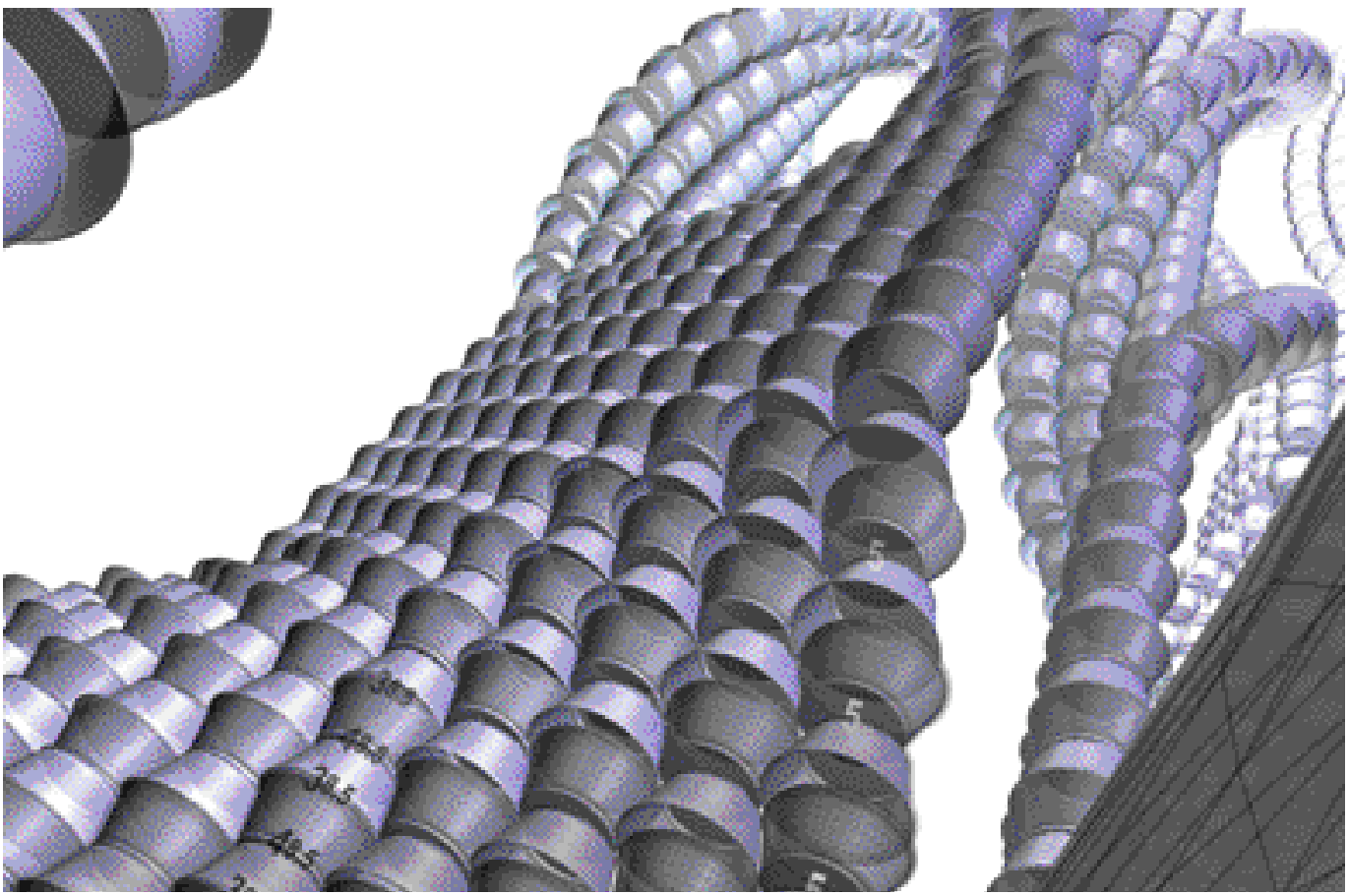
After Bittorrent: Dark Nets to Native Data

What are the implications of the inherent reflexivity of the Internet for the design professions? Anthony Burke argues that radically innovative and distributed forms of information exchange such as BitTorrent suggest a general shift away from the traditional conception of the architect as master builder to one more in line with the collaborative remixing and patching tactics of the hacker. BitTorrent is a communications protocol that allows massive information exchange across infinite users with minimum resources. Through its shear force of collectively pooled imagination, it provides a potent example of the sorts of platforms of information exchange that foster the new forms of communal organisation that Michael Hardt and Antonio Negri term 'the Multitude', and which productively challenge conventional models of cultural invention and production. In this context, Burke raises questions about the implications of this broader shift for the design professions' business organisation, as well as its more general methodologies.



Student work from 101 Arch Studio, Stripmall v2.0, University of California, Berkeley, September 2005
Developmental studies of collective component intelligence based on simple l-o-cal relationships. Students: Byron Chang, Christine Chang and Joseph Chieng.

Nothing is easier than to admit in words the truth of the universal struggle for life, or more difficult – at least I have found it so – than constantly to bear this conclusion in mind.

