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# Social, Supply-Chain, Administrative, Business, Commerce, Political Networks: a Multi-Discipline Perspective

**Edited by**

**Matthias Häsel[1], Thorsten Quandt[2], and Gottfried Vossen[3]**

1 **Otto Group – Hamburg, DE,** Matthias.Haesel@otto.de
2 **Universität Hohenheim, DE,** thorsten.quandt@uni-hohenheim.de
3 **Universität Münster, DE,** vossen@uni-muenster.de

**Abstract**

The information society is shaped by an increasing presence of networks in various manifestations, most notably computer networks, supply-chain networks, and social networks. Online networks nowadays connect people all around the world at day and night, and allow to communicate and to work collaboratively and efficiently. What has been a commodity in the private as well as in the enterprise sectors independently for quite some time now is currently growing together at an increasing pace. As a consequence, the time has come for the relevant sciences, including computer science, information systems, social sciences, economics, communication sciences, and others, to give up their traditional "silo-style" thinking and enter into borderless dialogue and interaction. The purpose of this Perspectives Workshop has been to play an enabling role in this future dialogue, to review where we stand today, and to outline directions in which we urgently need to move, in terms of both research and teaching, but also in terms of funding. This report summarizes the discussions of the workshop and their findings.

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# 1 Executive Summary

*Matthias Häsel*
*Thorsten Quandt*
*Gottfried Vossen*



The information society is shaped by an increasing presence of networks in various manifestations. Efficient computer networks are regarded as a significant enabler for the process of change towards networks of any size and complexity. They serve as an administrative and technological basis for social network structures, with the result that online networks connect people all around the world at day and night, and allow to communicate and to work collaboratively, efficiently, and without recognizable time delay. Companies reduce their in-house production depth, join forces in supply chain networks and establish cooperation with their suppliers, with their customers, and even with their competitors. By now, social networks like Facebook, Google+, LinkedIn or XING are seen as the de facto standard of "social networking" in the information society. Companies are mimicking their effects internally, allow overlays of networking applications with regular business ones, and a use of social networks for enterprise purposes including and beyond advertising has become common. Public administrations create and improve shared services and establish "Private Public Partnerships (PPP)" to benefit from synergetic effects of cooperation with private and public organizations.

As the interactions between people in these networks increase at various levels, new approaches are needed to analyze and study networks and their effects in such a way that individuals as well as organizations and enterprises can benefit from them. This Perspectives Workshops has convincingly shown that more interaction and collaboration between fields such as information systems, computer science, social sciences, economics, communication sciences and others is needed. The fields need to identify a common level of language, tools and set of methodologies so that the various aspects of networking can be addressed and jointly developed further. The most important point is the need for a renewed multi-disciplinarity. To a great extent, networks are driven and further developed by practitioners; which also means that they are evolving in a very fast manner and not emanating from a single scientific discipline. To be able to both understand them and contribute to the state of art, true inter- or multi-disciplinary research is needed that involves the fields mentioned. As these distinct disciplines grow together and embark on collaborative research, it is also important to convince funding agencies that multi-disciplinary research should arrive on their agendas. Finally, Web sciences need to be developed as a field, and also need to be integrated into teaching. This will most likely lead to novel curricula which receive their content from multiple disciplines in a balanced way.

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## 3 Introduction

The information society is shaped by an increasing presence of networks in various manifestations. Efficient computer networks are regarded as a significant enabler for the process of change towards networks of any size and complexity. They serve as an administrative and technological basis for social network structures, with the result that online networks connect people all around the world at day and night, and allow to communicate and to work collaboratively, efficiently, and without recognizable time delay. Companies reduce their in-house production depth, join forces in supply chain networks and establish cooperation with their suppliers, with their customers, and even with their competitors. By now, social networks like Facebook, Google+, LinkedIn or XING are seen as the de facto standard of "social networking" in the information society. Companies are mimicking their effects internally, allow overlays of networking applications with regular business ones, and a use of social networks for enterprise purposes including and beyond advertising has become common. Public administrations create and improve shared services and establish "Private Public Partnerships (PPP)" to benefit from synergetic effects of cooperation with private and public organizations.

