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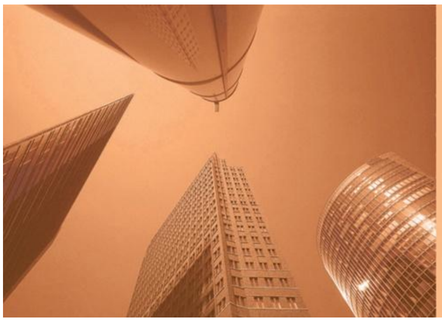

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# Public-private partnerships in Research and Innovation - Case studies from Australia, Austria, Sweden and the United States

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# Introduction

The 'Forschungscampus' programme (research campus) was initiated by the German Federal Ministry of Education and Research (BMBF) in 2011. It is the most recent and certainly one of the most ambitious initiatives by the federal government affecting the regional engagement of universities in Germany. What makes the 'Forschungscampus' programme so unique and at the same time so ambitious is that it goes far beyond of what similar interventions until now have been intended in terms of strategic, long-term private-public research partnerships which are institutionally and organisationally embedded in a certain region. Thus, with the 'Forschungscampus' programme the federal government implemented a new instrument to initiate and strengthen co-operations related to research and innovation. One of the basic assumptions of this particular approach is the observation that medium- to long-term research co-operations at the interface between science and business to unlock, bundle and exploit research results are becoming more and more important regarding the capability of Germany as an innovation location.

The 'Forschungscampus' programme features a combination of three distinct characteristics:

1. Proximity – the bundling of research activities and competencies at one location, as possible on a university or public research campus,
2. the medium- to long-term adaptation of a specific research topic, ideally in the frame of a research programme,
3. a mandatory public-private partnership.

A 'Forschungscampus' integrates a critical mass from science and business regarding research in a future-oriented subject. From the business sector, several companies are engaged in the Forschungscampus, ideally SMEs. However, it turned out that large (multinational) companies are mainly the drivers within the campus. From the science sector, one or several universities have to be involved. Furthermore, one or more non-university research centres should be engaged. Currently, nine different 'Forschungscampi', which have been selected in the course of a competition, are operating. Each selected 'Forschungscampus' will be funded by 1-2 million Euro per year over a total period of up to 15 years. In addition, the business companies and other partners which are involved in the RC will supply significant own contributions, at least at the same amount as public funding.

In addition to the selected 'Forschungscampi', the Fraunhofer Institute for Systems and Innovation Research ISI, Karlsruhe, was commissioned together with the Institute for Innovation and Technology in the VDI/VDE-IT GmbH, Berlin, to carry out a four years accompanying research in order to support the 'Forschungscampi' in their development process, to monitor developments, to promote information exchange and to analyse the field of university-industry collaboration scientifically in an international perspective.

Public-private partnerships in research and innovation are not only a subject in Germany, but also in other countries, where some already much longer experiences with respective measures exist (cf. Table 1). Influenced by the model of the Industry/University Cooperative Research Centers (I/UCRCs) in the USA, which operate since 1979, the National Centres of Excellence are operating in Canada since 1989, the Cooperative Research Centres in Australia since 1990, the Swedish Competence Centres since 1994, and the Austrian K1 and K2 Centres of the COMET programme since 2006.

Table 1: International Public-Private Partnership Programmes

| Country | Name | Duration | Responsibility | Type |
|---|---|---|---|---|
| **Australia** | Cooperative Research Centres | since 1990 | Ministry of Industry | Competence Centre |
| **Austria** | Kplus / Kind, Knet;<br>COMET | 1998-2009;<br>since 2006 | BMVIT/TiG, FFG<br>BMWA/FFG | Competence Centre |
| **Estonia** | Competence Centres Estonia | 2004-2007 | Ministry of Industry | Competence Centre |
| **Finland** | Strategic Centres for Science, Technology and Innovation (SHOK) | since 2006 | TEKE | Competence Centre / Cluster |
| **Canada** | National Centres of Excellence (NCE) | since 1989 | NSERC, CHIR, SSHRC | Network |
| **Norway** | Centres for Research-based Innovation Scheme (SFI), Centres of Excellence scheme (SFF) | 2006-2014 | Research Council of Norway | Competence Centre |
| **Sweden** | Swedish Competence Centres Program<br>VINN Excellence Center | 1994-2003;<br>2003-2018 | NUTEK/STEM/<br>VINNOVA | Competence Centre |
| **USA** | Engineering Research Centres (ERC), Industry/University Cooperative Research Center (IURCR) | since 1985<br>since 1979 | National Science Foundation | Competence Centre |

Within the scope of international comparisons, one aspect of the accompanying research was to look at programmes and centres similar to the 'Forschungscampi' in other countries. As a result of a selection process, it was decided to analyse the Australian CRC programme, the Austrian K1 and K2 centres of the COMET programme, the Swedish VINN Excellence Centers and the American I/UCRCs.

This report contains four respective case studies. The objective of the case studies was to understand the programmes and their implementation/execution better, to obtain impressions from a few centres and to use this knowledge in order to draw conclusions for the 'Forschungscampus' programme and the nine 'Forschungscampi'. Interviews were carried out in the four countries between July 2014 (Austria) and February 2015 (USA). We would like to thank all people who supported us in our case studies as interview partners or through organisational assistance.

A summary in German is provided at the end of this report.

Knut Koschatzky

July 2015

# I Case Study Australia - Cooperative Research Centres Program

*Knut Koschatzky, Anne Dwertmann*

## 1 Background information and objectives of the program

The Cooperative Research Centres Program (CRC) was established in 1990 and started operation in 1991. According to the first program guidelines in 1990, the CRC program was intended to "link and build on outstanding research activities in the public and private sectors. Emphasis will be placed on enhanced research cooperation achieved through concentrating research activities in one location, or through effective methods of networking; strengthening research training; and on the economic and social benefits of research" (CRC Program: Guidelines for Applicants 1990; cited in Australian Government 2014a).

To our knowledge, there were no previous activities to the CRC program. It is also not known whether there was a precise role model for the program, but probably international programs aiming at similar objectives were looked at or analysed. At this time, the University-Industry Research Centers program (now Industry/University Cooperative Research Centers) was already under operation in the USA (starting with a pilot scheme in 1972), and also the Knowledge Transfer Partnerships in the UK as another form of cooperation between a company and an academic organisation was an early activity which started in the 1970s (Koschatzky et al. 2008; Koschatzky 2013).

In a discussion paper underlining the recent review of the program, comparable activities like the Catapult Centres in the UK, the Network of Centres of Excellence in Canada, and the Fraunhofer Gesellschaft are mentioned as possible benchmarks to the CRCs (Australian Government 2014a, 5-6).

The **Minister** (in 2012 for Tertiary Education, Skills, Science and Research, in 2014 for Industry and Science) has the overall responsibility for the program, appoints program delegates and authorises them to carry out certain functions. The **Department of Industry and Science** (formerly the Department of Industry, Innovation, Science, Research and Tertiary Education) is the Ministry responsible for administrating the program. It provides secretariat support to the CRC Committee and seconds experts for certain supportive or administrative functions. The **CRC Committee** provides recommendations to the Minister regarding CRC funding, performance and monitoring of CRCs, and the planning, monitoring and evaluation of the whole program. The Committee has 14 members of which one is an independent chair, nine are independent members appointed by the Minister for up to five years, and four are ex-officio members.

The independent members should reflect on needs of the program like research, education, utilisation, management, industry and end-users.

The major objective of the CRC program is "to deliver significant economic, environmental and social benefits to Australia by supporting end-user driven research partnerships between publicly funded researchers and end-users to address clearly articulated, major challenges that require medium to long-term collaboration efforts" (Australian Government 2013a, 1). In its major objective, the CRC program is close to Forschungscampus, especially with regard to the generation of benefits to the economy, the environment and society, and addresses major challenges that require a medium- to long-term perspective. A difference is the use of the **term 'end-user'**. End-users are public or private entities "capable of deploying the research outputs to deliver significant economic, environmental and/or social benefits" (Australian Government 2013a, 2). According to the recent CRC Directory (Australian Government 2014b), the mix of end-users and the number of essential participants strongly depends on the topic of each CRC. While the Bushfire and Natural Hazards CRC has the highest number of essential participants (n = 43), the Dairy Futures CRC and the Space Environment Management CRC have only three essential participants each. As a matter of fact, companies (in Ltd. or Inc. format) usually play a much greater role as end users in CRCs with a higher number of essential participants. In the Australian Seafood CRC, 14 of 23 essential participants are private entities, whereas the Bushfire and Natural Hazards CRC is clearly dominated by public agencies (Fire Services, Fire Protection Association, Fire Brigades, Red Cross) and universities. In the thematic fields of mining and manufacturing, the number of private entities/companies is generally higher than in the fields of agriculture/forestry/fishing and services. It can be concluded that so far the CRC program is more open regarding partnerships than Forschungscampus with its orientation on 'industry'.

In the course of its development, the **CRC program underwent some changes** regarding governance, the funding model linked to performance reviews, the communication of the research findings, and the specific focus towards CRC's contribution to Australia's industrial, commercial and economic growth.

There is no direct integration of other programs, but according to the program guidelines other sources of government funding (e.g. by other ministries, research councils and activities like AusIndustry, Commercialisation Australia) may be used (subject to the respective funding rules).

## 2 Integration of the topic "science-industry cooperation" in the innovation system

One of Australia's problems is the low intensity in science-industry collaboration. In his paper "Science, Technology, Engineering and Mathematics: Australia's Future", the Chief Scientist of Australia, Professor Ian Chubb, wrote that **Australia lacks the engagement between business and research to get good ideas to the market**. He states that "across the OECD, Australia ranks 27th on business to research collaboration for small to medium enterprises (SMEs), and 28th for large firms. Of our large firms, only 3.3 per cent collaborated with research organisations: slightly above the level of collaboration - 2.3 per cent - by our SMEs" (Australian Government Chief Scientist 2014, 10). He therefore recommends to "design and deliver new models for collaboration for maximum impact (for example, the UK's Catapult Centres and Knowledge Transfer Partnerships)" (ibid, 18).

In the **"Action plan for a stronger Australia: Industry Innovation and Competitiveness Agenda"**, the Department of the Prime Minister and Cabinet emphasizes several times that it will be necessary to improve and foster collaboration between research (researchers) and industry (Department of the Prime Minister and Cabinet 2014). One of the proposals to address this deficit is the Industry Growth Centres Initiative which, among others, should "improve collaboration between businesses, scientists and researchers, enabling the adoption of new processes and development of new products" (www.industry.gov.au/industry/pages/industry-growth-centres; accessed 25-11-2014).

The **Industry Growth Centres Initiative** should lift competitiveness and productivity by focusing on areas of competitive strength for Australia. National key issues like deregulation, skills, collaboration, and commercialisation should be addressed. The main focus of the initiative will be on **five growth sectors**: food and agribusiness; mining equipment, technology and services; medical technologies and pharmaceuticals; advanced manufacturing; oil, gas and energy resources. Out of the five sectors, three are related to primary products and their processing. The growth centres are aimed at improving collaboration between businesses, scientists and researchers, to increase the commercialisation of new ideas, to identify ways to remove stifling regulation, to get more businesses to identify and participate in global supply chains and markets, and to implement skills strategies to future ready the nation's workforce. **Growth centres will be not-for-profit organisations led by industry leaders**. They will be rolled out from early 2015. For the first four years, a **budget** of 188.5 million AUD (129.3 million euros) will be available (which is an **annual average of around 46 million. AUD**). Of the whole budget, 63 million AUD will be available for market development, value chain or technology issues in order to deliver commercial output. 60 million AUD will be devoted on a competitive basis to covert high potential ideas into profitable commercial realities. Additionally, a new information technology platform (website, stakeholder support, online collaborative tools) will provide the basis for collaboration and extending the reach of the growth centres. With regard to the overall objectives of the initiative, **four major tasks** should be fulfilled by the centres: increasing commercialisation opportunities, enhancing workforce skills, addressing regulatory barriers, forging closer links with supply chains in their sector, and building export ready capabilities. To turn these tasks into practice, the growth centres should develop and implement a roadmap to lift sector competitiveness, to provide advice to the Government on how to reduce the regulatory burden, and to develop annual industry knowledge priorities to help inform the research sector of industry needs and commercialisation opportunities (see http://www.business.gov.au/advice-and-support/IndustryGrowthCentres/Pages/ default. aspx; accessed 20-03-2015).

It is interesting to note that despite a long-running and successfully evaluated program which is aimed at the promotion of science-industry linkages, i.e. the CRC program, the **cooperation intensity between science and industry is still low** and regarded as a substantial problem. During the case study interviews it was argued that the **CRC program** was a success with regard to punctual, local-regional project-related collaborations, but **was unable to change the overall collaborative behaviour**. The new Industry Growth Centres Initiative is not a substitute for the CRC program, but should complement it in a way of a network model with hubs and spokes that has no geographic focus, but operates nation-wide. Through this broader approach and the inclusion of five key growth sectors, it is an **industry-driven initiative** which is expected to have a more substantial effect on collaboration patterns than it was possible through the CRCs. However, it was critically noted in interviews that the budget for the Growth Centres is much too small and that they will never reach financial sustainability after such a short time.

In 2013, the Labor Government planned to commit 500 million AUD to establish up to 10 Industry Innovation Precincts in order to bring businesses, universities and research institutions like CSIRO together to pursue industry-led research projects (see http://caesie.org/news/2013/2/18/industry-innovation-precinct-to-create-jobs-of-the-future; accessed 20-03-2015). However, only two of these Precincts were realized, the Manufacturing Precinct and a Precinct devoted to the food sector. The program was abandoned under the recent Abbott government. This illustrates that Australian government policy concerning research and innovation can undergo substantial changes depending on the ruling party, and this lack of stability was criticised throughout a number of interviews (see http://www.chifley.org.au/a-policy-when-you-dont-want-a-policy/; accessed 20-03-2015).

The Industry Growth Centers Initiative is an interesting change in Australia's industry and innovation policy. In Germany, network promotion on a nation-wide scale was a popular instrument in the 1990s and early 2000s by supporting closer linkages between the research sector and industry (e.g. 'Kompetenznetze'), followed by a more localized cluster approach and now the 'Forschungscampus' initiative which is based on the concept of proximity between its different partners ("under one roof"). Australia, on the other hand, started with a program in which geographical proximity between the participants of a Cooperative Research Centre at least sometimes played a role, while nowadays this geographical focus is seen as being too narrow and is complemented by a non-geographical perspective through the Industry Growth Centres. Also in Germany, not all recent cooperation programs highlight geographical proximity (e.g. ZIM), but on a more general level, the Growth Centre Initiative and Forschungscampus are two opposite developments. In this respect, one has to take into account that Germany and Australia have very different geographic conditions which might make a 'Forschungscampus' approach more difficult in Australia.

Another model focussing on the concept of co-location are the **"Precincts"**. A precinct is an attractive location for organisations and people interested in a high level of scientific excellence and scientific research. Precincts focus on certain technologies or scientific fields and are part of urban development. Due to the necessity of face-to-face contacts and collaboration (implicit knowledge, joint use of laboratories and technical infrastructures), spatial proximity is an important requirement. Nevertheless, the local collaboration is complemented by a well-developed international connectivity. This connectivity is evident through research networks with universities and other research institutes abroad, but also through the creation of attractive working environments which attract researchers from other countries to come to Australia for temporary or permanent work. One example is the Parkville Biomedical Precinct in Melbourne which is part of the area covered by the University of Australia (see Figure A-1). The Parkville Precinct was said by interview partners to be a grassroots initiative which at first did not receive government funding.

Due to their scientific research focus, the explicit co-location principle, and their impact on urban development, precincts have at least these aspects in common with a Forschungscampus. While both the CRC and the Industrial Growth Centres program do not claim to organise research 'under one roof' or at least in spatial proximity, precincts do and are therefore comparable to a Forschungscampus, although more from the research and not so much from the industrial collaboration side.

# 3 Execution/Implementation of the CRC program

## 3.1 Responsible Ministry or any other organisations

The responsible Ministry is the Department of Industry and Science. The **Minister for Industry and Science** has the whole responsibility for the program. The **CRC Committee** provides recommendations to the Minister regarding CRC funding, performance and monitoring of CRCs, and the planning, monitoring and evaluation of the whole program.

## 3.2 Target group and their role

**End-users** either from the private, public or community sector and **higher education institutions** (or a research institute affiliated with a university) are e**ligible for funding.** These are the essential participants and among the two groups must be at least one Australian entity each. **Essential participants** are required to contribute resources to the CRC. In the course of time, additional participants may be secured or existing participants substituted (including essential participants). None of the participants are required to commit for the full funding period. Nevertheless, stability is an important criterion and flexibility in participant commitments must be balanced against stability. Through its monitoring activities, the CRC Committee assesses whether changes in the composition of essential participants affect the CRC's capacity to undertake the proposed activities and advises the Minister respectively. No specific roles are attributed to the members of a CRC in the program guidelines.

## 3.3 Selection process

The **selection of proposals** is done by the CRC Committee in the way of a "competitive merit-based selection process", supported by the Department of Industry and Science. Applications are assessed against the following **selection criteria**: **(1) research, (2) results, (3) resources**. Successful applications need to score highly against each criterion. Regarding the **first criterion**, a research program must be developed including the proposed milestones and outputs (plus a complementary education and training program and an SME engagement strategy). The assessment is based on excellence and innovativeness of the research and its relevance to the end-users (plus the track record of the key researchers). With regard to the **second criterion**, applicants must clearly describe the outputs of each research program and the IP arrangements. A robust estimation of the expected results (new or improved goods, services, processes, technologies), the time frame and the importance of the impacts to Australia has also to be provided. This includes a quantitative analysis on the expected return on investment. Assessments of the proposals focus on adequacy and appropriateness of the IP arrangements, the proposed utilisation strategy and the potential to deliver substantial benefits to Australia. For **criterion three**, the quality of the leadership team and the details of the collaboration are of major importance. In this respect it is important that all program leaders and senior managers must commit more than 50 % of their time and effort to the CRC. Assessment focuses on the need for a collaborative effort to address the major challenges, the relevance of domestic and international partners, and the appropriateness of the governance and management structures.

There is a two stage application process in which **stage 1** includes an evaluation by the CRC Committee, supported by expert advice. Criteria are eligibility, participant contributions, the just mentioned three selection criteria, Government priorities, and all other applications. As a result of this first stage, a shortlist will be prepared which includes those applications which qualify for stage 2. In **stage 2**, interviews will be conducted by a panel drawn from the CRC Committee and independent experts. The interviews are made with key personnel of the planned CRC. The interview panel makes recommendations to the full CRC Committee which, in turn, makes funding recommendations to the Minister. The Minister, finally, decides which CRCs will be funded. An overview on the application process is shown in Figure A-2.

## 3.4 Funding model and specific public funding in total

A specific limit for funding for each CRC does not exist. According to the program guidelines, "the total amount of funding available to the Program is limited by Appropriation" (Australian Government 2013a, 4). Since 2008, **successful applicants have received on average 3.6 million AUD per year**, but funding for individual CRCs has ranged up to 47 million AUD. Besides, it is possible to use other sources of Australian Government funding. Nevertheless, as part of the 2014/15 Federal Budget, the Government has decided to reduce funding for the CRC Program by 80 million AUD over the forward estimates. As a result of this decision, the 17th selection round (2014) did not proceed for new applicants (see http://www.business.gov.au/grants-and-assistance/Collaboration/CRC/ Pages/default.aspx; accessed 11-02-2015).

Funding is granted for a period of up to **five years**. The legal basis is the public good funding mechanism. In case of satisfactory performance, further five years of funding may be granted. Under exceptional circumstances, an application for up to five additional years is possible (**upper limit of funding is 15 years;** according to the recommendations of the recent program evaluation the maximum funding period should be 10 years). Exceptional circumstances can be the evidence of the CRC's success, the need for continued public support, outcomes of the most recent rigorous performance review, the identification of research programs which are significant to Australia. Under these circumstances, the CRC Committee will either recommend the extension of an existing CRC or the establishment of a new CRC to the Minister. The funding model is shown in Figure A-3.

For CRCs established prior to 2009 transition arrangements to the funding model just described exist. The upper limit of a maximum of 15 years of funding applies to them as well. In the past there have been CRCs that operated for four terms, for example the CRC-ACS (Cooperative Research Centre for Advanced Composite Structures).

