Accelerating Technology Transfer by Knowledge-Oriented Cooperation

Marco Bettoni
Center for Organizational and Work Sciences
Swiss Federal Institute of Technology Zürich (ETH Zürich)
Kreuzplatz 5, CH - 8032 Zürich, Switzerland
phone +41 61 331 4746 - mbettoni@ethz.ch

Christoph Clases
Solothurn University of Applied Sciences (FHSO)
Riggenbachstrasse 16, CH - 4600 Olten, Switzerland
christoph.clases@fhso.ch

Theo Wehner
Center for Organizational and Work Sciences
Swiss Federal Institute of Technology Zürich (ETH Zürich)
Kreuzplatz 5, CH - 8032 Zürich, Switzerland
twehner@ethz.ch

Abstract

The technology gap between research institutions as *suppliers* and industrial firms as *customers* of key technologies grows continuously. For meeting this challenge we propose a knowledge-oriented technology transfer network (TTN) between technology firms. We analyze current challenges for bridging the gap and examine the possibility to cope with them by means of a 2nd generation network approach. We describe the need for a generational change towards new forms of knowledge cooperation and outline an organizational model, which is inspired by the „Community of Practice" conception.

Keywords
Communities of practice, knowledge-oriented cooperation, second generation network, technology transfer network, participation.

1. Introduction

Cooperation between industry and science was in the early stages of western industrialization one of the critical success factors in national and international competition. Between 1805 and 1891 some machine building companies of repute like EscherWyss, Sulzer or also Brown Boveri were founded in Switzerland, which cooperated with the likewise internationally renowned laboratories of the Swiss Federal Institute of Technology and of the Polytechnic of Winterthur, founded in the same period. What has changed nowadays? In Europe the trend towards handing over university research to the private sector on the one hand and towards outsourcing of industrial R&D activities on the other hand remains unbroken and mature technologies are taken over by threshold and development countries; through that, research and development in the European industry decrease compared with the USA: „ *because it is a sad fact, that Europe in research and technological innovation is more and more dropping back behind the USA*." (Schatz 2004). What remains has only a short-term perspective. The main problem with this is the following: The care of long-term projects tends to be neglected more and more, so that both the danger of drifting away into technological offside and the inhibition of technology transfer - in particular in the case of pacing technologies - become more and more urgent.

2. Technology gap and technology interface

The problematic nature of the effect of this evolution onto technology transfer can be well illustrated by means of a technology life diagram (Fig. 1). Research institutes as suppliers of pacing technologies (P) and industrial enterprises as technology customers and appliers of base technologies (B) pursue different objectives: the first focus preferably on an academic perspective while the second must primarily follow the market demand for ripe products. Due to this divergence of perspectives a gap emerges in the life curve of a technology, which - at least in principle - should be bridged through technology transfer.
Technology transfer in form of research cooperation between universities and industry is increasingly becoming more important. However, existing transfer initiatives and centres often seem only ICT platforms - for example the Swiss Network for Innovation or the German portal "Kompetenznetze.de" - lacking practical cooperative practice: their effects remain limited in scope because without adequate organizational means and tools also the best intentions are almost useless.
Since new technologies are increasingly becoming more complex, more expensive and more short-lived and since *"the revolutions of the scientific system are probably nowhere as strong today as at the interfaces between industry and universities"* (Nowotny 2001, p. 9) the technological gap between research institutions and industrial companies grows in spite of various attempts to foster cooperation (Fig. 1).

