MARTIN WARNKE (LEUPHANA UNIVERSITÄT LÜNEBURG)

WHAT'S IN A NET? OR: THE END OF THE AVERAGE

Introduction

Hubertus Kohle and I had a very pleasant and intellectually challenging collaboration[1] that dealt with interrelationships of images and their details. He provided for an amazing corpus of images and very clever insights about it, those of prints done during the French Revolution, my group added software that made it possible to precisely mark and link image details in a very intertwingled way, as Ted Nelson would have called it. This made it possible to talk about the interrelations of image details, in that case: motifs, that migrated from one image to another, even ignoring political borders, almost as if they, the motifs, led a life on their own.

How to deal conceptually with a situation like the one I was in together with Hubertus? How to deal with complexity of that and of other types?

What up to now has been called the context of an entity, and this is my central thesis, now should be called and treated as the network of its linkage. Nets are the central notion to which to shift, and this will yield new and deeper insights into the material we deal with.

Why this request, why should we rather talk about nets than about contexts? This is, because the notion of the network provides us with a much sharper image of the structural properties of the complex situations we observe. A context is everything to help us to understand what surrounds the point of our interest. But a network not only surrounds what it constitutes, but it does so in a significant and highly differentiated way. Networks are the appropriate notion to describe complexity.

Doubtlessly the notion of the net gained its recent popularity from the new medium that dominates not only the discourse but also the economics and the everyday practise of the mass media: the internet with its World Wide Web. The interest in networks may be at least traced back to Frigyes Karinthy in 1929 and to Stanley Milgram in 1967 – by the way, the very same Milgram who performed these sadistic experiments using fake electro shocks. It was a topic especially in sociology, then in computer technology and now also affects the humanities. But the internet now stimulates network research enormously.

Let us look up what the pioneers of the internet thought and knew about networks!

Nets: the fabric of the world

<1>

Paul Baran in 1964 published his study on distributed communications, being payed by the Rand Corporation that took its money from the U. S. Airforce as part of the DARPA project that led in the end to the internet. He investigated different network types to be able to give advice to the military how to build a communications network that would not easily break down under the conditions of thermonuclear war.

<2>

He distinguished between three types of networks[2], not knowing that he missed the most important one that we will come to very shortly:

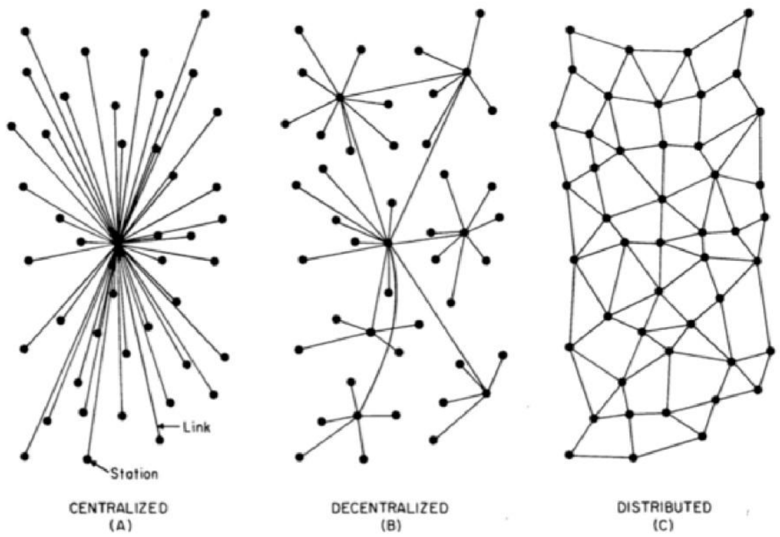


FIG. I — Centralized, Decentralized and Distributed Networks

<3>

The first two, the centralized and the decentralized types, will remind everybody who ever was in the army of the chain of commands he or she experienced, that went along a hierarchy. The drawback of such structures is that they fall apart very quickly when under attack. They lack redundancy, that a distributed net with mashups provides for. So Baran proposed to the military what was highly unusual to them: a redundant structure like (C) for the command chain. Barans results were so convincing, that a very rare combination of military people and of academic hippies together invented the internet,[3] introducing an explicitly non hierarchical structure, the mashed network, to a communication system.