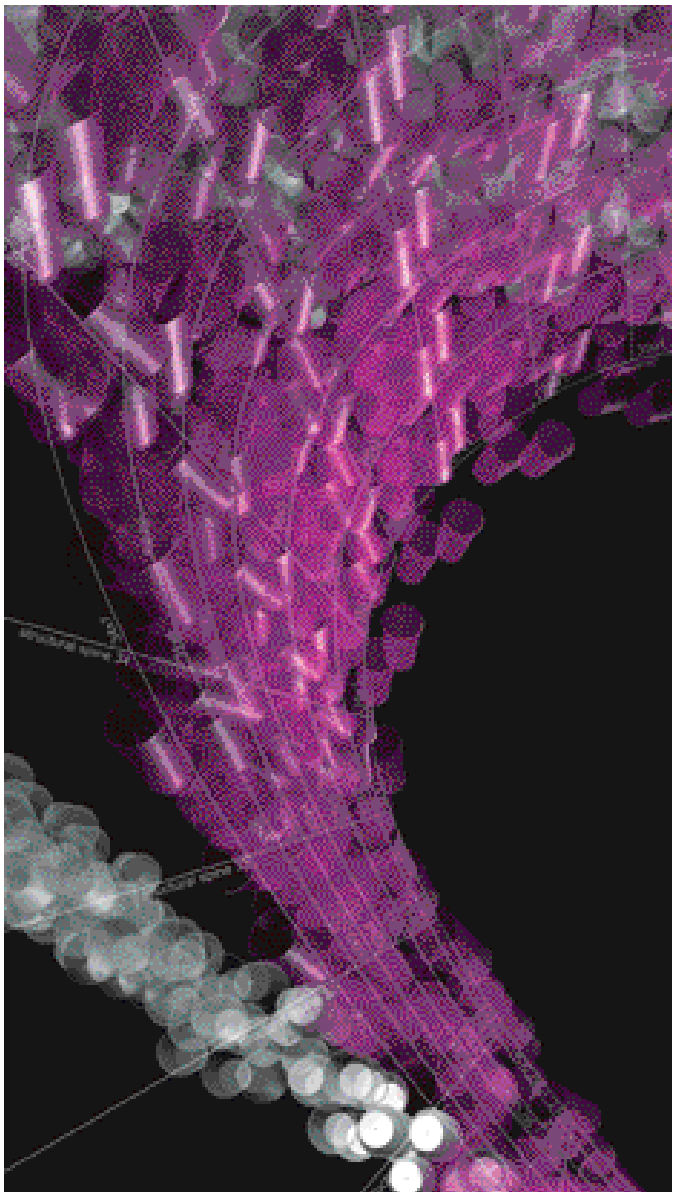
Charles Darwin, *On Natural Selection*[1]

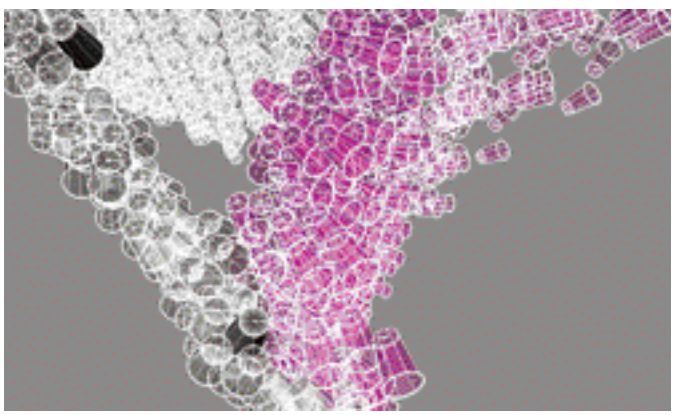
Architecture is undergoing a radical transformation in the face of developing organisational imperatives resulting from an intense period of theoretical, technical and social co-evolution of the logics of networks and complexity. As a result, the status of design more generally is being deeply interrogated and requalified. Witnessing the progression from object to operation to organisation fuelled by complexity theory and advances in information technologies over the last decade, the potentials of metastructural architectures of organisation are now being explored by designers, as much as the potentials of a new architect. While it is true that we are undergoing a kind of network fever,[2] post-complexity network logics offer a highly integrated philosophy of relational orders in an ecology of instrumental contextual registers that exceed the cultural/aesthetic interpretations of network thinking from the 1960s and 1970s by articulating a clear mathematical logic as well as material practice within its schema.

While architecture owes much to the precedents of the Metabolists, Archigram and New Babylon, today's network structures exceed the imperatives of architecture's visual/social regimes, instead looking past the singular object to the operational and structural continuums of dynamic organisations of massively distributed agents and resources, and the evolution of contextually responsive information ecologies.

At stake for architecture is the requalification of design as an act of negotiation, simultaneously more intrinsic and more extrinsic to the traditional notion of practice. That is to say, in many disciplines, as well as architecture, the relational logics that organise flows, that parse information, that allow interaction, be they biological, chemical, material or spatial, have moved from a model of external, or predefined, form as applied to matter, to an intrinsic model where form is the expression of the interaction and characteristics of the material intelligence that constitutes it.[3] Form, then, is not imbued or fixed; rather it must be encouraged and drawn forth through the expression of contextual, internal and material forces, and it is the negotiation between these factors that determines ultimate expression. Both extrinsic in that this thinking places the role of the designer in a meta-relationship to the object, instead working as a strategist and negotiator, organising networks of relationships to 'breed' a fitter species, and intrinsic in that the expressions of that negotiation are dependent on properties of material (molecular) organisation.[4] Hence the enthusiasm after complexity in the study of network logics over a broad range of disciplines as an activation of potentials embedded precisely within those organising relationships.

