Handbook of Research on Socio-Technical Design and Social Networking Systems

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Chapter L
Socio-Technical Communities:
From Informal to Formal?

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ABSTRACT

The chapter describes an empirical study of a socio-technical community—as an extended part of an institution—with the aim of revealing its changing processes. One hypothesis is that structures of socio-technical communities evolve from being less defined and informal to being more formal structures supported by evolving social control mechanisms, regulations and rules. The focus is the new emerging forms of socio-technical relationships. It is argued that the more established a socio-technical system is on the societal level, the more regulations will be developed which are enforced first by surveillance and social sanctions, and finally by technical determination. This chapter illustrates how socio-technical networks evolve in this direction under certain conditions.

Things are not what they seem, and appearances are certainly not the whole of the story. This need to look behind appearances in careful, detailed and systematic ways is, of course, the common inspiration of all scientific and investigative work.

—Bob Anderson, 1997

INTRODUCTION

The socio-technical paradigm, introduced by the Tavistock Institute, London, describes "*the study of the relationships and interrelationships between the social and technical parts of any systems*" [Coakes (2002), referring to Emery & Trist (1960)]. The approach of socio-technical systems (STS) keeps the relevant components together and attempts to improve their relationships. One object of their studies was the British Coal Mine as a new work system had to be integrated into this organisation.

Recently, new forms of socio-technical phenomena have emerged; for instance online communities, Internet-based networks and virtual worlds (e.g., Second Life). People are getting an increasing amount of information through the Internet e.g., e-mail, web-based discussion boards, instant messaging tools, Wikis and Blogs. Social networking applications like Facebook.com and Xing.com, or Social Tagging applications (e.g., del.icio.us) enable people to come into contact, to collaborate, share knowledge and build new relationships. These new forms of socio-technical structures differ from social systems in "how" people connect: their relationships and ways of communication are technically mediated. Technical and social elements are highly interwoven, and affect each other.

O'Reilly (2005) calls the evolving Internet-based relationships "Web 2.0". This buzzword emphasises social software applications that are heavily reliant on human interactions and collaborations. To describe Web 2.0 and newer forms of its applications, it is appropriate to compare Web 1.0 and Web 2.0. For instance, personal websites are disappearing and Blogging is becoming a new favourite way of maintaining an online presence. Individual publishing is morphing into Social Tagging. Wikis are replacing pure content management systems. The role of the user is changing from reader to author, from consumer to producer ("prosumer"). To conclude, Web 1.0 is still 'information download' whereas Web 2.0 is evolving into communication about information.

Current investigations of Internet-based communication show how social structures in Web 2.0 have evolved. Forte and Bruckman (2005) as well as Wasko and Faraj (2005) investigated the motivation of people and why they contribute to Wikipedia. As a result, knowledge sharing takes places when people assume their reputation will grow through online participation. Roberts (2006) has also analysed the social presence in Web based systems. Online presence has a positive impact on a person's reputation. The more often a person is online, the higher the estimation in which she is held by the public.

Another illustration is the study of Viegas et al. (2007) about the Wikipedia community. They show an increase of coordinating activities from 2003 to 2007. In spite of the potential of chaos in Wikipedia, "*the Wikipedia community places a strong emphasis on group coordination, policy, and process*". Viegas et al. (2004) also explore the behaviour of Wikipedians in conflict situation, how Wikipedians control specific terms in Wikipedia, how they feel responsible and how they discuss new entries. According to Viegas et al., the most activity in Wikipedia is not writing new articles but controlling the quality of written articles. Such controlling activities are first, cleaning new articles from false input, and acting as mediating between two or more authors (e.g., moderating discussions about spelling, or meaning). Third, some Wikipedians provide back-office functions, and finally, some of them take the role of 'vandal hunters' (i.e., when visitors enter funny rather than correct data).

Each of the studies reveals some social effects of Web 2.0 technologies. They illustrate that at least some Internet-based communities evolve from informal, trust based forms of organisation to more formal, defined structures that are socially enforced by the members.

In this paper, we will reveal further trends of evolving structures by describing the emergence of a socio-technical community and its evolution over time. In our long-term study from 2001-2007, we explored how a group—as part of a non-profit organisation—evolved into an online community. Instead of designing a socio-technical system from scratch we just offered the conditions in which such a system, network or infrastructure could develop. Thus, the central question is how these conditions became the foundation of a successful socio-technical community. The results indicate how a human network evolves from a trust based community with few formal rules to a community with more formal rules which are socially enforced by its members. It was the social mechanisms and not the software architecture that fostered the community's evolution. This chapter illustrates how a socio-technical community evolves in this direction under certain conditions.