**Funding** should **primarily be spent in Australia** and be used for salaries for researchers and support staff, fellowships and student stipends, and direct salary on-costs, costs for research, and for capital items, i.e. equipment. **No funding** is available **for the construction of facilities** like buildings or laboratories as well as for the payment of indirect support costs of participating organisations. In cases that **funding** is **spent overseas**, expenditures **must demonstrate high levels of benefits to Australia**.

**Supplementary funding** is only possible for new programs that combine research and utilisation activities or for new utilisation activities. Through supplementary funding, new participants (end-users, SMEs) can be added to the CRC, but only when they are integrated into existing activities.

Public funding must at least be matched by participants' contributions to the CRC. These **matching funds** can be cash, in-kind, tied and untied. For determining the amount of in-kind staff matching funds, cost categories for certain staff functions are provided (e.g. program leader/senior manager 420.000 AUD, researcher/professional 220.000 AUD). Universities and publicly funded research agencies are, by the way, not required to provide cash resources.

Although CRCs that completed the maximum funding period must leave the program, alternate funding options are available to them (activities for becoming self-funding, access to complementary innovation programs such as the ARC Centres of Excellence). Another option is to become a part of another organisation.

Name and logo can be used beyond CRC funding, subject to agreement by the Department of Industry and Science.

## 3.5 Thematic focus

In **2014/15** there are **35 active CRCs** in areas as diverse as hearing, healthcare, pest management, bushfire and natural hazards management, financial markets security and the auto and aerospace industries.

There is **no pre-defined thematic focus**, only the limitation that the research and commercialisation activities should be collaborative, medium to long-term based and end-user driven.

Following a program review in 2008, participation from all industry and community sectors and from all research disciplines including humanities, arts and social sciences is encouraged.

Compared to other public programs, CRCs should deliver a **research agenda driven by major challenges** identified by industries that face them, and should develop and maintain relationships between industry and researchers to conduct this research. Additionally, CRCs are required to have **education and outreach components** in their activities (Australian Government 2014a, 8).

The following CRCs were funded through the last selection rounds:[1]

**16th Selection Round (2013):**

- Cancer Therapeutics Cooperative Research Centre,
- Capital Markets CRC,
- CRC for Sheep Industry Innovation,
- Data to Decisions CRC,
- The Hearing CRC,
- Rail Manufacturing CRC,
- Space Environment Management CRC.

**15th Selection Round (2012):**

- CRC for Alertness, Safety and Productivity,
- CRC for Cell Therapy Manufacturing,
- CRC for Living with Autism Spectrum Disorders,
- Vision CRC.

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1 A short description of CRCs can be found in Australian Government (2013b and 2014b).

**14th Selection Round (2011):**

- Plant Biosecurity CRC,
- Invasive Animals CRC,
- CRC for Low Carbon Living,
- Automotive Australia 2020 CRC (AA2020CRC),
- CRC for Water Sensitive Cities,
- CRC for Polymers.

## 3.6 Time perspective

As already described, CRCs have a **long-term perspective of up to 15 years**, although funding is split into five-year periods. The medium to long-term, end-user driven collaborative research is one of the key elements of the program. An explicit phasing-out funding does not exist, but there are **specific funding options for becoming self-funding**, or there is the **option to become part of another organisation** (e.g. Commonwealth Scientific and Industrial Research Organisation or a university). Nevertheless, all CRCs have to prepare **transition planning** for the time after the funding has ended. It should include the strategy for maximising the utilisation of its outputs (e.g. regarding IP and know-how) and the strength of its collaboration.

## 3.7 Requirements regarding forms of organisation and governance

CRCs can be established as an **incorporated or unincorporated entity**.[2] It is open to the applicants which legal form they choose. The only limitation is that they need to ensure that they have fully considered the legal and taxation implications of the structure proposed in their application and that it deals effectively with the ownership and management of IP (Australian Government 2013a, 9).

According to the program guidelines, all CRCs must employ a **governance model** which demonstrates **good practice in design** (for the application) and **good practice in execution** (for the operation of the CRC). It must also be demonstrated why the governance arrangements are the most suitable for the proposed/intended results.

The program guidelines include **eight governance principles** as recommendations for the CRC. These governance principles were developed by the Australian Stock Ex-

2 A separate legal entity created through registration under the Corporations Act 2001 or another relevant State or Territory law that provides for the creation of legal entities.

change Corporate Governance Council and adapted to the needs of the CRCs. The principles are:

- **Principle 1:** Lay solid foundations for management and oversight (establishing the roles of the board and senior executives),
- **Principle 2:** Structure the CRC Board to add value (balance of skills, experience and independence on the board),
- **Principle 3:** Promote ethical and responsible decision-making (basic need for integrity, responsible and ethical decision-making),
- **Principle 4:** Safeguard integrity in financial reporting (meeting the information needs of the CRC, accountability and attracting investment and participation from end-users),
- **Principle 5:** Make timely and balanced disclosure (timely and balanced reporting on all material matters),
- **Principle 6:** Respect the rights of shareholders/participants,
- **Principle 7:** Recognise and manage risk (effective oversight and internal control),
- **Principle 8:** Remunerate fairly and responsibly (attracting required skills to achieve the expected performance).

Besides these principles, it is necessary that CRC boards must include an independent chair person and a majority of board members who are independent of the CRC's research participants.

Another necessity is the preparation of a **transition plan** for the period after the CRC grant. Additionally, at least in the second last year of funding, or in cases where the minister has decided to terminate funding, CRCs must **develop a final strategy**, including an evaluation of their achievements, and a comprehensive plan to manage the wind-up or continuation of their activities upon cessation of CRC Program funding.

## 3.8 Relevance of spatial proximity

A specific rule that CRCs should be organized in spatial proximity or under one roof does not exist. Depending on the thematic focus, **co-location** of the CRC participants is **sometimes possible**, **sometimes**, due to the size of Australia, a **spatially dispersed** pattern emerges. This is especially the case in agricultural CRCs. Also in cases where many partners are involved, e.g. for the 80 partners of the Water Sensitive Cities CRC, research under one roof is not possible. According to the interviews carried out for the case study, **spatial proximity is not regarded as first priority**. What matters more is the end-user orientation, the excellence of the partners but also the integration of international partners. **International connectivity** is of paramount importance for Australia.

A more spatially oriented model is the **'precinct' concept** (see section 2). Precincts are leading global research and teaching powerhouses in which co-location matters and a kind of eco-system is created. This enables researchers to work together in one or closely located buildings. One famous example is the biomedical Parkville precinct on the edge of Melbourne's CBD (see http://www.mh.org.au/melbourne-biomedical-precinct/w1/i1012322/). Another example is the New Sciences Precinct at the Australian National University (ANU) in Canberra. It includes a Chemical Science Hub, a Sciences Teaching Building, a Research Building and a Combined Science Workshop (http://bfb.ministers.treasury.gov.au/media-release/040-2014/).

## 3.9 Handling of IPR

**Strict rules** or guidelines how IPRs should be regulated, **do not exist**. IP arrangements should be negotiated among all participants in a manner which maximises the benefits to Australia, the CRC and its partners. Procedures should include arrangements on determining the allocations of IP, the income from IP, and the allocations upon future wind-up of the CRC. The program guidelines also state that "**responsibility for the protection and exploitation of the IP should rest with the participant organisation** (end-user, university, publicly funded research agency or the CRC) **that has the greatest capacity for this**" (Australian Government 2013a, 16). As a matter of fact, the partners can freely regulate IP matters as long as they respect the very broad framework defined by the program guidelines. Generally, in most cases the CRC management company owns IP. In the interviewed CRC for Advanced Composite Structures, legal ownership rests with the CRC-ACS company. All patents can be out-licensed for CRC members or for third parties, even for free. For the CRC, utilization is more important than commercialization.

## 3.10 Participation of SMEs

Small and medium enterprises (in the Australian definition companies up to 200 employees) are an important target group and participants of CRCs. CRC strategies should build on the innovation and/or R&D capacities of SMEs and SMEs can participate in the CRC program. **SMEs** are regarded as **important end-users** and the CRCs have to supply an SME engagement strategy. The contribution of SMEs is not so much on the financial side, but they invest time and open up their facilities. Since Australian SMEs are mainly small and not medium, they often miss the capacity to absorb students who want to gain industry experience or get a job. A general question for CRCs is how they can engage SMEs in a better way and what kind of assistance is necessary that they could play a more active role in the CRCs. A possible way is the assistance through a voucher system.

Compared to Germany, **Australia faces similar problems regarding SME involvement**, but these problems might even be stronger because Australian SMEs seem on average to be smaller than German SMEs. As a matter of fact, the 2008 review of the CRC program recommends that SME and service industry involvement in CRCs should be specifically encouraged (O'Kane 2008, viii). The same review states that "a wider diversity of participants needs to be encouraged to optimise the opportunities for innovative collaborations. In particular, SMEs have long been identified as a vital part of the Australian economy. However, they are vulnerable; growing and developing them is a challenge. Many have little time or capacity for accessing transformative research. Their involvement in CRCs needs to be specifically encouraged. This can in part be done through providing examples in the Application Guidelines of best-practice SME involvement and information on cognate programs such as R&D Tax Concessions and the ARC Linkage grants" (ibid, 65).

## 3.11 Monitoring and evaluation

Monitoring and evaluation is an integral part of the program. The framework for performance measurement is already made explicit in the program guidelines. **Monitoring** of the CRCs starts with a **welcome visit** shortly after the CRC has commenced operation. CRC management meets with the team from the Department of Industry which is responsible for the management of the funding contract. Management matters and review processes will be discussed. After the first year, the chair of the CRC Committee and representatives of the Department of Industry carry out a **first year review**. The purpose is to get an overall impression and the identification of emerging challenges.

Independent **performance reviews** are carried out every three to four years. They include an assessment of the CRC's achievements with regard to milestones, research, education, utilisation of outputs and other possible benefits. The review is carried out by an independent expert panel, established by the CRC Committee. Typically, the panel will review all CRCs in the same sector classification in order to obtain comparable benchmarks. Additional reviews are possible from time to time, depending on substantial changes in the activities of the CRCs.

Transition planning and development of a final strategy are also part of the monitoring scheme.

A **final evaluation** of the CRC is based on the impact tool which was used for the selection process (Figure A-4). CRCs have to collect all reports, formal reviews and other information and to submit this material to the CRC Committee and the Department of Industry which will evaluate the performance of the CRC over its life. Interviews with the CRC management are part of this process. As stated in one of the interviews, this evaluation is more based on anecdotal evidence than on a real independent evaluation.

## 3.12 Assessment based on evaluations

On the program level, there have been several evaluation and impact studies so far:

- Growth through Innovation and Collaboration - A Review of the Cooperative Research Centres Programme (2015),
- The Economic, Social and Environmental Impacts of the Cooperative Research Centres Program (2012),
- Collaborating to a purpose: Review of the CRC Program (2008),
- Economic Impact Study of the CRC Program (2006),
- The Economic Impact of CRCs in Australia (2005),
- Evaluation of the CRC Program (2003),
- Measuring CRC Outcomes (2002),
- Review of Greater Commercialisation and Self Funding in the Cooperative Research Centres Programme (1998).

In the **1998** study, the following general conclusions regarding the bridging mechanisms in the Australian innovation system were drawn: "The CRC Programme plays an important role in the Australian innovation system. The CRC Programme has strong and widespread support in addressing important national objectives and developing valuable new approaches to research management and commercialisation. There is no evidence of a diminution over time in the quality of new Centres. CRCs have contributed significantly to enhancing interaction with international research organisations" (Mercer and Stocker 1998, iv).

The **2008 review is more critical**. Some of the aspects which were raised are: the high costs of bidding for CRCs, the transaction costs of involvement with them, the lack of flexibility in suiting governance and management to the needs of the partners, and the lack of an adequate return on investment for partners, especially when the CRC is incorporated. Regarding **IPR**, the report states that "despite detailed coverage of this matter in the legal agreements for CRCs, early clarity seems to be lacking. Continuing unrealistic expectations by universities and government research bodies that the IP within a CRC will generate a major financial flow to their institutions underlies many of the cited difficulties in reaching agreement on IP arrangements. This is exacerbated by the belief – encouraged by the application process – that the CRC itself will be the commercialiser of the IP resident in the CRC" (O'Kane 2008, xiii). It is suggested that "agreements would be easier to negotiate if it were accepted that the industrial/end-user partners are the logical developers of the IP, with the question of fair and reasonable returns from the industrial partner to the research providers and their institutions a matter to be negotiated, in general terms, at the commencement of the CRC" (ibid).

Among seven overall **recommendations**, it is proposed in the report that the CRC Program guidelines should be modified in order to "permit much greater flexibility than at present including in organisational structures, governance models, lifespan (typically 4-7 years but up to a maximum of 10 years where appropriate), membership arrangements, intellectual property arrangements and size of Commonwealth grant (up to a maximum of $45M over the life of the Centre)" (ibid, vii). Additionally, it was recommended that

- SME and service industry involvement in CRCs,
- a strong engagement with international research groups working on similar challenges,
- CRC applications in Humanities and Social Sciences fields

should be specifically encouraged (ibid, viii).

The **2012** study deals with the economic, social and environmental impacts of the program. The time span of the estimates of impacts goes from 1991 to 2017, and includes the activities of nearly 120 past and present CRCs**. Direct economic impacts** reach a volume of **14.45 billion AUD**, of which 6.15 billion AUD can be allocated to the agricultural sector, 5.68 billion AUD to the services sector, 1.55 billion AUD to the mining sector, and 1.07 billion AUD to the manufacturing sector (Allen Consulting Group 2012, xi). Indirect economic impacts were analyzed with regard to effects on GDP, consumption and investment. While some slight negative effects were identified on consumption (-0.01 annual percentage points) and investment (-0.05), a slightly positive effect could be recorded on GDP (0.03). The net effect on economic growth for the period 1991 to 2017 is 7.53 billion AUD, translated into an **additional average annual GDP growth of 0.03 %**. Compared to the public investment in the CRC program, it generated a **net economic benefit of 3.1**, i.e. each invested AUD created an economic benefit of 3.1 AUD (ibid, vii). Another key output is the number of research postgraduate students. "Between 1991-92 and 2009-10, approximately 4,400 doctorate and masters degrees by research were awarded to students who had received industry focussed training as part of their studies with the support of a CRC" (ibid, x).

The recent **2015** review of the program, which was published in March 2015 (Miles 2015), made altogether 18 recommendations grouped into three categories: refocusing the programme, lifting performance, and streamlining administration. The evaluation suggests a **continuation of the CRC program**, but **in a refocused and more targeted way**. **Industry should be put in front and centre**, and CRCs should be closer oriented towards the recently announced growth sectors (Food and Agribusiness; Mining Equipment, Technology and Services; Medical Technologies and Pharmaceuticals; Advanced Manufacturing; and Oil, Gas and Energy Resources) and should **collaborate with the Industry Growth Centres**. The **program guidelines should be revised** with regard to the inclusion of new objectives (increased jobs, exports, productivity, integration into global supply chains, new technologies, products or services, increased revenues and intellectual property outputs such as patents), a simplified and more industry-focused selection and review process, changes in the composition of the CRC Committee, and a maximum funding period of 10 years. All current CRCs should be reviewed by the new CRC Committee according to the new criteria/objectives, and only those CRCs which are on track to delivering their outcomes should continue to receive funding. **Other proposed changes** are the introduction of a new stream 'CRC projects' for supporting short-term oriented (maximum of three years) industry-led research, a mandatory governance model (new CRCs should only be established as an incorporated company, limited by guarantee), streamlined IP agreements which should use best practice, a more focused training regarding industry needs, and a revised performance data collection in which only 'appropriate' data should be collected.

## 3.13 Convergence versus heterogeneity of the different models

Three 'models' were shortly described in this case study: the CRCs, the Industry Growth Centres as a new government initiative, and the Precincts. All three models have their own objectives, rules and funding mechanisms (the last applies to CRCs and Growth Centres only). Precincts are a spatial translation of a concept which generates and supports excellent scientific research. Growth Centres focus on industrial sectors and address explicitly the demands of industry which should be absorbed and processed by the research sector. CRCs focus on science-industry linkages and the joint work on certain research topics. In this sense, these models are heterogeneous. A convergence cannot be observed, more a threat to the CRCs which have become a kind of 'public good' since the operation of the program since the early 1990s. The **message of the recent Australian Government** is that **CRCs are not the only way**

**of organising interfaces between industry and research** and that, so far it has not been decided, the CRC program could come to an end somewhere in future.

## 3.14 Exemplary cases

### Monash – CRC Water Sensitive Cities

The CRC started in June 2012 with a total budget of 120 million AUD (60 million . in cash, 60 million in-kind contributions). More than 80 partners all around the globe are involved. Major Australian partners come from Melbourne, Perth and Brisbane. Among the 80 partners, 12 are research organisations (universities), including top experts for flooding in Europe, 14 State Government Departments, 30 local governments, 8 water utility companies, 2 training organisations, 4 private companies and 4 land development organisations. The CRC combines technology, society, urban planning and design, and industry application at its heart. In total, it is a very multidisciplinary approach.

The CRC is a non-for-profit organisation, personnel is employed by the CRC management, but seconded to Monash University. The CRC partners put in the money after signing an overarching agreement, but they do not have direct influence on the research topics. Administrative/management work was passed on to a former industry person (Tony Wong) and is not done by the leading researchers. Current activities focus on the performance of workshops with all stakeholders to give advice on how to redesign the Melbourne area Fisherman's Wharf.

In this but also in other interviews it was said that in Australia **different categories of third party funding** exist. The highest, most 'valuable' **category 1** is money coming from the Australian Research Council. The ARC funds pure basic research and this funding ranks first for universities and also in their internal evaluations. The lowest category is 4 and public grants for CRCs are rated as **category 4**. This is a reason why universities are less interested in CRC than in ARC funding. It is accepted, but when there are possibilities for a higher category, this kind of funding is preferred. In case of the CRC of Water Sensitive Cities, the CRC grant will lead to the situation that the involved researchers will have fewer chances to acquire ARC funding, because ARC knows that CRC grants are already available. The university researchers are therefore less able to be ranked high with respect to the criterion of ARC funding.

### CRC for Advanced Composite Structures (ACS)

The ACS has operated for four terms in the CRC rounds 1, 5, 8 and 12. They are now in the final year of the last five year extension. With the new rules there is now a maximum of 15 years (cf. section 3.4). The applied research personnel is employed by the

CRC management company; additional staff for research only is employed by the university. The last round is composed by eight initial projects of strategic and commercial value to DSTO (Defense Science and Technology Organisation), AGAP (Airbus Australia), PETRONAS and Australian SME operators. The budget was 65 million AUD for the initial five years.

A **spin-out company** is **ACS Australia**. It employs 30 highly skilled people. ACS Australia deals with the transition of the CRC in a way of creating a sustainable platform for the research activities after the public funding will cease. The company is already a global leader in composites and has been rewarded prizes for that. One of the activities is technology foresight. Most of the customers are international (not from Australia). The network of customers draws on the activities of the CRC.

The CRC educated around 100 PhD students who completed their PhD and generated also industry-ready graduates.

Regarding IPR, every CRC can set up own **IPR arrangements**. Current arrangements in ACS CRC are as such that legal ownership lies with CRC-ACS company. Licenses can be given out for free, because the utilization of technology is more important than the commercialization through the CRC.

**Foreign companies are involved** and there is no distinction between foreign companies and companies operating in Australia which are foreign-owned. The strategy behind this openness is that Australia needs to make itself attractive so that a multinational company carries out research in Australia. **SMEs are involved** in the CRC, **but not to a great extent**. Between 2003 and 2010, 23 SMEs were involved as associates, some new ones came in and some went out, but now there are much fewer SMEs than the initial 23. A possibility to involve SMEs could be the technology voucher scheme. If a company wants to do technology development, in Victoria they get a voucher for 25.000 AUD, but the company only puts in ¼ of that. Requirement: that must be the only kind of funding from the government (ICT, small technologies, biotech).

**Success factors of the CRCs** are: being industry-focused (not industry-led, but industry-driven); being able to deliver: strong team of partners, getting research into actual industry implementation; having the right source of R&D-staff; having been imbedded in the end-user-environment.