<4>

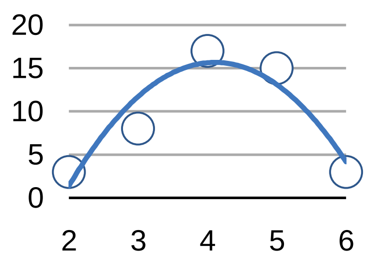
Lets have a closer look at network (C)!

If we count the number of links that every node of the net has, we arrive at the following distribution:

number of links	number of nodes having this number of links
2	3
3	8
4	17
5	15
6	3

<5>

There are nodes that have two, three, four, five or six links. Three of them have 2, 8 have 3, 17 have 4, 15 have 5 and another 3 have as much as 6 links pointing to other nodes. That is, most of the nodes have about 4 links, the number 4 obviously could serve as a typical scale for this network. A plot shows it graphically:

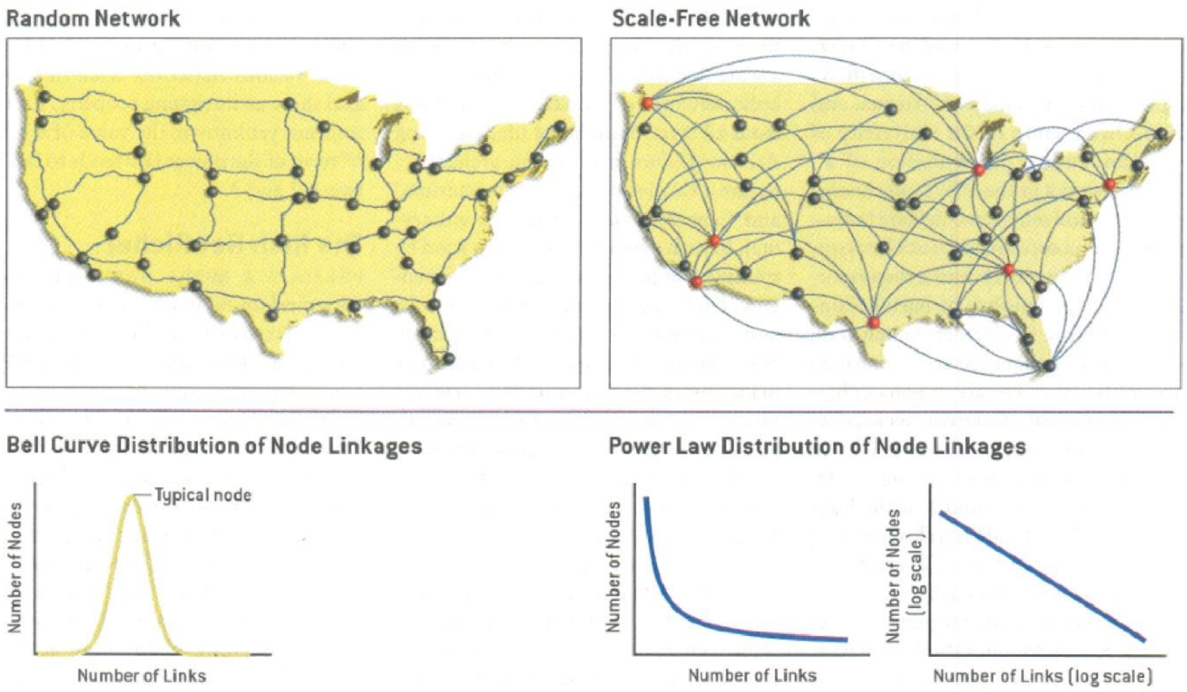


<6>

What we see is a gaussian normal distribution with a peaked average. The network type we have under consideration now is called a random one, for which we find prominent examples, e. g. the net of traffic roads for car mobility.