SOCIAL STRUCTURES IN SOCIO-TECHNICAL COMMUNITIES

How Social and Technical Systems Differ

When we talk about technical systems we mean Information Technology systems (IT). In contrast, social systems are, for instance, people in groups or companies. As Sommerville (2004) said: A socio-technical system is "*a system that includes hardware and software components that has defined operational processes that are followed by human operators and that operates within an organisation. It is therefore influenced by organisational policies (rules), procedures and structures*." Typical socio-technical systems are for example, groupware systems, knowledge management systems and applications for social networking. The challenge of such socio-technical systems is to design the interaction between social and technical parts. Whether this type of systems really contributes to knowledge sharing within organisations depends on the corporate culture and on the degree to which organisational and technical structures are adjusted to each other and how they are integrated. In other words, it depends on how efficiently and successfully the technical interacts with the social system, and vice versa.

In order to create a successful interplay of social and technical systems it is essential to understand the differences: the first one is autopoietic and constituted by contingent communication while the second one is deterministic (to its utility) and allopoietic (Luhmann, 1995). According to Eason (1988), Mumford (1995), and Cherns (1987), methods, guidelines and principles are focused on this integration. Eason emphasized: "*the specification of a new socio-technical system must include the definition of a social system which enables people in work roles to co-operate effectively in seeking organizational purposes*." According to Coakes' model (2002), the components consist of technical as well as social parts. Our focus lies on the 'web of communications', or in other words, a socio-technical system is technically mediated human interaction and communication.

Socio-Technical Communities and Social Structures

Similar to Preece et al. (2004), we use the term socio-technical communities to describe groups that have some online presence. These groups differ in the following four areas: size, primary content, lifespan and type of communication, "w*hether the community exists only virtually, or has a physical presence, or exists primarily through physical connections*" (p. 3).

In addition to these four areas, a socio-technical group also consists of social structures. Social structures are a "*relatively enduring pattern or interrelationship of social elements*" (Jary & Jary, 1991, p. 465). Social elements are for instance, expectations and social interactions that can be called "social roles" within groups of people.

According to Dahrendorf (1958), a social role is the sum of all behaviour expectations of a social group towards a concrete role actor. It is a set of descriptions defining the expected behaviour of a position (Biddle & Thomas, 1966). Roles in socio-technical communities depend primarily on technically mediated communication. Therefore, roles in online communities can be particularly observed through the written communications of their members. A role is then, a perceivable interaction pattern created through the repetition of social interaction[1]. Repeated and anticipated behaviour leads to expectations that affect a role, and vice versa. Similar to Herrmann et al. (2004), a role consists of both "structure" (including position and function) and "activity" (including role-playing based on social interaction).

Meeting on a virtual community platform does not have the same quality as participating in a "*bowling team*" (Putnam, 1995). Nevertheless, for people who are unable to find other people with the same interests in face-to-face situations, meeting in an online community is better than not meeting at all, and there are only few social duties people

have to agree to. This aspect is also known as social capital: *"Social capital is the sum of the resources, actual or virtual, that accrue to an individual or a group by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition"* (Bourdieu & Wacquant, 1992, p. 119). Members provide immediate support for others and build more social capital than without the technical system. In other words, social capital is the access to people, their friends, and support: a person's problem can be solved with the help of others. It is a visible benefit. According to Nahapiet & Goshal (1998), social capital can be differentiated into a structural dimension that includes "*patterns of connections between actors—that is who you reach and how you reach them*" (p. 244), and a relational dimension that indicates the "*personal relationship people have developed with each other*". In summary, the more members who actively participate in a social network—with shared basic norms, values and meanings—the more social capital will be created. The building of social capital depends also on the quality of social ties. But once again, the "*development of weak ties is better than not meeting at all*" (Preece, 2000, p.24)[2].

The cultivation of social capital is particularly dependent on trust, Fukuyama (1995, p. 26). Trust is "*the positive expectation a person has for another person, organization, tool, or process that is based on past performance and truthful future guarantees made by a responsible person or organization*" (Shneiderman, 2000, p.58).

From this theoretical viewpoint, we have applied three areas for our empirical research about evolving structures in socio-technical communities. These include the activity dimension (AD), structural dimension (SD), and cognitive dimension (CD):

Structural Dimension:

- Change of social relationships?
- Change of social capital in socio-technical communities?
- Change of online presence? Technically mediated social proximity?

Activity Dimension:

- Emergence/change of behaviour and roles? (online interaction patterns)

Cognitive Dimension:

- Change of pre-trust and trust?

CASE STUDY

In 2001, the Department of Computer Science (at the University of Dortmund, in Germany) had approximately 2,000 students. Between the years 1996 and 2001, problems were occurring. A lot of students did not graduate with computer science degrees (statistic report from 2001). This report made clear that many students ended their computer science courses after three or four semesters without a degree[3] or even moved to another university; others did not take the written examinations. However, we did not know exactly why the students were failing, and so, we wanted to find out why the students were dropping their computer science studies (initial situation). We assumed that the problem was not only related to the content of the courses but connected with the 'study management' (organisational problem). The primary question was: How do German computer science students organize their studies at a university? Do they have enough information about how to organize their studies successfully?[4]

Method: Action Research

Starting from the problem of the organisation of the study management, we started the WIS-project[5] in 2001. The aim was on the one hand, to find out what the barriers to studying were, and on the other hand, to establish which factors led to success for students of computer science and second to give the results back to the students in order to initiate a discussion about these issues. The primary purpose of the empirical procedure was to help students build their own online community that would be concerned with study management.