This material philosophy[5] now has the mathematical laws of small-world networks and power laws to corroborate and explain many natural and social phenomena. Duncan Watts



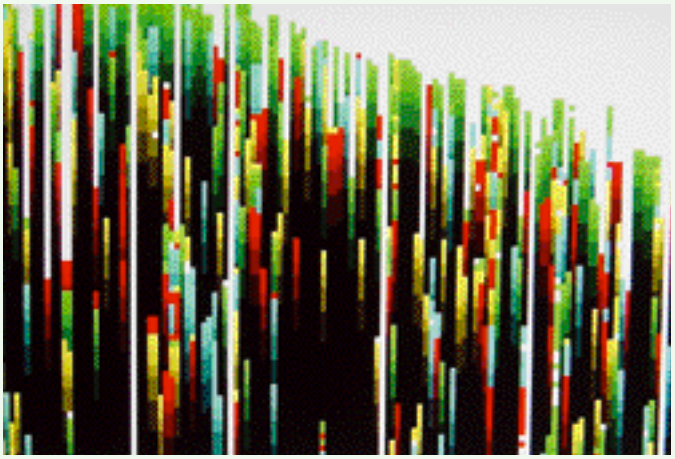


Student work from 101 Arch Studio, Stripmall v2.0, University of California, Berkeley, September 2005
Developmental studies of collective component intelligence based on simple local relationships. Students: Christian Olavesen, Alina Grobe and Andrew Domnitz.

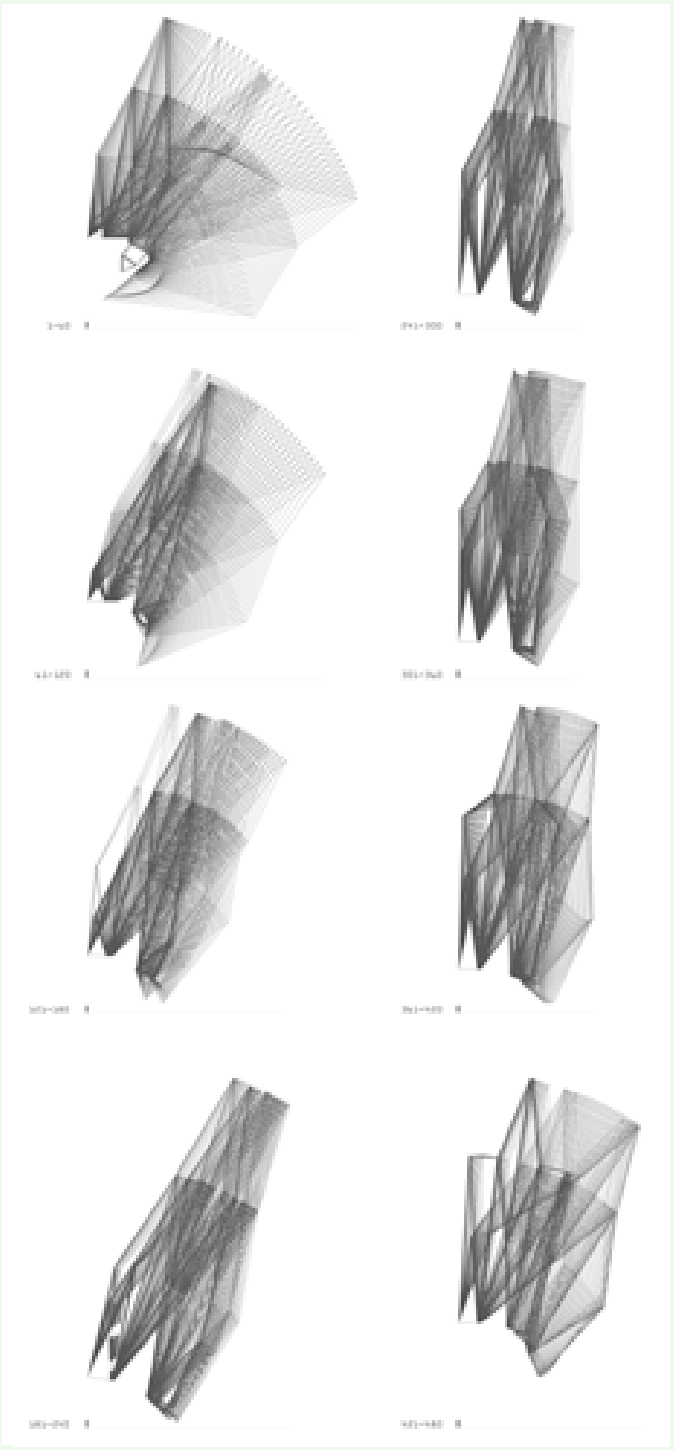
Anthony Burke and Eric Paulos, 180x120 installation, San Franciso MoMA member sessions event, 24 October 2005

Using 180 RFID tags to track and plot location over time, guests to this installation collectively construct a register of the event and the installation itself through building a history of movement throughout the space over 120 minutes. The projected histogram builds over time, revealing crowd intelligence, patterns of crowd distribution, zones of intensity and preferred locations as well as interaction with the screen itself. This installation was created by Anthony Burke, Eric Paulos for SFMoMA member sessions event on 24 October 2005.

