducted in cybernetic history. Gordon remained at the AA until he passed away in 1996. My hunch is that Gordon remained at the AA mainly because of his earlier relationship with Cedric Price. As Cybernetic Consultant he worked for and with Cedric on the Fun Palace, commissioned by Joan Littlewood, a famous fun park owner in the UK. Alvin Boyarsky retained him as a roving teacher and consultant.

Gordon Pask's importance for urban design was at that time possibly not understood and / or not well appreciated. John Frazer did realise his significance and drew him into the activities of his Diploma Unit 11, which he taught together with his wife Julia Frazer, a relationship possibly culminating in the experiments on artificial neuro-systems simulating urban decision making dynamics. In 1995 the AA published a book by John Frazer on the work of their Unit called 'An Evolutionary Architecture' which presents this work. But neither that cooperation, nor the very different ones with me and my students or Omar Khan, addressed the complexities of emergent technologies in urban contexts and the significance of the field of Cybernetics as a whole in the ensuing evolution in urban planning and design. At one stage Gordon moved into a different phase of life, and eventually passed away before any of us could restart this process. Only Ranulph Glanville, at that time working from a small cubicle in the basement of the AA, kept the link to Gordon and the wider field of cybernetics, architecture and design warm and alive.

In previous years, we dedicated several seminars to cybernetic research with students: a workshop with Omar Khan at London Metropolitan University, where I was teaching together with Tomaz Pipan, and at TU Berlin a workshop led by Tomaz Pipan, and various seminars organsied by Dietmar Köring and Holger Prang, the latter engaging in data-driven and data-based

digital planning tools utilising cybernetic thought and cybernetic principles. Liss C. Werner approached the subject slightly differently—with a twist and fascination for the logic of cybernetic systems on one hand, and a passion for Gordon Pask, his diagrams and rather unusual cybernetic machines on the other. She visited the Gordon Pask Archive, located at the University of Vienna under Albert Müller, numerous times to examine the work of Gordon hidden in piles of papers and boxes. Beyond archival research Liss had regular conversations with myself, Ranulph Glanville—who taught Liss at the Bartlett—and Paul Pangaro, both former PhD students of Gordon, and other colleagues of that time, including John Frazer.

Now, approaching the 2020s, we have started to take stock of this situation. We have started a process at TU Berlin, through the vehicle of my Chair, to rekindle the links between urban design, architecture and cybernetics; and turn it into something new—driven by the global wave of digitisation with all its consequences and strings attached. After steam, oil and electronics, digitisation is sometimes called the 4th Industrial Revolution. The impact of digitisation on urban design, systems and dynamics is enormous. More indirectly is the legacy of cybernetics in this revolution. Underestimated, even forgotten, is its importance on today's machine-learning, system thinking, brain activities analysis and emulation and management of innovation. We hope to contribute to both, recognizing this legacy as well as pursuing the ongoing significance of cybernetics as a field of research and foundation for applications in urban and other disciplines. Last year's conference *Cybernetics: state of the art* was the first step, this book is the second. One of the things Liss and myself have set out to do with this book series is to address the relevance of cybernetics for current developments in architecture, urban design and planning.

Raoul Bunschoten,
Berlin, 20th August 2017

Pask, G., Foreword in *An Evolutionary Architecture* by John Frazer, London, Architectural Association Press, 1995, p.7.

"The role of the architect here, I think, is not so much to design a building or city as to catalyse them: to act that they may evolve."

Gordon Pask 1995

PART 1

A CONCEPT AND A SHAPE

Cybernetics as Phoenix: Why Ashes, What New Life?

Paul Pangaro

Cybernetics: Where have you been and where are you headed? Born in the 1940s and seeming dead from the 1960s, can you be a phoenix rising? Today, cybernetics seems to pop up more often than any time since its inception—at least in its most misunderstood form as a melding of biology and technology to make a robot or 'cyborg'. But even in its proper sense, as the science of effective action, cybernetics is undergoing a resurgence of interest even while its core values—the roles of variety and language in effective action—are still not widely applied. Here I will argue that cybernetics offers values and skills critical to the practice of design in a world of unpredictable, unknowable complexity. While its first-order systemics gives foundation to understanding emergence and unintended consequences, second-order cybernetics offers an ethical, clear-eyed argument for transparent, value-driven design processes. Can cybernetics be a core teaching for schools and design practitioners, such that ethics and responsibility may overtake the hegemony of AI and computing, governments and ideologies? What else is necessary even to begin to approach this naively optimistic and yet potentially world-changing vision?