In addition to the practical purposes, we used the project in order to study people's behaviour as well as emerging changes of social structure and social roles in the online community. The project was based on an empirical exploratory research method including ethnographic observations, qualitative interviews and questionnaires as well as action research processes (Avison et al., 1999). The empirical exploratory method was essential since we did not have sufficient hypotheses in order to explain why the students dropped their studies. Our empirical procedure included the following phases of action research:

Part 1: Main Steps of Implementation Process

A. Identifying the Problem(s)

In semi-structured interviews, we uncovered different students' problems with study management. The interviews, held between 2001 and 2002 with an open-ended interview guide, included 14 people face-to-face (8 students and 6 professors/lecturers). The diversity of how students manage their studies was summarized in different areas, e.g., students know the importance of attending lectures and learning groups, though they do not attend[6]; students at German universities need a high degree of self-organization but they have not learnt it (and it has not been taught); too much unstructured information. Based on these practical problems, a standardized questionnaire was sent out to the computer science students at the University of Dortmund. 384 completed questionnaires were returned. This represented a total of about 20 percent of all computer science students enrolled in the bachelor courses. The results confirmed the thesis: The majority of students knew theoretically how to organize themselves for a successful computer science course but they did not practice it.

B. Creating an Information Portal

The interview results prompted us to create an Internet-based information portal which would offer an overview of each lecture, seminar and course per semester, a graphical plan of the first four semesters (similar to a bachelor degree). We decided to use computer support for two reasons: (a) due to the large number of students that would be involved and (b) to document the process for the next generation of students. Additionally, the portal would enable information from the study management advisors and other university roles to be shared. In 2002, the first prototype of the community-system called "InPUD" was launched.

C. Supporting Communication and Collaboration

Based on empirical insights about the InPUD prototype, we added a discussion board about study management, and selected undergraduate courses some months later. The aim was to improve the transparency of successful study management factors. Knowledge sharing was based upon voluntary participation. As we will describe later, that was the beginning of an online community.

D. Continuous Improvement

From 2002 to 2006, the project team enhanced the technical system and changed some things, for example, to improve the performance of the technical system. Meanwhile, a lot of new discussion boards were added, and more information about study management was included. The InPUD community grew continuously. In 2007, InPUD 2.0 was installed. The community portal has been converted for Bachelor and Master degrees.

Part 2: Analyzing The Implementation Process to Study Evolving Social Structures

Especially from 2002 to 2006, we analysed the InPUD community and its evolving social structures based on the following research methods.

First in 2003-2004, face-to-face interviews with 8 experts were held. The experts came from the area of study management, had experience of

'university management' and knew web based IT-Systems very well. We asked what the crucial factors for successful study management were in order to compare the experts' statements with InPUD's development. Based on the empirical results of the interviews with the experts, we supported the InPUD-Community with new ideas. One example was giving members with formal roles a role name and making roles visible, for instance, the study management advisors were labelled explicitly. Furthermore, we conducted participant observation of the online discussions in InPUD from 2002-2006. Moreover, the analysis also regarded user statistics, communication structures as well as qualitative content analysis focused on social relationships to understand the social interactions.

As a result, in this exploratory action research process we identified empirically based theses about the emergence of social structures through interactive technologies. The results can be found in the following section.

What Exactly is the InPUD Community?

The InPUD community (=Informatics Portal University of Dortmund, Germany) can be described as a 'socio-technical knowledge sharing community' for computer science students at the University of Dortmund in Germany (available at www.inpud.de). The InPUD-community differs from other online communities that are built in people's spare time and not a part of a company. InPUD was launched in 2002.

According to Preece et al. (2004), the InPUD community is characterized by a large size (more than 1,500 people). The community is an extended part of a Department of afore mentioned university and supplemented the existing formal organization of the university. The primary content of InPUD is knowledge—and its collaborative creation—about the study of computer science, its courses and study management. The students get information about how to study successfully, and the opportunity to discuss study management, content and exercises of lectures as well as seminars. Thus, InPUD helps to provide and share information to improve study practices. The community exists primarily online, but also has a physical presence through physical connections, e.g., networked students in different courses, seminars or lectures.

In detail, the InPUD community includes an overview of all classes and lectures which are offered during the course of a semester. The way that the information is structured is the same for each lecture or seminar. The information about the lectures, including any tutorials which are being held (and when they are being held), course materials, notices for examinations, lecturer contact information and often a free discussion forum are included as well as news and search functions.

