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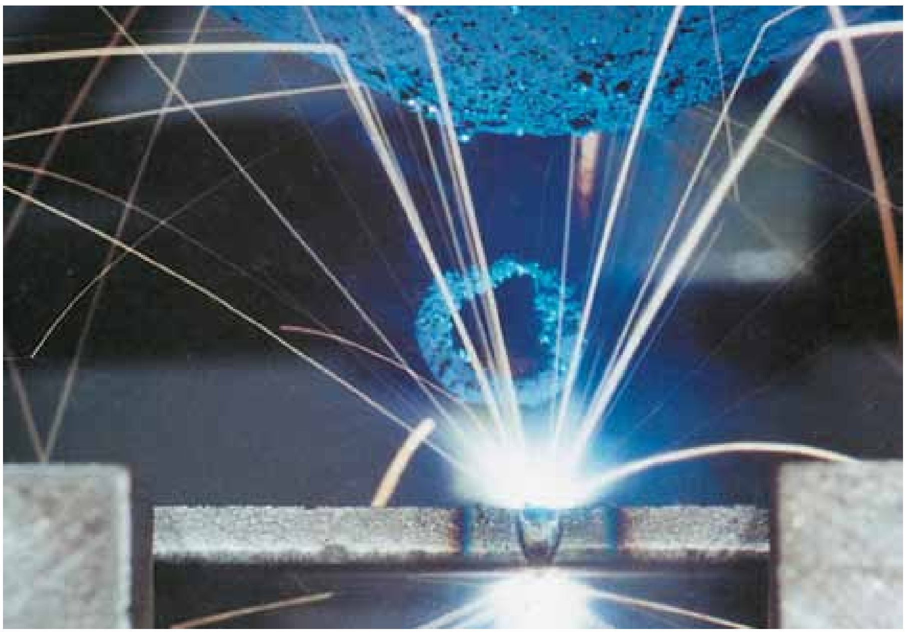
Integrated management of steel application research

SME-appropriate cooperation between the steel industry and the construction sector



Cooperative Research between steel industry and small and medium sized enterprises from the construction sector is a good possibility to generate greater innovation success. *Photo: FOSTA*

Application-oriented cooperative research (CR) is, for the sciences, an important element of their interaction with the economic sector. It also has a positive effect on the innovation behaviour of the participating companies (WR 2007). The benefits of pre-competitive forms of CR for small and medium sized enterprises (SMEs) in particular have been clearly demonstrated (rwi 2009). The steel industry supports this kind of CR by engaging in research projects with companies from steel application sectors like the automotive, construction, mechanical engineering or shipbuilding industry. In these sectors and among their suppliers, there are often a significant number of SMEs whose active involvement in CR poses a considerable challenge.

In Germany, CR for steel applications is organised by the Research Association for Steel Application [*Forschungsvereinigung Stahlanwendung e.V. (FOSTA)*]. This body, which is financed by the steel industry, works together with scientific institutions and the industry to develop pre-competitive research projects relating to steel applications and raises public sector and industry finance for new project ideas. Currently, ninety research projects to the value of about 41 million euros are in progress under the auspices of the FOSTA. In addition, the experience gained in more than 600 completed projects is available for reference.

This article reports on ways in which the FOSTA can organise CR with the construction sector more effectively, thereby boosting innovation success. First of all a stage-gate model of the CR process is introduced and typical associated weak points are identified. The typical attributes of the construction sector are then listed, showing additional barriers on the path to innovation success. An appropriate extension of the initial model is then proposed.

The innovation process in pre-competitive cooperative research

In industrial product development, innovation processes are often represented in the form of phase models. These often use Cooper’s stage-gate model (Cooper 2008) as a basis. Such a representation is helpful in the context of CR, as it shows recurring innovation activities in a standardised form, and systematises and brings transparency to developments that otherwise often proceed in an ad hoc manner. Previous representations of CR have often been restricted to the project phase, in which the research work is carried out. The model, however, must also include activities that take place in the early and late innovation phases, which are outside the project phase. Figure 1 shows these phases in addition to the project phase and other necessary administrative phases.