Keywords: cybernetics, second-order cybernetics, design, design education, complexity, transdisciplinarity, antidisciplinarity

Phoenix

A world-famous media lab is arguing that cybernetics is central to the participation of science as a member of the toolset required to tame the wicked problems of the world.

The phoenix is a mythical creature said to rise to new life out of its own ashes. The discipline of cybernetics emerged in the 1940s to influence generations and then burn out, its original intentions blurred by confusion with artificial intelligence and android robots. Never quite dead nor 'alive and well' neither, the meme of cybernetics, certainly at its beginnings, infused feedback and systemics into the popular imagination as well as the scholarly zeitgeist of countless fields. While there are many favored definitions[1], here we will call it the science of effective action and 'the science of effective organization' (Beer 1985). Also from its start it has been applying its principles to itself, emerging most recently as a rigorous way to view

conversation, problem framing, and language-creation (Dubberly & Pangaro 2017). Today, cybernetics is being credited as foundational for interaction design (Dubberly & Pangaro 2015), design methods (Dubberly & Pangaro 2017), adaptive architecture (Pask 1969; Haque 2007; Sher, Chronis, and Glynn 2013; Beesley 2010), and antidisciplinarity (Pickering 2013). A world-famous media lab is arguing that cybernetics is central to the participation of science as a member of the toolset required to tame the wicked[2] problems of the world (Ito 2016).

Why Ashes

By way of preamble, it's important to spend a minute to theorize why cybernetics dissipated, in two senses.

Cybernetics infused many other fields with its fabulous ideas, such as information about consequences of action becoming feedback to a system as it acts to achieve its goals.[3] Foundational among the fabulous ideas of cybernetics is that systems can be construed to have their own purpose (Pask 1962) and can be studied from the frame of information rather than functional organization—or, according to Ashby—'the immaterial' rather than the material (Ashby 1956). This gave primacy to purpose, for which cybernetics stands out from other systems approaches.[4] Surely the power of that insight helped to propel it into the cultural consciousness of academia across disciplines.[5]

Foundational among the fabulous ideas of cybernetics is that systems can be construed to have their own purpose.

But why did it dissipate, in the sense of diffuse and lose its identity while strongly influencing other realms. For one thing, beyond that ability to capture the imagination of the time, there was no machinery of cybernetics that would demonstrate its power and its practicality. Its dark twin, artificial intelligence, was far more fortunate. AI would come not just to dominate but to nearly eradicate cybernetics in part, if not largely, because it had immensely powerful machinery to demonstrate the apparent practicality of its ideas: the digital computer.[6] No one cared (indeed, few seemed to notice) that AI's claims were consistently implausible and over-blown; because who could disagree with the promises of a 'smaller, cheaper, faster' future. Given only better hardware that was obviously coming every

AI would come not just to dominate but to nearly eradicate cybernetics in part, if not largely, because it had immensely powerful machinery to demonstrate the apparent practicality of its ideas.

day, surely this path would inexorably give us 'smart machines.' (Not.) Perhaps in part it's because the concept of purposive systems didn't have a home in an existing discipline. At MIT there was no department where the great Norbert Wiener could live happily[7], except perhaps that of mathematics, his primary field, which was not the same as cybernetics—they are as different as a scientific law is from a story. Each of the disciplines that have been seriously influenced by cybernetics, perhaps anthropology as an example of a soft science, or a hard science such as biology, or an applied discipline such as engineering—none of these departments could contain a novel concept that was yet broader than any of them.

Indeed, the term now coming up is 'antidisciplinarity', coined by Andrew Pickering (2013). The term may sound like it's against being put into any discipline's silo, and also against being put into a single frame or vocabulary. It's brash enough to also be fighting the paradigm[8] which holds that silos are the only way to go.

From its inception until now, embrace of the discipline of cybernetics itself has not broadly occurred, though some off-shoots and tools did arise from it (first-order feedback, of course, and to much less extent, the rigorous concept of 'variety' from Ashby 1956).[9] Surely we can uncover some valid reasons for this. First, there are some disconcerting things about cybernetics. It zooms out rather than zooms in, and it's hard for most human beings to zoom out and maintain confidence in the face of uncertainty and a great increase in complexity. Whereas if you zoom in and you split the world into smaller and smaller pieces, as Heinz von Foerster would point out, you are then well-able to say more and more about less and less. And this can be very satisfying, at least for scientists, our custodians of 'science'—a term that comes from 'schism', splitting the world into smaller and smaller pieces (von Foerster 2014). This is one way of looking at what the hard sciences, such as physics, do.