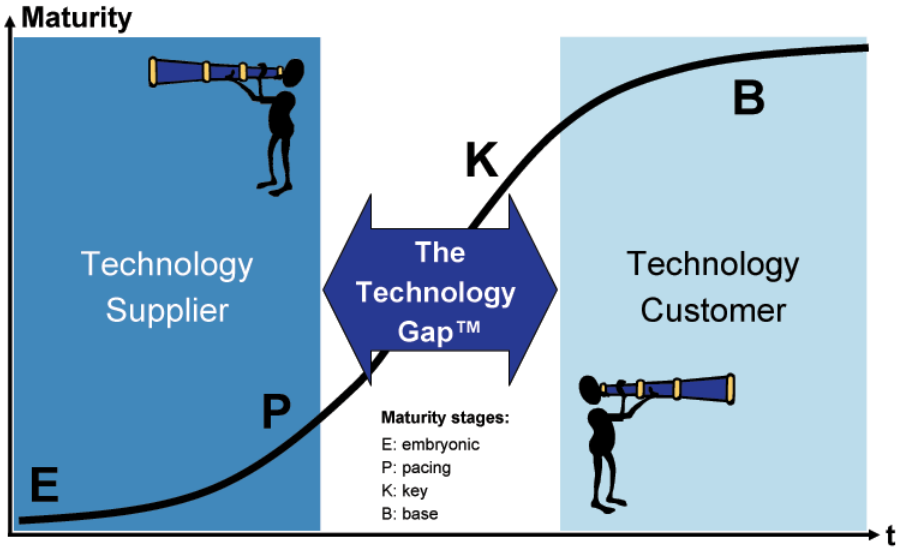

Figure 1. Technology transfer today: „Technology gap" (Räber, 2003)

The problem here is particularly the design of interactions - especially for understanding each others - between technology suppliers (TS) and technology customers (TC). Their individual interests diverge in part strongly. Technology transfer over the gap between research institutions and industry proceeds today mostly directly, rarely through intermediary actors, which have established themselves within the space delimited by the technology gap.
The direct transfer from a technology supplier to a technology customer is - for the previously pointed out reasons - problematic: different time horizons, different objectives or alternatively an insufficient maturity of the supplied technologies are among the main obstacles here.

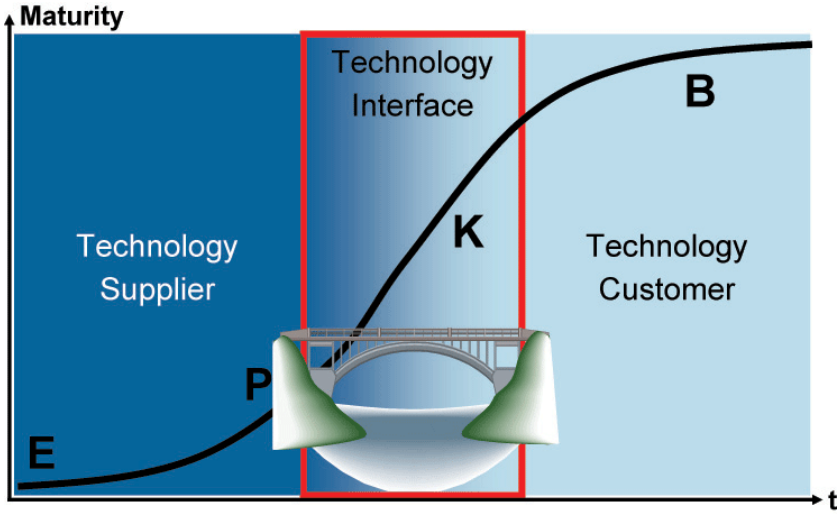

Figure 2 - Technology transfer tomorrow: „Technology interface" (Räber 2003)

What would happen if technology firms (TF) worked as bridge or as we said as a „technology interface" (Fig. 2) between TS and TC? In this case a technology transfer process might work in about so: a TF acquires in an early stage from a technology supplier pacing technologies based on basic research, increases then their maturity up to the stage of key technologies (K) and sells them finally to technology customers which either develop from that marketable basic technologies (B) or integrate these technologies into their own processes. Such technology companies would take over the function of a technology facilitator, which might positively affect technology transfer: time horizons would be more congruent, objectives better agreed and the maturity would rather achieve the necessary level. Due to their condition as individual actors in the market, these *technology mediators* would have to fight, however, with the problem that they would remain restricted in the width of their technology spectrum and could only in limited cases offer innovative technology combinations or integrations.