All types of networks have in common that they consist of actors (such as persons, computers, companies, administrations, etc.) which are related amongst and to each other; in a graph-based representation, actors become nodes, and their relationship become edges. At an abstract level, actors and their relationships can be subject to network theory, which is related to mathematical graph theory. From this perspective networks are systems that can be represented as (directed or undirected) graphs consisting of vertices and edges, representing actors and their relationships. As a consequence of ubiquitous computing and application integration that transcends organizations, networks are increasingly complex, from rather small ones (e.g., business contacts, friendships, federal organizations) towards highly complex networks of networks. The emergence of the latter suggests that the involved participants expect benefits from joining and participating in a network, such as by accessing information more easily or at lower cost (than without the network). Additionally, participants expect that uncertainty in business and private relations can be reduced by establishing networks. For instance, companies become capable of reacting more quickly to demand and supply fluctuations if routines such as load balancing have appropriately been established in their supply chain networks. Moreover, companies strive to reduce uncertainty related to hiring new employees by consulting social networks, while individuals keep themselves informed about the latest news in their social network by receiving information from their social networks — often aided by mobile devices that provide ubiquitous access to the Web. Networks thus emerge, persist, and dissolve not only in commercial, public, or private settings, but transcend traditional boundaries.

## 4 Purpose of the Workshop

With this Perspectives Workshop, it has been our intention to focus on three fundamental aspects of networks in order to analyze and study the design, interplay, and behavior of networks in the Information Society:

1. *Drivers*: Networks can be regarded as systems that are continuously shaped by their environment. In fact, the emergent structure and properties of networks are subject to

self-organizing processes — not unlike evolutionary processes — that create structure in the form of temporarily stable patterns of interaction between actors.

2. *Cohesion*: In a general context cohesion describes the phenomenon of (economic and/or social) solidarity, or, in other words, the intention of actors to act in the middle of their neighbors. Structural cohesion is the sociological and graph-theoretical conception for evaluating the behavior of social groups and networks.
3. *Dynamics*: A dynamic system is a system that changes its state over time. Concerning different network application areas, we regard the dynamics of a system as the change of states a system takes. On the one hand, we consider a change of state in a network as the exchange of entities (information, goods, etc.) between its actors. On the other, the change of state in a network is regarded as its evalution, which may involve, among other aspects, a change of the underlying system's structure over time.

The resulting research question of the Perspectives Workshop has been:

> *How do online networks evolve, how can they be conceptualized, and how can they be consciously designed and influenced, given the fact that multiple disciplines have a increasingly common interest in networks?*

This question, which was adapted from the regulation framework originally described in Figure 0.1 of [2], has been addressed from a thorough multi-disciplinary point of view which allowed participants to look at the evolution of networks, the drivers for evolution that promote the emergence of online networks, and the lifecycle of networks, their emergence, behavior, and maturity. Since networks are influenced by numerous aspects, the workshop was structured along two dimensions:

- *Views on networks*: From a perspective of communication and trust, IT-enabled social interactions between individual human actors must be considered. Issues of trust are of particular importance in this context [14]. Taking a view on governance, formal rules organizing the relations of actors in the network have to be discussed. Processes being performed are another aspect deserving closer attention. Finally, the underlying information infrastructure, shaped by developments of computer networks (e.g. mobile applications, concepts like Web 2.0, etc.), must be taken into consideration as it clearly is a major factor influencing network evolution. An integrative treatment of these issues takes account of their interdependencies.
- *Domains of networks*: Networks can emerge in different areas. These can be structured into economy, politics and administration as well as the society at large, each having unique an impact on a network. Thus, social, supply-chain, administrative, business, commerce and political networks will be considered.

The diversity of these research areas as well as the fact that various issues arise in more than one field necessitates a multi-disciplinary approach. Consequently, researchers from various disciplines, including computer science, information systems, economics, supply-chain management, and communication studies, participated in the workshop and helped to shed light on online networks from various angles. Their objective was to develop mutual understanding and compile a comprehensive state-of-the-art of networks across the involved research disciplines, thereby unifying the perspectives of different researchers on networks.

The discussions started out in four different areas pertaining to networks, which will be discussed in Section 5. They led to a comprehensive set of recommendations for future research and teaching as well as for future funding as reported in Section 6, thereby paving the way for a network agenda in the information society for the coming decade.