And this can be very satisfying, at least for scientists, custodians of 'science', from 'schism', from splitting the world into smaller and smaller pieces.

Science is a process designed to increase confidence, after all. Why would we expect it to help with 'wicked problems' in the strict sense of Rittel and Webber 1973, where uncertainties abound. For example, what are the actions that might be taken (a full set of solutions cannot be enumerated) or when might we stop (impossible

to know since the problem can never be fully eradicated).[10] Statements of what is possibly wrong and how a situation may be improved—so-called 'problem statements'—are subject to beliefs and values, and therefore framing and argumentation, rather than objective and easily agreed-upon facts (Rittel & Weber 1973). In wicked situations, the process of framing problems-to-solve will not look like a process of reaching a desired state from a current state. Such a pure cybernetic framing of convergence to goals is appropriate only once the goals are agreed. Instead, we need a way to track the process of formulating problems-to-solve based on the invention of new language, which may then be found to be viable by the range of variety it manages to span (Dubberly, Esmonde, Geoghegan & Pangaro 2002).

Another reason why I believe cybernetics dissipated: it's not only anti-disciplinary, it is anti-objectivity.

Another reason why I believe cybernetics dissipated: it's not only anti-disciplinary, it is anti-objectivity.[11] Cybernetics, particularly in its 'second-order' form, denies the right to objectivity that scientists sometimes claim—erroneously, of course. The Heisenberg Uncertainty Principle makes clear that the very question asked—the framing of the situation—has irrevocable implications for any answers that follow. Observation invites a framing of the situation, hopefully one from which the system being observed can be 'best' seen, where 'best' is some yardstick based on coherence for explaining the observations; based on measures of variety; and, ultimately, based on the viability of possible actions that stem from the chosen frame.

By the way, the frame of 'framing' says that science is not about objectivity. It's a frame based on a process by which its self-defined advances are made, where the process is called 'the scientific method.' Cybernetics dethrones science as the custodian of truth and objectivity, so it removes the claim to power made by conventional scientists (consciously or not). Certainly, when I was at MIT as an undergraduate from 1969 through 1974, it was clear to me in conversations with faculty as well as students that they wanted to be right and know the truth and know the world. Anything other than that would castrate them. Another reason for the dissipation of cybernetics, as described in the biography of Norbert Wiener called 'Dark Hero of the Information Age', is that Wiener contradicted the

political directions of the US after World War II by refusing to do any further war work (Conway & Siegelman 2009). This made him immediately suspicious as untrustworthy, perhaps a security risk. He also had mental health issues which further eroded trust in him, and therefore by association, cybernetics.

At least in one important instance—one that I and others heard from the lips of Heinz von Foerster more than once—a single refusal was a proximate contributor to dissipation. For some time von Foerster's Biological Computer Lab at the University of Illinois in Urbana-Champagne was funded from the US government. For years Heinz would go to Washington DC and discuss his next round of funding and then receive it at his lab directly from the government. In this way, he would maintain the extraordinary run of his BCL of some 20 years or so (Umpleby 2003). Yet as Heinz tells the story, one year he went to Washington as usual and was told that he was not going to get the money directly; instead, he would have to approach an individual through whom they were centralizing distribution. So, as he was instructed, Heinz went to Cambridge to MIT and requested funding from Marvin Minsky, the man now in charge of dolling out the money for AI and related research. And Marvin just said, 'No.'[12]

But perhaps in the end, the overarching reason for cybernetics dissipating and losing to AI was this: cybernetics did not have central problems that were clearly articulated, that many researchers could work on, and—most crucially of all—for which they could get paid. AI had the success of digital computing and therefore computer science departments as career paths, but cybernetics had none of it. (Cariani 2017). This is all part of our history, one way or another.

Now the legacy of cybernetics at MIT becomes fascinating.

What New Life?

