



Twenty Years of Successful Translational Research: A Case Study of Three COMET Centers

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Abstract. The term ‘translational research’ is traditionally applied to medicine referring to a transfer of scientific results into practice, namely from ‘bench to bedside’. Only in recent years there have been attempts to define *Translational (research in) Computer Science* (TCS), aside from applied or basic research and mere commercialisation. In practice, however, funding programs for academia-industry collaboration in several European countries – like the Austrian COMET Program and its predecessors which include opportunities for Computer Science institutions – already provided a unique framework for TCS for over two decades. Although the COMET Program was initially set up as a means of temporary funding, a majority of the partaking institutions have managed to stay in the program over several funding periods – turning it in a de facto long-term funding framework that provides a successful structure for academia-industry collaboration. How to (i) identify the key factors to the success of individual Competence Centers and (ii) maintain fruitful relationships with industry and other academic partners are the main aims of this paper.

Keywords: Computer science · Translational research · Technology transfer · Research centers · Academia-industry collaboration

1 Motivation

The transfer of technology knowledge and innovative results from universities and research institutions to industry was identified by the European Union as one out of ten key areas for action in 2007 [1]. With that intention, Austria established its first competence center program already in 1998 to increase scientific

and industrial competitiveness by fostering knowledge and innovation transfer from science to industry [2]. The follow-up program COMET (Competence Centers for Excellent Technologies) supports 25 competence centers in five sectors: digitization, information and communication technologies (ICT), energy & environment, life sciences, mobility, and materials & production.

The implementation of technology transfer in the sense of the COMET goals is particularly demanding for computer science as a cross-sectional technology characterized by highly interdisciplinary projects that require a great deal of flexibility, mutual understanding and education from all participants. Only recently, Computer Science has begun to adopt the translational research model [3] originally established by the medical domain to provide a formalized framework for the entire translation process from theory to practical use. Generally, literature highlighting implementation- and management strategies of such interdisciplinary IT projects at the border between science and industry from a research centers' perspective is still sparse. We aim at filling this gap by sharing and discussing insights, best practices and challenges summarizing over 20 years of experience of three COMET research centers in Austria performing successful research in Visual Computing,¹ Cybersecurity,² and Software and Data Science.³

2 The COMET Program

Since 1998, the COMET predecessor programs *Kplus* and *K_ind/K_net* had built up central research competencies in cooperation between science and industry in 45 centers and networks across Austria; the 'best-of' of the two programs has continued under the name COMET since 2005/2006.

COMET centers are funded by the Republic of Austria – specifically by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) and the Federal Ministry for Digital and Economic Affairs (BMDW), the participating federal states, and by industry as well as scientific partners. Together, a medium- to long-term research program is defined, with the goal to strengthen the cooperation between industry and science and to promote the development of joint research competences and their scientific and economic utilization. COMET centers are embedded in the national and federal technology strategies and in scientific, economic and political ecosystems as shown in Fig. 1. Furthermore, extending beyond challenges and problems formulated from purely market-based strategies, issues arising from digitization, climate change, aspects of sustainability as well as ethics and health, which are increasingly becoming the focus of society, are of ever greater importance to the research questions addressed in the competence centers.

According to the COMET Programme Evaluation Report [4] published in June 2021,⁴ around EUR 50 million from federal funds and around EUR 25

¹ <https://www.vrvis.at>.

² <https://www.sba-research.org>.

³ <https://www.scch.at>.

⁴ https://www.bmk.gv.at/themen/innovation/publikationen/evaluierungen/comet_evaluierung.html.

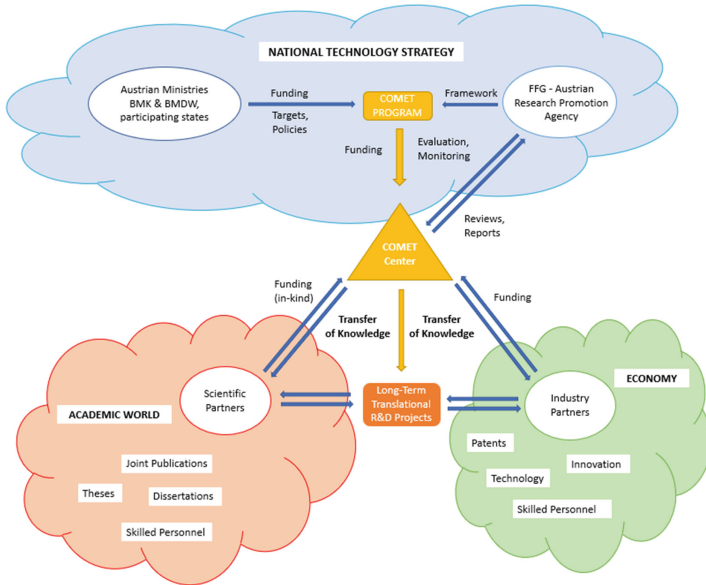


Fig. 1. Illustrating the network of relationships of COMET centers.