Compared to the CRC, the CRC follow up-company will generate no more PhDs, ACS Australia can only survive with commercial work.

# 4 Assessment of the CRC program and comparison to Forschungscampus

The recent CRC program review which was published in March 2015 (Miles 2015) was based on the following **assumptions:**

- Despite the CRC program, Australia still is poor in terms of science-industry collaboration,
- SME engagement is not as was expected,
- business creation around CRCs could be improved,
- CRCs are not self-sustaining (less than five are),
- self-sustainability is not an explicit criterion in the program,
- most of the involved multi-national enterprises (MNEs) are from abroad, because many MNEs withdrew from Australia or at least withdrew their R&D departments from the country.

The **basic question of the evaluation** is whether Australia got sufficient value for the money invested in the CRC program. As already pointed out, the CRC program is under threat, because the recent government changed its focus very strongly towards industry and it seems that there is the feeling that so far, at least in recent years, industry followed the research sector and not vice versa.

**Other topics** around the CRC program are that

- the regulations for the creation of CRCs grew too much,
- CRCs are regarded as a supplementary source for research funding by universities,
- focussed performance indicators are missing and that
- final evaluations are regarded as insufficient.

As can be seen from the recent review of the program (cf. section 3.12), the major recommendations mirror the assumptions and questions in a way that CRCs should be much closer oriented to the needs of industry and should contribute of overall objectives with respect to strengthening Australia's competitiveness in the new growth sectors. Additionally, CRCs should collaborate closer with the Industrial Growth Centres in a way that the CRCs should "develop ideas identified by the Growth Centres, commercialise them, and take them to domestic and international markets" (Miles 2015, 7). This shift could be interpreted that the so far quite open 'end-user' orientation will be focused much stronger towards an industry orientation in the future.

Although so far universities use CRC funding as a supplementary income source, especially the **eight high level universities** (Group of Eight) **do not consider CRC**

**funding as attractive to them**. They are mainly interested in category 1 funding (pure basic research) and regard ARC money as greater value to them than CRC money. As a matter of fact, not all 39 Australian universities assign the highest priority to collaborations with industry (e.g. organised via a CRC).

Additionally, university education is the fourth largest Australian export good. Universities earn a lot of money through students' fees. It is therefore not necessary for them to look for other funding sources, e.g. contributions from industry.

Comparing the CRC program with the Forschungscampus initiative, the following conclusions can be drawn:

- **Administration:** The CRC program administration lies with the Department of Industry and Science (ministry). A project executing organisation like PtJ does not exist. The equivalent to the Forschungscampus-Jury is the CRC Committee. This Committee makes funding recommendations to the Minister, but is also coordinating the performance monitoring of the CRCs and the whole program.
- **Not industry but 'end-user' orientation:** A difference compared to the Forschungscampus program at least in wording is the use of the term end-user. Cooperative Research Centres are not organised around science-industry collaboration, but around the research for end-users which are not only private organisations, but also public entities. These organisations/entities must be capable of transferring the research outputs into economic, environmental and/or social benefits.
- **Selection:** The program guidelines include an explicitly described selection process and selection criteria. It is made clear from the beginning how the CRCs are selected.
- **Commitment:** All partners in a CRC, even the 'essential participants', are not required to commit for the full funding period. Though stability in commitments is important, partners can leave the CRC at any time.
- **Organisation model:** For the CRCs, there is only the possibility to be organised as incorporated or unincorporated entity. Other variations are not possible.
- **Time perspective:** Comparable to Forschungscampus, funding is granted for a period up to five years with the possibility extending three times (maximum 15 years; according to recommendations made by the recent program evaluation up to a maximum of 10 years). A long-term perspective is thus also a basic characteristic of the CRC program.
- **Matching of funds:** As in Forschungscampus, public funding must at least be matched by the partners of a CRC. This matching can be realised through cash, in-kind, tied and untied contributions.

- **Internal governance:** All CRCs must employ a governance model which includes eight governance principles developed by the Australian Stock Exchange for corporate governance.
- **Leadership:** Leadership and its quality is an important criterion. It is therefore necessary that all program leaders and senior managers must commit more than 50 % of their time and effort to the CRC.
- **Employment model:** CRC staff is usually employed by the CRC management company and then seconded to the CRC participants (mainly to universities).
- **Education:** Education and qualification is very important. CRCs are evaluated according to their contribution to scientific education (Master and PhD theses), but also to the generation of industry-ready graduates.
- **International perspective:** Funding should be spent in Australia, but can also be spent overseas if this will have a benefit to Australia. Participants both from the research and the 'end-user' side can also be from abroad. This is often the case for larger companies, because many Australian MNEs shifted their research capacities to locations outside Australia.
- **Monitoring and evaluation:** The monitoring framework is already explained in the program guidelines. It consists of a welcome visit, a first year review, performance reviews every three to four years and a final evaluation by the CRC Committee.
- **Sustainability:** CRCs have to prepare a transition plan already at the beginning of their operation and a final strategy at least in the second final year of funding. Nevertheless, only very few CRCs succeeded to reach a sustainable status after funding ceased.
- **Proximity:** An obligation to organise a CRC in spatial proximity or under one roof does not exist. This is one of the major differences compared to Forschungscampus. Related to the topics of a CRC and due to the size of the country, the co-location of the participants is sometimes possible, sometimes impossible.
- **IPR regulation:** There is no fixed model of how to regulate the IPRs. They can be regulated freely in so far that benefits to Australia, the CRC and all partners are maximised. According to the program guidelines, IPR responsibility should rest with the participant organisation that has the greatest capacity for this. The condition of 'maximising benefits to all participants' could be interpreted as a regulation at 'eye level', but the transfer of IPR responsibility to the 'most capable organisation' is a more practical and not a legally based solution compared to the German situation. Usually the 'most capable organisation' is the CRC management company. Comparable to Germany, unrealistic expectations regarding the financial outputs of IPRs do exist in Australia. Evaluations of the CRC program came to the conclusion that it should not be the CRC which commercialises IPRs, but industrial or other end-user partners which provide reasonable returns to the CRC.

- **SME participation:** SME involvement is necessary but difficult. Australian SMEs are smaller than German SMEs (a company with more than 200 employees is already a large company) and often do not possess financial resources to engage in a CRC. Their contribution is more on the investment of time or facilities.
- **Humanities and Social Sciences:** The low participation of the humanities and social sciences in CRCs is a topic in Australia. It was therefore recommended in the 2008 program review that these scientific fields should specifically be encouraged to engage in CRC activities. At least a few of the CRCs from the last rounds belong to this group.
- **Use of logo:** After funding has expired, CRCs are allowed to keep their name and their logo.
- **General impact:** Due to its long operation and despite changes in the program guidelines over time, the CRC program is believed to be like a 'public good' in Australia. It was said during the interviews that the majority of Australian universities use it as a commonly available additional source of funding. Nevertheless, at least the top eight Australian universities prefer CRC funding (category 4) less than funding by the Australian Research Council. The latter is 'category 1' money which ranks much higher in internal evaluations than funding from the Department of Industry, because category 1 funding is devoted to pure basic research while category 4 is strongly application oriented. Reflecting these different interests, the recent Australian government believes that the CRCs are more under the control of the universities and less interested in the needs of the end-users, especially companies. This assessment is reflected in the recommendations of the recent evaluation of the CRC program. It recommends that the program should be refocused and targeted with regard to the needs of industry and that the CRCs should closely work together with the Industry Growth Centres. During the last few years, there seems to be a lower interest in the CRC program by the Australian Government. An indicator is that as part of the 2014/15 Federal Budget, the Government has decided to reduce funding for the CRC Program by 80 million AUD over the forward estimates. Additionally, the 17th selection round (2014) did not proceed for new applicants. Regarding the economic impacts of the CRC program, an impact study from 2012 found out that from 1991 to 2017 the program contributed to an additional average annual GDP growth of 0.03 %. The leverage effect was 1:3.1 which means that 1 AUD funding created an economic benefit of 3.1 AUD.

# 5 Background of the case study

This case study is based on the guidelines of the CRC program, on evaluation and impact studies, reports and materials about CRCs, and on interviews which were carried out by the authors between December 8th and 12th, 2014 in Melbourne, Canberra and Sydney. Additionally, the authors were members of a BMBF Delegation (Department 2) which visited Australia during the same week. This offered the opportunity to attend meetings with universities, the Department of Industry and Science, but also the full day Australia-Germany Joint Science and Technology Meeting in which the framework for and different developments in innovation policy were discussed. The authors thank BMBF and the International Bureau for this opportunity.

List of interview partners

| **Date** | **Location** | **Organisation** | **Interview partner and function** | **Interviewer** |
|---|---|---|---|---|
| 08.12.2014 | Melbourne | University of Melbourne, Doherty Institute (Parkville Precinct) | Dr. Charlie Day (Project Director Carlton Connect), Prof. Elizabeth Hartland (Department of Microbiology and Immunology), Dr. Sammy Bedoui (Department of Microbiology and Immunology), Marian Schoen (European Union Centre on Shared Complex Challenges) | Anne Dwertmann, Knut Koschatzky |
| 08.12.2014 | Melbourne | CRC for Advanced Composite Structures | Murray L. Scott (Chief Executive Officer), Paul Falzon (General Manager) | Anne Dwertmann, Knut Koschatzky |
| 08.12.2014 | Melbourne | Industry Innovation Manufacturing Precinct | Albert Goller (CEO of the Precinct) | Anne Dwertmann, Knut Koschatzky |
| 09.12.2014 | Melbourne | Evaluator of CRC program | David A. Miles (Chair Innovation Australia) | Anne Dwertmann, Knut Koschatzky |
| 09.12.2014 | Melbourne | CRC for Water Sensitive Cities | Ana Deletic (Associate Dean, Faculty of Engineering, Monash University) | Anne Dwertmann, Knut Koschatzky |
| 10.12.2014 | Canberra | Cooperative Research Centers Association | Tony Peacock (Chief Executive Officer) | Anne Dwertmann |
| 10.12.2014 | Canberra | various | Rob Porteous (Head of Division, Science Policy and Governance, Dept. of Industry), Aidan Byrne (Australian Research Council, Chief Executive Officer), Greg Gilbert (Advisor Science and Research, Office of the Minister of Industry), Sami Kara, Director of Postgraduate Re- | Knut Koschatzky |

| Date | Location | Organisation | Interview partner and function | Interviewer |
|---|---|---|---|---|
| | | | search, Faculty of Engineering, University of New South Wales) | |
| 10.12.2014 | Canberra | various | Kristian Wolf (Deutsch-Australische Industrie- und Handelskammer), Subho Banerjee (Deputy Secretary, Department of Industry), Chris Butler (AusIndustry Business Services), Christel Nolte (Science, Research and Innovation Division, Department of Industry) | Anne Dwertmann |
| 11.12.2014 | Canberra | Department of Industry | Jane Urquhart (General Manager, Science Policy and Agency Branch), Anthony Murfett (General Manager, Productivity and Competitiveness Branch) | Anne Dwertmann, Knut Koschatzky |
| 12.12.2014 | Sydney | National ICT Australia (NICTA) | Neil Temperley (Future Logistics Living Lab Leader), Robert Fitzpatrick (Director Infrastructure, Transport&Logistics) | Anne Dwertmann, Knut Koschatzky |
| 12.12.2014 | Sydney | DAAD | Joern Hausner (Director of DAAD Information Centre Sydney) | Knut Koschatzky |

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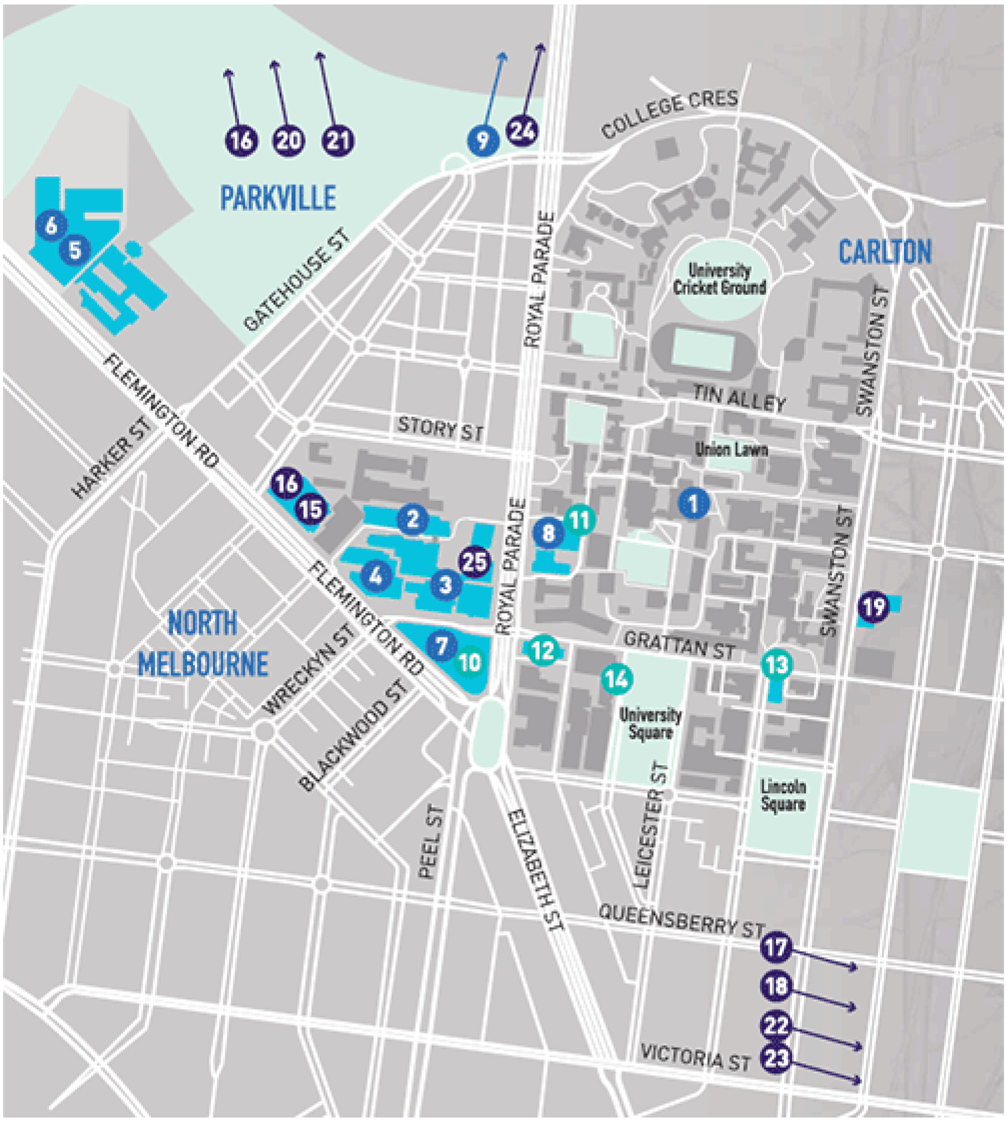
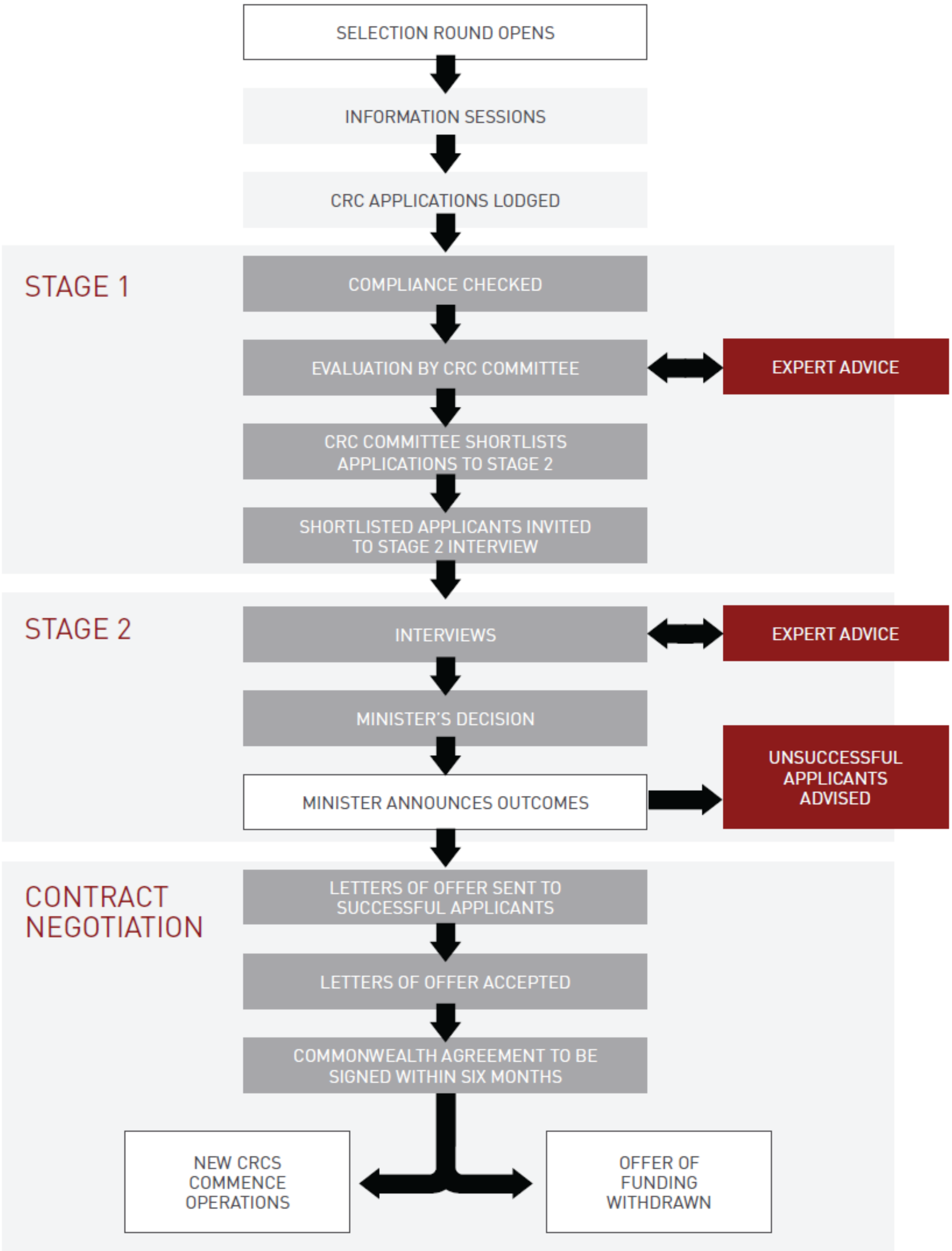
## Annex