# 5 Discussion Areas

The workshop started out with group work in four distinct areas that pertain to networks and networking:

1. Data in Networks,
2. network infrastructures,
3. the specifics of social networks and social media, and
4. the (observable) network effects of crowdsourcing.

For each group, whose work is reported in the four subsections of this section, the guiding goals were as follows:

- Identify the state-of-the-art and most pressing research issues for your group topic. What is already there, and what is needed or missing (in terms of expertise, research, products, mutual influence from other areas)?
- Is your topic (or its current treatment in research) purely academic or has it reached industrial exploitation already?
- Where do you expect networks to be in five years from now?
- If you have a new PhD student coming in, what do you want him or her to work on?

## 5.1 Data in Networks

Networks produce massive amounts of data, either automatically through machines (e.g., Web server logs, supply-chain control) or through user input. Indeed, user-generated content has been one of the distinctive features of "Web 2.0" or the evolution of the Web from a "read-only Web" to a "read-write Web" [19]. Moreover, accessible data on the Web, whether created by computers, by Web users, or generated within professional organizations, are growing at a tremendous pace. Social networks like Facebook, search engines like Google, or e-commerce sites like Amazon store new data in the terabyte range on a daily basis. Due to the emerging usage of cloud computing, this trend will not only continue, but accelerate over the coming years, as not only more and more data is generated, but also more and more data is permanently stored online, is linked to other data, and is aggregated in order to form new data.

Regarding the various kinds of data on the Web and in networks, including linked open data, socio-economic data, big data, and user-supplied data, relevant topics are technical aspects of data, usage patterns of data, types of data in networks (e.g., process data). Questions to be asked include, but are not limited to the following: Is storing all this data necessary? What can be done with all this data? How can data flow between networks? How can data produced in one network be beneficial for another?

Regarding data arising in the context of computer networks, a first observation was that the term "big data" should rather be "*broad data*," as various developments, including linked data, the Web of data, and others are currently coming together. In particular linked data [4] has gained recent popularity in the context of the Semantic Web [3], as Semantic Web people think in terms of *links*, as opposed the previous thinking in terms of *pages*. This perception nowadays also applies to data creation, updating, and analysis. Surprisingly, data scraping is still in wide use, since linking is not yet fully understood and reasonable alternatives are not available (e.g., based on metadata standard formats). On the other hand, data is most useful when it can be combined with other data, which is what we currently see on social networks like Facebook with their underlying graph databases, where there is a rising usage of inherent semantics as well as implicit context.

Clearly, data is heavily spreading across networks, but we still do not understand how to create networks appropriate for a specific purpose, where the spreading of data can be directed and controlled in some way, or how to bring together (structured, semi-structured etc.) data and information. Besides data, it is important to distinguish *networks of machines* from *networks of people*: There are attempts which try to join the two, while others want to keep them apart. Human actors are obviously important in the network picture, since they are prime suppliers of data and its connections, especially in social networks.

Whether data is linked or not, what is of increasing importance is to be able to identify *data provenance* (or data lineage, i.e., the ability to trace given data to its roots, points of creation, and along its history of changes). Provenance has a different meaning for data ("where does it come from?") and for networks; in the latter case, it is more process- or document-oriented. Data provenance [6] [7] has originated from scientific applications, e.g., in physics or in molecular biology, where reproducibility has always been an important aspect; however, provenance has meanwhile reached even business areas. From a technical perspective, provenance is often seen in connection to data curation, as exemplified, for instance, in the DBWiki project [5].

The traditional database approach to large data collections has been the *data warehouse* [15], where data is collected from various sources, put through an ETL process (short for *extraction*, *transformation*, and *loading*) and finally integrated into a single data collection, the warehouse. The latter then forms the basis for data analysis, online analytical processing (OLAP), as well as data mining. If that is to happen on the fly, a data warehouse is not good enough, since an ETL process takes too much time. A data warehouse stands for slow integration with high quality, whereas fast integration with lower quality is often more desirable, in particular since data changes occur on the network, "by themselves." For that, a linking of data sets seems again more appropriate; networks of data are needed, which at best amounts to a warehouse in a cloud-like world. This is in a way similar to developments in software engineering (from traditional to agile approaches).