The model consists of seven stages and five gates. The stages contain the individual steps of the innovation process in CR. The gates describe the information from the previous stages that has to be approved by the appropriate decision makers before the process can advance any further. As in Cooper (2008), the model describes a macroprocess. The microprocesses proceed within the individual phases. They range from the active search for ideas in the initiative phase to the first application of the research results in the use phase and possible subsequent transfer to other application sectors. If necessary, sector-specific representatives of industry are involved in the individual phases. In the research phase, these representatives are informed about the progress of the research within the framework of industrial working groups.

In practice, it is often the case that only some of the stages are gone through, or certain gates are not monitored. In addition, there are a wide variety of actors on the macro and micro-level, such as representatives of universities, research funders or industry, who often pursue different and at times conflicting interests. This makes the CR process a complex and sometimes extremely fragmented system. Typical weak points culled from various reports on the management of cooperative projects include the following:

- Innovation is often unsuccessful due to lack of market focus (Sexton et al. 2006).
- The project objectives are often not specific enough with respect to the expected outcomes and are largely open to interpretation (Barnes et al. 2002).
- There are inevitable differences in the requirements and expectations of the (project) partners (Barnes et al. 2002).

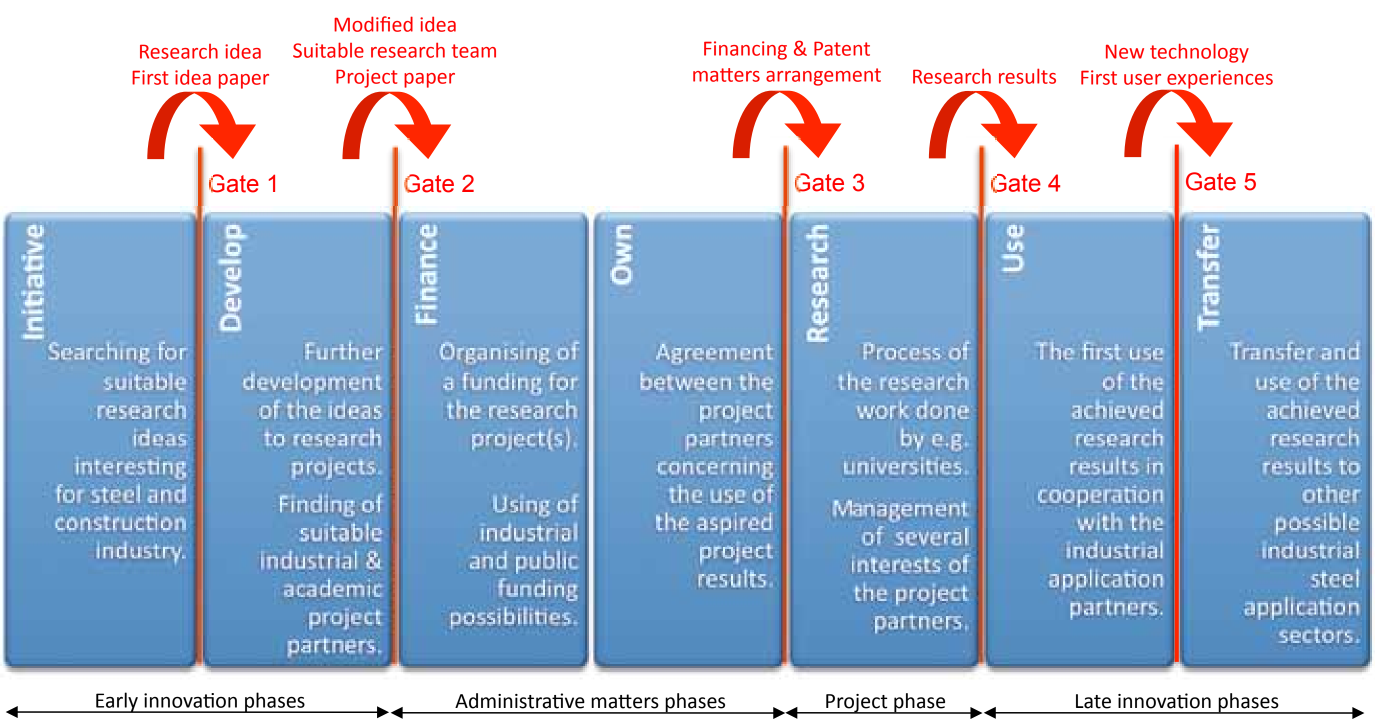


Fig. 1: Innovation process of cooperative research in the form of a stage-gate model