The information and content about the study management domain were integrated with online discussion boards. These enabled potential members to build active social interactions. The discussion boards exist for each lecture as well as for study management. They are embedded into an information website that includes facts about course guidance as well as graphical maps of how to study which course at which time.[7] The discussion boards include discussions about selected lectures. At the time of writing, 30 boards are on-line, each with their own moderator. It is possible to discuss exercises and their solutions on the discussion boards. Furthermore, there is information, and discussion boards, which have been initiated by study management advisors, and course guidance. The discussion boards include questions and answers referring to study management, for example "*how to study successfully*", "*how and where to register for written examinations*", "*content of special courses*", "*which semester is best suited for studying abroad*".

The members are primarily students from the Department of Computer Science but also people who are interested in studying e.g., high school students. Some InPUD members are also made up of advisors from course guidance and study management. As mentioned, the InPUD community consists of students who could theoretically meet at lectures. However, this face-to-face communica-

tion is unlikely due to the fact that the courses are oversubscribed. Sometimes there are more than 600 students on a single course—direct social interaction with each person seems to be difficult to achieve.

How the Socio-Technical Community Grew

The InPUD community is continuously expanding. Since its launch in May 2002, more than 1,330 registered participants have written more than 24,000 contributions. Registration and login is only necessary when actively contributing. Observation and reading is possible without registration and without logging in; each user has access to all available information. InPUD is used by more than 60 percent of students within the Department of Computer Science at the University of Dortmund.

The InPUD discussion board provides an awareness tool that provides information about activities of the users, formal roles and current status, and shows who and how many users are online at the same time. The community grew without any marketing or any external advertising.

The number of requests has grown consistently—cf. Figure 1—and the access rate usually peaks at the beginning of a new semester. In October 2002 there were only 171,408 requests. A year later, in October 2003, there were 292,155 requests and in October 2004 this had increased to 491,330 requests.

Figure 2 (next page) shows the analysis of the communication structure: About 2,000 students (100 percent) are enrolled at the Department of Computer Science in Dortmund. More than 1,330 (66.5 percent of all students) were registered in September 2006. We do not know if the 'not registered persons' are lurkers (passive users), or if they do not use the platform.

About 868 of 1,330 registered members contributed actively. A core (of about 190) individuals regularly provided contributions: ranging from 26 to 391 postings (questions/answers) per individual. That is a significant number. The core members are the elders, leaders and partly the regulars (Kim, 2000). The other 678 active members (167 and 511) made postings in the range from 1 to 25. These members can be described as regulars, too, but also included novices and visitors.

462 members were registered but did not post. We assume that these registered InPUD lurkers (23.1 percent of 2,000 students) wanted to show their interest in the community although they did not actively participate. According to Preece (2000), there are different reasons why they do not post, for instance, no motivation, no personal need, and curiosity without exposure. Maybe they are waiting for the "right" moment to post.

The success of the InPUD-Community can be measured by the significant number of active students. More than 60 percent of computer science students use the community. The large number of participants indicates that a significant number of students appreciate this form of knowledge sharing. They discuss, ask questions, answer the questions of others, come up with new ideas and help each other.

RESULTS

This section shows results that help to understand how InPUD became a sustainable, continuously growing socio-technical community, and how it evolved over time. The following results from our InPUD case study between 2001 and 2006 are not representative but indicate some empirical evident theses that show the trend from open, informal, and undefined to defined, formal structures.

1. Change of Socio-Technical Relationships

One result of our analysis is that the members of the InPUD-community, in particular students, developed social relations online. The members built different qualities of social relationships—that were dependent on individual needs (cf. previous section: differentiated structure of participants). Some people even built close ties, for example, the same people met habitually at the same discussion

Figure 1. Continuous flow to more usage (dark bars show beginning of new semesters)