Another important aspect is that data is increasingly considered as *goods* which have a *value* or come at a price: If the goods are rare, you collect them; if there is abundance, collecting is no longer necessary (an example is music, in particular records vs. music obtained from the Web). Indeed, marketplaces for data are on the rise (see, for example, the MIA project at TU Berlin[1]) which aim at the development of reliable and trusted platforms for the production, provision, and use of data. In this area, where sophisticated search and analysis tools are needed, there is a link to *crowdsourcing*, i.e., the idea to outsource a task to a possibly anonymous group of people. Numerous examples from recent years prove that having the user in the loop can improve data quality (e.g., maps of Haiti before and after the quake; the UK map of bus stops before and after it had been opened to the public). However, the effects achievable with crowdsourcing depend on the specifics of the crowd. Here it is important to distinguish between a "pre-defined" crowd in a professional environment (a "club," e.g., for building a plane) and a "randomly gathered" crowd (as in the case of the bus stops). The techniques used in either category may or may not be the same; the size of the crowd may be a determining factor: As the crowd gets larger, the need for individual experts potentially decreases, but control remains an issue and beyond a certain size experts are needed again for helping to separate useful information from nonsense. So a question is how

[1] http://www.dima.tu-berlin.de/menue/research/current_projects/mia/

a crowd can be triggered to do what it is expected to do or what a system (e.g., Wikipedia) requires them to do. Ultimately, such a crowd will decide about what is right and what is wrong.

A final aspect relating to data is that of a *process view*, which can be considered similar to views in relational databases; one process could be about gathering data, but integration and usage are done by other processes. Both processes and the data they operate upon might change over time. Processes may have common patterns; if they do, these (usage) patterns could have an impact the design of data gathering processes.

## 5.2 Network Infrastructures

Network infrastructures increasingly shape modern societies. In comparison to traditional infrastructures such as traffic, energy or health care, network infrastructures based on the Internet and its services are developed much faster, at a considerably wider scale, and they facilitate widespread participation. Computerized network infrastructures are easily scalable due to the availability of massive computing and storage power as well as network bandwidth and due to the availability of standardized protocols. They are versatile and represent a generative regime (they facilitate the growth of new infrastructures). Several network infrastructures can thus be conceptualized as commodities and are seen as a societal resource for innovation, economic development and welfare.

Topics to be discussed in this area include decentralized network architectures, cloud computing, emergence and design of network infrastructures, simulation of network behavior, informated logistics infrastructures. Questions include the following: Which infrastructures are particularly suited for which area (e.g., SCM and logistics, service industry)? Do we still need to care about infrastructure, or will it soon be all invisible like electrical current?

The *definition* of a network infrastructure should cover aspects such as non-rivalry access, one infrastructure for one purpose, and visibility only in the case of failure. According to Nicholas Carr,[2] infrastructure does not really make a difference, at least as far as IT infrastructure is concerned: If each enterprise has it, it can no longer help to sustain a competitive advantage. Important are standards; there is a technology stack with infrastructure at the lowest level. Infrastructures require administration, (legal) regulation, and accessibility. The proliferation of the network society may have an effect on infrastructures. Research topics to be studied include governance, comparison of infrastructure types, infrastructure lifecycles, vulnerability of infrastructures, as well as privacy. Twitter and Facebook have the potential to become infrastructures.

## 5.3 The Specifics of Social Networks and Social Media

Social networks are at the heart of modern network usage, demonstrated by the wide user coverage (if Facebook was a country, it would currently be the third biggest in the world). They have different foci, be it on personal or professional issues (or a mixture of both), they serve as extremely efficient and sometimes highly specialized news and communication platforms (think, for example, of the role of Twitter in the Arab spring of early 2011), and they are to an increasing degree discovered by enterprises as an instrument for reaching out

[2] http://www.nicholasgcarr.com/doesitmatter.html

internally to employees and externally to customers. The result is an increasing professional investment in social media technology and advertising, although the ultimate effects, in particular the external ones, still remain to be seen.

Topics for discussion in this area include (social) network analysis, social networks for the public domain, social media (networks), and social commerce. Questions to be asked are: Which distinctions can currently be made between various social networks (e.g., Facebook, Google+, Path et al.)? How could the future of social networks look like? Will Facebook be the new "operating system" of the Internet? What value do online social networks have for an economy from a macro-economic perspective? What influence does my online social network have on me, and what influence do I have as a node in that network? Can I influence my personality by forming specific (online) relationships? Is the Internet a special case for all existing research results on social networks? What are the specifics of online social networks that the social sciences provide? Does the Internet enhance existing or enable new social behavior? Does the mere size of a network or community make possible new effects that have not been possible before due to quantitative thresholds? What are parallels (and metaphors to describe them) between the real world and the online world?