Now the legacy of cybernetics at MIT becomes fascinating. The head of the MIT Media Lab, Joi Ito, published an initial volley for the resurgence of cybernetics in a journal called "Design + Science" (Ito 2016). I recommend to read it, partly because it's a curiosity.[13] Ito wants to reclaim antidisciplinarity as key to the future of science in combination with design, which all together become a means to

solve the world's wicked problems. Here he is speaking about the pubpub.org online publishing platform:

> *"I believe that by bringing together design and science we can produce a rigorous but flexible approach that will allow us to explore, understand and contribute to science in an antidisciplinary way… Our thinking is to create a vehicle for the exchange of ideas that allows all those working in the antidisciplinary space between and beyond the disciplines to come together in unexpected and exciting ways to challenge existing academic silos. Our aim is to create a new space that encourages everyone, not just academics, to come together to create a new platform for the 21st century: a new place, a new way of thinking, a new way of doing."*
>
> Ito 2016

Rather than for publishing, I prefer to read him as speaking of 'space' in form of rich conversations he might host at the MIT Media Lab, erminiscent of the Macy Meetings from the 1940s and 1950s.

I know Ito slightly, from three separate conversations across several months. In the first, I was expecting to talk about his interest in the revitalization of Detroit—he is from nearby and I'm currently chairing an MFA program in Interaction Design at the College for Creative Studies near downtown Detroit. In an email prior to the meeting he said he was interested in talking about cybernetics because he was trying to apply design to science and felt that 'second-order cybernetics X design X some modern version of the Bauhaus' is what is needed 'to fix science' (Ito 2016b). I thought I was hallucinating when I saw this and I had to read it five times. When we met, instead of talking about Detroit he asked probing questions about the history and viability of cybernetics as an exemplar of antidisciplinarity. He specifically asked whether the MIT Media Lab should take up the banner of cybernetics.[14]

I thought I was hallucinating when I saw this, and I had to reread it five times.

A few months later he texted me about his piece in Design + Science before publishing it, seeking feedback. We had a 90-minute conversation about a few factual things, such as dates, which weren't

hard to fix. But there were other things I voiced concerns about, that were not much changed when published, which I accept may have been a conscious desire to simplify.[15] He used the field of cybernetics as a primary example of antidisciplinarity, which in his terms is the breaking down of the silos of existing disciplines.[16] He speaks of cybernetics as having the power to aid action in the context of deep complexity, even unknowability—recognizing that is the world we live in today. How do we tame systems—*can* we tame systems, particularly those that overlap wicked problems. Surely something of the depth and power of a system science like cybernetics could help us in a world where we can't simply *know*, that is, we cannot have enough reliable information to act with high certainty. We don't know all the interactions. We don't know how conditions will change. And we don't know the unintended consequences.

So is cybernetics a science? Certainly it's a discipline—where the prime attention is on actions taken to perform well, actions to achieve goals, as opposed actions of a science to acquire knowledge.

Can cybernetics help here?
Could it, were it a science?
(Or, to Ito's point, help more so if it is not?)

Certainly it's a discipline—where the prime attention is on actions taken to perform well, actions to achieve goals, as opposed to actions of a science to acquire knowledge. This is the distinction Pickering makes when he calls cybernetics a 'performative ontology' (Pickering 2013). I'm not saying science is bad, but it's different than a discipline whose focus is to act well in the world, rather than to gather knowledge about the world. So, Ito would claim (Ito 2016)—and I and many others would also—that science doesn't really cut it, which we know because of the many wicked, unresolved situations at play across the globe—pollution, climate, energy, water, famine, social and economic disparity, and so on. If science is so great, why do these problems persist—doesn't it say something about the limitations of science? In this context, efforts with colleagues have been to understand if can we counter the serious challenges of wicked situations in the world by using cybernetics as a tool. This brings me to a syllogism about the necessity of cybernetics in the context of design (Dubberly & Pangaro 2016):

a **If design, then systems**—by which we mean, if you're doing design, and you're doing design in the complexity of the world as it exists today, including wicked problems, then you must incorporate a systems view. I think this is neither contested nor even controversial. Surely digital technology, web and Internet of Things, and the fact that design in general has shifted from giving form to creating systems to support effective human interaction—for all these reasons, designers need to have literacy around systems, because we need to be able to 'read' (understand) and 'write' (design / edit / modify) complex systems (Dubberly 2014).

b **If systems, then cybernetics**—because the interactions and complexity of systems involve humans, we must incorporate goals, feedback, and information, because we are driven by these things. And these are what cybernetics is all about.

c **If cybernetics, then second-order cybernetics**—because wicked problems are not about finding the solution or expressing the truth of an objective world, they are about establishing effective language for arguing for a framing a worldview that enables effective action. Because of the subjective nature of this framing, we must be responsible for our actions in terms of our values and viewpoints. This, in turn, requires that we are transparent about those values and viewpoints. This is where second-order cybernetics comes in. It's about knowing that when we 'see', we do so from the frame of our language and beliefs and values. Rather than a stance of objectivity, our stance comes from interacting with the world and creating meaning, that is, 'making sense of a world.' This is pure second-order cybernetics.

d **If second-order cybernetics, then conversation**—because design is grounded in argumentation, and therefore requires conversation, so that participants may understand, agree, and collaborate, all toward effective action. Not so that we can say, 'Wow, we know what's going on!' but rather so that we might say, 'Wow, we're getting somewhere, we're improving things!' We are seeing more and acting better.