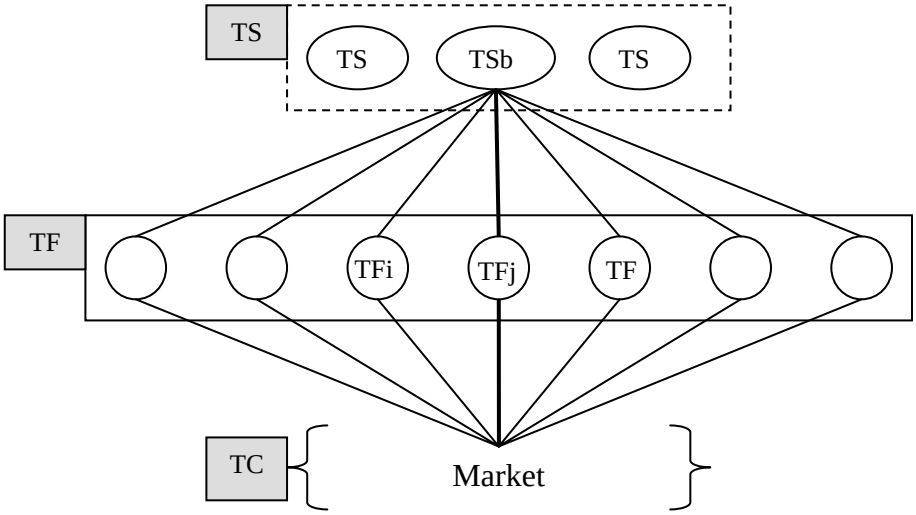

Figure 3: Individual technology transfer paths

Technology companies which already work as technology facilitators today, typically walk the technology transfer path individually (Fig. 3). Frequently only the own relational network and the own – exclusive - interactions with technology suppliers and technology customers are maintained. Neglected remain - so our viewpoint of the current state of the art -

networking options with other actors which also function as technology facilitators. Technology suppliers are on the other hand often intensely busy with repeating again and again similar interactions with different partners, without becoming aware that these redundancies can hinder also their own technology transfer. The preceding considerations let us presume, that technology transfer between pacing and base technologies is today not - or only insufficiently - realising the chance of its potential synergies.

3. Dealing with the „technology gap" and current challenges

In fact the gap between pacing and base technologies can less and less be bridged by an individual company alone, since the available time is becoming increasingly shorter and the needed tasks more complex and more expensive. Resource problems are so the rule for technology transfers. In addition the technology gap leads to a further difficulty: it has to do with the problem of "risky decisions", a situation which is well known in companies. What is new is that the time factor plays also here an increasingly critical role today: therefore acting and developing under insecurity can not be coped with anymore only in an isolated way within the boundaries of the enterprise. Moreover the necessary investments have become immense so that not only the acquisition of financial resources is a problem but principally the related risks, since they can no longer be carried by an individual company alone. The connection of enterprises into partnership networks could increase the internal efficiency and effectiveness through the inter-organizational sharing of resources during the preparation of a risky decision under insecurity. For this task the enterprises already own a set of instruments and tools - as for example market observation, technology monitoring, innovation field observations, expert meetings, expert exchanges, workshop circles, scenario techniques etc. - that could be shared in networks. Since in the process of decision preparation these instruments are applied by working from the bottom up like when building levels of a pyramid, collecting and connecting them in the network could create additional synergies.

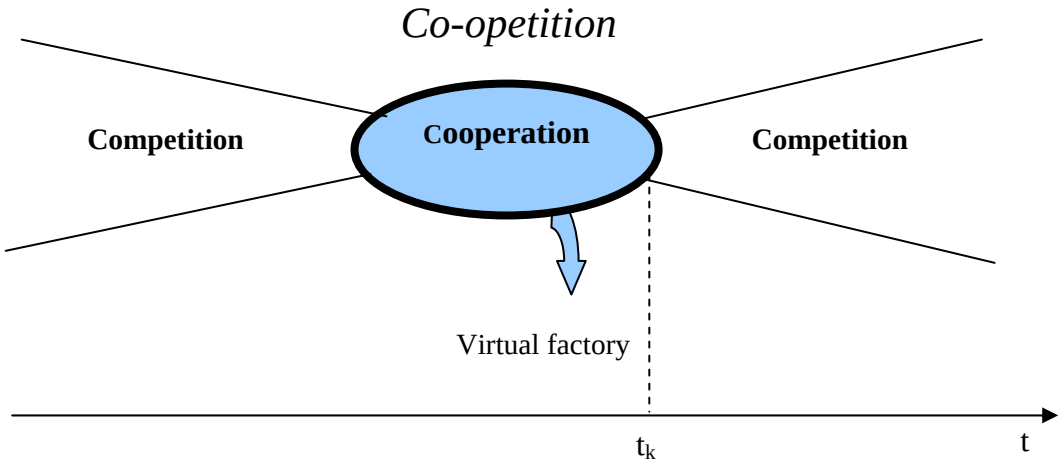

Figure 4 – Synchronicity and interplay between competition and cooperation: co-opetition

But what happens, when this process does not run within companies, but in the context of a partnership network? What happens in the next stage after the mentioned cooperative decision preparation? Does the interaction change into competition? Or can cooperation during the product development phase lead to a virtual factory? As the example of cable technology for automobile industry shows (Endres & Wehner 1996), the inter-organizational logic normally leads to an interplay between competition and cooperation (Fig. 4).