<7>

Contrary to that, in recent times scientists discovered another type of network, and this is called the scale free type. It has a highly uneven distribution, showing no average. The net of airports in the U. S. is an example of this kind of nets.



From Barabási, Albert-László; Bonabeau, Eric: Scale-Free Networks.
Scientific American (2003), May, S. 50–59.

<8>

The curve we can observe now starts at its left with the sites with few links and drops quite suddenly to all the other highly linked ones. There is no bell curve with a peaked average, there is no typical scale. The curve has the mathematical form of a power law:

number_of_Nodes = a * number_of_links-k

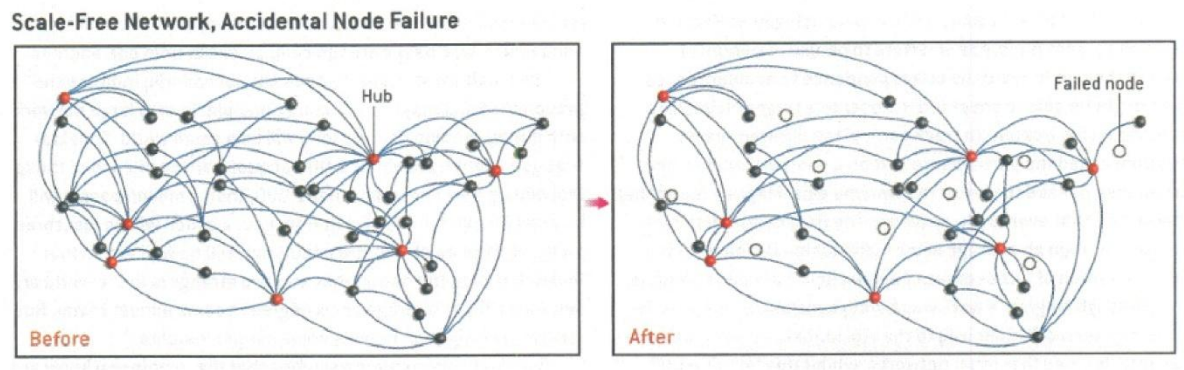
The value of the exponent k is then a significant property of the net under consideration. The bigger k is, the more uneven the distribution will be.

<9>

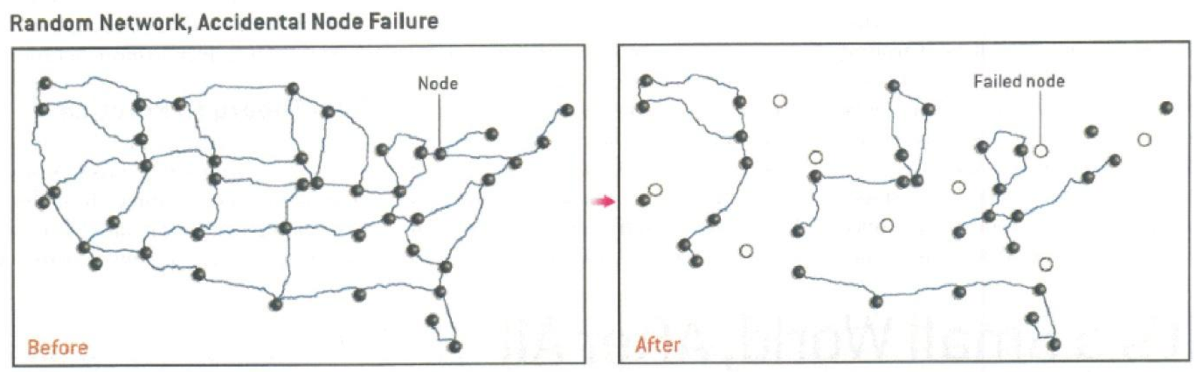
Many nets with this form exist. The distribution of words in Shakespeares plays, the food chain in a fish pond, the genes on the DNA with their corresponding proteins, but also the internet looks like this. These scale free networks with a power law shape have very interesting properties that distinguish them from the random networks like the road system.