These are my comments, which I hope are useful as foundation for a brief conversation between Kristian Kloeckl, Liss C. Werner, Omar Kahn, and me:

Kloeckl: Thank you, Paul, for this comprehensive overview. You began with a view of the origins and early history of cybernetics. What has changed since then? Why does it make sense to talk about cybernetics today and how do you suggest we move forward from here?

Pangaro: In terms of what's changed since the start of cybernetics, there has been a huge shift, in that a system's view of the world is no longer new or shocking. The world is more full of systems thinkers and disciplines that are systems-oriented. I think the vast problems on a rampage in the world are showing that, as Joi Ito says, essentially, science isn't cutting it (my crude paraphrase), so that we need something else. His idea that a solution may lie in second-order cybernetics + design is a very viable and brilliant proposal.[17] I think the world is better prepared, and we as a systems community are better prepared, and as so many in the world see things are not working, there is a better opening than ever before for second-order cybernetics—which still requires at least one and probably two moves from mere systems. But this mind-shift toward systems and antidisciplinarity of the last few generations has been a transformation. No longer are individuals so tied up in their individual disciplines from which they derived power and satisfaction and a sense of progress, at least within the narrow confines of carving up smaller and smaller parts of the world about which they can say more and more.

This mind-shift toward systems and antidisciplinarity of the last few generations has been a transformation.

So I think it's a new time and we have to be hopeful that the world is better prepared for a systems view and second-order conversations. What is that cliché—when the student is ready, the teacher will come? The world—including perhaps the scientists, formerly in the business of carving up the universe into smaller parts—is / are students of systems much more now than ever before. There has been a transformation from an old guard tied up in the silo-ed disciplines, and fiercely committed to those. The individuals

from the Macy Meetings were part of a generation where dividing up the world made sense for the times—even while Macy attendees saw far beyond that. But in the decades since, we've more than embraced inter-disciplinarity, cross-discipline conversations, and even have a hierarchy for it: meta-disciplinary, inter-disciplinary, and trans-disciplinary.[18] I believe strongly that we must operate at the trans-disciplinary level. I hope that the world is better prepared not just for a systems view, but for a cybernetic view, and not just a cybernetic view but a second-order cybernetic view, and ultimately for a conversation age (Pangaro 2011). Our world is one in which we grow up and access our worlds [sic] on the phone, and have access to data at least, and we move that into information in our interpretations and our worldview and our needs and goals. Every individual in this vast, intractable flux of complexity needs both rational tools, namely systems science, as well as emotional tools, namely learning to be more comfortable in embracing uncertainty and unknowability as foundational to existence.

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Here is another answer to why it makes sense to continue with cybernetics: I've seen this transition to systems thinking in the students of the last 18 or so years, in my efforts to teach successive student cohorts the same concepts of cybernetics for design—namely, first-order loops, requisite variety, second-order loops, conversation, and biocost (Dubberly & Pangaro 2007). Over that timespan I've seen a more immediate intuitive uptake for the systemic views in these models. Students today are more natural systems thinkers, they're much more able to start with a diagram of something rather than just a verbal explanation. What we should expect from an iterative approach is greater traction with the models of second-order and conversational systems. If these fail, we need to assess what variety is missing from the design conversation, and change the design of that conversation.

Students today are more natural systems thinkers, they're much more able to start with a diagram of something rather than just a verbal explanation.