On the highest level of the pyramid - in the development phase - the strength of competition reaches its highest value and that of cooperation its lowest one. Nevertheless, from bottom to top the entire interactive process is characterized by bringing together competition and cooperation in a win-win interplay between complementors, a process for which a new word has been coined in the nineties: 'co-opetition' (Brandenburger & Nalebuff 1996).

4. Knowledge-Oriented Technology Transfer Network

Networking is increasingly becoming a central action model of enterprises and/or business units and through that subject of different theoretical approaches as well as numerous investigations in economics, sociology, business and computer science (Endres & Wehner 1996; Fleisch 2000; Sydow 2003). In fact cooperation of enterprises in networks represents an organizational model that can solve resource problems and thus safeguard and improve the competitive market position. Networks are able, at least in principle, to achieve a maximum of competence and flexibility with a minimum of structural overhead - i.e. structurally generated transaction costs. Indeed costs arise also in the case of networking. They can, however, be smaller, than by externally accessing the needed resources (engagement of consultants, procurement of capital, personnel acquisition, etc.). In addition cooperation facilitates the reduction of insecurities and the distribution of risks (Kösel 1992). Accordingly, the already mentioned use of synergies in an enterprise network could contribute, that the necessary spectrum of competences and resources is covered in common instead of individually and thus help the network partners to realize their technology transfer in shorter time, to smaller costs, distributed over a greater spectrum and by enabling participation in more complex projects. Last but not least partnership networks are understood as a form of cooperation in which the logics of cooperation and competition can coexist (Funder 2000; Sydow 2003).

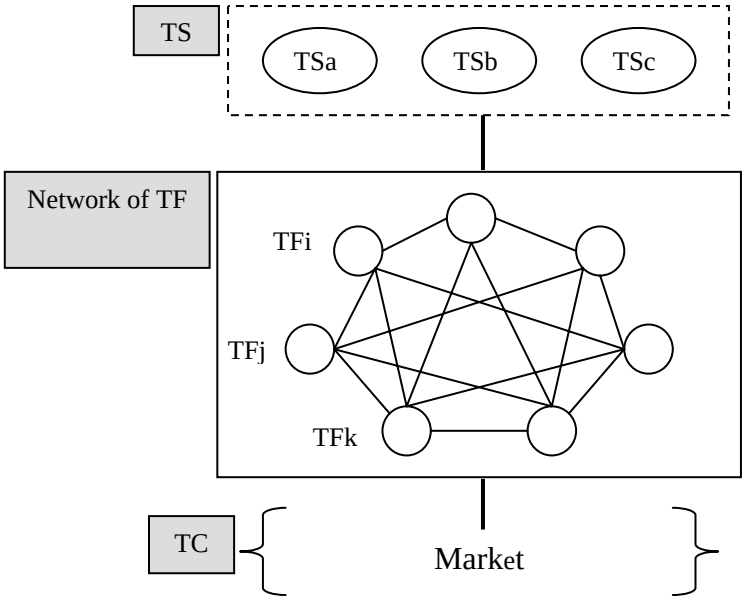

Figure 5 – Knowledge-oriented technology transfer network

For a technology transfer on the way from pacing to base technologies we suggest therefore a network of technology facilitators hence a *technology transfer network (TTN)*. Within such a network ideas, knowledge and experiences are not only shared and individually used, but also and primarily cooperatively stewarded (Fig. 5).

The characteristic function of such a knowledge-oriented network consists in facilitating a coordinated technology transfer between technology suppliers and technology firms (partners of the network). Thanks to the efficiency increase (benefit) that can be obtained through that, by functioning as interface the network could improve the entire technology transfer and thus lastingly support the innovation and competition ability of whole industry branches.