### Figure A-1: Melbourne Biomedical Precinct



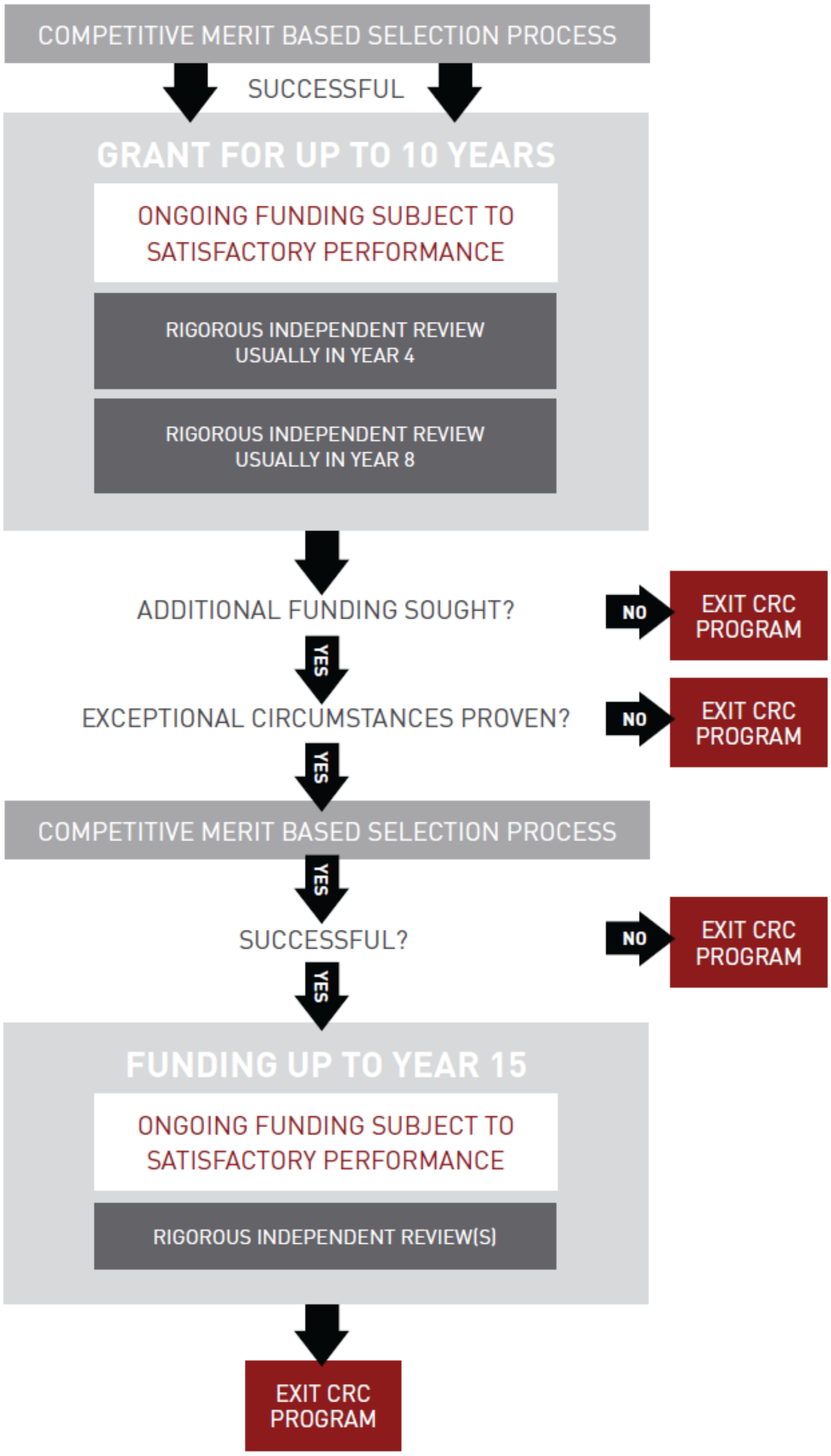

Source: http://www.mh.org.au/melbourne-biomedical-precinct/w1/i1012322/; accessed 04-03-2014

**Figure A-2: Typical Application Process**



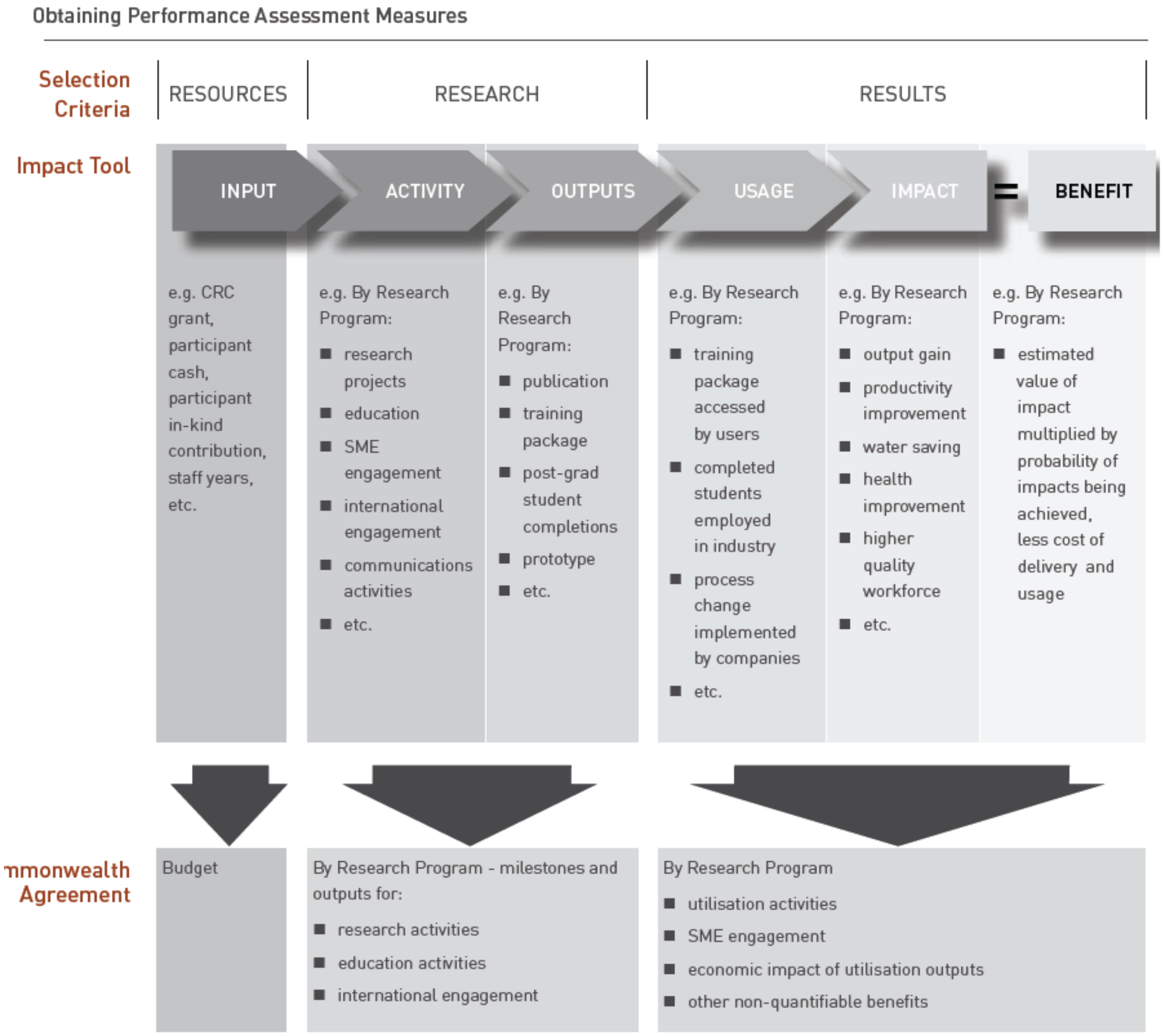

Source: Australian Government (2013)

**Figure A-3: CRC program funding model**




Source: Australian Government (2013)

**Figure A-4: Performance Assessment Framework**




Source: Australian Government (2013)

# II COMET Case study[1]

Thomas Stahlecker

## 1 History and objective of the program

The COMET program – Competence Centers for Excellent Technologies – supports the creation of competence centers focused around a high quality research program jointly defined by science and industry. COMET's *strategic objectives* are to build up new competences by initiating and supporting long-term research cooperation between science and industry at the highest level, as well as by developing and securing the technology leadership of companies. The aim is to enhance Austria's position as a research location in a sustainable way by bundling and further developing its existing strengths and integrating international research know-how. COMET has the following objectives:

- to strengthen *longer-term strategic research cooperation* between science and industry at the highest level – continued strengthening of the *new culture of cooperation* created by the previous competence center programs (see below);
- it is geared towards the strategic interests of industry and the scientific partners. The aim is to create joint research competences, initiate new science-technology developments and innovations and help pave the way for their utilization;
- *pooling and networking* actors using *content-related synergies* to better equip them for growing international competitiveness;
- the creation of some centers that achieve *international acclaim* due to their top-level research and the involvement of globally renowned researchers and companies and that strengthen Austria's position as a research location as a result;
- *to strengthen human resources* by attracting excellent researchers, supporting the *transfer of know-how* to industry, creating attractive opportunities to develop and utilize researchers' skills in science and industry;
- *to consider gender issues* both as a research topic and by ensuring the best possible balance of male and female researchers.

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1 This case study was prepared based on a comprehensive screening and analysis of existing program documents, evaluation reports, monitoring data and in-depths interviews with experts from COMET’s environment (including the program’s owner/director, the Austrian Research Promotion Agency (FFG)).

### Target group of COMET

The program targets both existing competence centers and new consortia of science and industry cooperation. The condition to be fulfilled is that the consortia have to be made up of at least 5 (K1 and K2 centers) or 3 industrial partners (K projects) and at least one partner from science. Applications can be made in all three program lines (see below) by both existing centers and projects and new consortia. As a result, the existing competence centers compete with each other and with new consortia. Existing COMET centers that have reached the end of their lifespan and that are not successful in their COMET application, or are not interested in continued COMET support can apply for a *phasing-out* plan. This is intended to ensure that the centers can carry out their planned research projects at full capacity right up to the end of the funding period. COMET addresses *companies of all sizes from all sectors*. The program is open to *small and medium-sized companies as well as large ones*.

### History of the program

Science and industry have been working together in Austria since 1998 to develop key research expertise in more than 40 centers and networks via the competence center programs Kplus, K_ind, and K_net. This has created a landscape characterized by hubs of high quality research. The first centers reached the end of the planned funding period of 7 years in 2005. COMET sees itself as an innovative further development of the previous Kplus, K_ind and K_net programs with the objectives of continuing to strengthen the culture of cooperation between industry and science and to advance the development of joint research competences and their utilization. The distinct new elements of the program are its ambitious orientation towards excellence, the integration of international research know-how and developing and safeguarding the technology leadership of companies to strengthen Austria's position as a location for research.

The initial conditions at that time were very different to today's: Industry-science cooperation was very weak in the 1990s. The only activities worth mentioning in this field are the nuclear research center of the Austrian Institute of Technology (AIT) in Seibersdorf, the Joanneum Research organisation and the Doppler centers. An important framework condition of that time was the first technology policy strategy that was developed, financed and implemented using the state's revenue from privatization. Its objective was to remove the structural and technological deficiencies that existed then – also in light of the lack of a Fraunhofer-Gesellschaft and large research organisations.

The international role models for COMET include the Australian Cooperative Research Centers, the Competence Centers in Sweden and the Networks Centers of Excellence in Canada.

**Responsible ministries and participating organisations**

COMET is designed as a program on the national level. The program's owners are the Austrian *Ministry for Transport, Innovation and Technology (BMVIT)* and the Ministry of Science, Research and Economy (BMWFW). The program is managed by the Austrian Research Promotion Agency, FFG. The Austrian federal states also support COMET with their own additional funds and can strengthen their own regional technology policy objectives in this way. The central government offers the federal states different cooperation options that are formally agreed to bilaterally and in writing. If regional funds are granted based on the current program document, the federal states can influence the selection of centers and projects in several ways:

- The federal states take part in the selection procedure.
- The federal states have the opportunity to formulate an opinion to the expert evaluators.

# 2 Embedding COMET and the field of "science-industry cooperation" in the innovation system

COMET plays a key role in the Austrian innovation funding architecture and is the "flagship" in the field of industry-science cooperation. For instance, about half of all funding grants approved by the Austrian Research Promotion Agency FFG, which is responsible for managing COMET, are for the COMET program. With an annual state budget of 50 million euros for COMET, about 10% of all FFG funds flow into the COMET centers (for comparison: about 40% of total FFG funds go to cooperation projects).

Apart from the COMET program or the COMET centers, there are other institutions in Austria that are active in cooperative research or contract research: the Austrian Institute of Technology (AIT) receives annual state funding of 45 million euros, and the Christian-Doppler-Gesellschaft (with 77 laboratories) gets 25 million euros of state funds annually. The Doppler centers represented a bilateral form of cooperation between science and industry even before COMET existed. The "CD-Labs" in Austria represented small but excellent research units in which a company worked together with a university or research organisation for seven years in application-oriented basic research. These projects are therefore also generally more "scientific" than COMET projects.

In principle, Austria has three large funds or funding possibilities for science and research:

- Programs of the Austrian Research Promotion Agency: Funding applied research (Budget: 400 million euros annually),
- science funds: Funding basic research,
- Austria Wirtschaftsservice GmbH (AWS) (Austrian federal promotional bank; low-interest loans, subsidies and guarantees to companies).

# 3 Structure, financing model and characteristics of COMET

### Program lines

COMET is made up of three program lines: K projects, K1 centers and K2 centers. The projects and centers of all program lines are characterized by high research competence and close ties to science with simultaneous high relevance for implementation in the business sector. These are also the main evaluation criteria.

*K projects* aim to initiate high quality research in science-industry cooperation with medium-term perspectives and clearly defined topics that have future development potential. The idea is to increase the program's flexibility and also give research subjects and consortia a chance to participate that do not have sufficient potential for a K1 center. K projects integrate science and industry and have a "multi-firm" character (a minimum of 3 company partners). The projects are strategic in the sense that a sustainable profile is the objective in the medium term. Re-application is a possibility. K projects can be used by new consortia for new research projects with the potential to evolve into a K1 or K2 center in the future. Financing is not available for purely networking or initiation activities, only for joint research, although accompanying activities (such as initiation activities, awareness, network development and platforms) are possible to a reasonable extent.

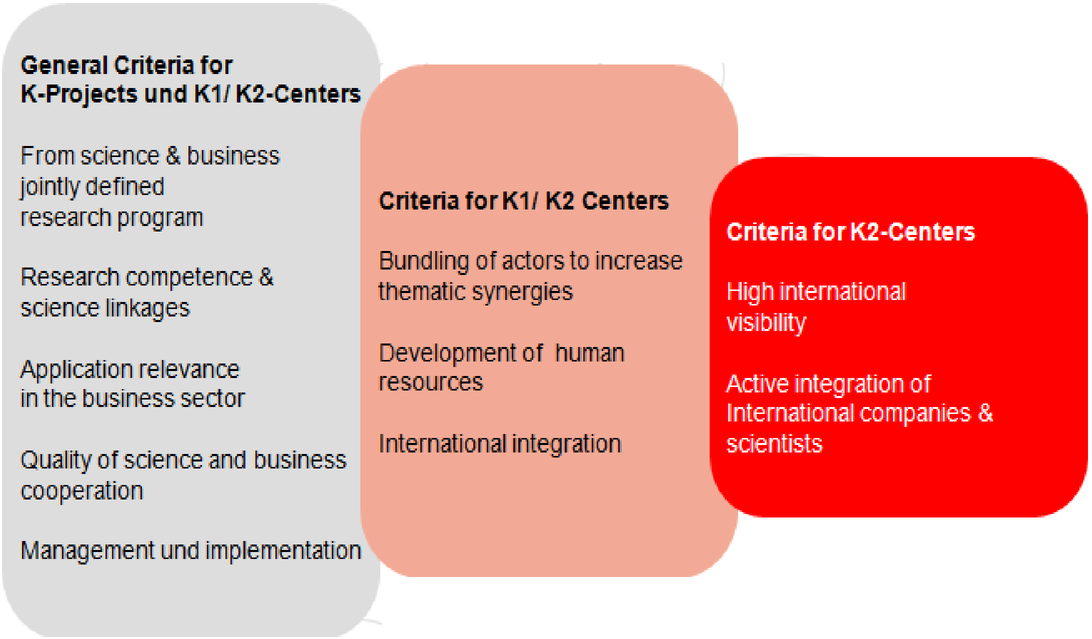
*K1 centers* pursue the goal of initiating high quality science-industry cooperative research with a medium- to long-term perspective. K1 centers conduct advanced research and focus on science-technology developments and innovations with a view to relevant future markets. The defining features of K1 centers are a joint research program with at least five companies and an interim evaluation in the fourth year of the program. Where possible and reasonable, existing structures and focal points of excellent research should be combined or new ones created. Re-application is possible.

Regular calls should ensure the renewal of all centers. There is competition between existing centers and new initiatives (see below).

The objective of *K2 centers* is to pool existing national expertise in the long term and cooperation with the world's leading researchers, scientific partners and company partners in joint strategic research programs at the highest level. The intention is to strengthen and significantly increase the attractiveness of Austria as an international research location in the long term. The defining features of K2 centers are a particularly ambitious research program and associated high risks in development and implementation. They have particularly high international visibility and are integrated in international networks. K2 centers are intended to create the ideal conditions for cooperation with outstanding international researchers and companies, also outside Austria. Young scientists with high potential from Austria and other countries should be offered the best international career opportunities. K2 centers have a clear commitment to institutionalization, the development of expertise and long-term work: They are initially designed to run for 10 years. There is an interim evaluation in the fifth year, and the center is only continued if the results are positive. The centers are encouraged to reapply for continued funding even after 10 years, provided that a second evaluation is also positive.

The following figure illustrates the differences between the criteria of the three program lines. The mix or weighting of the types of research (strategic, long-term, basic, high-risk etc.) is used as another criterion to differentiate the rate of funding within each program line. Complementarity to existing research work and activities in closely related thematic fields has to be guaranteed. The research program's uniqueness in a national and international context has to be ensured. In addition, all research work and activities should strive for the balanced participation of male and female researchers. Additional measures to achieve equal opportunities and special efforts to address women are also desired.

**Figure II-1: Summary of COMET criteria**




Source: FFG: COMET – Competence Centres for Excellent Technologies

### FFG's requirements for the centers/projects

COMET is designed as a *thematically open program*, but still contains a number of requirements that refer to the application (and should this be successful) the later phase of implementation. Alongside the COMET criteria, these mainly concern aspects like the legal form, owner, strategic orientation, organisation & management, human resources and targets. The corresponding criteria are specified in the program guide-lines. Basically, however, the program permits the centers to have different forms with regard to content and organisation. The most important distinctive features refer to the:

- close proximity to universities and businesses,
- science and innovation orientation,
- international orientation or regional embedding.

In line with the program guidelines, competence centers have to be implemented as independent *legal entities*. The legal form foreseen for centers is a "Gesellschaft mit beschränkter Haftung (GmbH)", the German expression for a "company with limited liability" or a comparable legal form (see below). The research activities have to be concentrated for K centers to achieve the required visibility and attractiveness. A center can have facilities at more than one location as long as its character as one center is preserved.

Specifications concerning the *research program* to be outlined are directly related to COMET's main objective. The focus here is on a research program jointly formulated by science and industry in which strategic "multi-firm" projects play an important role. In this sense, the K1 or K2 center is not simply a collection of individual projects, but creates obvious added value through the cooperation and orientation towards a joint strategy.

The *planned cooperation* with company partners and scientific partners and with associated partners has to be described in detail analogous to the program's objective, as do the rights and obligations of the partners and the rules governing the cooperation and its termination.

Another important task is regulating how the results or *the rights to the results* (IPR) are handled: Basic rules determining the treatment of IPRs have to be defined in COMET agreements. These form the foundation for more detailed IPR regulations in the contracts of the respective cooperative projects that may not contradict those contained in the agreement. The aim is to guarantee a balanced utilization of the results by both the partners and the center. The COMET center should be strengthened in its position as a joint knowledge holder and the build up of expertise at the center ensured. Rights to R&D and innovation results arising from the activity of COMET center's employees are to be allocated to the COMET center in full.

With regard to the *organisational structure* of the centers, the aim is to achieve a balanced ownership structure without the dominance of a single owner. Where possible, the aim is for balanced, mixed ownership relations involving partners from science and industry. The *center's management* should act independently and follow the center's objectives and interests. It should manage business efficiently and lead the center both scientifically and organisationally.

**Financing model and legal form**

The following table summarizes the main features of the three program lines, especially with a view to size, funding intensity and amount of funding. On average across all three program lines, 45-55% of the funding (income side) comes from the state and federal states, between 40 and 50% from the participating companies and 5% from the scientific partners (services in-kind). The centers should set up a so called "non-K area" in addition to this to reduce the dependency on national and federal state funding. Possible financing sources of the non-K area can be the EU, industry or other Austrian programs. 60% of the centers' costs are incurred in the GmbH, 20% in the participating companies and 20% in returns to the scientific partners.