It is obvious that the social sciences know a lot about social networks, but miss the technical expertise, a fact that needs to change (see the findings in Section 6). Yet the question is how social scientists (who have questions) can be brought together with information systems researchers (who have tools to answer these questions). What social sciences *can* contribute and study are questions like "what influence does my network have on me?" or "Can I form my personality through an architecture of social contacts?" Some people claim that the Internet as well as mobile devices fundamentally change the behavior of people and the way they communicate, and that the Internet is hence not just "yet another medium."[3]

For online networks as they exist today and the transparency they provide (which is much larger than it used to be prior to online networks), control and regulation are needed, yet how to do this (if it can be done at all) is still vastly unclear. Governance approaches are also needed for commercial networks. On the other hand, the added value of online social networks is undeniable.

The added value of online social networks can be discussed in multiple dimensions: The personal value of users, the commercialization value generated by platform providers (such as Facebook), and the value generated by businesses (such as brands that advertise on Facebook). However, from a provider perspective, commercialization does currently focus on simply-targeted advertisements. New business models in terms of bringing together supply and demand will appear and need to be researched in the future. For example, being able to develop social software using APIs such as the Facebook Platform or OpenSocial opens up a wealth of different business opportunities because businesses do not have to build a new social graph from scratch. Internet companies can exploit this, for instance, to boost their outreach and profile immensely — by positioning their existing product on other networking sites as a social application [10].

For now, a big question for businesses is how to attribute revenues from social media to the different touchpoints a customer has had with their brand or products. People tend to switch between distinct contexts all the time (reading email on their smartphones, browsing the Web, shopping online, participating in a chat, checking in on Foursquare etc.), but the interplay of digital touchpoints still needs to get on the research agenda. Also, it is largely unclear how user behaviour in social networks depends on the device used (e.g., PC,

[3] http://www.theshallowsbook.com/nicholascarr/Nicholas_Carrs_The_Shallows.html

smartphone, or tablet) and context of usage.

Physical presence has a distinct meaning in a social context. The same applies to shopping: Online shopping is different from going to a store. For example, it is usually more focused, yet there may be more impulses. *Servicescape* is a concept that was developed by Booms and Bitner to emphasize the impact of the physical environment in which a service process takes place.[4] As they state in their paper, "the ability of the physical environment to influence behaviors and to create an image is particularly apparent for service businesses such as hotels, restaurants, professional offices, banks, retail stores, and hospitals." But what holds for the physical world may as well apply to the virtual world; in other words, how can I find out that the world that Google is showing me is the real world?

Along similar lines of thought goes the observation made, for example, by N.A. Christakis (Harvard Medical School) that we influence our networks, but at the same time they send information and emotion back to us and are a source of infection to ideas and even diseases.[5]

## 5.4 The (Observable) Network Effects of Crowdsourcing

One of the most striking "network effects," besides the creation of large friends networks, is the already mentioned area of *crowdsourcing*. According to [1], "Crowdsourcing is a type of participative online activity in which an individual, an institution, a non-profit organization, or company proposes to a group of individuals of varying knowledge, heterogeneity, and number, via a flexible open call, the voluntary undertaking of a task. The undertaking of the task, of variable complexity and modularity, and in which the crowd should participate bringing their work, money, knowledge and/or experience, always entails mutual benefit. The user will receive the satisfaction of a given type of need, be it economic, social recognition, self-esteem, or the development of individual skills, while the crowdsourcer will obtain and utilize to their advantage that what the user has brought to the venture, whose form will depend on the type of activity undertaken." Crowdsourcing has been successfully applied to tasks that are easier to solve for a human than for a computer (e.g., image analysis), but also to many other areas, and it has meanwhile developed "subareas" such as *crowdfunding* or *crowdvoting*.

Topics in this field include large-scale cooperation, collaborative editing, constructivism via digital means, knowledge management, IT supported collaboration in logistics networks, and agent-based coordination. Questions here are the following: Which effects can be observed by employing crowdsourcing? In which areas has crowdsourcing failed up to now and why? Which new areas could benefit from crowdsourcing (technical ones such as query optimization, social ones such as crowdfunding)?