Beyond these, I don't have a way of saying what we should now all go out and do, what the action should be. But a conversation about the meta-process would be something I could join. What was close by in the conversations with Joi Ito, but I don't know that I made quite clear enough, is the idea of variety from Ashby, and that

we have to have the right people in the conversation, and we can create a cadence of conversations over time such that the unfolding conversations encompass the necessary (requisite) variety and the scope of potential action is more powerful (Pangaro 2006). I know at least that we must design conversations for the variety that we learn along the way is what we need to make progress. Convening a space in which we can ask each other about situations and therein find meaningful questions, a focusing question. Paying attention to the conversations needed for design is a work of collaboration for some years with Hugh Dubberly (Dubberly & Pangaro 2009 and 2016). Designers need to create conditions under which we can define the difficult focusing questions. Focusing questions should be narrow enough to make progress and yet powerful enough to be useful—to apply to the larger problem space—if we crack it. For example, with climate change: Can we produce an artificial photosynthesis that eats the CO^2 in the atmosphere and produces oxygen as a result? This casts CO^2 as a surplus, as a wealth-creation opportunity—which is simply a matter of reframing. Who should be in the conversation? This is analogous to conversations to build the first atomic bomb in the Manhattan Project, when they knew from a theory that they could unleash vast amounts of power by converting matter to energy. From that starting frame, it was a matter of 'increasing the variety in the room', and iterating conceptually and ultimately experimentally, until something practical could be made. (This is an horrific example, however.) So, convening those conversations, and having the meta-process idea in mind—designing the conversations toward requisite variety for solving a focusing problem—is as far as I can get to an answer.

I know at least that we must design the conversation for the variety that we need in order to make progress.

Kloeckl: You point to the concept of variety and you mention the smart phone. I want to consider these two together: having easy access to time and location specific data and information on one hand and your pointing to variety in it on the other. Not too long ago an article in the New York Times pointed out how the increasingly detailed and timely information available about neighborhood demographics – age, language, education, ethnicity, income, etc.

–appears to contribute at a new level to a dynamic where people purchase homes close to people that are like themselves. It is somewhat a Yelp-syndrome if you will, a very effective system that helps you find likeminded places and people. We often think of the access to information as a contribution to discover novelty and to increase variety. But here we see a trend towards sameness rather than variety based on the way the system is set up.

It is somewhat a Yelp-syndrome if you will, a very effective system that helps you find likeminded places and people.

Pangaro: Well, all we need is Gordon Pask, because so many of the machines he built were about increasing the variety in a conversation in a way that stayed connected to the context of the participants (Haque 2007). He understood that effective conversation was an exchange that increased novelty, within limits, and thereby stimulated continued engagement in the conversation. These interactions were about understanding where an individual was specifically starting from, not from 'big data' or machine-learning (a.k.a. statistical averaging, a.k.a. smudging). Rather his whole approach was to start from this individual, right now: Where I am. From understanding that, you know that information taking me in one particular direction is redundant and repetitive and boring, and information at some opposite extreme is far too new and will be cognitively disconnected and possibly disconcerting if it too much contradicts what I already know and believe—if I can even comprehend it. So Pask's conversational machines hunted for a place in the middle which is novel enough to engage me but not so novel as to repel me. And, as he famously said, human beings are prone to seek novelty and having found it, to try to control it (Pask 1970). As a consequence of our evolution, we seek novelty and we want to engage with things that are somehow new. Of course, the 'filter bubble' may be at play[19], which we can contravene by bringing these Paskian mechanisms into our designs. These services could seek to increase measures of engagement that track novelty, rather than raw numbers of 'eyeballs' or impressions, which lack indicator of value.

Well, all we need is Gordon Pask, because so many of the machines he built were about increasing the variety in a conversation in a way that stayed connected to the context of the participants (Haque 2007).

I want to add that his mechanisms are much more fine-tuned than those based on serendipity or randomness. The response of the machine in the conversation is calculated specifically from

a cognitive point of view that relates to the individual participant's knowledge, interests, context, anything you like in available data that is specific to this person. This contrasts with today's machine-learning systems that aggregate vast collections of data into a form of 'lowest common denominator' person. This is one of the flaws of these heuristics. By being Paskians we can have a system's interaction operate between the fuzzy calculations of the machine heuristics—doing the best it can, not overwhelming but rather harnessing the intuition of the human—and an individual's curiosity, and knowledge and interests, in a beautiful pairing that's completely consistent with our human need for novelty.

By being Paskians we can have a system's interaction between the fuzzy calculations of the machine heuristics, doing the best it can, not overwhelming and rather harnessing the intuition of the human.