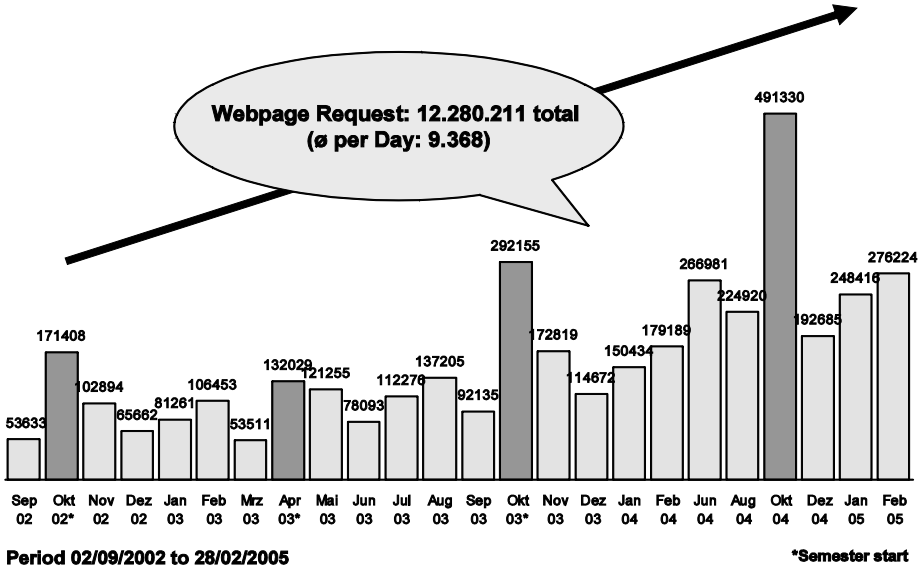
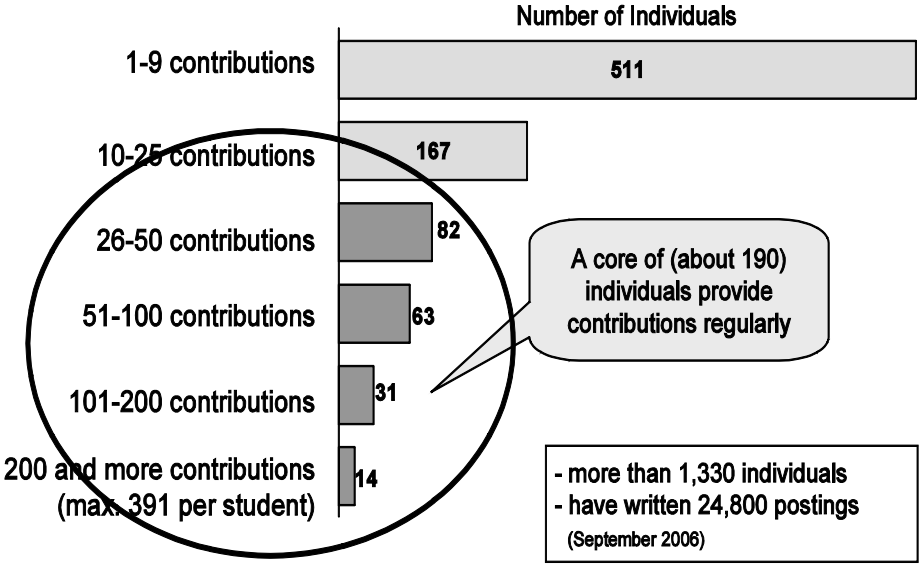


Figure 2. InPUD discussion board—Number of contributions per individual



board at the same time. Wenger et al. (2002) call these members "*the core of the community*", those whom Kim (2000) differentiates as elders, leaders and regular members. The emergence of social ties was affected by the following aspects:

First, the analysis shows that it was not necessary to create face-to-face communication among students before the online community was created. The students were unable to take advantage of the opportunity to build social relationships at face-to-face meetings (e.g. seminars, or lectures) because of the fact that there can be more than several hundreds students at lectures.

Although the interviewed experts said it would be important to promote face-to-face communication before cultivating a web-based community, we know today that this is not correct for every online group: we explain these differences with homogenous and

heterogeneous groups. a) The student members of InPUD have homogenous interests, and therefore a face-to-face workshop was not relevant. The underlying idea is that homogenous groups have the same (or similar) interests and therefore the members act truthful and rely on the others (in more detail cf. point 3). b) Heterogeneous groups include people who work in hierarchical dependences. In the investigated case, people work in different formal roles, for instance, they are advisors, part of the counselling services, work at the examination office, at the registry office, and they are lecturers, and so on. Such people—in different formal roles—do not have the same goals (although they may have many similar interests in the context of student support).[8] Consequently, for heterogeneous groups it might be better to create a trust-building face-to-face workshop before supporting their knowledge sharing with IT. For example, the 'central office for study management at the University' created a face-to-face workshop for advisors.

Second, the community gave its members—through the medium of the technical system—the opportunity to find people with same interests, problems or passion. A person could find people with the same interests although the group was large with a lot of anonymous members. From an individual's viewpoint, the community helps members to become "*someone with a name*": a person who needs information from others but also has information to share with other people.

Third, the InPUD-analysis shows: members could foster their collaborative knowledge sharing with a minimum of formal regulations and limited university control. Without registration, every person can read all of the InPUD content—also external people. Registration is required only when one wants to give answers or pose questions. Registration requires just a username and an email address.

Finally, InPUD is available 24 hours a day and people are able to connect to others around the clock. Some students answered questions and helped other students at night. Instead of one-to-many users' communication, InPUD is able to support the communication from many-to-many users, and promote the "*wisdom of the crowds*" (Surowiecki, 2004).[9]

The Internet-based InPUD community gave its members easy access to many people and their combined knowledge—this is what we call the 'social capital' of a group. The analysis gave some hints about the core members of InPUD who built rather strong ties. These core members did not share only pure information but they also wrote some emotional sentences to create new social relationships. For example, the members "*wish good luck for the exams*" and said "*thank you*" when other people helped them.

These factors enabled the members to build different qualities of social relationships online—right at the moment when people need knowledge or other people. The InPUD-members combined and shared information and jointly developed their own understanding 'as a community'.

2. Online Presence and Social Proximity Through the Technical Medium

The InPUD analysis indicates that some members are more visible than others because of the number or quality of their contributions to online discussions. The degree of online presence affects the perception and reputation of people, their expectations, and finally their behaviour. For instance, an InPUD member who made postings more frequently and gave answers more regularly than others (e.g., who contributed just one time) was more visible within the web-based community than others (cf. previous section, statistic analysis: several members posted contributions every day).