**Table II-1: Key structural features of the three COMET program lines**

| | K projects | K1 centers | K2 centers |
|---|---|---|---|
| Number (across all calls) / employees | 46 approved ("multi-firm proj.") | 26 approved (ca. 50 FTE) | 5 approved (>100 FTE) |
| Public funding (max. state & federal state) | 45% | 55% | 55% |
| Funding intensity industry partner (min.) | 50% | 45% | 40% |
| Funding intensity science partner (min.) | 5% | 5% | 5% |
| Amount of funding from state | max. €0.45 mill. /year | max. €1.7 mill. / year | max. €5.0 mill. / year |
| Amount of funding from state & federal state (2:1) max. | €0.675 mill. / year | €2.25 mill. / year | €7.5 mill. / year |
| Duration | 3-4 years | 8 years (4+4) | 10 years (5+5) |
| Partner structure | min. 1 sc. partner & 3 companies | min. 1 sc. partner & 5 companies | min. 1 sc. partner & 5 companies |

Source: Pichler, M. (2015): Das österreichische Kompetenzzentrenprogramm COMET; FFG: COMET – Competence Centres for Excellent Technologies

There are currently 35 K projects, 16 K1 centers and 5 K2 centers being funded. When fully developed, around 1,500 FTE will be employed in the centers (mid 2013: 1,300 employees, of whom around 1,000 researchers). COMET's total finances in 10/2014 amounted to 1,479 billion euro, of which 465 million euro are from the Austrian state, 233 million euro from the federal states, 708 million euro from the company partners and 103 million euro from the scientific partners (see FFG Fokus 2013). 1,100 partners are taking part in K centers, split into 830 company partners and 270 scientific partners.

**Table II-2: Program history since 2006/2007 as of 10/2014**

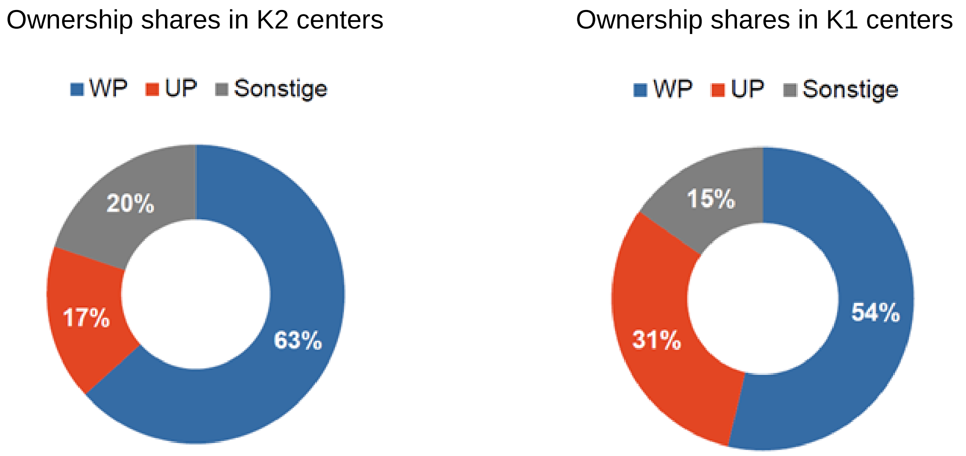
| Program lines | Calls | applied for | approved | Status |
|---|---|---|---|---|
| K2 centers | 1.-2. Call | 10 | 5 (50%) | 3 new K2 centers have been added in the 2nd funding period |
| K1 centers | 1.-3. Call | 44 | 26 (59.1%) | 16 K1 centers in 2nd FP (8 centers are set to continue, 3 are in the process of phasing out, 2 new K1 centers from 1.1.2015) |
| K projects | 1.-5. Call | 99 | 46 (46.5%) | 22 K projects have been completed; 24 currently being funded |

Source: Pichler, M. (2015): Das österreichische Kompetenzzentrenprogramm COMET

### Legal form

Besides the structural characteristics in the above table, it is also important to mention the legal form taken by K centers. All K centers are organized as a GmbH – in contrast to the German research campuses – with the different company partners and scientific partners named as shareholders (formalized in the articles of association). From a company perspective, therefore, K centers are company participations and not company subsidiaries. The scientists and the technical and commercial staff are employed directly at the centers. Compared to the research campuses, this does not involve any secondments of the participating partners. As mentioned above, there are two accounting entities for the K area and the non-K area.

**Figure II-2: Ownership shares of the centers**




WP = Science partner, UP = Company partner, "Sonstige" = Others

Source: Pichler (2015)

Taking the solution of forming a GmbH is understandable given the background of Kplus, one of the predecessors of COMET. Because Kplus was implemented under the old legal situation, it was not possible to place the centers at the universities. The main idea at that time was that the centers should be incorporated into universities or non-university research organisations. But this has not yet happened.

### Competition between the centers and phasing-out as important program features

An important program feature of COMET is the competitive component between existing and new projects or centers. The selection of new centers and projects is done based on applications as part of regular calls. The existing centers are prolonged based on interim evaluations or terminated. K1 centers are evaluated in their 4th year, K2 centers in the 5th year. K projects, in contrast, are not evaluated while still running but are evaluated ex post in the 3rd-5th year.

If a center receives a negative interim evaluation, the following procedure is defined: If the four year evaluation of a K1 center is negative, a so called *phasing-out* period starts that lasts a maximum of one year. The same applies if a K1 center is not renewed following an unsuccessful reapplication after 8 years. This aims to ensure the centers can conduct their planned research activities right up to the end of the funding period at full capacity. The annual funding volume of the phasing-out period is limited to a maximum 50% of an average funding year of the previous funding period.

The same applies to the K2 centers: If a K2 center receives a negative evaluation after five years or after 10 years, then a phasing-out period starts of a maximum of 1.5 years. The same principle applies to a K2 center after 10 years if its reapplication is not successful. Similar to the K1 centers, the annual funding volume is limited to a maximum of 50% of an average funding year of the previous funding period. This is to ensure that centers are able to carry out their planned research activities in full capacity until the end of the funding period.

**Selection and evaluation process**

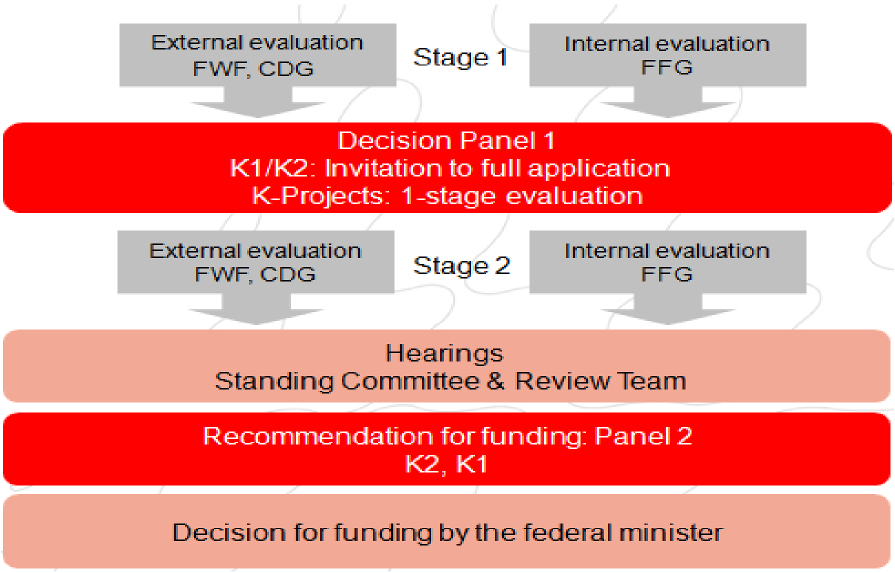
A two-stage, criteria-based selection procedure is used to select centers (see Figure II-3). The maximum cash value of the funding is proposed by the FFG expert and recommended by the evaluation jury. The results of the jury are only recommendations. The actual funding decision is in the hands of the program owners (Austrian federal ministries) and the decision is made based on the jury's recommendation including any possible requirements and/or conditions.

*K1/K2 applications* are reviewed by experts from within the FFG as well as external experts (of the Christian Doppler Forschungsgesellschaft (CDG), the Austrian Science Fund (FWF) and international peers). Invited consortia submit applications for K1/K2 including a detailed research program covering all the criteria and a detailed and precise budget for the first years as well as binding participation and financing commitments of the company partners and scientific partners. Applications are subjected to an internal and external expert evaluation. The expert assessment covers all the criteria and includes a detailed check of the management and the budget and financing plan. Each consortium is also subjected to a hearing. A jury then recommends which consortia should be funded as K1/K2 centers.

There is a shorter procedure for *K projects*. The evaluation process is similar to that for K1/K2 applications, but does not include a hearing.

The *funding decision* is in the hands of the Austrian federal ministries and is made based on the evaluation jury's recommendation including any requirements and/or conditions. The decision whether funding is awarded is communicated to the applicant in writing; in the case of a refusal, the decisive reasons for this are given.

**Figure II-3: Outline of the selection process (ex-ante evaluation process)**



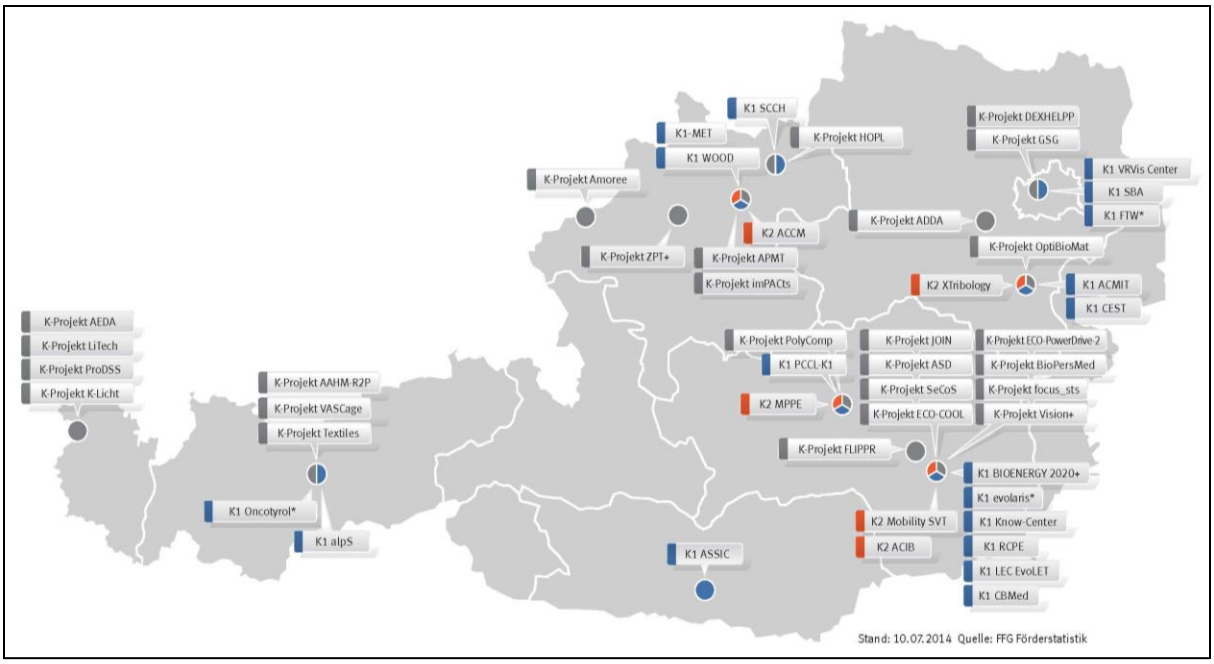

Source: FFG: COMET – Competence Centres for Excellent Technologies

### The significance of spatial proximity in COMET

Spatial proximity plays a key role for the K centers due to the existence of physical entities. Each center also has a main location (headquarter). In rare cases, however, there may be cooperation across 2-3 locations (even in different federal states[2]). To enhance the idea of centers as physical entities with a spatial focus, it was determined that at least 60% of the costs have to occur at the respective main location. There is one center (K1 center BioEnergy 2020+) that is one of the few acting with a polycentric structure. Basically, there is no university in Austria that is not integrated in COMET. COMET's main areas are the large university cities like Vienna, Graz and Innsbruck and/or the industrial regions of Upper Austria or Styria.

2 The Austrian federal states' support is in proportion to the company contributions originating in their region.

**Figure II-4: Regional distribution of the K centers and K projects (date: 07/2014)**



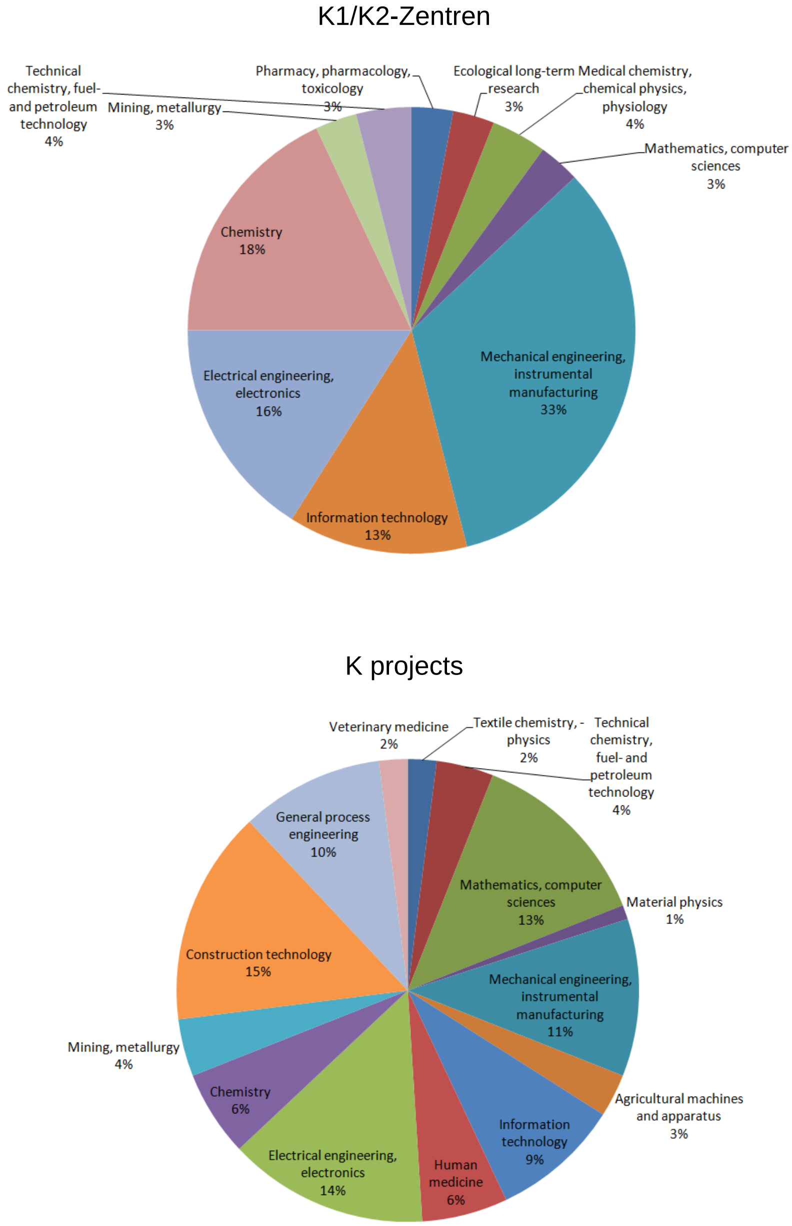

Source: Pichler (2015), based on FFG Förderstatistik

Figure II-4 shows the spatial distribution of the K centers and K projects in Austria. The concentrations in Graz, Vienna, Linz and Innsbruck are clearly visible. The leading federal states are Vienna, Upper Austria and Styria (Leoben is also worth mentioning here alongside Graz).

**Thematic focus**

From a thematic-technological viewpoint, the resulting landscape of centers and projects is quite diverse because of the *thematic openness* of COMET and the respective calls. Almost half of the funded centers/projects covers the field of production, 20% the field of life sciences, 15% ICT, 10% mobility and 6% energy and natural resources. The following figure illustrates the content-related orientation of the centers/projects by branches of science. Mechanical/instrument engineering dominates the K centers with 34%, followed by chemicals, information technology and electrical engineering/electronics. The K projects, in contrast, are dominated by civil engineering followed by electrical engineering/electronics, mathematics/computing, mechanical/instrument engineering, general process engineering and information technology.

**Figure II-5: Thematic orientation of the centers/projects by branches of science**




Source: FFG: COMET – Competence Centres for Excellent Technologies

## Evaluation of COMET

There are many different kinds of evaluation in COMET at the level of both the program and the centers. Each of these evaluations has a different character and function, but the individual elements should interact in a meaningful way. The objective of the evaluations scheduled as part of COMET is:

- to analyze the quality of the research activities at the level of the centers/projects, their additionality and the degree of success in achieving their targets and to obtain a decision basis for their creation and/or continuation,
- to analyze the design, implementation and impact of COMET at the level of the program and derive recommendations for continuing and for modifying the program.

Because of the program's size, the evaluation demands a suitable mix of quantitative and qualitative elements, not just at center level, but also at the *level of the program* itself. The evaluations at program level are performed exclusively by external experts; the team of evaluators is selected by invitations to bid.

Analyzing the program's impact and the degree of success in achieving its objectives is done using quantitative indicators among others. These include indicators that are relevant at center level and are therefore aggregated from the centers' data, but also indicators that are only relevant at program level and that are generated as part of the program's evaluation using primary data. The indicators are derived directly from the program's objectives:

- to develop new skills and expertise through research cooperation at the highest level (examples of indicators: publications, patents),
- to initiate new science-technology developments, innovations and their market potential (follow-up projects at the company partners, implementation of new products, processes, procedures etc.),
- to develop and secure the technology leadership of companies (acquisition of additional third-party funds from business contracts),
- to enhance Austria's position as a research location in a sustainable way: pooling existing strengths and networking to better exploit content-related synergies, quality of science-industry cooperation (indicators of the intensity and quality of cooperation based on network analysis),
- to strengthen human resources development (assembling an adequate pool of employees, qualification schemes for researchers considering gender mainstreaming requirements),
- international visibility (indicators to determine the degree of international recognition and international reputation).

The program's evaluation is largely based on the results of the centers' interim assessments. The first program evaluation takes place after the interim evaluations of the first K2 centers, but at the latest 6 years after the launch of the first centers. Further interim evaluations at program level are done at intervals of not more than 5 years. The results of the impact analysis are used as input to the program evaluation.

The *evaluation of the centers/projects* is carried out in a multi-stage process illustrated in Figure II-5. The main rules for the *ex ante evaluation* are laid out in the program document and the evaluation guidelines: A two-stage, criteria-based process is used to select K centers; a one-stage procedure without a hearing to select K projects (see above).

A *review* takes place halfway through the K projects. This review gives first feedback on the K projects and is primarily a recommendation. An assessment is made of: the work to develop and manage the K project, implementation of the project's planned measures, and fulfillment of the requirements. Any possible problems or difficulties are pinpointed. Another issue is whether the planned target achievement is still on schedule. The emphasis is on learning: The aim is to reflect on the experiences gained so far and to learn from these for adaptations needed for the rest of the K project's duration. The review is planned and carried out by the FFG; external experts can be consulted where necessary.

In the final year of the first funding period, every center is subject to an *interim evaluation* that is simultaneously an ex ante evaluation of the center's plans for the second funding period. The evaluation looks at the fulfillment of the work program, the results of the research activities and the achievement of qualitative and quantitative goals. On this basis, among other things, indicators are used that were chosen by the center itself when making the application and that are collected as part of the FFG's monitoring and reports. The consequence of this interim evaluation is a "stop or go" decision, i.e. the decision is made whether to continue the K center or not based on the evaluation results. The interim evaluation is processed by the FFG together with FWF and CDG and conducted by external and internal experts.

Finally, an *ex post evaluation* takes place at the end of the scheduled term. This is done by internal and, where necessary, external evaluators. Centers that are phasing out and not planning to reapply are obliged to involve an external expert.

**Figure II-6: Evaluation stages of the K centers/ K projects**

| Ex-ante evaluation | Review | Mid-term-evaluation | Ex-post evaluation |
|---|---|---|---|
| **Time** („When?“) | K1: in 2nd yr<br>K2: in 3rd yr<br>KP: Mid-term | K1: in 4th yr<br>K2: in 5th yr<br>KP: none | K1: in 7th yr<br>K2: in 10th yr<br>KP: 3.-5. yr |
| **Evaluation-subject** („What?“) | Center/<br>K- Projects | Center, objectives, results, Research plan for the years 5-7 (K1) or 6-10 (K2) | Center/<br>K- Projects<br>Results |
| **Executor** („Who?“) | FFG (External reviewer) | External reviewer | External reviewer |
| **Implications** („Which consequences for the center?“) | Recommen-dations | Stop or Go | |

Source: FFG: COMET – Competence Centres for Excellent Technologies

Both the ex ante and the interim evaluations are of key importance because these form the basis for decisions made about public funding. This is why qualitative and quantitative data are combined to obtain as complete a picture as possible about the quality and performance of the centers and projects. The following information sources are used:

- data collected as part of the reports,
- the report on the interim evaluation for K centers or the review of the K project,
- data collection at company level,
- measurement of impact/impact analysis at the companies,
- list of main indicators.