<10>

First, they are extremely robust. When under random attack, as imagined in the early times of the internet, they actually do not fall apart into pieces easily, but remain one net, although damaged.



The random type with a scale turns out to be vulnerable to damage as it falls apart easily:



The stunning robustness, by the way, will not work when the hubs, the most important nodes, are under specific attack.

<11>

Obviously Paul Baran, the internet pioneer, should have proposed the scale free type of networks, but they were not known in his times, it took his work leading to the internet to bring them to the attention of scientists.

<12>

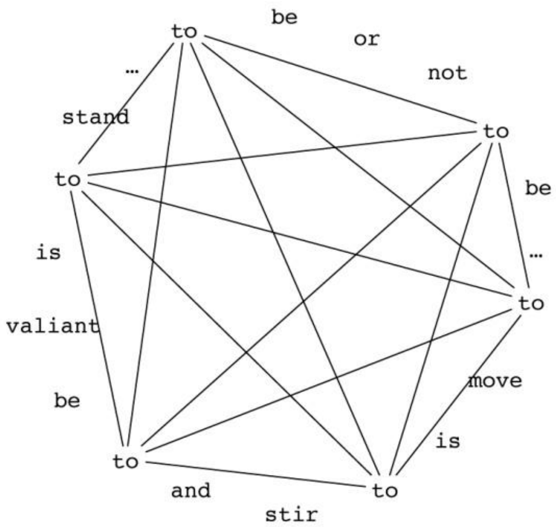
The second very important feature of scale free networks is their ability to grow without limits. Random networks tend to suffocate as effect of their growths, as could be easily observed at the roads e. g. in megacities like Mumbay. Car traffic never could have grown as the internet, that has done so by a factor of 400 billion within 40 years without severe traffic jams.

<13>
So we could state: an uneven complex structure of the scale free type without an average yields networks with remarkable properties, robustness and the ability of infinite growths, that distinguish them sharply from their scaled random counterparts. It is of the utmost importance to know what type of network we have under consideration. And: close investigation of the parameters of nets, using the wisdom of mathematical network theory[4], lets us compare magnitudes, as we do when taking the measures of an artifact, telling a thumbnail miniature apart from a Tübke panorama. As in the network case, the internet is by far the biggest network we ever encountered, taking at about 19 link traversals from one node to another following the optimal path.

<14>
So: talking about networks instead of just, say complexity or context, gives us a wealth of very precise means of observation and description. It is, so to speak a new type of naturalism to describe complex situations with their network properties.

Art: networked artifacts

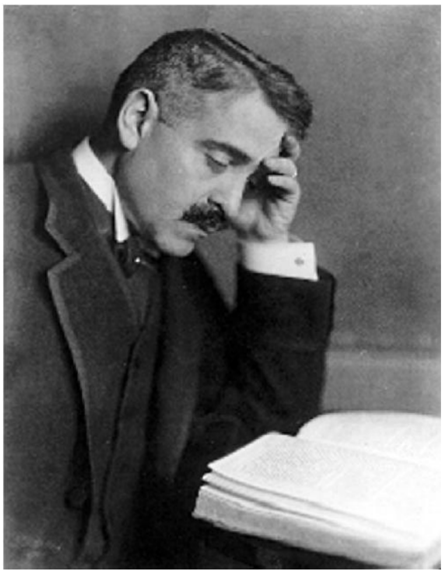
<15>
Ex. 1: Shakespeare's words
In the thirties of the last century, George Kingsley Zipf discovered a regularity that he turned into a law that was named after him: Zipf's Law: if one sorts the word of a text corpus by the frequency they appear, this frequency is proportional to the inverse of the rank of the word. That means: irrespective what text corpus we investigate, there is always a numerical regularity concerning word frequency.
Lets take e. g. Shakespeare's plays. A very short excerpt from Hamlet and Romeo and Juliet, drawn as a network of identical words, looks like



This network has a scale free distribution of nodes and links with an exponent of -1, following Zipf’s Law.