A tessellated paper screen embeds the anticipated histogram within the depth of the geometry of each tile unit. The overlay of projected real-time information updated every 60 seconds reveals the gap between fore-cast and reality.



Screen shot of histogram build.



Laser-cut templates for the creation of each unique tile.

and Steven Strogatz summarise the potentials of small-world networks, stating in their ground-breaking paper 'Collective dynamics of "small-world" networks' for *Nature* magazine in 1998 that: 'Models of dynamic systems with small-world coupling display enhanced signal propagation speed, computational power, and synchronizability.'[6] That is to say, understanding how to recognise and utilise the dynamics and organisational structure of networks of coupled dynamic systems leads to vastly improved communications, intelligence and coordination within any system – social, technical or chemical. These relationships organise around both hierarchically clear (exogenic) and emergent (endogenic) structural logics that necessarily coexist in the development of complex systems and are most highly optimised in a state 'somewhere between these two extremes'.[7]

As the threshold of autonomous computational agents surfaces as an active constituent of both our design space and our environment, we are compelled to recognise the combined intelligence of the material environment and the virtual environment (or software agents) and to bring them into an information-rich design space. Negotiating the balance of design partners along these lines opens the potential of this active communal space for design, and capitalises on a collective systemic intelligence that embeds multiplicity (both/and) within the reformulation of the structural relationships of network performance, invoking entirely novel trajectories for material expression and spatial organisation in the process.

The shift in status of information itself also signals an immanent regime change for design, and it is both the currency and superfluity of information that enables these networked developments. According to Hans Christian von Baeyer,[8] all material systems can be understood as a function of their informational content, and reduced to the basic atom of information, the bit, with the qubit[9] extending this logic into the quantum universe. The structural logic that organises fluid informational molecules from qubits to feature-length movies and gives them meaning underpins a reconsideration of design practice, product and place in light of new orders of performance involving human, environmental and informational (artificial intelligence) collaborators. The challenge for architecture, then, is more social than technical. As the frame of reference around design is projected into an engaged and productive space of negotiation, an architecture mired in the cult of the object is unable to utilise the advantages of collective organisation and interconnection, preferring tidy distinctions and clear boundaries over protocols of exchange within deep networks.

The Distributed Underground

Studies of the creation of information show not only a profoundly massive amount of data being produced every year, but that more than 550 times more data resides in the 'deepnets' and 'darknets' well below the radar of browsers and search engines than is visible in the surface net.[10]

A darknet is a private virtual network benignly equated to friend-to-friend networks or, in more provocative terms, the domain of the illicit file-sharing communities and home to the digital resistance. The term was coined in 2003 by Microsoft researchers who state that: 'The darknet is not a separate physical network but an application and protocol layer riding on existing networks.'[11] Darknets are networks limited to a select group of users through encryption and structural security measures paradoxically built around logics of extreme distribution and flexibility. Darknets, Deepnet and Dark Internet are terms that have arisen to articulate the balkanisation of information space into differing structural regimes responding to environmental parameters such as privacy, anonymity, community and security.[12] As the attorneys of the Hollywood studios and the recording industries continue to pursue legal action against the likes of BitTorrent[13] through targeting file indexes and traffic hubs, they continue to unwittingly push the pace of development for content distribution systems and cement attitudes of information freedom in the file-sharing public, sending the development of distributed structures and their supporting technologies on a trajectory aimed deeper and deeper underground. Rather than the democracy of information of the Internet, in Web 2.0[14] the vast majority of data will be dark.

In this light, many theorists believe the copyright wars we are in the midst of are the death throws of mass media as we have known it. The underlying architectures of networks no longer favour large companies with the infrastructure and equipment required to both create content and distribute it. More importantly, the operational understanding of distributed systems has become socially entrenched, such that to a whole generation of users, accessing distributed content is a fundamental right and simultaneously as pedestrian as email. File-sharing networks have grown to accommodate a generation of users where, as Clay Shirky describes, 'everyone is a media outlet ... There are no more consumers because in a world where an email address constitutes a media channel, we are all producers now.'[15]

While users now expect all content to be mutable, fundamentally a worldview of collective organisation and fully distributed content spread over contextually scalable networks rivals, if not replaces, the culture of the commercial monolith, constituting the conditions for a post-consumer mentality.[16] The development of distributed file-sharing structures over the last five years not only charts a sophistication of the advanced structural logic of network theory as it becomes instrumentalised, but mirrors a societal transfer of organisational logics from the stabile to the mobile. While we were downloading MP3s we were also trading paradigms.

Activating Organizational Structures

... centralized schemes work poorly for illegal object distribution because large, central servers are large single points of failure.[17]

Bittorent creator Brahm Cohen, as well as Freenet principals Ian Clark and Oskar Sandberg, quote from network theorists such as Barabasi (*Linked*)[18] as well as Watts and Strogatz (*Small-World Networks*), discussing the structural logics of small-world networks, power laws and super-hubs that underpin the current metastructural preoccupations in design. The creation and success of these file-sharing peer-to-peer networks constitute some of the first implementations of advanced network theory springing from complexity studies at the Santa Fe Institute in the early 1990s to be instrumentalised in popular culture and simultaneously make Hollywood and the recording industry insanely anxious.