million from state funds flow into COMET funding. Furthermore, the report underpins the COMET funding program’s goal of establishing long-term research collaborations by illustrating the durability of established centres already funded by the initial K programs. This applies to 64% of the active COMET centres (16 out of 25). The focus of the COMET centres on applied research and the associated knowledge transfer is also underpinned by the report: 38% of project resources are spent on basic research, 50% on industrial research and 12% on experimental development. The competence centres currently employ 1,742 full-time equivalents (2,389 researchers), which in turn underlines the contribution to retaining and promoting excellent researchers in Austria.

The numbers of publications, associated theses, patent application, and the generation of revenue outside COMET are strong indicators for the success of the program. Every year, there are now around 2,200 publications connected to COMET centers, about 700 of them in reviewed journals and conference proceedings. About 7 % of PhD theses on relevant topics under progress at Austrian Universities are already associated with COMET and in the review period from 2015–2019 centers reported over 50 new patent applications. In addition, centers triple each Euro they get in COMET funding in revenue. Feedback by a majority of industry partners indicated enhancements of existing products as well as product, process, and service innovations through COMET [4]. The much needed certainty for translational style research and a sustainable academic-industry partnership can be achieved via back-to-back applications within the COMET program granting currently funding for research centers in phases of

eight years. This allows successful centers to enter a de-facto long-term funding (as demonstrated by the three centers presented in this paper). Nevertheless, longer funding periods would be beneficial for successful centers to avoid the massive overhead of repeated applications, to provide stability as a R&D partner and to attract and bind international talents. Beyond, and in the context of translational research, it is the goal to enable industry partners to independently further the advantages drawn from their collaboration with COMET centers in the long term.

3 The Three Centers

VRVis Zentrum fuer Virtual Reality und Visualisierung, Austria's leading research center in the field of visual computing, operates with around 70 researchers at locations in Vienna and Graz. *VRVis* was founded in 2000 and became a K1 center within the COMET program in 2010. With two decades of experience in application-oriented research in close cooperation with national and international partners from science, business, and industry, *VRVis*' main goal is to develop customized and innovative solutions for direct use in practice [5], using the newest technologies in visual data analytics, artificial intelligence, extended reality (XR), image processing, simulation, and digital twins.

SBA Research, located in Vienna, was originally founded in 2006 and currently employs about 130 people. This COMET center covers both the scientific- and industry aspects of information security. In addition to the COMET flagship program *SBA-K1*, SBA continuously conducts between 20 and 30 national and international research projects. The topics range from IoT- and Industry 4.0- to Internet- and software security. Questions like privacy protection or the long-term effects of digitization for our society - always with a special focus on cybersecurity - are a central concern. SBA's network encompasses national and international institutions from academia and industry alike. A special emphasis is on the creation of bridges between theoretical, scientific high-quality research and immediately usable results for company partners. In the field of professional services, the focus is on security analyses, both in the organizational and technical areas. In this regard, SBA has been working with ministries, public authorities, large companies, and SMEs for many years.

SCCH (Software Competence Center Hagenberg), is a non-university research center founded in 1999 by the Johannes Kepler University Linz. Since then, the center has continuously been growing and currently employs over 100 people. Since 2008, *SCCH* is supported as a K1 center within the COMET program. *SCCH* drives innovation in the creation and application of software by integrating fundamental research with the solution of complex application problems. *SCCH* acts as an interface between international research and regional industry and business. The center conducts research along the full AI system engineering life cycle focusing on linking Software and Data Science [6] in the areas of intelligent

software testing, software evolution and documentation, user-centred software engineering, big/stream data processing, smart data discovery, fault detection and identification, and predictive analytics and optimization.