- Universities and industry sometimes seem to talk different languages (Abbott et al. 2008).
- The knowledge universities produce is (often) not in a form that can be directly applied or commercially exploited (Couchman et al. 2006).
- Current technology transfer mechanisms are not sufficiently informed by, or engaged with, company strategic direction and organisational capabilities (Sexton et al. 2006).

CR can therefore be modelled, but always requires additional integrated innovation management, which can monitor the individual performances for passing the gates, adjust to the complex character of the system, and elminate the listed typical weak points in the system process. Additional demands are made on management as a consequence of the specific innovation characteristics of the construction sector.

Innovation characteristics of the construction sector

The construction sector is often characterized as being not very innovative and having a traditional structure (Reichstein et al. 2008). R&D investment and the number of registered patents are both extremely low relative to other sectors (Barrett et al. 2008). Innovations occur less within the framework of the sector's own innovation projects but rather in response to the special demands of specific construction projects (Fairclough 2002). Innovation opportunities therefore also depend on the many regulations that define specifications for materials, technologies and processes (Harris et al. 2007).

Against this background, the construction sector can be seen more as a user of technologies that originated in innovative companies of the construction supply chain (CSC). Blayse et al. (2004) identify the following key players in the CSC: authorities, certification bodies, material suppliers, product manufacturers, designers, contractors, owners, end users, service providers, industrial associations and scientific institutions, and emphasises that active networking between the participants is of crucial importance to innovation success.

The innovation behaviour of the sector is also influenced by its corporate structure. In Germany, SMEs make up 99.8 percent of the construction industry and account for 75.1 percent of sales (HDB 2009). The preponderance of SMEs means that a number of additional specific innovation characteristics have to be taken into account in the management of CR with the construction sector, because construction SMEs:

- do not have the ressources and the knowledge to develop innovations on their own (Sexton et al. 2006);
- have an organizational slack in comparison to large firms which invest in strategies with long-term return (Sexton et al. 2003);
- are marked by the dominant role of the owner and therefor a strong personal relationship is needed (Sexton, et al. 2003);
- invest less in R&D than large construction companies (emcc 2005);
- have to find problem solutions in everyday work situations in particular, and greater efforts should be made to utilise the innovation potential of these solutions (Abbott et al. 2008);
- need a different technology transfer system to those of large construction companies (Sexton et al. 2006).

For innovation to be successfully boosted in CR with the construction sector, it would therefore be worthwhile to integrate representatives of the total CSC in a research project and address, in particular, issues associated with the specific SME characteristics of the sector.

Zusammenfassung

Wie kann die Stahlindustrie ihre kooperative, vorwettbewerbliche Anwendungsforschung mit den klein- und mittelständischen Unternehmen des Bausektors effektiver gestalten und dadurch eine Erhöhung der Innovationserfolge erreichen? Als Basis für Verbesserungsvorschläge wird der Innovationsprozess der sogenannten Gemeinschaftsforschung in einem Phasenmodell abgebildet. Bisherige Fehlfunktionen werden aufgezeigt und die speziellen Innovationseigenschaften der Baubranche erläutert. Zur Optimierung wird die Funktion eines „Innovation Brokers“ und die projektbegleitende Nutzung einer innovationsoffenen „Community of Practice“ vorgeschlagen. Dadurch lässt sich das eingangs aufgestellte Modell modifizieren und durch dessen Umsetzung eine Steigerung des Innovationserfolgs erwarten.

A suggestion for improving steel application research with the construction sector

Under the described circumstances, the FOSTA is of the opinion that it would be helpful to extend the CR model shown in Figure 1 by the following two aspects:

1. Establishment of an innovation broker (IB) for the integrated management of CR, to ensure that the innovation process with the construction sector is continuously accompanied at the macro and micro-level.