Any new technology, any extension or amplification of human faculties when given material embodiment, tends to create a new environment.

Marshall McLuhan[19]

The implications of network logics have already begun to reorganise the sciences and humanities, and architecture is no exception. If we look at architecture as a practice of spatial, material and, even, intellectual organisation then it is clear that the effects are potentially profound. But these patterns of organisation that we are now aware of in everything from beehives to movie stars (the popular game 'Six Degrees of Kevin Bacon', for instance) also challenge the current normative modes of architecture and raise questions and unique opportunities for this emerging generation of designers. The impact on the forms of practice, the nature of design and the nature of the spaces we design are open for exploration and reinvention as the current ties to representation, form and practice are unable to negotiate the complexity with which we work. So it is that we see new forms of practice emerging, sitting at the edge of traditional disciplines and existing between research and practice, as well as between disciplines. And, as the theory and implementation of post-complexity organisational constructs mature, the implications are rapidly extending beyond the digital environments of information and communication systems to combinations of physical systems of sensors and ubiquitous computational and real-world agents.

In the late 1990s the US military responded to these conditions by announcing its broad-based Network-Centric Warfare (NCW) initiative intended to integrate all aspects of military operations and resources into a collectively intelligent force. Recognising the ineffectuality of large traditional military forces, the military has been pumping money into tactics and strategies that focus on information superiority. Through the networking of all information within the vast military complex, both active situational information as well as static (inventory, specifications, and so on) data, the military hopes to regain the advantage in the field that it lost to small, nimble, semi-autonomous groups of loosely affiliated guerrilla cells spread across an unbounded and decentralised battlespace.

Through initiatives such as the Global Information Grid (GIG)[20] and a host of experiments in all aspects of C4ISR [21]

The Self-Healing Minefield (SHM)

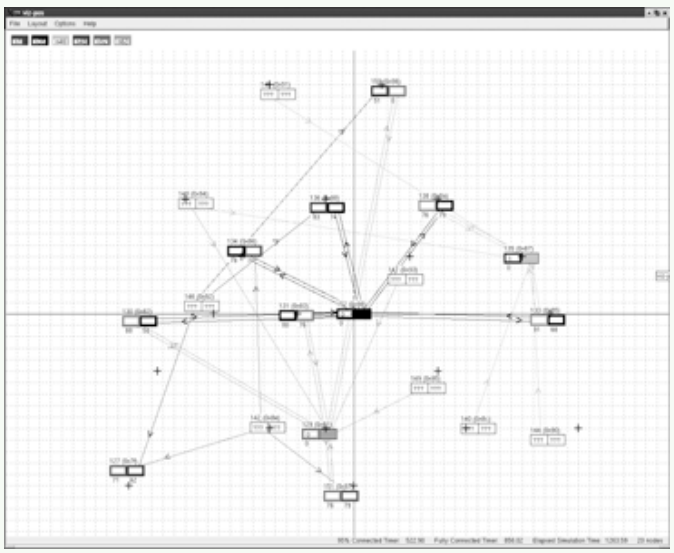
Among a sea of initiatives to operationalise network strategies within the US military, the 'self-healing minefield' (SHM) is one example of a generation of autonomous strategic and tactical systems under development. The project, sponsored by Advanced Technology Office (ATO) of the Defense Advanced Research Projects Agency (DARPA), began in June 2000 and was fully tested at Fort Leonard Wood, Missouri, in April 2003.

The SHM is comprised of a system of Antitank Landmines (ATLs), each of which has mobility, RF communications, ranging, and distributed computation subsystems. Upon deployment, the ATLs autonomously assemble a totally ad hoc wireless network via their frequency hopping spread spectrum (FHSS) radios. This peer-to-peer network, which is logically flat and does not rely on any predefined routing, rapidly detects and adjusts when an ATL leaves or enters the network.[22]

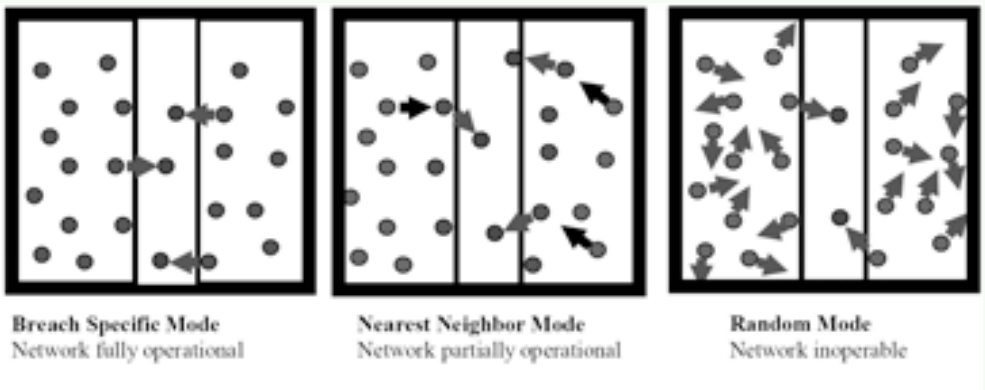
Activating the operational logics of networks, the SHM has the capacity to assess its own status and operate in one of three operational modes, 'gracefully' degrading over time and use. The aim of the SHM is to literally heal itself once munitions have been expended and nodes drop from the network by autonomously redistributing the field of mines to seal any breech. Literally, each individual mine is a 2-kilogramme (4.4-pound), rocket-propelled node in a flat ad-hoc network that recognises the location of all the other mines in the field through a continual monitoring over a frequency-hopping spread spectrum radio with the capacity to jump as far as 12 metres (39 feet) in any direction to ensure field integrity.