The people's motivation behind this interaction—degree of online presence—is similar to aspect 1: to build social ties. Interviews with students showed that some of them wanted to "*break out*" from the anonymous mass (from a large student group of approx. 2,000 members). The online community gives the students the chance to keep in touch with people who share their problems. A second argument is the 'self-profiling' or self-expression of those people. People respect such members more

when they are more present in InPUD. In other words, the high degree of regular online presence is connected with a higher degree of competency that can result in a higher status—assigned by others to such 'leaders' or 'power-users'. To conclude, some interviewees assume a connection between the frequency and quality of contributions on the one hand and a higher social status and acceptance in the community on the other hand. Moreover, such a raised online status could also impact on their lives outside of InPUD. These people might feel more confident in their face-to-face communication as a result of their higher online status. For instance, interviews with some students revealed that some of them knew the 'strong' members personally—in spite of their online nick-names. Studies of Wikipedia indicate a similar result: active power-users at Wikipedia upload their pictures in Wikipedia on a special website[10]. Wikipedia has more than 324 faces.

The online presence also influences kinds of 'online social proximity' through the technical system (what we describe as computer-mediated social proximity). Indicators for such online proximity are emotional interaction patterns, for example, they say 'thank you' or wish 'good luck' with exams and further hints. In summary, some contributions drift from the main topic—only pure information—to questions about personal interests, for example, "*where do you live*?" that have positive influences on the building of social proximity. Instead of "bowling alone" (Putnam, 1995), the InPUD case indicates that people bowl together online. One research question is: Do online contacts appear as digitalisations of offline relationships or do people have more social relationships in online communities than in our 'normal society' (what quality do they have)?

3. Pre-Trust and Trust

Although the InPUD community was mainly built through computer-mediated communication, the InPUD members who communicated with other users did not generally know them outside of this virtual space. Our observation indicates that the members respect each other and act in a trustworthy manner. In contrast, betrayal of trust can have a significant negative impact on the online community and can limit or dissolve collaborative learning. "*When there is trust among people, relationships flourish; without it, they wither*" (Preece, 2000, p. 191).

The InPUD community had the opportunity to create trust from the start. Similar to Shneiderman's model (2000) to facilitate trust, we *clarified the context*, for example, we made it transparent that InPUD is part of the Department of Computer Science. Second, it was important to "*make clear commitments*", for instance, each discussion board has a description about possible content and the announcement that "*off topic discussions will be deleted*". And finally, trust–building was supported by ensuring that each discussion board had one or more formal moderator, a task that has to be taken by academic personnel. The static information in InPUD is also checked by the academic personnel, in particular by the administrators. However, the formal moderators act moderately and not often. Nevertheless, they gave the InPUD-community the context for facilitating trust continuously.

Pre-trust as well as trust has existed since its inception, and has not significantly changed over time. This could be explained by the supporting activities of the moderators who facilitated the building of trust in the community.

4. Change of Behaviour and Roles

InPUD has many participating members; hundreds of people who give ideas and share their knowledge online. During the initial stages (in 2002) the majority of the community's members occupied the same position: "user". Tasks were transparent for each new member. At the outset of InPUD, the main tasks were posting/contributing, only reading, and less activities of moderation by academic staff. In the initial phase (from 2002-2004), we observed that the members began to employ new forms to communicate. We defined these new forms as 'informal moderator. Some core members did not

have the formal role of a moderator but guided other members with words.

Following points illustrate some informal posting activities (in more detail, see prior work Herrmann, Jahnke, & Loser, 2004):

- **Scaffolding:** person who gives structure to the discussion, for example: "*Please, look at the thread of study management, before you ask the same questions like the others before*"; "*This question was already answered in thread 19*".
- **Conflict-mediator:** acts as mediator in emotional conflicts (when two people or more have a dispute); intervention in emotional discussions (enabling the discussion to continue), e.g.: "*I understand your problem, and it is good that you want to change something, but this thread is not the right way to solve your problem. Would you mind talking with the professor face-to-face?*"
- **Technical-support:** solves technical problems, e.g., "*Why is the board so often offline at the weekend*?" The answer of a user (not the formal administrator or moderator!) was: "*I just asked the technical project team and they said they had upgraded the software. The new version should work in two weeks. Hopefully they are right.*"
- **Promoter of the procedure:** makes the current procedure more transparent; promotes the discussion, or activities; motivates to participate, e.g.: "*Yes, I could explain the seven answers of the exam after the exam—when there are enough students who will participate. I suggest Wednesday, 14 February, 10am in room E28. I will not do this if there are just 3 or 4 people. So please, come to the meeting*".
- **Informal moderator:** Informal moderating activities are often supported by students. Informal moderators help other members and tell them "*how to ask questions*" or "*this question has already been answered on board 6*".