2. Development of the role of the working groups that accompany CR projects, making them theme-oriented communities of practice (COP). This would enable cross-sector know-how from the total CSC to be created and utilised in the research process. It would also enable the specific SME characteristics of the construction sector to be addressed more effecively.

The Role of the Innovation broker

The role of an IB in the innovation process is not fundamentally new. His activity profile often depends on the company involved and is difficult to describe in general terms. As a basis, key person concepts are often used. Of these, the gatekeeper and promotor concepts are the main orientation aids (Hauschildt et al., 1999; Folkerts, 2001; Walther, 2004). In the construction industry, such roles have so far only been discussed as a sector-internal solution for individual projects (e.g. Blayse et al., 2004; Abbott et al., 2008).

In the CR of the steel industry with the construction sector, the FOSTA, as a cross-project organisation positioned between scientific institutions and different business sectors, fulfils the role of a gatekeeper in the model shown in Figure 1. The transport of interim results on the macro-level to the subsequent phases is supported and the task-appropriate processing of these results is ensured. This is of particular importance in the early and late innovation phases, as these are outside the project execution phase and there is a risk of delaying the innovation process.

The gatekeeper function, however, only covers part of the IB profile envisaged here and must therefore be expanded as follows, especially on the micro-level (i.e. in the individual phases).

In the early innovation phases, the IB mainly organises the preparations for cooperation between the steel industry and SMEs in the construction sector. To do this, he utilises the cross-project networks he has established in both sectors. He drives forward the development of a research idea to project maturity and supports the creation of suitable project teams from science and industry. He takes action to remedy any weak points, such as an insufficiently exactly formulated objective or a lack of market orientation. In this phase, his scope for action corresponds to that of a coordination and contact point. According to (Haller 2003), the challenge mainly relates to the concentration on the interaction with idea originators and on supporting their individual needs in finding, formulating and implementating new innovation ideas.

In the administrative phases, the IB mainly helps the project team to raise public sector and industry finance for a previously defined project idea, as a translator between technical and economic language worlds. This gives SMEs in particular the opportunity, despite their often scarce resources, to develop and implement innovation ideas with his help.

In the project phase, the appointed representatives of scientific institutions carry out the actual research work. The IB functions here on the micro-level as a moderator between scientific and industrial project participants. The intensity of his role can vary considerably during the course of the project. Barnes et al. emphasise that in this phase: "… it is important to manage perceptions and issues on the academic and industry side..." (2002, p. 275). All participants bring their

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own expectations to the project. Repressed or ignored ideas may therefore suddenly crop up, with counterproductive effects. In this phase the IB contributes to the prevention or elimination of conflict potential among the participants and therefore improves project efficiency.

During and after the late innovation phases, the IB helps to disseminate the research results. The success of this is not apparent immediately after the conclusion of the research work but, in the case of application-oriented CR, depends largely on the practical orientation and therefore on the integration of industrial information as early as in the research phase. For the construction sector, Abbott et al. emphasise that: "…there is a need to move away from the old fashioned notion of the university developing new ideas through research, and then transferring and disseminating these ideas to industry in a linear fashion" (2008, p. 19). It is therefore sensible to integrate fundamental parts of the transfer of the results of CR in steel application into the research phase.

Analysis of the type of industrial information that is needed shows that it originates throughout the CSC. Lütolf et al. confirm this and emphasise that "…far-reaching innovations in the construction industry can only originate at interfaces between disciplines and with the combined strength of the total CSC" (2009, p. 5).

Project-Participation without entry barriers

FOSTA regards a community of practice (COP) that is appropriate to the research theme as suitable for satisfying this requirement if, on the path to innovation, it reflects scientific intermediate results on a broad basis in an application-oriented manner and, in conformity with an open innovation strategy, enables interested parties throughout the CSC (including SMEs) to participate in the project without having to overcome entry barriers. Besides representatives of the steel and construction industry, a COP may include service providers from the CSC, such as architects, engineers, and the authorities responsible for planning permissions, who carry out everyday planning and licensing work. They can use research results directly in their practical projects and simultaneously contribute their project experience to the research projects.