5. Second Generation Cooperative Networks

Organizationally most cooperative networks are mainly based on enterprise network models arisen in the nineties (Sydow 2003), which were supported worldwide through state programs - especially in Denmark, Norway, Australia, Canada and New Zealand. Subsequently similar networking strategies were realized also through newer cooperative networks as for example the Virtual Factories in North-West Switzerland or in the area Euregio-Bodensee (both focused on short-term, venture cooperation for exploiting specific opportunities; cf. Schuh et al. 1997) or „Sonet" the socially oriented network for sharing innovative ideas (Vollmer et al. 2003). Such early stage networks - 1st generation of cooperative networks - represented primarily a kind of learning spaces in which the value of inter-organizational cooperation could be recognized. The awareness for cooperation could be achieved; in most cases however, a changed practice could not be established. Daily cooperative practice mostly remained too much opportunistic - short-term cooperation, ad-hoc integration, constant alternation of the value chain configuration - for establishing lasting common relationships. However, times seem now ripe for a second stage of promotion, for a *second generation of cooperative networks*.

To this aim we need to develop instruments, models and ways to concretize the awareness for cooperation into a corresponding practice of cooperative business performance, in order to realize so the further objectives of inter-organizational cooperation. Investigations are needed here in order to clear among others also which internal conditions and/or foundations are needed. These aspects belong to the business case investigations that an enterprise needs in order to evaluate its potential membership in the network. Within the context of „Sonet" it became for example clear that the organization-wide sharing of ideas can only succeed if the internal conditions, i.e. for example a successful practice with Total Quality Management or Staff Suggestion Scheme systems, are available (Vollmer 2003). Further also processes and means already used by network members belong to the set of internal conditions that are in need of clarification in order to deal successfully with the technology gap.

As virtual organization studies show (Franke 2002; Vollmer et al. 2003) clarification is required often also concerning the management of cooperative networks - for example the search for suitable partners, needed trust level, need for cooperation management, stages and success factors of network development, and so forth. They point in particular to the fact, that in virtual organizations a common identity and mutual trust between the partners are of greatest importance (Jansen et al. 2002; Clases et al. 2003a) and that knowledge management methods are indispensable for a successful network construction and sustainable network operation (Warners & Witzel 2002; Hoffman & Zadek 2003). On the operational level during the setup of second generation cooperative networks, mastering skills and processes of cooperation between the member companies is of course essential, for example for product or order processing in order to implement proactive product innovation (Schuh 2003).

6. Knowledge management as management of knowledge cooperation

Although enterprises recognize the value of knowledge and the need to develop an intentional knowledge strategy, how to do that is for many executives still unclear (Wenger et al. 2002; Ortega 2003). However, researcher and business companies have in the meantime at least discovered that even the best information and communication system does not alone solve the problem of how to manage knowledge processes. Companies that had invested their entire knowledge strategies in such ICT systems discovered the hard way that knowledge is not a thing that can be managed like other corporate assets and can not be stewarded in a purely technological way - for instance by means of database solutions.
Knowledge is bound to human action. Knowledge cooperation - the cooperation of different domain experts with the aim of generating, preserving or transforming knowledge – is a living process with both tacit and explicit elements, with both individual and social components, a process that constantly changes and further develops through actions and interactions. Knowledge in such processes can not be completely reduced to an object of managerial actions, but must be treated as a kind of organic entity, bound to persons, to interactions as well as to social contexts (Wenger et. al 2002; Bettoni & Schneider 2003; Bettoni et al. 2004 b). On this background the point of view of work psychology becomes more relevant: thanks to its focus on social dynamics the work psychological approach views knowledge management as analysis and organization of knowledge oriented cooperation (Clases & Wehner 2002; Dick & Wehner 2002; Clases, Dick & Wehner 2002; Clases 2003; Clases et al. 2003 b). From this perspective one recognizes, that human interactions and relationships are of greatest importance for knowledge management and it appears thus more reasonable, to design the management of organizational knowledge processes by resorting to socially oriented approaches and methods, like for instance “Communities of Practice" (Wenger et al. 2002; Huysman et al. 2003).

7. Organizational model

In a technology transfer network member companies seek observation and reporting about new technical developments or, if possible, also cooperative manufacturing. These tasks will require knowledge creation and will have to be accomplished mainly through cooperative knowledge processes. Therefore, for a successful bridging of the gap between technology suppliers and technology customers, knowledge oriented cooperation will be necessary. Through that it becomes possible to identify the existing challenges, collaboratively work on them and implement solutions in a 2nd generation cooperative network. Since *“cooperation is a matter of communication, learning, and knowledge sharing”* (de Michelis 2001) and since the biggest value of knowledge cooperation lies not only in exchanging information, but primarily in sharing individual and collective insights as well as experiences of participating actors, we suggest to design both the structural and the stage model of the network following the organizational model of „Communities of Practice (CoP).
A CoP can be defined as a group of persons that functions like a rather informal organisational structure, in which members participate voluntarily and without reciprocal reporting relations; they don’t necessarily work together every day but they meet because they share a concern or a passion about a knowledge domain or topic; by interacting for cooperatively stewarding their common knowledge they build valuable relationships based on respect and trust. CoP members come together from different hierarchical levels and functional fields of the organization because they find individual value and identity in their interactions; step by step they contribute to cultivate an open group of persons developing organically (Bettoni et al. 2004a).