During its growth the InPUD community created informal roles. In this stage, the students were the driving force behind InPUD. Because of the evolving practice by the active members, new people were encouraged to become involved in this online collaboration.

In the phase of sustainable development (from 2005-2006) a lot of new members in formal roles occurred, for example, moderating activities by academic staff and professors. These new formal members started a lot of new topics on the discussion boards, for instance, studying abroad, women in computer science, discussions about new bachelor and master courses.

The formal role of a moderator as well as a promoter is essential. However, the frequency of their comments was less important than the fact that the other (or new) members knew that a moderator exists and she/he can delete contributions or comment on false contributions. If there is a moderator's role, it is also essential to make the rules and (off)topic contents visible. The moderators "*must learn to achieve a balance*", (Preece, 2000, p. 291). In the InPUD case, "balance" means that the moderator should act in a moderate way, for example, delete off-topic remarks, comment on factually incorrect answers, clarify which content may be discussed, which topics are not required, and make them visible. The InPUD-moderators have a very moderate position, they only provide answers when other students had no idea or provided incorrect answers.

5. How Online Role Naming Affects The Evolution Of Socio-technical Communities

In the case of the InPUD community the formal role of moderators were advisors of study management. They were integrated into the community by a permanent presence of a role description, for example, "*Mr. Miller, Advisor of Study Management*" or "*Mrs. Smith, Lecturer for Computer Science Study: Human-Computer-Interaction*". The formal roles were visible when people contributed online.

The 'formal role presence' helps new community members to easily assess the quality of information. The members, in particular students, ascribe more expertise and knowledge to those members who have formal roles. Therefore, the visible presence of role names improved the ability to assess the quality of the information, and this could have improved the frequency and quality of requests that finally encouraged the members and affected the evolution of the community (cf. trust, point 3).

TREND: FROM UNDEFINED TO DEFINED

From the InPUD case and some observation from the Web 2.0 phenomenon, it is possible to derive a trend of tendencies evolving to socio-technical relationships. According to some Web 2.0 applications, InPUD also shows a new tendency: We await reinforcements of regulations that are socially and technically driven.

The empirical case study might help to explain under which conditions the actors developed a shared area of interests that led to new social practices, rules, norms and further new social procedures. The case study also revealed new relations between new forms of communication and socially mediated technical structures and described how these new forms can lead to a shift from undefined to defined structures (e.g., rules as well as roles).

Therefore, one conclusion is: Although easy success and non-regulated behaviour are success factors in the early phases of a socio-technical Internet-mediated network, structures and regulated behaviour grows with the networks age and maturity—a new form of socio-technical relationships has emerged. Table 1 shows the three phases of emergences and the next generation.

The first phase of evolving socio-technical networks includes mainly trust-based communities, which are formed by free participation with very informal rules. Recently, a lot of online communities and different kinds of web-based social networks in our Internet society are noticeable, for example, Facebook.com, Xing.com, online boards about Harry Potter or other topics, and Blogs of IBM or Siemens, or many different wikis in business companies. The prominent representative is Wikipedia that is "still" in the first phase. However, a lot of studies (e.g., Viegas et al. 2004; 2007) indicated a lot of new structured activities, so that Wikipedia is on its way to the second phase.

In the second phase, clear rules are evolved by social conventions, social rules and system boundaries that are mainly socially enforced. For instance, in the last years the online language "*Leet*" emerged. Leet is a written slang used primarily on the Internet in online games. Today, it is also part of Social Networking applications, in YouTube.com or in chats. A new language has developed. Leetspeak consists of letters and numbers, for example, l33t means leet. Using such a language means building new social exclusion. Another prominent example is Ebay.com. The interaction rules are not only built by the technical system but also by the social system: the company made new policies for sellers, rules for buyer, and now "rules for everyone".

In the third phase of socio-technical networks, we assume that clear rules arise but they are mainly technically determined. For the majority of people the technical determination will be hidden, for example, the Google Page Ranking: only a few people know that the web page ranking includes ten factors to rank web pages. Most of the ten factors consist of algorithms and other mathematical factors. So, the Google search list guides our behaviour through a technical rule.

The mentioned study of the InPUD community is evolving from the first phase to the second because of the emergence of new socio-technical structures which are mainly socially enforced. In the third phase, it could be observed that the InPUD community members could be guided additionally through the rules of the technical system. Not only the social mechanism but also the technical mechanisms of InPUD will enforce people's behaviour. InPUD will be more closed (in the sense of social borders and social exclusion of other people) than before through more social regulations than before.

First empirical insights show some hints for those emergent structures. For example, the development from InPUD 1 to InPUD 2 in 2007 to 2008 aimed to introduce new technical concepts. However it also included changes in the usage. InPUD 2 has a more complex system than before.

The case study of InPUD gives some evidence of the transition from undefined to defined regulations, from loose to formal structures. Social system boundaries—socially and technically mediated—are emerging in different forms. Online communication and relationships are at first mainly trust based, socially enforced, and later also technically determined. As a result, a continuous process of dissolving and re-modelling of the boundaries within as well as among networks is taking place.