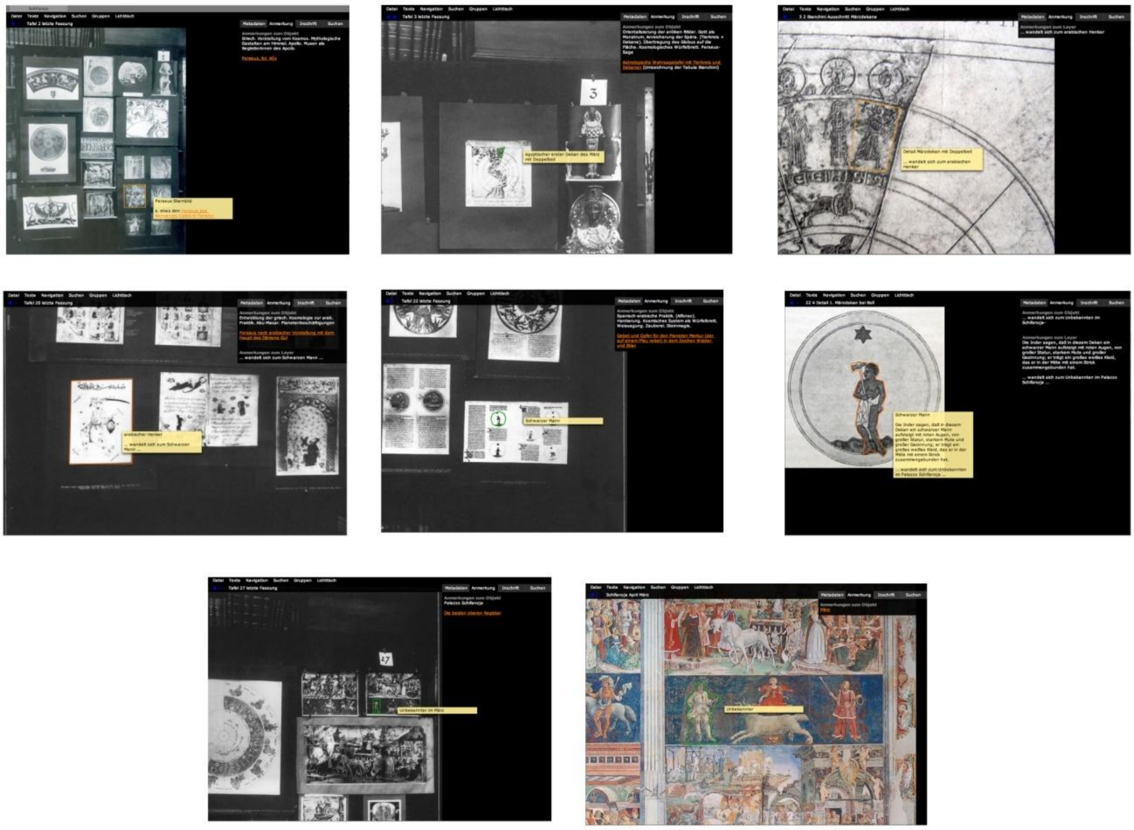
<16>

Ex. 2 Aby Warburgs Investigations



Aby Warburg (1866–1929)