Werner: There are issues here about scale and issues of variety versus sameness, their differences in distinctions. The deeper you go into the system the more differences you find along scales; I would like to refer to Heinz von Foerster's description of what happens when you keep on zooming into a system. So, let's consider that diving deeper and deeper gives us the opportunity to distinguish the things we find. Some of them we do mark as relevant or influential or other. I would like to suggest that they are marked spaces or paradigms—in the sense of George Spencer Brown's *'Laws of Form'*—that keep moving, developing, overlapping and changing constantly. Thus, marked and unmarked spaces do differentiate between each other and in themselves. They are never the same. I would want to disagree that the sameness we are working into—when differentiating marked and unmarked spaces -is of the same detail that for instance an entailment mesh is; an entailment mesh like Gordon Pask invented and created 'as a gift' for us. If you take this though and look at a system from the point of view of variety a system may not even be about sameness but more about how you—or in fact each individual observer—differentiates. I guess this is the very issue that we have been talking about today and in the last five to ten years within the associations of cybernetics, systems, and complexity: I think we yet need to find out what cybernetics means. Is it a science or is it a tool, is it a protocol or do we define it through instruments like the *Law of Requisite Variety* in first- or second-order cybernetics or the

I would like to suggest that they are marked spaces or paradigms that keep moving, developing, overlapping and changing constantly. Thus, marked and unmarked spaces do differentiate between each other and in themselves.

Viable System Model, which could be seen as crossing the border from first- to second-order cybernetics? We are increasingly favoring second-order cybernetics; however, I regard first-order cybernetics as not such a bad thing, in fact it can be very useful. If we understand entailment meshes as representations of temporary structural coupling, Humberto Maturana's notion of self-organization and hence the subject of complexity also becomes highly relevant for the debate. It—observing and engaging in ever-changing entailment meshes—does become very complex, indeed. This is the point where I wonder and where I do have a question about designing conversations (in a way, thought-experiments of entailment meshes), what if you can't find participants with the right variety, what agency becomes responsible for moving ahead, who governs the process of debate? This may open up a can of worms.

Pangaro: That's what cyberneticians like, to begin with complex problems in the form of a can of worms, and then to reframe. These are beautiful points, Liss, and they bring to mind the idea of a self-governing system that functions somehow to let the best ideas arise. So I'm hand waving a bit but I'm trying to say that the system may govern itself, or to put it better in your terms, the agency of action is the system as a whole not any given individual.

So I'm hand waving a bit but I'm trying to say that the system may govern itself, or to put it better in your terms, the agency of action is the system as a whole not any given individual.

Kahn: I love this idea of the resuscitation of second-order cybernetics, and the reconstruction of these Paskian machines. I think, as I said in my talk earlier, where is this to be housed? We have a fundamental problem in our institutions—I work very closely with engineering and there's not a single person who would even utter the word cybernetics, which has become an embarrassment in America. And so, where I think cybernetics really has to be housed is in architecture. I'm becoming more and more convinced of this. It is interesting to consider the MIT Media Lab, where I was for a period of time studying, which has an interest in design. I think it is a very interesting topic to contemplate if you're going to adopt this post-disciplinary, anti-disciplinary position. How do we now begin to construct the space, an invitational space in which this can take

And so, where I think Cybernetics really has to be housed is in architecture. I'm becoming more and more convinced of this.

place? Paul is at an art and design school, I am at an art and design school, this conference is taking place at an architecture school, this is all suggesting the location for it. But how does one influence design? How do we get to frame these problems is fascinating and it's very nice to see we're moving in the right direction of it.

Endnotes

1 For further definitions of cybernetics, see http://www.asc-cybernetics.org/foundations/definitions.htm or http://www.pangaro.com/definition-cybernetics.html.

2 See later in the text for the sense intended by 'wicked' in throughout.

3 First 'feed-back` and then 'feedback', the term rose sharply in popularity as a result of cybernetics. One need only run the Google Ngram Viewer on both terms to see the timing that corresponds to the appearance and popularity of cybernetics.

4 System Dynamics has been undergoing a resurgence recently, for good reasons. Cybernetics is different in that it forefronts goals as directing system behavior and therefore goals are construed as a kind of agency. However, System Dynamics is only one of many alternative 'systems' frameworks that can be usefully contrasted with cybernetics.

5 The first copy of Wiener's cybernetics that ever saw was brought home by my eldest brother, an engineering and architecture student at Rensselaer Polytechnic Institute in the late 1960s. He bought it because it was part of the zeitgeist of that era, and despite the fact that he, like so many including myself, could not understand the serious mathematics that makes up the majority of the work.

6 One of the many great teachers of the second-generation of cybernetics was Jerome Y. Lettvin, who made this point in person often (Lettvin 1995).