Following the structural model, that puts this CoP concept into practice (Wenger et al. 2002, p. 27 ff) and considering the central design categories for knowledge processes in organizations (Derboven et al. 1999, p. 20 ff) we distinguish in the structural model of our technology transfer network three core elements or elementary organizational dimensions that mutually necessitate each other and should be held in a balance. These are a knowledge domain, a community of people and a shared practice (Fig. 6).

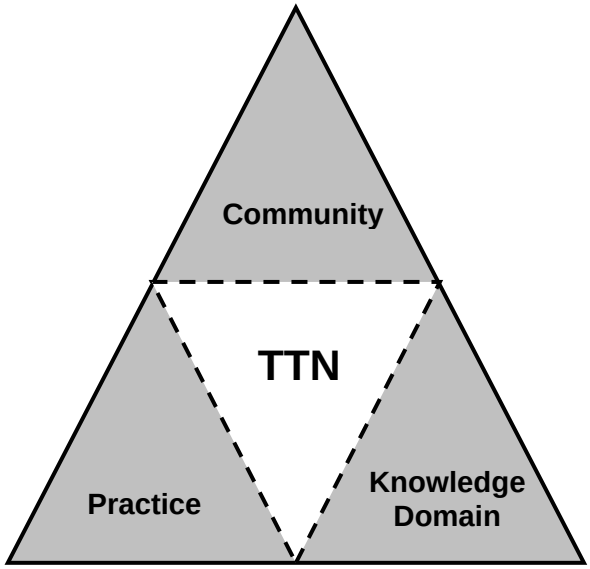

Figure 6 - Structural model of a knowledge oriented technology transfer network (modified from Derboven et al. 1999)

The knowledge domain is a collection of topics, problems and open issues that are of great importance for the network members and inspires them to contribute and participate. A shared knowledge domain is not clear and fixed from the beginning; instead it must be identified through an intense dialogue among partners. Further on, shared meanings of objects, situations and ideas have to be negotiated within a dialogical process (consensus). This process of social understanding is decisive for the formation of a common basis and the emergence of a collective identity.

The community consists of personal and institutional relationships between network members and includes the members as persons or companies, their ties, their interactions (regularity, frequency, and rhythm), the atmosphere, the development of individual and collective identities and the spaces for meeting each other. Community is an essential element for a 2nd generation network design; in fact it is here that the foundations for solidarity and cohesion of the network are laid. Community is the proper place for developing the mutual relationship potentials in form of trust, norms, regulations, interaction standards as well as behavioural rules (Reiss 2000, p. 221).

The practice covers approaches, reference frameworks, standards, ideas, tools, cases, stories, experiences and common documents that the members of the network share. The focus here is primarily on specific, collectively elaborated knowledge over how a certain task can be performed (know-how). Through repeated utilization, this knowledge is reproduced and adapted. By that also the subjective and collective strategies for the fulfilling of the tasks are modified and optimized. Tasks and knowledge condition each other here and continuously further develop in a reciprocal way (Derboven et al. 1999 p. 20).

Together these three elements – when they function well - can form an ideal social knowledge structure which at the same time also represents the basis for a successful and sustainable creation and cultivation of common knowledge within the network.

8. An Example: Biomedical Informatics Research Network (BIRN)

The Biomedical Informatics Research Network (BIRN 2004) promotes advances in biomedical and health care research through the development and support of a cyberinfrastructure that facilitates data sharing and multi-institutional collaboration. Sponsored by the National Institutes of Health's (NIH) National Center for Research Resources (NCRR), the BIRN's charter is to create an environment encouraging biomedical scientists and clinical researchers to make new discoveries by facilitating sharing, analysis, visualization, and data comparisons across laboratories. The three top goals are:

• Encourage collaborations among members of diverse research institutions and scientific domains that traditionally conducted independent investigations.
• Allow hypotheses testing through sampling of sparse, distributed patient populations.
• Develop an infrastructure that enables sharing and collaborative use of distributed biomedical databases, analysis and modeling software, and visualization tools.