The activation of the field into a meshwork of mines that are able to organise and work in concert with each other is a small example of the potential of the Net-Centric Warfare once larger groups of multiple systems are linked. The intelligence of the system comes from the quality of the information gained from networking each node in a local informational context, or 'habitat', that allows 'high-quality situational awareness information and understanding'.

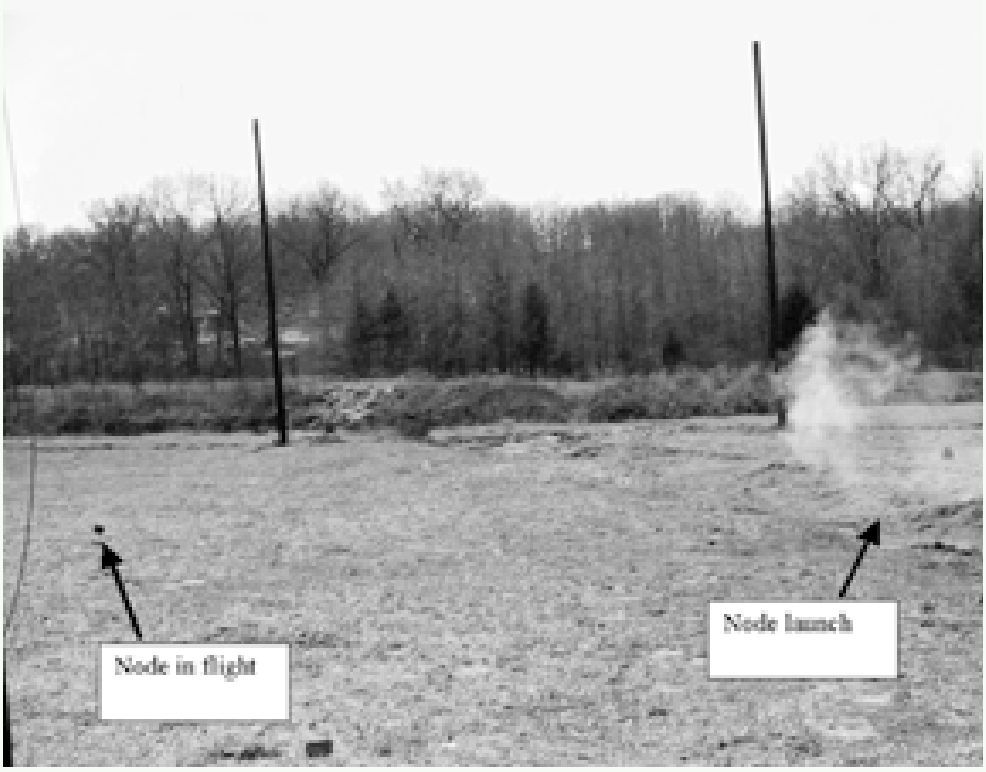
The Self-Healing Minefield, fully tested in 2003, exemplifies both the collective intelligence of a synchronous network of agents, and is one of the first active environmental applications of the theories of network logics within the US Military's Net-Centric Warfare initiative.



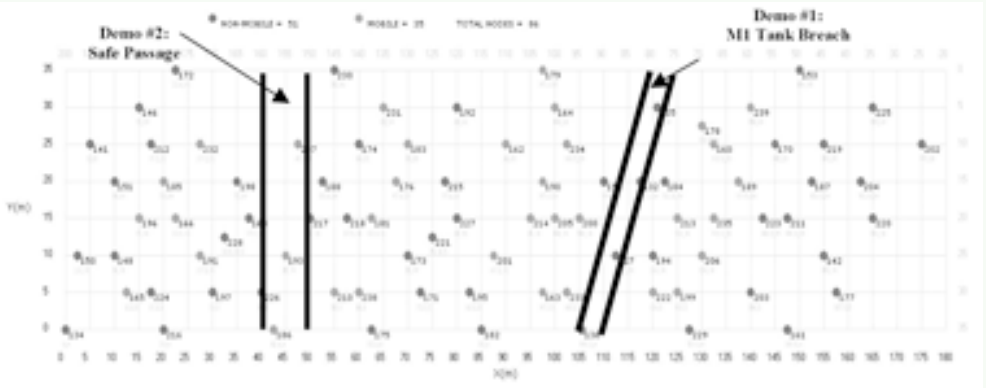
Screen capture demonstrating network connectivity and relative geolocation. Ground truth positions are shown by the crosses.



The multimodal healing algorithm allows for graceful performance degradation.



Self-healing minefield mobile node test hopping out of a ditch.



Location of the first two demonstrations relative to the viewing stand.

that bring network theory into network practice, the military is already testing a slew of distributed weapons, surveillance and overlaying information gathering, processing and analysis networks that are as physically active as they are informationally.