The way Aby Warburg dealt with the migration of pathos forms from the antiquity to the renaissance obviously forms a network. In his mnemosynae atlas he arranged images on frames, marked and linked motifs with pins and wooden filaments, observed the interrelations of visual and texual artifacts through wide areas of space and time, as may be illustrated with the images of his investigation of the affrescoes in the Pallazzo Schifanoia in Ferrara:

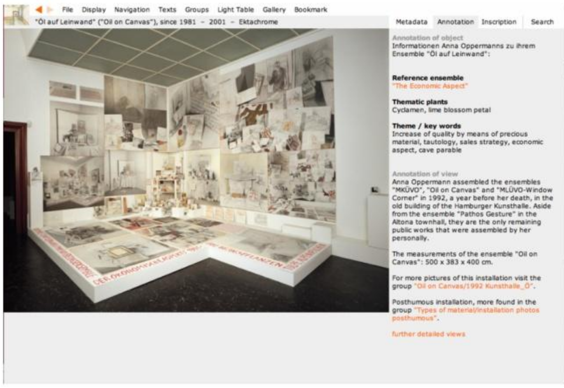


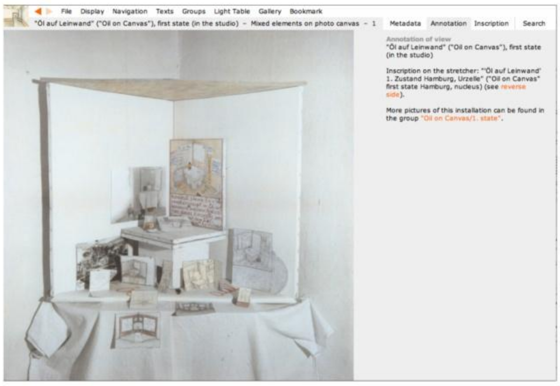
What characteristics his nets have I do not know, but I would very much like to.

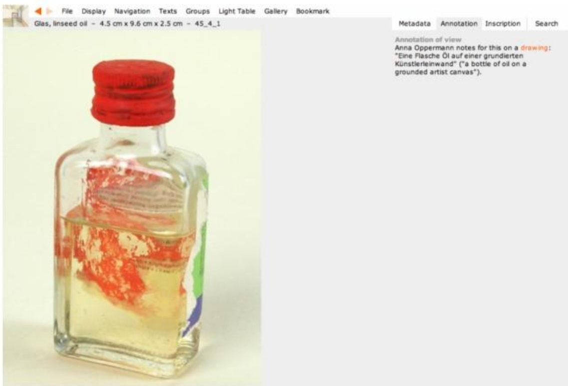
<17>

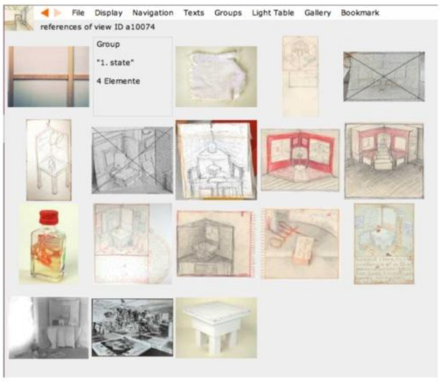
Ex. 3: Anna Oppermann’s complex image nets

What I know quite exactly is the net of images and their references the late Anna Oppermann (1940–1993) has developed as her artistic form. She depicted her own images, e. g. as could be seen in her Ensemble *Öl auf Leinwand* in the Kunsthalle Hamburg:

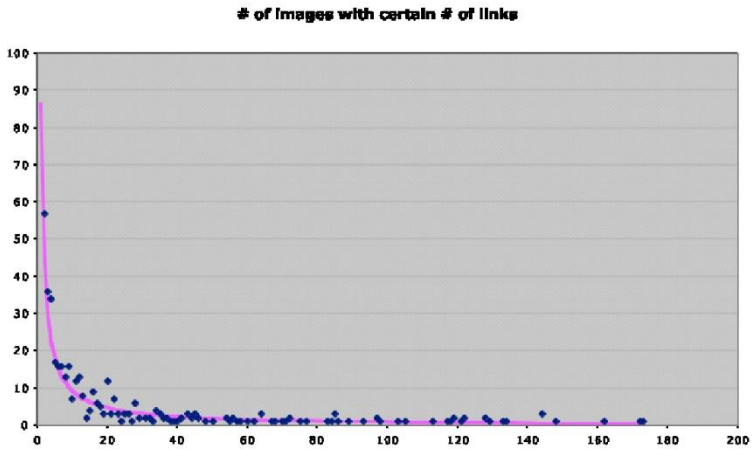








The net of pictorial interrelations has the following graph:



with an exponent very close to -1. This means: her image networks have a characteristic similar to word nets in literature. The complexity is one that has to be compared with, e. g., Shakespeare’s plays. This was not known before the investigation of the network of her image network in this particular Ensemble.[5]

<18>

Ex. 4: Meta-Image grows art historian's nets

The knowledge about Anna Oppermann's particular network characteristics stems from our computer based methodology that enables everybody with a web access to build referential image nets. At www.hyperimage.eu you find examples, also the Oppermann and the French Revolution pieces, and at www.meta-image.de we published what we do together with Humboldt University Berlin and prometheus, the distributed digital image archive for research and education.

<19>

There we just now establish a platform for image discourse using the 750.000 images of artworks from 60 connected art historic institutes in Germany, Austria and Swizerland. We wonder what kind of communicational networks will emerge when Meta-Image lifts off. We will have a very close look at this within the third year of our research.

Author's profile:

Martin Warnke was born in 1955, studied in Berlin and Hamburg, acquired his PhD in theoretical physics in 1984, and then began his affiliation with the University of Lüneburg, where he was head of the computing and media center for many years. He finished his Habilitation at the University of Lüneburg in 2008, becoming an associate professor for digital media/cultural computer science, and is currently the university's Director of the Institute for Culture and Aesthetics of Digital Media at the Faculty Culture. He is also a visiting professor in Vienna, Klagenfurt, and Basel and works in the fields of history, digital media, and the digital documentation of complex works of art. He heads the Meta-Image research project, and works with the IFIP and the Gesellschaft für Informatik, as counsellor to the Zeitschrift für Medienwissenschaft.

Selected Publications: Martin Warnke: Theorien des Internet zur Einführung. Hamburg: Junius Verlag 2011. Martin Warnke, Georg Christoph Tholen, Wolfgang Coy (Hrsg.): HyperKult II – Zur Ortsbestimmung analoger und digitaler Medien. Bielefeld: transcript 2005. Martin Warnke, Uwe M. Schneede (Hrsg.): Anna Oppermann in der Hamburger Kunsthalle, Hamburg: Hamburger Kunsthalle 2004. Mit einer DVD von Martin Warnke, Carmen Wedemeyer und Christian Terstegge. Martin Warnke, Wolfgang Coy, Georg Christoph Tholen (Hrsg.): HyperKult, Basel: Stroemfeld 1997.

Postal adress: PD Dr. Martin Warnke, Leuphana Universität Lüneburg, Institut für Kultur und Ästhetik digitaler Medien, 21335 Lüneburg, Germany

E-Mail: warnke@uni.leuphana.de

---

1 Examples could be found at www.hyperimage.eu.

2 Baran, Paul: On Distributed Communications: I Introduction to Distributed Communications Networks. – The RAND Corporation. 1964. p. 2.

3 In case you are literate in german: see Martin Warnke: Theorien des Internet, Hamburg, 2011.

4 For an excellent overview, see Barabási, Albert-László: Linked. New York: Plume, 2003.

5 Martin Warnke, Carmen Wedemeyer: Documenting Artistic Networks: Anna Oppermann's Ensembles Are Complex Networks. In: Leonardo Journal. 2011. In print.