The applicants already compile the list of main indicators when submitting their plans. As part of the ex ante expert report, an evaluation is made to what extent these targets are appropriate and realistic given the research field and environment. A comparison of the planned and actual situation is made for the interim evaluation that is in turn subjected to an assessment.

#### Monitoring and reports

The main function of the FFG's monitoring and reporting is to prove that funds are being used as intended and thus form the basis for payment of the funds. In addition, the FFG's monitoring system also collects data as a basis for the ongoing statistical evaluations and for the interim evaluations. Monitoring is also implemented as a data basis for the program evaluations. The FFG carries out on-site checks while the K center is operating.

# 4 Output and impacts

Table 3 shows the results and main output variables for the three program lines based on the ongoing monitoring of the FFG. As of April 2014, the K centers and K projects employed a total of around 1,700 persons; of whom 1,400 were researchers. More than 1,000 companies and more than 500 scientific institutions were integrated across all three program lines. In terms of technology, the centers and projects can refer to 316 patent applications and almost 8,000 scientific publications. There were more than 1,100 completed and still ongoing PhD theses and almost 1,500 Master theses.

**Table II-3: Main output variables of COMET (date: 4/2014)**

| Overview | K1 | K2 | K projects | Total |
|---|---|---|---|---|
| Employees (FTE) | 839 | 606 | 310 | 1,755 |
| Researchers (FTE) | 649 | 465 | 262 | 1,376 |
| Companies | 472 | 351 | 240 | 1,063 |
| Scientific partners | 201 | 193 | 110 | 504 |
| Patents & licenses | 168 | 107 | 41 | 316 |
| Publications | 4,149 | 2,484 | 1,355 | 7,988 |
| Theses (incl. ongoing) | 586 | 406 | 144 | 1,136 |
| Masters (incl. ongoing) | 832 | 398 | 236 | 1,466 |

Source: Repp (2015)

A distinction has to be made when looking at the impacts between those at company level and those at the level of science or universities. The parallel impact analysis made of COMET (cf. Technopolis 2013) showed that COMET led to the participating companies having better access to scientific results and to better cooperation networks with science. The better access to technical know-how was also emphasized as were safeguarding and/or creating of R&D jobs. The universities participating in COMET mentioned effects such as the presentation of conference papers, publications in scientific journals, expansion of research areas, carrying out dissertations, employment of PhD students and using the results as input to university teaching.

# 5 Success factors of COMET and "Lessons learnt"

Based on the analysis of COMET and the results of interviews with those responsible for the program, the following success factors can be named that have emerged since the program began in 2005/2006:

- High level of trust between science and industry,
- long-term commitment on the part of science,
- long-term commitment on the part of the companies,
- research manager at the centers,
- legal form of the centers as GmbHs and as physical entities,
- openness to international environment,
- research program as a "living" construct: constant modifications and adaptations as well as the ability of the committees in the centers to deal with them,
- competitive components from the regular calls and the "predetermined breaking points",
- thematic openness: priorities are not forced; the selection is not done based on predetermined topics (e.g. societal challenges).

# 6 Perspectives and challenges

Despite the undoubted successes after 10 years of the COMET program, there are still some fundamental questions about the future of the centers and the further development of the program. Two fields of conflict seem particularly relevant from the viewpoint of the program owners:

- The fixed time limit vs. sustainability,
- cooperation vs. competition.

With regard to the fixed time limit/sustainability, currently the aim is not to transform COMET centers into a structure of permanent, non-university research organisations. The national and regional authorities are committed to the stability of the program, but have no wish to establish an umbrella/supporting organisation along the lines of the Fraunhofer-Gesellschaft. De facto, the K centers are already seen as an independent "pillar" of the Austrian research and innovation system. On the other hand, there is the need to ensure that the already established and still evolving cooperation structures are sustainable. Putting a time limit on the centers seems impossible at present. Many centers are already too large, too institutionalized and too productive for this – especially the non-K area that is developing very dynamically in some centers – and, it is argued, that would not be possible without COMET support (in the sense of preparatory research). Furthermore, there is the need to sustain the lead established in specific fields, but also to ensure a certain "circulation" in the sense of existing centers leaving and new ones entering the support program. In this context, the question of whether to continue differentiating between K1 and K2 centers needs to be resolved.

Concerning the role of the participating universities and companies, it can occasionally be observed that both partner groups sometimes assign more importance to their own core tasks than the centers. Economic reasons on the part of the companies are sometimes responsible for shifts in priorities. In addition, it can be observed that companies' propensity to cooperate declines in the case of competitive situations with other companies.

There are a series of future options at the level of the centers, for example with a view to reapplying for COMET funding (or phasing out), possible integration into other organisations (universities, non-university research organisations), continued existence in the context of other funding options (other programs, countries), continued existence as a contract research organisation (expansion of the non-K area) and finally also with regard to closing the center.

# 7 Documents/reports/sources used

**Slides:**

Pichler, R. (2015): Das österreichische Kompetenzzentrenprogramm COMET.

Repp, R. (2015): COMET Monitoring.

FFG: COMET – Competence Centers for Excellent Technologies.

**Programme documents:**

Bundesministerium für Verkehr, Innovation und Technologie / Bundesministerium für Wirtschaft Familie und Jugend / Österreichische Forschungsförderungsgesellschaft mbH (2013): Programmdokument für das Kompetenzzentren-Programm COMET.

FFG (2013): Evaluierungskonzept für das Kompetenzzentren-Programm COMET.

FFG (2013): COMET-Zentren und –Projekte. Spitzenforschung für Österreichs Zukunft (Programm-Broschüre).

FFG (2014): Leitfaden für COMET K1-Zentren. 3. Ausschreibung.

FFG (2014): Monitoringbericht 2012/2013 COMET-Zentren.

FFG (2014): K-Projekte Review.

FFG: COMET: alle Zentren und Projekte (Stand: 31.10.2014)

**Reports, Studies:**

Technopolis (2013): COMET-Wirkungsanalyse. Endbericht.

Joanneum Research / Austrian Institut of Technology AIT / University of Manchester (2013): Ex-post Evaluierung der Kompetenzzentrenprogram Kplus und K_ind/K_net.

# III Case study Sweden – VINN Excellence Center Programme

*Mirja Meyborg, Monika Huber*

## 1 Origin, precedessor programme and objective of the VINN Excellence Center

The program VINN Excellence Center offers a completely new generation of competence centers in Sweden, which strengthen the link between science and industry by creating an excellent academic research environment. Industrial enterprises participate actively to generate long term benefits. Their mission is to strengthen the important link between academic research groups and industrial research and development (R&D) in the Swedish innovation system in the long term. The participation of industry means that research is focused on those areas which are interesting for industry and present a challenge for academia. The purpose of this approach is to create new knowledge and new technologies which result in new products, processes and services.

**Background**

The creation of competence centers in the university landscape has already had a long tradition in Sweden. Even in the early 90s NUTEK (*National Board for Technical and Industrial Development – VINNOVA's predecessor*) started the first generation of such centers (Competence Research Centers CRCs) in Sweden. Between 1995 and 2005 the Swedish industry, the government (NUTEK/VINNOVA) and universities together invested €550m (4.9 BSEK) in research cooperations of the 30 selected CRCs which were all affiliated to a total of eight Swedish universities. Sweden was therefore one of the first countries in Europe which supported this type of competence center (Lidgard and Lundberg 2010).

The reason to initiate the CRCs was the Swedish market failure which was primarily caused by insufficient production of knowledge relevant to industry. The reason NUTEK gave for the implementation of the predecessor programme CRC was that Swedish scientists only had very weak contacts to other areas of society and that universities made relatively low investments in industry-related research. In order to resolve this situation NUTEK saw the need for a new organisation which would coordinate research and industry. The long Swedish tradition of concentrating resources for research particularly on the higher education sector is the reason why this is not done by extramural research institutes (Stern et al. 2013).

The objective of these competence centers was to achieve increased interaction between science and industry in order to improve the NIS (Arnold, Clark and Bussillet 2004). This should be done by systematically integrating industry into long-term multidisciplinary academic research to sustainably increase the international competitiveness of the Swedish industry. According to NUTEK, the increasing complexity of technologies made it necessary that industry does not only conduct its own research, but also opens up to external knowledge. The universities, on the other hand, would have to meet societal requirements for relevant knowledge and make R&D efforts more efficient (Hjorth 2000).

**Predecessor program**

In 1993, the Swedish government finally asked NUTEK to create 30 competence centers. The two main criteria for the selection of the centers were that a university filed the application and that a certain number of private enterprises participated financially and actively in the research. 60 of the 300 proposals which were received were subsidized by a planning grant. In the following phase, the competition was opened to others in addition to the initial 60 which had received a planning subsidy. The result were around 120 final applications and again in 1994 30 were selected. The explanation for the relatively large number of 30 centers was the broad industry structure in Sweden and the plan to test the new funding instrument (ERAWATCH 2014). The program had the following objectives:

- Conducting research relevant to industry,
- producing high quality scientific results,
- developing scientifically qualified human capital which has knowledge of areas relevant to industry,
- funding the development of an interdisciplinary critical mass in science which are also relevant to industry,
- changing the research culture and/or adapt it to the needs,
- producing innovations in participating enterprises (Stern et al. 2013).

As of 2001 the Swedish innovation agency VINNOVA financed 23 centers and an additional five which dealt with energy relevant issues were financed by the Swedish Energy Agency (STEM). The Competence Research Center Program ended with a phasing-out phase in the period from 2005-2007 (ERAWATCH 2014). The model for the CRCs was the US program of the Engineering Research Centers which has been conducted since 1985 (Arnold et al. 2004). The experiences from the US show that the majority of centers (80%) still existed after public funding ceased, however with a lesser focus on long-term research and with a smaller budget (Stern et al. 2013).

The theoretical basis of the program is the two dimensional model of basic research. This model arranges a research topic on the basis of two axes and/or two dimensions in a matrix. One axis describes the "fundamental understanding" and the second the "usability". Focusing on just one of the two dimensions which is done traditionally in universities ("fundamental understanding") as well as in enterprises ("usability") does not lead to an optimal result. Therefore a connection of the two dimensions i.e. "application oriented basic research" would be desirable. In addition, this could create positive external effects, as for example spill over. However, the results of the basic research can hardly be monopolized; consequently individual enterprises are not keen to invest in this area. Regarding basic research this leads to market failure which can be overcome by public investments and subsidies (Arnold et al. 2004).

**Objectives of the VINN Excellence Centers**

The VINN Excellence Centers are not focused on research in specific areas or disciplines, although they focus more on the strategic aim of sustainable growth than their predecessor program the competence centers. The VINN Excellence Centers deal with basic research and applied research and they collaborate in order to ensure that new insights and new technological developments result in new products, processes and services. Overall, they can be regarded as the second phase of the Swedish predecessor program of the competence centers and with that also pursue the fundamental objectives which this program itself has pursued. Naturally in the new program of the VINN Excellence Center the emphasis is particularly placed on,

- Advancing the development of academic excellence centers which actively involve enterprises and research groups and conduct joint research,
- supporting the introduction and implementation of new technologies and sustainably expanding and strengthen the technical competence of the Swedish industry.

Additional priorities are the funding of R&D cooperations, strengthening excellence, relevance of research management at universities as well as training researchers and others who are involved in the innovation process (ERAWATCH 2014). Attaining these objectives is to contribute to sustainable growth in Sweden.

In comparison to the predecessor program, partners from the public sector should be more involved and the Centers are to be more visible in public. The Centers should also do more so that new scientific and technological findings lead to more new products, processes and services. Also a stronger focus should be on the capabilities of the Centers to further develop products which are outside the core areas of the partner enterprises, for example by establishing new companies (Lidgard/Lundberg 2010).

# 2 Integrating the topic area cooperation of science and industry into the Swedish innovation system

One of the most important factors in global competition is an internationally strong research and innovation environment. Particularly for small and internationally dependent countries it is important to focus on a number of strong, internationally acclaimed research and innovation environments in order to support national growth, and at the same time, assert the own competitiveness internationally (Hjorth 2000). Sweden is a relatively small country which is strongly integrated into international structures, and at the same time, it is dependent on them. Increasing international competition also means increasing importance of research and innovation for competitiveness and sustainable growth. For this reason the Swedish government stressed in its "Research Bill" in 2004 the importance of a strong research environment and increased government expenditure for internationally competitive excellence centers in all scientific areas (Lidgard/Lundberg 2010). As already mentioned in Chapter One, the creation of so-called competence centers in the university landscape has a long tradition in Sweden. The reason for initiating these centers is particularly the Swedish market failure at the beginning of the 90s which was caused by the insufficient production of knowledge relevant to industry. Therefore the Swedish government asked NUTEK in 1993 to create 30 so-called competence centers. The objective of the program was to achieve stronger interaction between science and industry to improve the Swedish NIS (Arnold et al. 2004). Between 1995 and 2005 the Swedish industry, the government (NUTEK/ VINNOVA) and universities jointly invested €550m (4.9 BSEK) in research cooperations of the 30 selected CRCs which were all incorporated into eight Swedish universities (Lidgard and Lundberg 2010). Until it was dissolved in March 2009, NUTEK was the Central Office for Economic and Regional Growth in Sweden. The authority which was created in 1991 by joining three central offices had around 220 employees in 2005 and a turnover of approximately €185m (1.68 BSEK). Approximately €145m (1.3 BSEK) from this budget were contributed to different programs and projects. NUTEK was attached to the Ministry of Economy (VINNOVA 2014a). In 2001 the government merged a number of traditional science councils which previously run different disciplines in the Swedish science council. At the same time, VINNOVA was established as Sweden's new innovation agency and took over important areas of responsibility from NUTEK. VINNOVA itself is responsible for applied research, technology and innovation as well as social and economic development.

As part of this general restructuring process, it was decided to create the concept of the so-called Centers of Excellence (CoE) as a financing model. It was decided to concentrate financial resources on setting up of a sustainable research environment with a focus on strong leadership integration and working under one roof (Aksnes et al. 2012).

Today there are about 15 different CoE systems in the Swedish research landscape which are under the patronage of seven research sponsors (Hellström 2014). VINNOVA's vision for Sweden is to become a global leader in research and innovation and thereby an attractive location for investments. The cooperation between enterprises, universities, research institutes and public authorities is supported. Every year VINNOVA invests around €300m (2.7 BSEK) in different initiatives (VINNOVA 2014a). VINNOVA is therefore an important actor in carrying out the government's national innovation policy by investing in research and development and is responsible for strengthening of networks which are a necessary part of the innovation activities. VINNOVA's initiatives aim to further establish and reinforce the collaboration between researchers, the public sector and industry (Lidgard and Lundberg 2010).

In promoting innovation, VINNOVA itself defines four strategic fields:

**Knowledge Triangle:** aims to establish interactions between education, research and innovations and therefore also to increase the relevance and use of university activities.

**Innovation Capacity in the Public Sector:** aims to support and develop the innovation capacity of systems, organisations and individuals.

**Innovative Small and Medium-sized Enterprises:** developing and strengthening the capacities of SMEs regarding the development and application of new knowledge and new activities in new business models.

**Individuals and Innovation Milieus:** aims to create a strong research infrastructure and an internationally competitive innovation milieu and to increase the number of cooperations.

Science and industry collaborate particularly in the strategy field "Individuals and Innovation Milieus" which includes the program of the VINN Excellence Center (VINNOVA 2014b).

# 3 Organisation of the VINN Excellence Center

The VINN Excellence Center Programs focuses on groups of researchers, industries involved in R&D and actors of the public sector. Universities as well as researchers can initiate such a center although the center itself always has to be at a university. All those involved in a center have two basic tasks, financial and active involvement in the research process. Currently VINNOVA supports 18 VINN Excellence Centers financially where a total of nine universities collaborate with over a hundred enterprises and public research facilities. The 18 centers are financed in four phases for a maximum of ten years. Before every new phase an international evaluation of its activities as a whole is carried out for each center (Anaya-Carlsson/Lundberg 2014 und Lundberg 2011).

NUTEK already worked out the *original selection criteria* of the centers in 1993 during the first call for tenders for the Competence Research Centers which for example stipulated that the call for tenders was primarily directed at universities and technical universities. It also became clear that the main selection criteria were that a number of industrial enterprises committed themselves to financially support the individual centers and to actively participate in research (ERAWATCH 2014).

The *selection* for the last call for tenders of the VINN Excellence Center from 2004 - 2006 was based on the following *criteria*:

- Potential for sustainable growth,
- profile and quality of the research program and the potential for an excellent research environment,
- competence and exemplary commitment and the importance for the participating actors from science, industry and the public sector,
- focused research environment, explicitly carry out forms of collaboration and management style,
- put the proposed VINN Excellence Center into the context of the long-term university research strategy and innovation environment.

Gender aspects were generally taken into consideration when evaluating the proposed centers. Importance was also put on the necessity of a gender perspective in research.

In addition there is a *three-phase approach for the application, selection and preparation* of the new VINN Excellence Centers. The first step (not absolutely necessary) is that the Centers apply for a grant, the second step is the presentation of a detailed concept for the excellence center while the last step is the decision by VINNOVA which concept is to be subsidized. Finally, the agreement is signed. VINNOVA emphasized in the current call for tenders the special significance of a holistic evaluation of the proposed VINN Excellence Centers. A group of international experts and representatives from industry as well as other societal players and actors from science conducted the evaluation. All actors who participate in a VINN Excellence Center can also be questioned during the evaluation process in order to get a broader picture of the respective concept (ERAWATCH 2014).

The *total investment volume* of the program is approximately €500m (4.5 BSEK) for a period of ten years. The remaining amount should come in equal shares from the universities and enterprises (Lidgard/Lundberg 2010). Accordingly, VINNOVA invests up to €7m (63 MSEK) per Center during the entire 10 year period. Overall, each Excellence Center will be able to invest a minimum of €23m (210 MSEK) in its research activities through the participation of the cooperation partners (Lundberg 2011).

Although there are no *specifications regarding the subject matter,* certain thematic priorities can be seen. In terms of the classification of VINNOVA the sector "Telecommunications & Innovative Services" has the highest number of centers, i.e. six. The sector "New Materials & Production Methods" has five centers, followed by "Biotechnology & Better Health" with four centers and just three centers for the sector "Modern Working Life & Sustainable Transport" (see also Chapter four) (Lundberg 2011). A personal interview with VINNOVA showed that Swedish universities are considered particularly efficient and capable in these areas.

The research programs are elaborated together with the partners (Hellström 2014), even if there are no official specifications regarding the research plan. However, the following specifications for the presentation of the research program were given for the evaluation 2009 (Reeve et al. 2009):

- Length: 5 pages,
- brief descriptions of the individual research projects: explanation of the principles, methods and particularly the necessity. Also the research question and technological objectives,
- summary statement about the research productivity.

VINNOVA makes no stipulations regarding the *organisational form and governance*. Centers are managed by a managing director and a board. The participants can decide on the research direction. Members of the enterprises and the public are the majority (ERAWATCH 2014). Regarding the creation of effective and efficient organisational structures, the first evaluation (2009) advises VINNOVA to analyze best practice structures and guidelines and thereby offer the Centers support (Reeve et al. 2009).

There were no explicit stipulations in the call for tenders regarding the *spatial relationship* which has to exist between the persons involved in a VINN Excellence Center. Nevertheless, it was required that the Centers must be located at a university which stipulated the spatial component. In addition the spatial dimension was a significant success criterion in the first evaluation. The "geographical programs" for which the majority of work was done directly at the university were evaluated as particularly positive as they achieved a "minimum degree" of interaction between research and education (Reeve et al. 2009).