7 At a dinner arranged by Gordon Pask's research company in the 1980s, Elizabeth Pask intentionally sat me next to Eduardo R. Caianiello, the Italian physicist and cybernetician, because I was of Italian extraction. Caianiello told me that he knew Wiener especially well because Wiener loved Capri and they spent time there together in the summers. After some cordial conversation and some easy silences, Caianiello turned to me and said matter-of-factly, "You know, Wiener was very bitter at MIT." He explained that Wiener felt exploited by the MIT public-relations machine—which frequently piggy-backed on references to him as "MIT's Norbert Wiener".This was very much the case when I arrived to MIT in 1969, 5 years after Wiener's death. But Wiener also felt that MIT didn't sufficiently respect him or his students or his work. I take this characterization by Caianiello to be highly reliable. Notwithstanding the plausible contribution of Wiener's difficult personality traits to this situation (Conway & Siegelman 2009), it seems reasonable to assume that MIT's treatment of Wiener also contributed to the limits of the flowering of cybernetics at MIT and therefore limits to its influence elsewhere as well.

8 The term 'paradigm' was made globally famous by Thomas Kuhn (1962) but Heinz von Foerster illuminated it best by reminding that 'paradigm' by definition means you are limited in your thinking and you don't know it (von Foerster 2000).

[9] A litany of offshoots and tools that derive from cybernetics—to apply cybernetics to problem-forming—is an entire paper on its own and would retell a significant portion of the history of engineering from the 1940s. For a very modest list of highly pragmatic models used from personal experiences in teaching design, consider these: first-order feedback, nested feedback, conversation. Methods emerge by applying models to principles: requisite variety, creating new language. See Dubberly & Pangaro 2007 for an explication of these examples.

[10] If not already familiar with the work, readers may wish to refer to Rittel & Webber 1973 to understand the nuance and depth to the term 'wicked problem' in its original formulation by those authors. There are too many such attributes that permeate wicked problems to be explained here.

[11] This statement is not universally agreed, for example, Peter Cariani believes that the anti-objectivity formulation of second-order cybernetics arose only after conventional funding dried up, that is, in the 1970s (Cariani 2017).

[12] Stuart Umpleby and I have exchanged emails about the timing of this, he feels it was in the early 1970s, which would be compatible with the decline of BCL from that time.

[13] Ito himself is an unusual choice to run an MIT laboratory, given lack of academic degree or research chops. I recommend to read his piece in Design + Science also because the cybernetics community should have a response to Ito's views on design and cybernetics, and because the whole point of the publishing platform that it's on, pubpub.org, is to enable immediate publishing and also commentary online and thereby to diminish the influence of journal editors, publishers, and the peer-review process.

[14] My answer was, if anyone can, you and the Media Lab can. However, from the later conversation it was clear that the faculty was not in favor and it was never pursued, though perhaps for additional reasons not known to me.

[15] For example, he collapses second-order cybernetics to layers of complex first-order systems, not mentioning constructivism, framing, language, or subjectivity.

[16] Ito speaks about antidisciplinarity as the white space between points on a page, where the points are the disciplines and their limited and silo-ed vocabularies. Andy Pickering, whose work I can't recommend highly enough, has written eloquently about the concept of antidisciplinarity, a term he likely coined in Pickering (2013). He has also advocated for holding a new set of Macy meetings, founded on the idea of this antidisciplinarity, an idea I floated to Ito in our third conversation (Ackermann, Felde, Ito, Pangaro, et al 2016).

[17] However, as noted above, it is not being taken up by Ito's lab at this time.

[18] I owe it to Albert Müller for calling attention to Erich Jantsch (Jantsch 1972) who defined multi-disciplinarity as the maintaining of individual languages in a conversation with participants from multiple disciplines; inter-disciplinarily as the juxtaposition of existing languages in such a conversation; and trans-disciplinarily as the creation of new language—in cybernetic terms, wholly new framing. For more on creation of new language, see Geoghegan, Dubberly, Pangaro, and Esmonde 2002.

[19] The concept of filter bubble is that today's internet services such as Facebook and others will tend to bring us content that matches our pre-existing interests and that of our friends, who also tend to be like us. This places us in a metaphorical bubble that is massively filtered, the result of which is that we rarely see anything that is different from our existing knowledge and prejudices. The concept became widespread with Eli Pariser's book, The Filter Bubble (Pariser 2012).

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