In general, (North et al. 2004) describe COPs as communities that have existed for a long period of time and consist of people who have an interest in a common theme and know how to jointly gather and exchange knowledge through ideas, insights and experience. In contrast to a project-oriented industrial working group, a COP is focussed in particular on information exchange and collective knowledge creation. A COP is therefore an instrument of knowledge management and its lifetime is not bound to the duration of a project. Participation is voluntary, and a COP is kept in existence through the participants' commitment and their identification with the theme.

For steel application CR, there would be regular meetings between the research team and the COP during the research phase of a research project. At these meetings, information woud be exchanged between science and business and, more importantly, intermediate scientific results would be jointly interpreted and placed meaningfully in an application-oriented context. This would give the participating companies of the CSC (including the SMEs) a forum to which they could bring their knowledge in a theme-oriented manner and from which they could take new knowledge, without having to overcome barriers to their entry. The opportunity advocated by Sexton et al. for construction research projects "…to convert tacit knowledge to/from explicit knowledge…" (2006, p. 15) can be realised in this way even for SMEs and also lead to the creation of "usable knowledge for mutual benefit" promoted by Couchman et al. (2006, p.153). COPs can also continue to function beyond the duration of the project, and new practice-oriented research ideas can be generated from them.

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To make maximum use of the advantages of a COP, (North et al. 2004) recommend a certain level of management support. In this context, (Zboralski 2007) has shown empirically that here, too, a broker function has a positive effect on the task fulfilment, interaction frequency and interaction quality of the group. The IB should therefore take over the responsibility for forming a COP and also for the interaction of the participants. He would motivate possible members to participate, guide the COP and drive forward the exchange of knowledge, both in the COP and with the research team.

If the roles of the IB and the project-accompanying COP are integrated into the innovation process of CR (Figure 1) and the corresponding effect is taken into account, the result is the modified model of CR between the steel industry and companies in the CSC. This is shown in Figure 2.