4 Factors for Successful Translational Research Within the COMET Framework

Close collaboration with industry partners is one of the core tenets of the COMET funding program. Companies joining a COMET center not only contribute money, but also the time and expertise of their employees as well as information about their business, R&D efforts, and research needs. Therefore, mutual trust between the COMET center and the company partner is crucial, and a lot of time and effort is allocated to building these relationships. In the following, we want to outline how we establish partnerships, mutual understanding, trust, and knowledge and technology exchange with long-term impact. We report on our experiences and established practices, how we manage sector-specific goals and tackle the challenges arising from fast-changing business environments and new digital technologies. As competence centers, we also maintain relationships with other scientific institutions, which is a further topic we will place a focus on. To conclude, we will pay particular attention to the topic of knowledge transfer between the scientific world and industry.

4.1 Initiating Successful Industry Collaborations

The first steps towards a successful long-term relationship are made when the collaboration is initiated. In all of the three centers, similar patterns have emerged for supporting industry partners in finding their way to joint R&D activities from individual and often very different starting points.

Individual Contact Points for Companies. What does it take for a company to join the COMET program? Written agreements regarding, e.g., IPRs and rights to publish, are typical legal cornerstones. However, ultimately it is the strong personal relationship that staff of COMET centers establish with their industry counterparts which drives those partnerships. While it may occur that a company approaches a COMET center directly, the initial contact usually unfolds via personal networking at industry events, attending low-threshold formats like Meetups, or using the services of dedicated platforms (e.g., Austria Start-ups) or semi-public bodies like the Vienna Business Agency; the latter provides ‘match-making’ in both directions, supporting companies with research needs as well as research centers in search for a industry partner suitable for a given scientific endeavor. Given that the industry partners range from local SMEs and Start-ups to large multi-national corporations, COMET centers and their administrative and scientific employees are well-versed in adjusting to a variety of company cultures, complying with very diverse procedural requirements, and meeting research needs in all shapes and sizes.

A Joint Path to R&D Activities. If the first contact sparked mutual interest - and assuming that the company in question has not yet worked with a research institution - the following unfolds: First, acquainting the company with the world of research and the related funding landscape. This often takes place via small-scale funding schemes which facilitate projects running three to twelve months (a path to structured R&D activities, e.g. funded by FFG) and are independent from the COMET program. They can usually be applied for with comparably little effort and funding decisions are swift. Here, COMET centers share their extensive know-how regarding grant applications, since especially start-ups and SMEs often do not have first-hand experience with such matters. On occasion, especially bigger companies might even commission research at a COMET center, with the same effect of building a first bridge between these two parties from science and industry.

Common Language and Mutual Understanding. Secondly, embarking on the process of clearly defining the research and/or innovation need, establishing common ground and a shared vocabulary, so that all people involved eventually speak the same language. This may take place through in-depth workshops between research groups and industry experts during which problems are defined, available state-of-the-art solutions are discussed and evaluated, and initial R&D roadmaps are agreed upon. In other cases, a center's management and/or specialized personnel manage this initial phase and see to it that researchers, practitioners, and managers come to the same understanding of a given research endeavor. In the mid-term, these efforts lead to small- to medium-sized projects which give all parties involved a sense of how cooperation works out and if a more long-term collaboration - as in the COMET program - is of interest. Lastly, it should be mentioned that even working on a grant application together, regardless of if the project gets funded or not, is a very effective way to build a rapport between science and industry. In more than one instances, 'failed' project proposals have led to mutually beneficial partnerships in the long run.

4.2 Maintaining Long Term Relationships with Industry Partners

Given its runtime - eight years per call, and successful centers usually get granted back-to-back funding - the COMET program offers an excellent precondition for long-term partnerships between science and industry. The COMET centers featured in this paper have been up and running for more than 20 (VRVis, SCCH) resp. 15 (SBA) years each, and some of their company partners have been with them from the very beginning. How is this long-term relationship accomplished, especially in the fast-paced world of ICT?

Flexibly in Adapting to Cooperation Requirements. First and foremost, investing time and effort in building company-center relationships and, thus, firmly establishing mutual trust is the very foundation of successful long-term partnerships. Taking the time to align diverging mental models, to foster a joint

understanding of and respect for the needs, abilities, goals, and constraints of all involved parties and to be responsive and accommodating should issues arise has proven crucial in maintaining a center's relationship with their industrial partners. Secondly, although it might take time for a company to be willing to become a COMET partner, once this decision is made, the further procedures are straightforward. A company can join a center, and joint work on R&D challenges can start the following day. Nevertheless, it is also quite unbureaucratic to scale a company's involvement up or down throughout the project, or to even release an industry partner from its obligations. Avoiding a lock-in situation is essential for industry partners, since they have to compete in a dynamic market environment where strategic plans are subject to change when new business opportunities arise.