In the Network-Centric Warfare (NCW) paradigm, battlespace agents autonomously perform selected tasks delegated by actors/shooters and decision-makers including controlling sensors. Network-Centric electronic warfare (NCEW) is the form of electronic combat used in NCW. Focus is placed on a network of interconnected, adapting systems that are capable of making choices about how to survive and achieve their design goals in a dynamic environment. ... The grids carry a flood of data and information among the entities that can be used to increase the tempo of operations. This flood will overwhelm human actors and decision-makers.[23]

Embedded organisational intelligence takes over the day-to-day information gathering and processing while human interactions with these intelligent systems exist at the strategic level and humans become tuned to a higher-order structural and operational intelligence schema. As data breeds, or automatically assembles and constitutes new data, interaction with human actors is not only marginalised at the level of the field, but actually problematic. We are out of the immediate decision loop because our capacity to make large amounts of time for critical low-level decisions from vast arrays of interconnected factors is inadequate. As sensor devices and AI engines propagate in the fertile conditions of their own information ecology, human participation in networks of communication and decision-making has at an immediate level become categorically undesirable. Our networks are thinking for us.

Native

Another study in Nature, looking at the global network's growth dynamics of the Web, confirms the idea that the World Wide Web follows natural laws and can be studied as 'an ecology of knowledge'.[24]

The power laws, small-world behaviours and super-hubs of network theory, while applied to information and communication systems, were initially revealed not in information science, but through mathematics, biology and sociology. Structures of networks are based on mathematical laws, but biological and social systems exemplify these structures and formally describe the complex processes that capitalise on the evolutionary properties of a networked and collaborative intelligence.

As self-generating data frees itself from our control it could be said to go native, developing more complex informational ecologies and necessarily changing our interaction with it. Technically we become unencumbered by the need to create the raw material that our sensors now do for us, and as negotiator/designers we are motivated to organise and edit as a creative act. Like botanists, as information ecologies flower, we will trim (delete) unproductive or overly productive branches of data and splice and graft (copy/paste/hyperlink) streams of information to cultivate new hybrid species (threads). As data goes native, we can speculate on the possibilities of cultivating large crops of information types for mass consumption (for example, popular music) as well as lavish and manicured parcels of highly articulate but private or limited gardens of code (such as private banking). Finally, we can consider the extremes of truly wild data, venturing into those forests for recreation or prospecting.[25]

The act of design strategically broadens and we are not only working in a context of data, but with data as a partner. The ability to operate in this medium will depend on the intelligence of the tools we can create and the partnerships with our software intelligences that can be cultivated. Developing and maturing relationships with a larger computational intelligence in this context is highly likely, and it is entirely possible that given the growth of ai, practices will develop their digital personas as an enduring set of design processes and preferences that represent a collective of like-minded designers. This highly 'practice-specific' software, trained over an extended period, ultimately embodies an evolved ethos of design amounting to a collective and directed design intelligence. Again, this is to some degree already in place with dumb software, where a design office will develop a way of working with it that suits them, collecting information that is continually used or referred to, creating their own hacks and patches and essentially activating collective intelligence in a fairly benign way. Similarly, the nature of traditional disciplinary discreet practice is challenged, as what could be thought of as intellectual property of one discipline or another (say, architecture or engineering) is transformed into a common project space and with it the space of a design ethos rather than a disciplinary speciality.

The surface properties of a living being were controlled by the inside, what is visible by what is hidden. Form, attributes and behavior all became expressions of organization.[26]

Similarly, forecast is the change in the nature of our relationship to the processes and tools we develop and use and, consequently, the expression of those tools and processes in the generation of form. The negotiation between architect and software (intelligent or routine) both disempowers the architect from the sole genius role and empowers him or her through the integration of information and a continually evolving range of intelligent computationally derived generative techniques. The architect as director essentially stages the project, guiding final formal outcomes as a product of intrinsic processes engendered from the collective power of the informational environment that surrounds the design space. Form from within is shaped, tested and reshaped, built on a series of related informational (molecular) constraints and the possibilities of their material and organisational expression.

As the environments we design are themselves becoming intelligent, they require something more like an ongoing relationship to negotiate or manage their evolution over a much-extended period. Integrating aware surfaces, and computational power, designers will come to approach project spaces the same way they approach software, installing updates, tweaks and working out bugs periodically while adjusting to new environmental parameters, entailing ongoing monitoring and analysis. Ultimately, 'patching' and 'hacking' environmental systems will become a new strain within the purview of the evolved discipline and its new architects.

Architecture in this context can be seen not as the production of built products, but the development of ideas and methods that result in vectors of research marked by built moments. In this sense, practice itself becomes a locus of design where formal inconclusions or delay are not a temporary moment before reaching some ideal architecture or final form, but rather an ideal state in and of itself. It is the goal: to remain open, responsive and fluid, to negotiate and renegotiate as new contextual pressures become apparent; to imagine practice as a project within which projects may be built but are never complete, but are always in a state of evolution.