CONCLUSION

In this paper we have described an empirical case study which reveals the factors influencing the cultivation of a socio-technical community within an organization. The case study gave us initial results of how the relations between new forms of communication and socially mediated technical structures e.g., web-based discussion boards, e-learning, and e-government, can lead to a shift from undefined to defined structures, rules and new roles. So, one new form of our modern society is a two way communication which depends on technically mediated communication as well as regulation: a *socio-technical society* is arising.

New web-based applications will change our networks into forms of socio-technical relations. How will communication and cooperation in such a socio-technical society change our lives?

With newer 'easier-to-use' Web2.0 technologies, the socio-technical gap—what people demand and what technology does—will be narrowed relative to few years ago. Users are also becoming designers. However, the technically driven phenomenon (cf. third phase) could expand the gap again because technical systems, which include partially hidden concepts, will affect people's behaviour and most of them will not know about the technical determinism.

Further research should pay more attention to this shift in order to analyze the effects of socio-technical networks on people's lives in the future, for instance, investigations of effects on data privacy, or misuse of profiling based on data gleaned from Web 2.0 applications.

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Table 1. Towards a socio-technical society: Shift from informal to formal structures

First phase	Second phase	Third phase	Next generation
a. Mainly trust-based virtual communities, very informal rules (architecture of free participation)	b. Clear rules (conventions, borders, etc) that are mainly socially enforced	c. Clear rules, mainly technically determined (but for most people obscure):	Basis for emergence of new socio-technical networks ⇒ first phase begins again but on a higher technical level
e.g. Wikipedia's current stage	e.g. Ebay; Online Language 'Leet'	e.g. Google page ranking	"*Next loop begins*"

→ *Evolving new socio-technical relationships* →

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KEY TERMS

Action Research: Action research is an iterative research process which enables researchers to understand a social or sociotechnical phenomenon with the aim to improve its quality. It consists of several phases of analysis (reflection) and action (interventions) which are alternate and interwoven (cycle of activities): Action research includes a problem diagnosis, action intervention, and reflective learning in real situations, gain feedback from this experience, modify the theory as a result of this feedback, and try it again.

Formal Structures: characterized by conventional forms of behaviour; established conventions (e.g., behaviour which is formally bound by a contract).

Informal Structures: not formal, casual; spontaneous; unplanned; unofficial, loose (e.g., an informal gathering of people; informal communication at coffee breaks).

Social Relation/ship: A social relation is a relation between people. It consists of a multitude of social interactions regulated by social norms, between two or more people, with each having a social position and performing a social role. Social relations form social structures and roles.

Social Roles: A role is the sum of all Behaviour expectations of a social group (all different members) towards a concrete position, and a set of descriptions defining the expected Behaviour of a position which is being held by a person. Roles in groups are dynamic that means that they are 'created' in social interaction processes (often unconsciously).

Social Structures: Social structures within a group or society are relatively enduring pattern, interrelationship of social elements, or relations to other group members (e.g., expectations, social interaction, and relationships within social systems).

Socio-technical Community: A socio-technical community is a special form of a socio-technical system including human-computer interaction and communication from human operators that operates. Communities are bound by informal relationships, people with similar interests, problems or passion for something. Instead of online communities that are pure online groups, socio-technical communities are groups of people that have some online presence in combination with some physical connections.

Socio-technical Paradigm: The socio-technical paradigm is the study of the relationships and interrelationships between the social and technical parts of any systems.

ENDNOTES

1 Inspired by Bales' "*interaction process analysis" (Bales, 1950)*, who studied small groups face-to-face.

2 The strength of weak ties was analyzed particularly by Granovetter (1973).

3 The standard length of an undergraduate computer science degree in Germany is nine semesters (4-5 years). The majority of students take 12-14 semesters to complete their course (6-7 years).

4 German students often have a high degree of freedom: the decision of when to attend lectures or seminars (in which semester) or even when to take examinations (in which semester) is left to the discretion of each student.

5 WIS is an abbreviation for the project 'Development of Computer Science' at the University of Dortmund (Prof. Dr. Thomas Herrmann), promoted by the State North Rhine Westphalia (Germany) from 2001-2004.

6 It is not obligatory for German computer science students to attend lectures to take examinations.

[7] German universities offer a multitude of lectures and students have to create their own semester plan for lectures; meaning they can choose which lectures they attend and when to attend them.

[8] People don't have same aims since the role of 'study management advisor' is perceived as "*just an additional job*" which must be conducted by the academic staff from the Department of Computer Science. This job is an extra job besides research activities, lectures and doctoral thesis. Hence, from the viewpoint of such people, the job 'study management' is not their priority.

[9] Surowiecki argues that the aggregation of information in groups, resulting in decisions, is often better than by any single member of the group.

[10] Retrieved December 27, 2007, from http://en.wikipedia.org/wiki/Wikipedia:Facebook