By synchronizing developments in advanced wide area networking, distributed computing, distributed database federation, and other emerging capabilities of e-science, the BIRN has created a collaborative environment that is paving the way for biomedical research and clinical information management. This pioneering project has resulted in a new suite of tools that allows scientists to share, aggregate, analyze, and interpret larger sets of data than are possible in the traditional single-institution study paradigm. The BIRN infrastructure is already leading to new insights into such disorders as unipolar depression. BIRN is transforming the way scientists conduct research by taking advantage of two revolutions already happening in science and technology: the explosion in the amounts of scientific data about biological systems available to researchers, and the rapid growth of information technologies.

But the growth of BIRN also signals a revolution in the sociology of science. Researchers—once known for keeping their data under tight wraps—are now openly sharing their findings with other investigators from a broad range of disciplines. The complexity of problems emerging in research and clinical care can only be addressed through cooperation among scientists coupled with increased reliance on advanced information technologies, said Dr. Mark H. Ellisman, director of the BIRN Coordinating Center (CC), which resides at the University of California, San Diego School of Medicine in La Jolla.

9. Conclusions and outlook

As regards innovative technological research - particularly for pacing technologies - Europe falls back always further behind the USA. That this is the case is not only due to innovation obstacles like those described by Schatz (2004). What are missing are also concepts for *innovation accelerators* and organizational means for their conversion into practice. Applying the perspective of knowledge oriented cooperation to technology transfer issues - as outlined in this contribution – enabled us to describe the idea of such an *accelerator*. Notice however, that we do not consider our ideas of a knowledge oriented technology transfer network as a closed conception, but as a programmatical position.
Our sketch is supposed first to outline the framework for new organizational forms of

knowledge oriented cooperation, second to stimulate reflections and investigations over tools and means suitable for their implementation and finally to address possible prospective partners for a cooperation in further developing this model both theoretically and in practical settings. In relation to the contemporary state of the art in national and international management theories, in our proposition of a knowledge oriented technology transfer network, the innovative elements and connections are primarily the following five:

1. Bridge function. The postulate of an independent field of actors („technology interface"), that should arise between technology suppliers and customers and which makes appear reasonable activities with a bridge and transfer function so that the technological gap between pacing and base technologies can be overcome.

2. Technology transfer network. The idea of a network of technology companies as facilitator between technology suppliers and customers for the exploitation of synergies during the realization of the bridge function.

3. Second generation network. The concept of an inter-organizational cooperative network of the 2nd generation which is especially sensitized for the social dynamics of knowledge oriented cooperation.

4. Knowledge oriented cooperation. The conscious focusing on the social dynamics of knowledge oriented cooperation - as work psychological perspective on knowledge management - that reflects on it also methodically and thus offers starting points for a successful network construction by means of „Communities of Practice".

5. Practice community. Essentially what we propose is that knowledge oriented technology transfer networks be designed and cultivated following the Communities of Practice (CoP) approach. Viewing the tasks of network management from a knowledge perspective has in this case the advantage that two central thoughts gain importance: voluntariness and interest. Vouluntariness of participation in the network interactions as condition for successful cooperation on the level of shared (knowledge oriented) interests.

What unites these elements to a whole is the hypothesis, that *voluntariness and interest* should be understood and applied in the management of a technology transfer network as critical success factors for the creation of a lively cooperation around knowledge (consensual negotiation in knowledge processes).

Up to now no business model for knowledge oriented cooperation has been successful. Only by leaving the tier of a competence, service and business oriented exchange, we will be able to ascend to the upper tier of knowledge oriented interest and there, to successfully manage the inter-spaces necessary for an open meeting and cooperation. With that, a supposed weakness of the technology transfer process - the described technology gap - could be redefined as a starting point for a new strength. With other words: Knowledge oriented dynamics in partnership network structures should transcend the established thinking in (inter-organizational) interfaces and open the perspective to a management of (organizational) inter-spaces. To this aim these inter-spaces must be, however, first created. A way to this goal could be provided by the second generation cooperative network management approach sketched in this paper, if we understand it as a - still to be invented – "Inter-Management".

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