Stability of the Research Program. Being able to handle the discrepancy of how research and industry operate differently in terms of available funds, time and personnel resources is a central asset of COMET centers. This is on the one hand thanks to the program's structure which favors multi-firm projects to exploit synergies and promote cross-company knowledge transfer, as well as to ensure the continuity of a COMET project, even if an industry partner should leave. On the other hand, industrial partners are provided with a stable group of contacts at COMET centers which employ their staff via permanent contracts (as opposed to universities which usually have substantial fluctuation at the MSc and PhD level). Personal contacts are essential in maintaining long-term working relationships between organizations. Good personal relationships and a sense of how the other party works is also very important when it comes to other possible fields of tension, most notably with regards to IPR strategies vs. a researcher's need to publish.

Impact by Translational Research. COMET centers and their partners contribute substantially to getting research results from the *laboratory* to the *locale*: while the centers further develop along the edge of the state of the art, companies do apply the research outcome in their field of business. Thanks to the close collaboration, feedback from the application of research results in practice is immediate, and lessons can be learned quickly. Through incremental research strategies, known scientific methods can be translated into industry practices, and experiences from these practices are fed back to the researchers. While industry does depend on cutting-edge research by scientific institutions, those institutions are in turn dependent on insights into the issues and needs of companies 'in the wild' - a COMET center working in the field of ICT must be able to reorient itself constantly to stay at the forefront of research and meet the needs of its industry partners. However, this to-and-from does not happen via joint projects and knowledge exchange alone. COMET centers are a unique place where people are trained on the interface of science and industry, thus making career changes between those two domains easier. With personnel, one

may postulate that also knowledge and expertise translate from the laboratory to the locale and back.

4.3 Teaming Up with Academia

In general, COMET centers build upon stable networks of national and international scientific partners who are directly involved in the COMET program. These networks form the basis for transferring knowledge from basic research and ensure through close collaboration the firm embedding of the COMET center's research agenda in a national and international context. The composition of academic partners is shaped on one hand by the need for a strong local network of academic partners supporting directly the research agenda of the COMET center, and on the other hand by the need for complementary expertise and exchange on an international level.

Complementary Scientific Contributions from Academic Partners. As specified by the COMET program, *key researchers* are selected based on the core topics of and recruited from these institutions. These are recognised scientists who, with their expertise as advisors, scientifically accompany research projects and the centre management in strategic decisions. They also often take over the academic supervision of students and doctoral candidates working on research projects at the center and, thus, contribute to a direct knowledge transfer between the university and the research centre.

The core network of academic partners is complemented by an extended network of associated academic partners with whom cooperation takes place either within the framework of non-COMET projects or within the framework of the strategic work on a more informal level, e.g., in the form of joint publications, co-supervision of doctoral students, and exchange of scientists.

Conversely, the scientific partners also benefit from insights into practical problems in the context of industry. COMET centers add a complementary application-specific perspective to the academic view on a research topic: the challenges of transferring theoretical results and proof-of-concepts from a laboratory setting into the typically much more complex environment of the real-world application.

Application-Relevant Knowledge and Talent Exchange. Effective collaboration between academia and a research center is frequently implemented in form of PhD- and master students involved in project work with industry and supervised by research partners. Four-year funding periods, including strategic projects, allow for PhD work at our academic partners with some distance to the 'daily business' of industry projects. This enables deep-dives into specific research topics, while supported with practical research questions and real use cases for evaluation.

Direct talent transfer from universities and scientific partners to the COMET centers ensures inflow of fresh academic knowledge and is quite common due

to attractive working conditions and unlimited working contracts. The transfer from personnel back to the universities, still rather infrequent, is supported by all centers in order to enable all kind of research careers and to further strengthen the relationships to academia.

All three COMET centers are also active research institutions by themselves, showing a strong presence of the centers' key personnel in the respective research communities in terms of scientific contributions and engagement in scientific events like the organization of conferences and workshops at national and international level, being editors of special issues in journals, and participation in reviewing, scientific committees and associations.

4.4 Conducting Knowledge and Technology Transfer

The transfer of knowledge originating from basic research to the application domain, which is in the focus for industry, is a core task as well as a core competence of COMET centers. In the course of the many years of experience of the three centers described above, several best practices have been established to master this multifaceted challenge.

Direct Collaboration in Joint Projects. One of the most important and frequent opportunities for knowledge transfer results from direct collaboration in joint projects – whether within the COMET program, other funded research projects, or directly commissioned projects. Knowledge transfer happens through regular exchange at project meetings, working together on technical and scientific tasks, regular content-related discussions and retrospectives, as well as jointly prepared reports and scientific publications. Direct collaboration in the context of ongoing project work provides the opportunity for exchanging experience and best practices regarding processes, methods and tools, scientific approaches and technologies. Employees of company partners participate in the project to learn about new practices and technologies, e.g., from the subject area of ML/AI, Visual Analytics, or security.