Collaboration between people is often seen as a form of art (e.g., in music[6] or social writing) and differs from the kind of collaboration we practice today. Most examples of crowdsourcing we see today are those which are working well. Different forms of crowdsourcing have had different successes (e.g., Galaxy Zoo[7] and Zooniverse[8]), and it turns out that creative work

[4] http://www.jstor.org/stable/1252042, http://en.wikipedia.org/wiki/Servicescape
[5] http://www.wjh.harvard.edu/soc/faculty/christakis
[6] See http://www.npr.org/2012/05/13/151712146/first-listen-hilary-hahn-and-hauschka-silfra for an example representing the taste of one the authors and http://www.inc.com/articles/201103/ted-collaborative-communication-social-media-age.html for a more general coverage.
[7] http://www.galaxyzoo.org/
[8] https://www.zooniverse.org/

requires a selection process for the crowd. This might lead to a revised notion of "crowd," e.g., "active," "participatory," or "unconsciously voluntary:" A member may be invited, participate actively, register by herself, or be used without knowing about it.[9] Data querying and analysis are increasingly seen as an application for crowdsourcing (a mixture of human computation and automation) [9]. Crowdsourcing is constantly producing process data and content data. Another emerging specialization that might arise in the future is the *private crowd* (e.g., inside an enterprise) vs. the *public crowd* (e.g., AWS Mechanical Turk).

Social sciences should take a leading role in the design of social networks, not just analyze them. The goal should be to make it easier for people to meet, get together, and let them do the rest themselves. For example, flashmobs minimize risk and maximize outcome; they are a low-level form of crowdsourcing.

There is a link between economics, social media, and human computation. It is about give and take, giving and receiving: I am willing to contribute to a social network because it, say, saves me an address book. People contribute because they expect a return. Another principle is self-sufficiency: In gaming, you may need data for a game you do not have; if your game is not self-sufficient, you constantly need to crowdsource to get more data. So data is an input to crowdsourcing.

More targeted social media are coming (especially to the workplace, in the sense of a given activity or given goals). For example, car navigation systems show the effects to be expected: They may help, but can overdo it, i.e., create a traffic jam they actually want to avoid.

There are also cases where the crowd is less efficient than a hierarchy. Examples include warfare (but there is also network-centric warfare) or emergencies. On the other hand, even social media might be designed in such a way that they incorporate hierarchy (such as Wikipedia). In some areas or applications crowdsourcing is not just inapplicable, but has failed or is (or has become) inappropriate, e.g., teaching material in a university program, military applications based on classified information, or generally applications requiring fast decisions. Crowdsourcing is not even useful in an arbitrary application, since it may destroy creativity or a vision in a given setting.

# 6 Findings

In this section we report on the findings of the workshop. We first review general findings which arose from plenary discussions following the group discussions. We then state a number of suggestions for future research, and finally summarize other findings that were brought about.

## 6.1 General Findings

The workshops has convincingly shown that more interaction and collaboration between the various fields represented here (and others who were not here) is needed. The fields need to identify a common level of language, tools and set of methodologies so that the various aspects of networking we discussed can be addressed and jointly developed further. Indeed, the most

[9] Matt Ridley describes in "When ideas have sex" that it's all about creating and sharing (he calls it trading), see http://www.ted.com/talks/matt_ridley_when_ideas_have_sex.html.

important point in our findings was the need for a renewed multi-disciplinarity. To a great extent, the networks we have discussed are driven and further developed by practitioners; which also means that they are evolving in a very fast manner and not emanating from a single scientific discipline. To be able to both understand them and contribute to the state of art, we need true inter- or multi-disciplinary research that involves computer science, social sciences, economics, and more. Much can be learned by viewing a network-based situation from an alternative disciplinary perspective.

A crucial issue in this context is grasping the dynamics of networks at a conceptual as well as a methodological level:

- Levers of change include technology, as it has proliferated across societies;
- spill-over effects across domains, e.g., the public, political, and commercial domain;
- counter-forces, dark networks show a similar dynamics;
- innovation and defective behavior: innovation is often driven by defective behavior, e.g. young people challenging the power of global media companies;
- methodologically, e.g., living labs.