Regarding the *management of IPR (eye level principle),* VINNOVA has in principle no binding stipulations regarding the collaboration of actors from science and industry. In principle, many individual agreements about IPR are therefore possible (Runesson 2006). However, over time VINNOVA commissioned a model agreement as it transpired relatively quickly that this issue in particular was difficult to clarify. All partners were constantly in contact while this model agreement was drawn up. In the beginning the lawyer VINNOVA commissioned received approximately 300,000 ideas which he needed to examine. After six months, a contract was drawn up and all three parties (industry, university and public sector) came to a so-called 70% agreement. The model agreement is applied everywhere. The model agreement consists of the following regulations regarding research results:

- All parties of the center can make use of the results for future research free of charge.
- All parties of a project can make use of the results for commercial purposes.
- Parties of the Center may not refer to their background knowledge to prevent another party form using the results free of charge.
- Enterprises which participate in a project and are not competitors can sign own contracts on the right to commercialize the results. These contracts do not affect the usufruct of the universities
- The usufruct of the results for the project parties also includes the right to give a license to a third party after an agreement has been reached with the other parties.
- When a project party has made a claim to exclusively make use of a result the other parties can forbid that competing enterprises receive licenses.
- The other parties always have to give permission to license results if the results are part of an R&D background which the party pursues with another party from the Center or pursues jointly with a third party or was commissioned by a third party.
- Enterprises which are involved in a Center can always grant licenses for the results to companies for which they alone have control or to enterprises that have control over the party.
- The university can transfer its usufruct to the involved enterprises.
- Agreed restrictions of the usufruct are only to be applied so the usufruct is based on the sole intellectual ownership or constitutes commercial law. Agreed restrictions of the usufruct are to be restricted to a maximum of seven years as of the EU market introduction of the products. Agreed restrictions of the usufruct can expire earlier or become invalid if the total market share of the enterprises exceeds a certain threshold and when agreed thresholds are considered a barrier to competition.

In principle, this model proposal treats all parties of a Center as equals and pays particular attention to enterprises which are involved are not disadvantaged when other enterprises make use of licenses or third parties are granted licenses.

Finally, there are several *evaluations* for each individual Center. These are evaluations which are conducted in phases and take place every two to three years. For example, the first evaluation takes place two years after financial support has begun. Each evaluation has a different focus. International teams conduct the evaluations. In order to get as broad a picture as possible, these teams are to include an expert of the respective topic area and a generalist who has experience in university-industry partnerships. In addition to these "external" evaluations, each Center is to publish an annual report (ERAWATCH 2014/Hellström 2014).

# 4 VINN Excellence Center: Evaluation and recommendations

The VINN Excellence Center Program offers like our research campus approach an excellent forum for the cooperation of the private and public sector, universities and colleges, research institutes and other organisations which conduct research. In April 2005, VINNOVA selected four VINN Excellence Centers in the areas transport and working life. In June 2006, 15 more Centers were added. Today, VINNOVA funds 17 VINN Excellence Centers (VINNOVA 2014c). All Centers operate in the following four areas (Lundberg 2011):

**Bio technology and better health:** Swedish researchers and enterprises are leaders for the international mapping of human proteins. This is a unique basis for the VINN Excellence Centers which produce new medicine and technologies based on proteins.

- AlbaNova Center for Protein Technology, Royal Institute of Technology,
- Antidiabetic Food Center, Lund University,
- BIOMATCELL – Biomaterials and Cell Therapy, University of Gothenburg,
- Supramolecular Biomaterials Structure Dynamics and Properties, Chalmers University of Technology.

**Tele communication and innovative services:** IT and wireless communication are strong areas in Sweden. Some VINN Excellence Centers produce small wireless sensors. These can monitor everything – from industrial processes to patients' health – or they can be included in intelligent packaging.

- Center for Sustainable Communications, Royal Institute of Technology,
- CHASE – Chalmers Antenna Systems Excellence Center, Chalmers University of Technology,

- GigaHertz Center, Chalmers University of Technology,
- Mobile Life Center, Stockholm University,
- iPack Center – Ubiquitous Intelligence in Paper and Packaging, Royal Institute of Technology,
- WISENET – Uppsala Center for Wireless Sensor Networks, Uppsala University.

**New materials and production methods:** New revolutionary tailor-made materials are the objective of a number of VINN Excellence Centers. These include technologies to manufacture thin film ceramics for high strength tools or new electronic components. Enterprises in Sweden are also leaders in using natural raw materials from the forest. Many enterprises and universities also research better paper products and completely new renewable raw materials.

- BiMaC-Innovation, Royal Institute of Technology,
- Faste Laboratory – Center for Functional Product Innovation, Lulea University of Technology,
- FunMat – Functional Nanoscale Materials,
- HERO-M – Hierarchic Engineering of Industrial Materials,
- Wingquist Laboratory Excellence Center for Efficient Product Realization, Chalmers University of Technology.

**Modern working life and sustainable transport:** Goods and people are becoming increasingly mobile due to advancing globalization. Some centers research transport efficiency and simultaneously decreasing environmental impact. New developments are environmentally friendly vehicles for road and rail. Additional efforts for sustainable transport are the development of public transport in consultation with enterprises and the public sector.

- Center for ECO2 Vehicle Design, Royal Institute of Technology,
- HELIX – Managing Mobility for Learning, Health and Innovation, Linköping University,
- SAMOT – The Service and Market Oriented Transport Research Group, Karlstad University.

The VINN Excellence Centers collaborate in order to ensure that new insights and new technological developments lead to new products, processes and services. VINNOVA itself plans to establish up to 25 centers in future which are funded for a period of ten years.

**First evaluation**

The VINN Excellence Centers are evaluated extensively every two to three years (phased evaluation). The aim is to examine the effectiveness of the funding initiative and the degree of international top performances of the Centers. In addition, every center has to complete an annual report for VINNOVA. In October 2007, the first evaluation of the first four VINN Excellence Centers (Ngil, HELIX, SAMOT, ECO) took place. The centers were in the last month of the first phase. Overall the evaluation of this first phase focused on the extent to which the centers were able to build an effective form of organisation and thereby created the potential for a long-term partnership. The objective of the first evaluation was to give advice and recommendations for each of the four centers, how they can establish themselves even more efficiently and effectively. The results show overall that the performance of the VINN Excellence Center is highly satisfactory. A number of things were established: a high level of academic competence, talented and enthusiastic students, a strong commitment to cross-border research, a supportive academic environment, committed partners in industry as well as the vision and the desire to create societal value added by combining academic research and economic needs. Furthermore, the evaluation proposed to become more active on the international level. Among other things, cooperations with internationally leading organisations are to be established, international financing and students are to be recruited and participation in the wider international community is to be intensified. Between August 2008 and October 2009, VINNOVA paid for the evaluation of further fifteen VINN Excellence Centers two years after the program had started. The evaluators tried to give each of the fifteen centers and VINNOVA constructive criticism and goal-specific recommendations, explicitly intending to contribute to the lasting success of the VINN Excellence Center Program. The aim of the evaluation was to assess the scientific quality and productivity, the relevance regarding scientific use, marketing and society as well as organisation i.e. guidance, governance and management. Overall, the evaluators came to the conclusion that there is a high level of scientific quality and productivity at the centers, that they make a substantial contribution to the development of technical competence and have a high degree of industrial and societal relevance: The centers deal with scientific and technical research on the highest level which addresses many of the relevant societal challenges. Their work contributes to the development of the highest level of expertise. The targeted training of students and the commitment of the industrial partners in science are essential here. Establishing effective partnerships between universities and industry was very successful. Part of the centers' success is due to industry's substantial financial support in cash and in-kind, often exceeding the required amount. All in all, the contribution of the industrial partners who participate actively in the success of transnational research is significant. The productive translation of science to companies is successful even if innovation and the development of technology are usually left to industry. It is also common practice that graduates from the centers are employed by the industrial partners and are a good indicator of the success of excellent training in the centers and the Swedish industry can profit substantially from this (Reeve/Anderson 2009).

**Advice and recommendations from the first evaluation:**

All in all, the evaluators see a need in all centers for a formal advisory group which focuses on the continuous development of the entire research program (already existent in some centers). The newly formed groups should be composed of high-ranking scientists from the centers and leading scientists or engineers from the partner companies. The group should be represented by a scientist from industry or a leader in technology who reports to the managing director. The group should meet regularly, for example two or three times a year. It should have the entire research program in mind and pay attention of its continuous development. As the decision-making body the group should be responsible for finding ideas, as well as developing, prioritizing and reviewing projects and conducting the strategic analysis of the center. In this way, the group's report can gain influence on the director and be involved in the successful development of the centers.

In order to be successful internationally monitoring by an independent group of experts is sensible; for example the formation of an international Scientific Advisory Board (ISAB) could be significant. In this context, it was recommended to VINNOVA for example to work out a number of guide lines for the funded centers by using international best practice and edit them accordingly to support the centers.

Furthermore, the evaluators were often frustrated by interpreting the respective financial reports. Centers are complex institutions, both from a scientific and an organisational perspective but also inconsistent and confusing reports regarding financing, (e.g. by a mixture of cash and in-kind contributions) hamper the analysis. Some centers have reported on related research programs, others have not. Some have reported n bilateral projects in such a manner as if they were part of the activities of the center. In the end it was ambiguous inasmuch they had been funded by cash and in-kind contributions. Furthermore, inconsistencies regarding the reporting of overheads, particularly in terms of university contributions (Reeve/Anderson 2009) were noted. It was recommended to VINNOVA to check the accounting directives in terms of simplifying and clarifying the financial reports and also to offer unambiguous instructions to complete the tables.

Furthermore, the difficulty of bringing into force a regulation for joint IPRs was discussed and it was regarded as sensible that VINNOVA gives significant input to solve the respective problems in the centers. Consequently, VINNOVA arranged the preparation of a model agreement to regulate IPRs (see Chapter three).

As it is important for the VINN Excellence Centers to include SMEs, VINNOVA was asked to develop an instrument which could help the intense exchange of best practices to include SMEs. Incentive mechanisms which encourage stronger involvement of SMEs should also be developed. It is also considered appropriate to give a prestigious award to outstanding partnerships to recognize innovations and at the same time to generate more.

In conclusion, it was established that it is important for the success of the centers to have a well-organized management system. In the first generation of competence centers, there were for example a number of scientifically sound results but no sufficiently professional management system. This was not very conducive for the successful continuation of the centers. VINNOVA reacted to this and invited the center managers (mostly professors) to discuss their management systems; almost all managers accepted this invitation. Particularly professors had to learn how to lead and how to think cost effectively. In the mean time, VINNOVA offers leadership training for center managers. In this context, it also pointed out that it is essential to invite different actors to a shared dialogue in order to join the way of thinking of both science and industry, or to increase awareness on both sides.

### Second evaluation

The second evaluation took place between October 2010 and September 2012 when the centers were in the second phase (between 3 and 5 years). It focused on long-term outputs and outcomes which were a result of the collaboration of the heterogeneous partners in the centers. A summary of the results is as follows (Reeve et al. 2013):

*Productive VINN Excellence Centers*

- The VINN Excellence Center improved and/ or completed 158 products, services or processes and three licenses were issued in 2012,
- four centers contributed to the establishment of eight new companies,
- 32 patents were registered and/or and trade mark protection was granted for nine centers,
- furthermore, research cooperations have resulted in 748 publications (133 co-publications with partners from the public sector and industry) and 73 doctoral positions.

*Interdisciplinary cooperation and innovation leadership*

- 75 actors from industry, from both national and international enterprises, have participated in a leadership workshop (have participated in a leadership capacity),
- 12 projects were not part of the respective center agreements and were funded, either fully or partially, by industry.

*Mobility, exchange and the cooperation in research between industry and science*

- 33 researchers from the centers were employed in industry in 2012,
- 133 publications were released jointly by companies, the public sector and researchers from universities.

*Internationally established and in demand*

- 56 visiting scholars from abroad conducted research at the centers,
- 24 EU projects were completed at the centers.

All in all, this second evaluation also aimed to provide more advice and recommendations how every center can work more efficiently and effectively. In particular it was noted that at least half of the centers received detailed **recommendations** for the following issues:

- *Vision Strategy and Organisation:* Many of the organisational problems of the first phase were rectified and only five centers were issued with new recommendations to improve the center management: increasing the management team, formalize the roles of the management team, develop a succession policy for the director. There were also a number of questions about the organisation of the center board. Twelve centers were given recommendations for improvement as for example better representation on the higher levels of the university, stronger participation of SMEs and renewed membership on the board of directors in order to eliminate any semblance of a conflict of interests.
- *Internationalization:* About twelve centers received recommendations to improve their international scientific activity. The following issues in particular should be taken into consideration: cooperations, exchange, profile, benchmarking, financing and publications (number and impact). International recruitment was also recommended to improve the program. Some centers already have active and successful programs to recruit international research staff; however, five centers were advised to intensify the recruitment of international doctoral students, post doctoral students and experienced researchers.
- *Finances and financial reporting:* In general, the centers' finances and financial reporting were fine. The evaluators issued recommendations to five centers with the result that the partners from industry increased their financial support, even though non-cash benefits are important and essential for a successful cooperation between universities and industry. Universities need money to implement their ideas and

concepts. It was also pointed out that in nine centers more attention needed to be paid to detailed reports regarding precise information of seconded personnel. Several centers reported during the interviews that the actual number of seconded personnel was higher than specified. The reason for the imprecise information was that the required threshold had already been reached. It is, however, of great importance to have precise information about personnel so that the true strength of the mixed teams in the individual centers can be assessed.

- *Gender Equality issues:* Recommendations were made in nine centers to increase the share of women in one or more areas: students, doctoral students, experienced researchers within the ISAB and the board of directors.
- *Partner in the centers:* Recommendations were made in eleven centers regarding the opportunities for an improved partner constellation. In particular, the number of enterprises and SMEs should be increased.

In addition, the evaluators gave VINNOVA the following **recommendations**:

- Employ personnel who monitors at least once a year the reactions of the centers to the evaluators' recommendations at least once a year, e.g. regarding financial reporting, correct information about in-kind contribution, content of the ISAB reports, significant deviations from the business plan, disclosure of key performance indicators including metrics for the influence on national productivity, international commitment and interaction with non-Swedish partners.
- Every center is to develop a plan how it can fund itself after ten years; this profit plan can be assessed as a criterion for success for the evaluation in the third phase.
- Before the start of the next round of evaluations, a consultation round and discussion between VINNOVA and the evaluators is to take place to discuss VINNOVA's vision and strategy regarding the lasting success of the centers and the role of the evaluation process.

All in all, the program was assessed as good. While some centers consistently performed very well the rest was able to record continuous progress. On the basis of the evaluation results, VINNOVA ultimately decided that 17 of 19 centers are to be approved for a third period.

# 5 Conclusion - VINN Excellence Center and Research Campus

After the Swedish funding initiative of the VINN Excellence Centers has been outlined in detail, it can be said that the three key characteristics of the Research Campus initiative can be transferred almost completely to the VINN Excellence Center program:

- Both support programs **pool competences and/or research activities** from economic and public research **in one location** if possible on the campus of a university or research institution. Even if research in one place is not explicitly prescribed in the Swedish funding initiative the centers have to be based **at a university** so that the spatial component has been given here. Also the spatial dimension was a significant success criterion. However, the centers are also looking specifically for international cooperation partners; the reason being that Sweden as a country with a small population can thus increase its competences and improve its international visibility.

- Both take on **new topics** in the joint interest of science and industry with a **medium to long-term perspective** and deal with them according to their specific research profile, in the ideal case on the basis of an established research program.
- Both are funded by a **binding public-private partnership**. This public-private partnership is backed by substantial contributions by the participating partners who have to be involved in establishing the research campus/VINN Excellence Centers. These contributions should be made through cash payments and contributions in kind.

Overall, both funding initiatives develop new, highly complex research areas with a high research risk and/or special potential for leap innovations in a profitable manner. It is intended to facilitate new technology and know-how leaderships as the research areas "for the day after tomorrow" are often distinguished by a new profile, strong interdisciplinary and early needs orientation.

Regarding the recommendations which should be taken non-board, the intensification on the **international level** needs to be emphasized. One of the suggestions was to establish cooperations with internationally leading organisations, international financing and to recruit students and to intensify the participation in the wide international scientific community. This issue was also classified as significant within the research campus initiative. The evaluators proposed an independent group of experts; thus, for example **establishing an international Scientific Advisory Board** (ISAB) could be particularly significant. During the second evaluation more intensive recruitment was proposed to improve the program. Furthermore, it could make sense for the research campus initiative if a number of **guide lines** were established (e.g. international best practice/simplified financial reporting) which would give them guidance for their further existence.

In all centers the need for a **formal consultation group** was observed which would focus on the continuous development of the entire research program. The newly formed groups should be made up of the centers' high-ranking scientists and leading scientists or engineers of the partner companies. As a decision-making body the group should be responsible for finding ideas, development, prioritization and monitoring of projects as well as the strategic analysis of the center. Thus, by reporting to the director the group could gain influence and help constructively to further develop the centers.

It was also quickly realized that difficulties regarding a **regulation of joint IPRs** have come about so that it is considered sensible if VINNOVA gives significant input to solve the respective problems at the centers. VINNOVA then arranged that a model agreement on regulating IPRs was drawn up.

As cultural differences between industry and science still play a major role, a well functioning management system is particularly important for the continuing existence of the centers. It appears particularly recommendable to offer **leadership training for center managers** in order to continue to join the way of thinking of science and industry and at the same time to raise awareness of the respective needs on both sides. A formal consultation group can also be significant as it focuses on the continuous development of the entire research program.

In this context, it should also be considered how industry can be more involved in research and how overall **incentive mechanisms** can be developed which result in a **stronger commitment by SMEs**. VINNOVA for example was asked to develop a tool how best practices can be exchanged regarding practices to involve SMEs more. A prestigious award for outstanding partnerships between science and industry could also help to further stimulate innovations. Regarding the sustainability of the research campuses, it is also very important to develop plans in good time how they want to work once funding ceases, the objectives they set themselves, how they want to reach them and how they want to fund themselves.

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# IV The Industry/University Cooperative Research Centers Program (I/UCRC) in the United States

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## 1 Background information and objectives of the programme

### 1.1 Start and Duration of the Programme

The Industry/University Cooperative Research Center (I/UCRC) Program was initiated in 1980 to develop long term partnerships among industry, academia and government. The I/UCRC Program is thus one of the oldest and longest-standing of its kind around the globe and has been sustained for close to four decades, largely unaffected by substantial shifts in political trends and paradigms that have occurred during this period (Gray/Walters, 1998a; Gray et al. 2015a; 2015b).

While several adjustments were made to the programme along the way and some specific sub-lines (such as state co-financed I/UCRCs) were at some point introduced and later abandoned, the overall nature of the programme solicitations has been notably stable since the mid-1980s (some notable changes that in fact have occurred will be explained in more detail below) (Gray et al. 2015b).

The fact that the programme has remained so notably unaffected by government policy and politics is fairly unusual among U.S. support programmes for university-industry collaboration and can, among other factors, be attributed to the high institutional autonomy of the National Science Foundation (NSF), under whose remit it falls, and its comparatively low budget volume.

### 1.2 Precursor Programs

In 1973, the NSF started to support the first three pilot models for university-industry collaboration (ERDIP Program) among which the one at MIT was already very similar to today's IUCRC. In official NSF publications the starting date of the IUCRC programme is therefore often stated as 1973. A full-scale programme with solicitations and the standard support framework has been maintained until today, however, it was not put into place until 1980. Hence, 1980 should be considered the technically precise starting date of the programme as known today (Gray/Walters, 2012; Gray et al. 2015b).

## 1.3 Objectives

According to its mission statement in the current I/UCRC Program solicitation, the National Science Foundation (NSF) invests in partnerships between university and industry mainly

- to promote research programmes of mutual interest,
- to contribute to the nation's research infrastructure base,
- to strengthen the science workforce through the integration of research and education,
- and to facilitate technology transfer.

In more detail, the I/UCRC Program seeks to achieve these goals by NSF (2013):

- Contributing to the U.S. research enterprise by developing long-term partnerships among industry, academia and government,
- leveraging NSF funds with contributions from the industry to support graduate students in performing industrially relevant research,
- expanding the innovation capacity of the U.S. competitive workforce through partnerships between industries and universities, and
- encouraging the nation's research enterprise to remain competitive through active engagement with academic and industrial leaders throughout the world.