Information wants to be free.[27]

As a generation of users executing a mastery over media we expect to engage with a two-way interactivity completely unlike unidirectional traditional media and architecture, where assembly and organisation create meaning, forecasting the transformation of the figure of the architect necessarily along the lines of the negotiator. Design becomes the ability to activate patterns and relationships and to construct intelligent tools. The architect becomes a builder of spatial contracts, organising computational agents towards specific performative goals achieved through designing the relational matrix of the design space. The role of the architect is to arrange these agents into a hierarchy of prominence, to foster a community of intelligent agents to work towards sympathetic goals through mediation of the protocols determining the flows of highly networked information. The transfer of the architect's role requires trading in the romance of form as an endpoint for the courage to embrace a distributed and expansively operational disciplinary trajectory of collaborative intelligence within a network-centric framework. AD

Notes

1. Charles Darwin, *On Natural Selection*, Penguin Books (New York), 2004, p 1; extract taken from 'The origin of the species', first published in 1859.
2. Mark Wigley, 'Network Fever', in *Grey Room 4*, MIT Press (Cambridge, MA), 2001 .
3. Manuel DeLanda has written extensively on this philosophical framework: see Manuel DeLanda, *A Thousand Years of Non-Linear History*, Zone Books (New York), 1997. See also Ludwig Von Bertalanffy, General Systems Theory, *General Systems Theory: Foundations, Development, Applications*, George Braziller (New York), 1969, as a precursor to an integrated organisational schema overlaying many disciplines, most notably with regards to the effects on morphology within mathematics and biology.
4. Ibid.
5. This materialist philosophy been articulated through a philosophical trajectory that includes Spinoza, Deleuze and DeLanda among others
6. Duncan J Watts and Steven H Strogatz, 'Collective dynamics of "small-world" networks', *Nature*, Vol 393, 4 June 1998, p 440.
7. Ibid.
8. See Christian Von Bayer, *Information: The New Language of Science*, Harvard University Press (Cambridge, MA), 2003.
9. A qubit is a quantum unit of information – 'it is a concept not a thing. Where a bit can have the value of zero *or* one, a qubit is defined as a quantum superposition of zero *and* one.' From Christian Von Bayer, *Information: The New Language of Science*, Harvard University Press (Cambridge, MA), 2003, pp 183–4.
10. Peter Lyman and Hal Varian, 'How much information 2003?', sims, University of California, Berkeley, c 2004, http://sims.berkeley.edu:8000/research /projects/how-much-info-2003/.
11. Peter Biddle, Paul England, Marcus Peinado and Bryan Willman, 'The Darknet and the Future of Content Distribution', Microsoft Corporation, http://msl1.mit.edu/ESD10/docs/darknet5.pdf.
12. Briefly, the deep net holds file locations on the public World Wide Web that are inaccessible to conventional search engines, and the dark internet is a network of computers inaccessible to the World Wide Web. According to one study the amount of information contained in the deep net is 550 times greater than the surface net, in the words of the Microsoft researchers who coined the phrase.
13. BitTorrent is a peer-to-peer file transfer protocol created by Bram Cohen in 2001. For more on BitTorrent see www.bittorrent.com.
14. The next-generation Internet, reported widely as Web 2.0, will feature context-sensitive information capabilities and predictive information through linking many different sources of information based on user histories and profiles.
15. 'RIP Consumer, 1900–1999'; http://www.shirky.com/writings/consumer.html.
16. Ibid.
17. Biddle, England, Peinado and Willman, op cit.
18. Albert-László Barabási, *Linked: The New Science of Networks*, Perseus Publishing (Cambridge, MA), 2002.
19. Marshall McLuhan, 'The relation of Environment to Anti-Environment, in Eric McLuhan and W Terrence Gordon (eds), *Marshall McLuhan, the Unbound project (04)*, Ginko Press (Corte Madera, CA), 2005, p 6.
20. See 2002 Milcom Proceedings, 'Global Information Grid – Enabling Transformation Through 21st-Century Communications', copyright 2002, IEEE (IEEE Copyrights manager, NJ) 2002.
21. C4ISR: command, control, communications, computers, intelligence, surveillance and reconnaissance.
22. Glenn Rolader, John Rogers and Jad Batteh, 'Self-healing minefields', in Raja Surech (ed), *Battlespace Digitization and Network-Centric Systems IV*, Proceedings of SPIE, Vol 5441, SPIE (Bellingham, WA), 2004.
23. John C Sciortino, Jr, James F Smith III, Behzad Kamgar-Parsi and CDR Randall Franciose, 'Implementation of battlespace agents for network-centric electronic warfare', in Raja Suresh (ed), *Battlespace Digitization and Network-Centric Warfare*, Proceedings of SPIE Vol 4396, 2001.
24. Alan Boyle, 'Measuring the Web's "diameter"', http://www.msnbc.com/news/309085.asp?cp1=1.
25. 'The ecology of ideas' is elegantly discussed as a social/cultural phenomena by Pierre Lévy in 'Towards a language of collective intelligence', in Christine Schopf and Gerfried Stocker (eds), *Code: The Language of Our Time*, Hatje Cantz (Ostfildern, Germany), 2003.
26. François Jacob, *The Logic of Life: A History of Heredity*, Vintage Books (New York), 1973.
27. From R Polk Wagner, 'Information wants to be free: Intellectual Property and the mythologies of control', *Columbia Law Review*, Vol 103: 995, p 999. (http://www.law.upenn.edu/polk/wagner.control.pdf). Though it has clearly taken on a life of its own, most people attribute the origins of the phrase to Stewart Brand: see Stewart Brand, *The Media Lab: Inventing the Future at MIT*, Penguin, reprint edition, 1988.