Science is currently driven by the fast development and changing character of social networks. Taking into account the high relevance of understanding the dynamics of networks, only an inter-disciplinary view on the different aspects of networks could develop the chance to grasp the nature of networks dynamics. A methodological mesh of different approaches used in the various disciplines could be a promising way to tackle the numerous research questions. Furthermore the comparison of the different network characteristics (social, business, logistics, etc.) and investigating the possibilities of transferring principles between the different network types could bring up new ways of understanding and managing these networks.

Business networks will grow (we will see more and different shaped business networks), personal networks will change (Facebook in the future will not be as Facebook is right now). We will see an integration of business networks and personal networks (social networking platforms like Facebook, XING, LinkedIn etc. will be integrated parts of businesses and business networks). Law will not be able to cover all the implications of computer-supported networks and will loose its controlling function. Interdisciplinary research is necessary to recognize, to describe, to explain and, even more important, to design and to innovate social, supply-chain, administrative, business, commerce, and political networks.

We are stuck analyzing the present; we should start developing the future. We are also stuck in the silos of our disciplines. One crucial aspect that will help to change this situation is student training. Three key takeaways are:

1. We need to get ahead of the curve, i.e., instead of dealing with old networks, we need to understand how to monitor dynamically and predict the development of current and future networks at some appropriate level of abstraction.
2. The notion that methods working for offline networks (viz. process mining in supply chains and/or enterprises) can be used for exploring online mechanisms needs to be explored more.
3. The traditional economic models applied for networks may be from a wrong perspective; for example, the increasing interest (by commercial providers such as Factual, Socrata, or Kasabi, to name just a few) to view data as "goods" that have a price tag and that can be traded on a market may help to explain changes and predict needs for a Web free of data issues.

In particular, we should strive to make methods of IS research, such as business process management, decision support systems or data mining, better accessible for investigating phenomena of social networking.

A question immediately following from the discussions summarized above is whether we can use what is happening on the Web today in order to help to solve real world problems. Network research is a crucial piece of this, but it remains open — at least for the time being — how the different research areas and findings can be brought together.

Deriving solutions from the network effects that we observe today would ultimately result in the development of *social machines* [12]. These and other approaches such as *Games with a Purpose* (GWAP)[10] bring many disciplines together (analysis and theory, engineering and technology, social sciences and communications, economics and law etc.) [18]. We need methodologies for studying these approaches, their effects, their consequences, and their interplay (e.g., cyber-bullying).

The important observation is that networks cross all disciplinary boundaries. Research communities are discovering this at the moment, while funding agencies are not. In order to change this situation, it would be advisable to start by creating a common vocabulary and/or methodology to bring together the various disciplines required. An area that might also help here is (social) business process modeling (BPM) [16], since we encounter a situation similar to the "process modeling vs. process mining" debate. The challenge is to look at scalability in a network; the domain is more probabilistic and has other characteristics that these methodologies need to be adapted to. Petri nets could be applied, maybe in combination with hidden Markov chains. Also, we require an appropriate level of abstraction where process models can be useful. Past attempts to achieve this have usually challenged process technology.

## 6.2 Suggestions for Further Research

Over the next few years, network research will be particularly interesting, since many additional research prospects will emerge. However, for a range of reasons, interdisciplinary research will make little progress. These reasons include funding as well as challenges of mixed methods and/or disciplines. In the meantime, the number and scale of problems related to networks will be greater, so the gap will become bigger. There will be a growing number of research on singular, specific network-related topics, but less interdisciplinary than we, as a group, would appreciate.

Social networks comprise many different research topics in design, implementation, and application. We found several analogies in different sciences that could be used to understand and describe those networks (e.g., graph theory, neurology, sociologic models, etc.). Any cross-disciplinary research so far suffers from a missing common model (including glossary, models and toolkits) that grants a common ground for all different kind of research. Indeed, vocabularies and process models can be seen as two components of a "methodologies toolkit" that should be put together in an attempt to cross the boundaries of individual scientific areas. Other pieces to be included in this toolkit are network analysis, visualization, social simulation (focusing on trust, e.g., in a supply chain), methods to create trust, and provenance. Also, it is important to look at networks over time, not just at a particular instance or point in time.