Frequency and intensity of exchange activities vary and need to be customized according to research topic, project and funding type, company culture and size. In multi-firm projects, knowledge transfer also happens through COMET center staff being involved in the collaboration with different company partners over time and promoting spill-over effects. In such a cross-company settings, several companies may have the same, similar or complementary research needs, but at (slightly) different times, and synchronization is not always possible in these cases. COMET project staff therefore 'buffers' relevant knowledge and transfers it between companies when needed. Furthermore, in addition to collaboration in the course of project work, dedicated knowledge transfer workshops are organized not only for individual companies but in the form of joint events in which all companies of a multi-firm project take part.

Transfer of Personnel. Knowledge transfer is also supported by personnel exchange during the project duration, i.e., a COMET employee may stay with the partner company for a limited period of time or vice versa. Student interns working in collaborative projects are considered especially helpful in translating scientific knowledge [7]. In general, access to excellent personnel is seen as a major advantage by corporate partners. Regardless of the personnel transfer, whether from the research center to the company or vice versa, this strengthens mutual relationships and even paves the way for new projects and partnerships.

Transfer Events Beyond Project Collaboration. In addition to joint projects with company partners, special funding programs such as *Innovation Camps* of the Austrian Research Promotion Agency (FFG) allow to translate COMET research results into workshops and trainings for a broader audience, beyond the partners in established collaborations. Several other instruments for knowledge transfer include cluster initiatives, joint hackathons, community building events such as meetups or tech talks, special interest groups and networks that enable knowledge exchange with industry outside of dedicated projects.

In a long term perspective, being able to convey scientific research to diverse target audiences and stakeholder groups, ranging from youth to laypeople, other researchers, practitioners, management and many more are key success factors for knowledge transfer to industry and society in general.

5 Conclusion

VRVis, SBA Research, and SCCH are three instances of research centers operating in the frame of the Austrian COMET program. All three centers have a long and successful history of knowledge and technology transfer in collaborating with industry. In this paper we showed that *translational research*, a concept adapted from medicine to Computer Science, has in fact been practiced by Austrian COMET centers for the last two decades. The following cornerstones facilitate such successful translation of research results *from laboratory to locale* and into industrial applications:

- The first step towards a successful long-term industry collaboration is to offer **individual contact points for companies** starting into R&D activities with different levels of experience, background, and culture.
- Furthermore, defining the **joint path to R&D activities** together with prospective company partners helps them to get acquainted with the world of research and the related funding landscape through joint small-scale projects or commissioned research.
- In the course of such endeavors, strong working relationships are built and **a common language and mutual understanding** is established as basis for long-term collaborations with industry partners.

- Maintaining **flexibility in adapting to cooperation requirements**, also in the course of ongoing collaborations, is a key strength of COMET centers, which allows to accommodate the inevitable changes companies are facing in their usually highly dynamic business environments.
- At the same time, the COMET centers' **stability regarding their research program** over at least four years guarantees the necessary continuity to stay focused on a clear research vision and agenda.
- **Impact by translational research** is accomplished through the centers' further developing along the edge of the state of the art, while the companies are applying the research results in their domain. Close collaboration allows for immediate feedback from applying research results in practice.
- **Complementary scientific contributions from academic partners** support the high scientific standards and output of the centers' research projects. Active scientific partner networks also ensure intense knowledge transfer between universities and research centers.
- **Application-relevant knowledge and talent exchange** offer on the one hand a complementary application-oriented perspective about academic research; on the other hand, direct talent transfer from universities benefits the COMET centers, while transfer from personnel back to the universities is supported as well.
- Knowledge and technology transfer to industry is typically achieved via **direct collaboration in joint projects** at regular project meetings as well as through active and direct technical and scientific collaboration. Transfer activities are tailored to the respective research topic, project type, as well as company size and culture.
- Additional **knowledge transfer via exchanging personnel** usually takes place during a given project. Access to excellent personnel is seen as a particular advantage by industry partners, and such exchange strengthens the mutual relationships between the centers and their partners.
- **Transfer events beyond project collaboration** serve the dissemination of project results and novel solutions to a larger audience. Instruments of knowledge transfer include, but are not limited to the participation in open science initiatives, community networks, and public events.

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