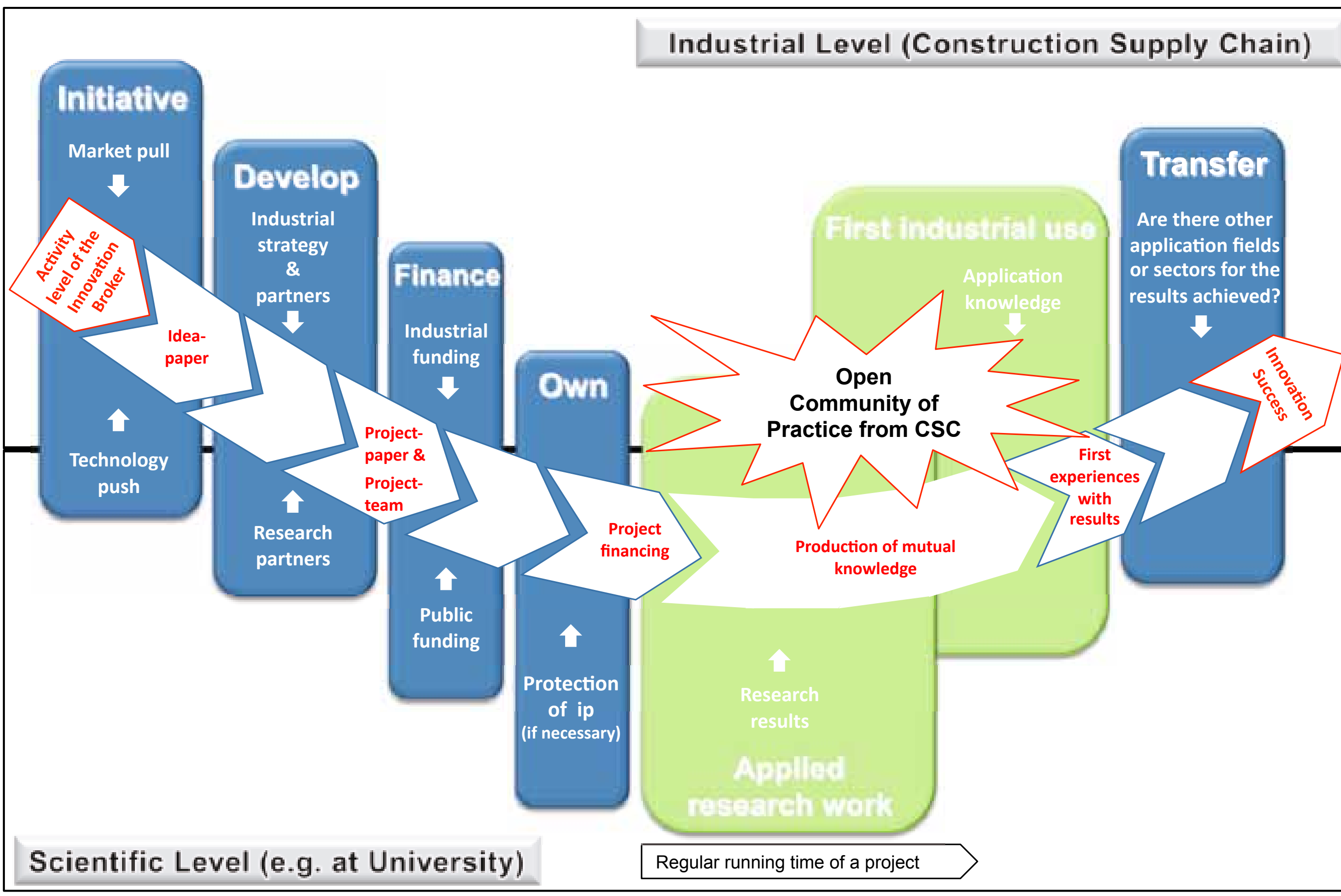

Fig. 2: Modified model of cooperative for steel application research with companies of the construction supply chain (CSC)

The role of the in-process IB with the described task profile brings about a reduction in the interface problems that are initially present at the gates throughout the innovation process. It makes a considerable contribution to the achievement of interim results in the individual phases and therefore to quality assurance and process flow. The vertical phase shift in the additionally inserted industrial and scientific levels shows, which partners are most actively involved in which phases. The IB is active here as a link between the levels. The establishment of the innovation-open, knowledge-creation-oriented COP in the described manner results in an overlap between the research and use phases, thus bringing about an application-oriented research and transfer process. The CR process now emerges as an integrated, innovation-open system, in which cross-sector continuous accompaniment from idea to successful implementation is ensured.

Conclusions and outlook

For the FOSTA, the use of the described integrated model is a viable practical option for addressing possible weak points in the process, as well as the specific innovation characteristics of SMEs. The objectives of implementing the model can be summarised as follows:

(1) consistent development of the, until now, often sector and function-oriented make-up of the working groups in order to arrive at innovation-open, theme-oriented COPs, which contribute to the knowledge creation of all participants and can be used SMEs without them first having to overcome barriers to entry;

(2) development of the gatekeeper role to that of an IB in the total CR innovation process;

(3) the establishment of an integrated systematic vision within the management of CR, in order to foster a uniform understanding of the process among the participants and to open up CR for future interdisciplinary research themes in the construction industry.

As a first application example, in 2009 the FOSTA initiated a research cluster on the theme of "sustainability in structural steel engineering". With the proposals of more than 100 scientific institutions and the participation of a large number of representatives of industry, a joint research package was developed in the early innovation phases with the help of an IB-function. The establishment of an interdisciplinary COP under the guidance of the IB is planned for the research phase to ensure that application-oriented research and the transfer process proceed in parallel. At the same time the FOSTA, within the context of accompanying research with Kingston University, London, and University of Applied Sciences and Arts, Holzminden, will analyse project-accompanying processes between science and industry and expand the activities profile of the IB and the CR model for future projects. The desired improvement in efficiency is then no longer related to the application-appropriate and transfer-appropriate research process but to the employment of public sector and industry finance.

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