Social scientists use psychological profiles and combine it with structural data, then use the result as a predictor. An example from [8] is cyber-bullying behavior at schools (where

[10] http://www.gwap.com; see also http://duolingo.com/, http://en.wikipedia.org/wiki/Human-based_computation_game

structural information is about friends and their relationships). A general question is how to design systems (e.g., learning systems such as Backstage [13]) in such a way that people would voluntarily use them since they can see the benefit for themselves. Yet, the real benefit is when you can initiate some kind of social dynamics and sustain it. There are cross-cutting topics where the various disciplines represented in this workshop can contribute, e.g. trust. Network dynamics could use a mechanism design to make social networks more resistant to tampering so that they cannot be manipulated (e.g., by first creating trust, then abusing it).

In five years from now, more people as well as organizations will use the infrastructure, and the richness of infrastructure will rise (Facebook and other social networking platforms will have more content; ERP will be a part of the infrastructure and no longer a specific part of a specific company). This infrastructure will be more vulnerable, and its governance structure will not be solved. Intellectual property and privacy will be even bigger issues in Western countries, but might be no issue at all in China. There will also be demographic change relating to medical infrastructure, decentralized usage of information systems, house systems, speed of growing new developments (e.g., the German Pirates party), and we will have more social norms instead of legal regulations.

## 6.3 Other Suggestions

**Funding:** As distinct disciplines grow together and embark on collaborative research, it is also important to convince funding agencies that multi-disciplinary research should arrive on their agendas.

**Teaching:** Web sciences need to be developed as a field, and also need to be integrated into teaching (as it is done in the WeST Institute at Koblenz,[11] for example). This will most likely lead to novel curricula which receive their content from multiple disciplines in a balanced way.

# 7 Concluding Remarks

We are at the dawn of a new way of doing research, namely detached from the fact that "I belong to a particular department", "I need to publish in certain journals", "I get funding only in my field". Instead, we are overcoming field boundaries and diving into other areas together with new people. That applies even to the workshop acceptance criteria at Dagstuhl itself. We need a problem-oriented approach to get away from silo thinking: What is the problem? What expertise is needed to solve it?

Web-based systems will transform society: large numbers of users can interact; the available technology enables communities to build and run their own social machines. For a platform to be successful, it should not crack or allow for a bad experience, which requires more than a research prototype. Instead, we need professional software developers. We also need advertising, which is not funded either. The emerging area of *Web Science*[12] has apparently recognized this need, and is working in various ways on bridging the gaps between disciplines [11].

[11] http://www.uni-koblenz-landau.de/koblenz/fb4/AGStaab
[12] http://webscience.org, http://eprints.soton.ac.uk/265186/1/metadataisthemessage.pdf, http://journals.cambridge.org/action/displaySpecialPage?pageId=3656

Intuitions we have on certain aspects seem to be wrong most of the time; this is what we see in the network domain (e.g. growth of Facebook). Now that fields are starting to converge, this is even more true. Therefore we need to start looking into the real problem. Economics enjoy modeling, but at the price of complexity reduction. In the micro/meso/macro layer setting, we need to analyze the dynamics between these layers. Studying dynamics becomes even harder that way. A good example is human-computer interaction (HCI). Interfaces were studied for years because they stood still during that time; that is not the case anymore. Now you have to know your users in advance when you build a system. HCI has developed methodologies, which have broken down. This example is about speed of change, not networking. Also in other examples, speed of change is a big issue.

We consider to arrange another workshop to discuss the various methodologies that are used in the different fields of research.

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## Participants

- Jörg Becker
Universität Münster, DE
- Daniel Beverungen
Universität Münster, DE
- Franqis Bry
LMU München, DE
- Clemens Cap
Universität Rostock, DE
- Ingo Dahm
Deutsche Telekom – Bonn, DE
- Stuart Dillon
University of Waikato, NZ
- Emese Domahidi
Universität Hohenheim, DE
- Matthias Häsel
Otto Group – Hamburg, DE
- Bernd Hellingrath
Universität Münster, DE
- James A. Hendler
Rensselaer Polytechnic, US
- Stefan Klein
Universität Münster, DE
- Nicolas Pflanzl
Universität Münster, DE
- Thorsten Quandt
Universität Hohenheim, DE
- Michael Räckers
Universität Münster, DE
- Gottfried Vossen
Universität Münster, DE