Importantly, the I/UCRC Program does explicitly *not* intend to promote on-site collaborations between university faculty and industrial researchers. While it is encouraged and in fact often the case that "industrial monitors" (see below) are closely involved in scoping and designing of the centres' research activities, they do not usually participate in actual research activities. Consequently, it does *not* support the creation of jointly invested infrastructure and/or facilities in which government and industrial researcher can work together "under one roof".

Overall, the I/UCRC Program can be considered as one based on the notion of a clear division of tasks between academia (pre-competitive research) and industry (applied research generating IP) rather than institutionalised co-operation between them. This, however, is not to say that it was based on a traditional technology-push concept or unidirectional understanding of technology transfer. On the contrary, the model seeks to bridge the cultural gap between university and industry by establishing a culture of cooperation and thus to enable what in the literature has been termed "use-inspired basic research" ('Pasteurs Quadrant') (Stokes 1997).

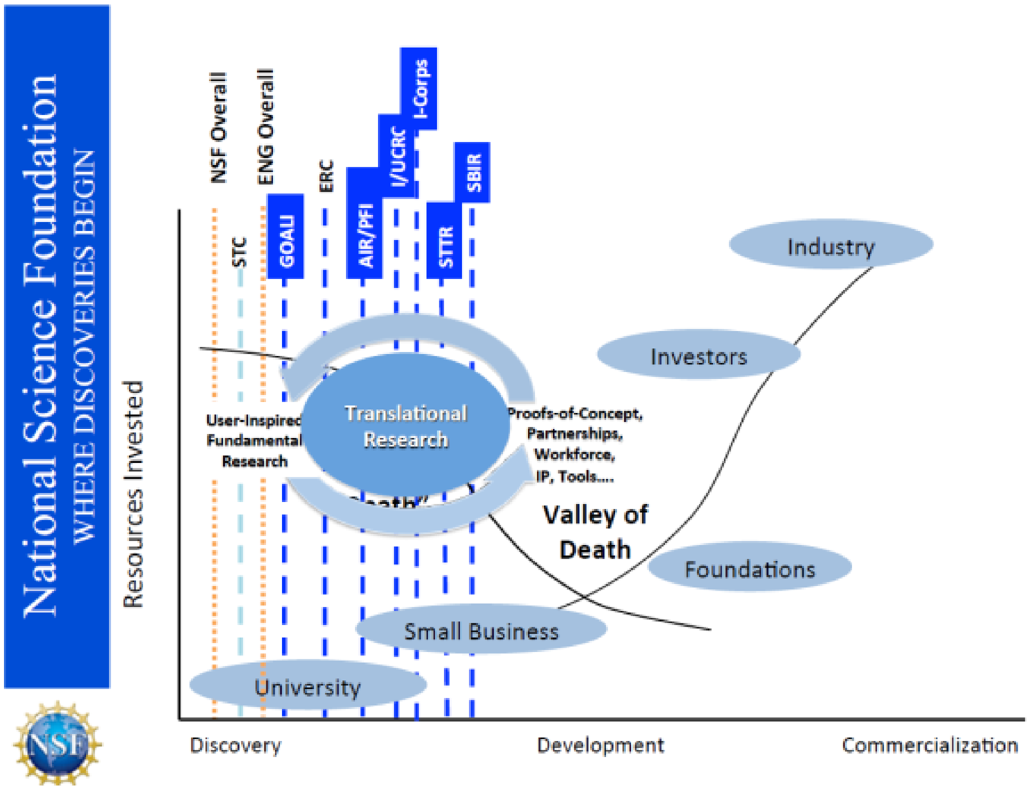
The Industry/University Cooperative Research Center's program develops long-term partnerships among industry, academia, and government. The centres are catalyzed by a small investment from the National Science Foundation (NSF) and are primarily supported by industry centre members, with NSF taking a supporting role in the development and evolution of the centre. Each centre is established to conduct research that is of interest to both the industry members and the centre faculty. An I/UCRC contributes to the nation's research infrastructure base and enhances the intellectual capacity of the engineering and science workforce through the integration of research and education. As appropriate, an I/UCRC uses international collaborations to advance these goals within the global context (NSF 2013b).

## 1.4 Integration with other programs

The I/UCRC Program is – within NSF – integrated with a number of other programmes in the sense that – by nature – R&D activities facilitated by them could either precede or succeed I/UCRC enabled efforts. Programmes in question include: GOALI, PFI: ARI-RA, PFI: ARI-TT, SBIR/STTR, and I-Corps (cf. www.nsf.gov/funding/azindex.jsp, Figure IV-1). Also, it relates to a number of other programmes supported by other agencies such as NIST (Figure IV-2). When (made) aware of such situations, NSF will seek to ensure a smooth transition of funding from one type of programme to that from another. As will be illustrated in detail below with respect to the specific provisions for coordinated support from I/UCRC and SBIR/STTR, some programme's solicitations also make direct reference to each other.

Nonetheless, better access to complementary NSF programmes was raised by many interviewed centre directors as a key motivation to join or set up I/UCRCs. While the I/UCRC funds themselves are in general considered 'tough (and little) money', their effect as a 'door opener' to other, better endowed and less strictly monitored NSF programmes is considered as decisive by many. While being a member of an I/UCRC does not always entail preferred access in a technical sense, it often leads to close interaction with NSF and better awareness of opportunities. Moreover, I/UCRC funds may serve as a stepping stone to gain access to other federal funding sources beyond NSF. Several I/UCRC even involve DoE- or DoD-related agencies as members directly and through their participation gain good insights into further funding opportunities. Moreover, working with federal laboratories in the context of an I/UCRC can often be a good leverage point for working with potential government or public research partners who have privileged access to federal resources (cf. Gray et al. 2015a).

**Figure IV-1: Positioning of the I/UCRC with respect to other NSF Programmes**




Source: Internal NSF Presentation, cf. also Gray (2015a)

**Figure IV-2: Positioning of the I/UCRC with respect to other Programmes, including those of NIST**


Source: Molnar (2014)

# 2 Role of Science-Industry Cooperation in the National Innovation System

## 2.1 General Framework of Cooperation between Science and Industry

### 2.1.1 Factual Prevalence of University-Industry Linkages

On the one hand, the U.S. has a long-standing, vivid and resilient culture of collaboration between science and industry. In studies on the subject matter, first models were identified back in the 1930s, with a notable increase in activities following WWII in the 1950s and 60s. Nonetheless, the 1950s and 1960s must as well be seen as setting the scene for an ensuing weakening of university-industry relations that culminated in the 1970s. An uptake in federal investment in university research and teaching on the one hand and an increasing reliance on in-house R&D departments in the corporate sector on the other reduced both need and inclination to bridge the gap between academia and practice on both sides. Starting in the late 1970s, however, federal funding for universities started to diminish and the in the 1950s far more pronounced reservations regarding defence-related research began to subside. As a result, the 1980s and 1990s saw a dynamic uptake of university-industry collaborations and various efforts to support these, of which the I/UCRC model is but one expression. In 1994, a study found that more than 1,200 university-industry collaboration centres were operating across the country, a figure that experts estimate to have risen at least threefold since. Nobody, however, has systematically taken stock of these efforts in the past 20 years. Nevertheless, it is clear that many of America's lead corporations continue to regularly co-establish cooperation centres with leading universities in various fields. On the other hand, many of the U.S. leading engineering schools, most prominently the MIT, are not only open towards but actively support such efforts. Even at smaller land grant universities and/or colleges similar efforts exist, even if not always with a comparable scope and/or impact. Moreover, federal programmes like the I/UCRC model have added momentum to science-industry cooperation on a broad basis for more than three decades (cf. Gray/Walters 1998a; Shapira/Youtie 2008; Gray et al. 2015).

On the other hand, most of these activities depend strongly on the bottom-up initiative of either select corporations or high-profile universities. Policies to structurally build such endeavours with federal or state money, in contrast, are less common and often prevented by the ban on industrial policy, which is politically non-negotiable in the U.S.. Genuinely joint engagement of federal and corporate researchers in which individual firms gain preferential access to taxpayer's money, e.g. through privileged access to government-funded infrastructure, would be far less accepted in the U.S. than it is in

Europe. At the same time, U.S. corporations are even more reluctant than their European counterparts to commit to long-term co-operative efforts and/or to invest substantial resources into the creation of jointly-owned infrastructures. While there seems to be at least as much of a trend towards the 'outsourcing of corporate basic research' in the U.S. as there is in Europe, corporations expect to retain flexibility in the choice of their partners and to remain free to opt out of failing endeavours at any time. Consequently, a strong nexus of science industry co-operations typically only evolves in those fields and sectors where both sides are financially strong and willing to mutually engage. This, however, is no longer the case in many fields of the U.S. manufacturing industry as well as it may, by definition, not yet be in freshly emerging technological niches. Furthermore, there is a certain tendency in U.S. universities' and corporate culture to believe that mutual science-industry co-operation can in many cases be substituted by entrepreneurship. To many, outstanding spin-off success stories seem to confirm that the feared 'valley of death' between the initial conception of a technology and its development into a market-ready product could on a systemic level be bridged by spinning out relevant projects *from* universities and, if need be, their later re-acquisition by corporate America. Many observers, however, increasingly point to the fact that this approach on its own cannot and does not sustain a healthy national innovation ecosystem (c.f. e.g. Hart et al. 2012; EOP 2011; EOP 2012; EOP 2014).

### 2.1.2 Policy Background

In terms of political framework conditions, the United States has for the majority of the past three decades not had a strategically orchestrated research and innovation policy. Politically kept from venturing into the domain of applied research too strongly (industrial policy is and will remain rejected by an overwhelming majority of congressmen and women), most administrations have been content with sustaining a system of basic and/or specifically mission driven research, trusting in the capabilities of industry to organise their own applied R&D efforts and to establish cooperation networks with public research to the extent needed for the national economy to thrive (Shapira/Youtie 2008).

Different from many other countries, moreover, the U.S. does not have a dedicated ministry with the overarching task of co-ordinating national R&D. Although there has long been an Office for Science and Technology in the White House (OSTP), it performs a mostly consultative function, has close to no own funds to allocate and no real mandate to advise other government departments on how to spend their budget. As a result, most federal departments have focused on sponsoring mission driven research within their specific domain according to their own, internal strategies which are in part coordinated across agencies, yet more regularly not so. The most prominent exponents of this system are the Department of Defense (50% of federal R&D spending in 2014), the Department of Health (24%), NASA (7.4%), the Department of Energy (7.3%) and the Department of Agriculture (1.8%). Together, department-sponsored activities make up more than 80% of all federally funded, non-defence related research, while only 8.8% are funded as *general science and basic research* by the National Science Foundation. While the NSF as an organisation is answerable only to the White House, it has a substantial degree of autonomy in developing its strategy, its impact on the U.S. innovation system is thus by definition more limited than that of major research councils in other nations (calculations based on www.nsf.gov/statistics/fedfunds/, www.nsf.gov/statistics/fedbudget/).

Arguably, this approach to national science and innovation policy has enabled some spectacular breakthroughs in various fields such as defence, aviation, spaceflight etc. At the same time, however, it has neglected to take a broad-based focus and for too long a time remained unaware of the rifts and weaknesses that the U.S. innovation ecosystem had started to develop in the past decades. While most U.S. administrations remained content with the various high-profile success stories that the country's industry still produces in certain fields, no response was sought to the increasingly visible and disruptive process of de-industrialisation and the ever more evident fact that, contrary to assumptions, many U.S. industries were no longer finding suitable solutions on their own.

First steps beyond this traditional, fragmented approach were the 2007 and 2010 America COMPETES Acts that in general terms mandated stronger cooperation between central government agencies (OSTP, DoE, NASA, NSF, etc.) in a number of broadly acknowledged areas of 'critical national need'. In practice, however, they mostly focused on increased appropriations to existing agencies (some of which never materialised) rather than any genuine commitment to structural change.

Recognizing that the traditional approach to Science and Technology policy was no longer suitable to re-establish international competitiveness and that the America COMPETES Acts had not lived up to expectations, the current administration decided to publish a comprehensive *Strategy for American Innovation* in 2011 (NEC/CoEA/ OSTP 2011) and had the President's Council of Advisors on Science and Technology prepare a report entitled *Ensuring American Leadership in Advanced Manufacturing* (EOP 2011) in the same year. As a result, a standing *Advanced Manufacturing Partnership Steering Committee* was created that submitted its first major report in 2012 ('Capturing Domestic Competitive Advantage in Advanced Manufacturing', EOP 2012) including a set of practical recommendations. In a slightly different set-up, that same committee prepared and released a second report entitled '*Accelerating U.S. Advanced*

*Manufacturing'* in 2014 (EOP 2014). In this overall framework, the Obama administration has begun to push strongly and persistently for stronger and better inter-agency coordination of efforts in the field of research and innovation policy, explicitly including applied research. The recent NNMI initiative (see below) and the resulting effort to set up IMI centres creation is one major outcome of this ambition (Molnar 2014).

## 2.2 Similar funding instruments

Beyond the I/UCRC, there are other support programmes within the NSF that pursue similar ambitions and that have from some perspectives at times been considered as a potential rival to the I/UCRC program.

The most notable among them is the **Engineering Research Centre (ERC) Program** that was also set up as early as 1984 and currently supports 17 centres across the United States with a total of more than $ 500 million of NSF funding, i.e. easily above $ 20 million per site. Overall 64 centres were supported between 1985 and 2014, 38 of which have graduated, 17 are still being supported and nine had to be terminated at some point. Of the 38 graduated centres, 31 had by 2014 become self-sustaining while seven had to be disbanded (NSF 2015b).

The latest solicitation envisaged $ 13 million of funding for the first year of up to four additional centres amounting to about $ 3-4 million annually per centre and giving the ERC Program a scope and scale quite different from that of the I/UCRC Program. (NSF 2013b). In terms of size and scope, ERC are thus more similar to the Forschungscampi than I/UCRC.

Other than the I/UCRC Program, the ERC program is a large volume support programme that has the ambition of being the federal elite programme in support of university-industry collaboration. While, again, this does not necessarily imply the co-operation of industrial and university researchers in the same laboratories, it does to a much stronger extent imply the creation of infrastructure for use-inspired basic research. As with the I/UCRC, centres can be found in the fields of (NSF 2015b)

- Advanced Manufacturing,
- Biotechnology and Health Care,
- Energy, Sustainability, and Infrastructure,
- Microelectronics, Sensing, and Information Technology.

Proposals are solicited in two tracks (NSF 2013b):

1. Open Topic ERCs, where the PI's are free to structure the engineered system's vision and research program without restrictions on the research content and

2. Nanosystems ERCs (NERCs), where the PIs are free to structure the engineered system's vision but the research program must include a substantial body of nano-scale fundamental research.

The last full ERC proposals were due in February 2014. As indicated, stipulations are substantially more demanding than for I/UCRC and even long-graduated I/UCRC have failed to meet the criteria, even if at times by a narrow margin. In any case, applying for an ERC is by many not seen as a natural consequence of having a successful I/UCRC but as a decision to take instead of applying for an I/UCRC, because that appears insufficient to enable the full potential of a certain site.

In more detail, some compulsory stipulations for ERC proposals include (NSF 2013b):

- A proposed ERC must be multi-institutional (i.e. multi-site), with a lead university and no more than four additional domestic university partners,
- to qualify as a partner institution, there must be a minimum of three faculties participating in the ERC along with at least a total of three students,
- the lead or one of the domestic partner universities must be a university that serves large numbers of students from groups that are predominantly underrepresented in engineering in the U.S. who are studying in STEM fields (diversity aspect),
- commitment to include, in the full proposal or in the future, collaborations with foreign faculty to enable U.S. students to have an opportunity to carry out research in their laboratories,
- commitments from domestic lead and partner universities for cost sharing, as instructed below,
- firm and/or practitioner fee-paying members of the centre are required. These intended memberships must be documented in letters of commitment as part of the full proposal,
- innovation partners, such as university and/or state and local government organisations devoted to promoting innovation and entrepreneurship are required, although they do not have to pay fees,
- pre-college education partners are required. Letters documenting these intended commitments are required as part of the full proposal.

Overall, ERC grants are much more difficult to obtain than I/UCRC grants, raising higher requirements with regard to the research itself but also to teaching and additional aspects regarding such as diversity. Centre proposals have to lay out a system's vision, the planned ERC's configuration with respect to partners and affiliated institutions, a strategic research plan and a concrete research programme, a university education programme and a pre-college education programme. In addition, the proposals need a layout of the ERC Innovation Ecosystem including detailed information on Industrial/Practitioner Advisory Board (IPAB), IPAB membership agreements, partnerships with university, state and local government facilitators of entrepreneurship and innovation and technology transfer and translational research partnerships, as well as information on the centre's human and material infrastructure including directors for the various fields of activities, management processes and systems and technical facilities. The sheer breadth of these activities tends to substantially reduce the at first sight significant annual budget factually available for research. Hence, some mid-size universities shy away from the (unfunded) effort of preparing such a proposal and apply for (if need be multiple) I/UCRC instead.

The ERC award typically covers five years, with year 1 start-up budgets of up to 3.25 million, year 2 budgets of up to 3.5 million, year 3 budgets of up to 3.75 million and years 4 and 5 budgets of up to 4.0 million each, pending satisfactory annual performance. Pending performance and the outcome of two renewal reviews in the $3^{rd}$ and $6^{th}$ year, support for years 6 through 8 can once more amount to up to 4 million annually. Support for years 9 and 10 is then reduced by 33% of the previous year's support annually to prepare the ERC for self sufficiency at the end of 10 years' support. The lead and partner universities will be committed to support and sustain the ERC through real and in-kind cost sharing. Evidence of this cost sharing is already required in the first full proposal (NSF 2013b).

A further major federal programme in the field of university-industry collaboration is the **National Network for Manufacturing Innovation (NNMI)**. In the context of the president's signature initiative on Advanced Manufacturing the administration promotes **Institutes for Manufacturing Innovation (IMI),** five of which were already set up in 2012, 2013 and 2014. Beyond substantial federal backing, these high-profile institutes are supported to a substantial extent by their host states and thus often explicitly or implicitly part of regional-level innovation policies (NIST 2015; Molnar 2014).

According to the administration's mission statement, the novel institutes' purpose reads as follows: "In an IMI, industry, academia, and government partners leverage existing resources, collaborate, and co-invest to nurture manufacturing innovation and accelerate commercialization. Institutes will be a partnership between government, industry, and academia, supported with cost-share funding from Federal and non-Federal sources. It is expected that institutes will typically receive $ 70-120 million in total funds, over a 5-7 year timeframe it is envisioned the total capitalization of an institute over this period will be $ 140 to 240 million" (NIST 2015; Molnar 2014; Figure IV-3). The first IMI set up in Ohio ("America Makes") indeed received $ 30 million of federal investment (mostly DoD), matched by $ 40 million of industry, state and local funds (Ratcliffe 2014).

According to a recent key report on Advanced Manufacturing activities of IMIs should include:

- applied research, development and demonstration projects that reduce the cost and risk of developing and implementing new technologies in advanced manufacturing,
- engagement with education and training at all levels,
- development of innovative methodologies and practices to increase the capabilities and capacity for supply chain expansion and integration,
- engagement with small and medium-sized manufacturing enterprises, as well as large Original Equipment Manufacturers (OEMs), and
- provision of access to shared facility infrastructure, with the goal of scaling up production from laboratory demonstrations and making technologies ready for manufacture.

Overall, the initiative can be seen as a central outcome of the current administration's **Strategy for American Innovation** that was first published in 2011 (NEC/CoEA/OSTP 2011) and will soon be renewed. Originally, President Obama had asked Congress to authorize a one-time one billion federal investment in NNMI to be matched by private and other non-federal funds to create an initial network of 15 IMIs by 2016. Over the span of 10 years, he has proposed to further extent the NNMI initiative to finally encompass 45 IMIs (NIST 2015).

Factually, however, congress has only approved 350 million of funding of which 300 million were re-appropriated from existing budgets elsewhere (mostly DoE), while only 50 million are new money. Against this background, the current NNMI initiative cannot operate from a dedicated budget but funding for the individual centres has to be pieced together from different federal department's budgets, e.g. the DoE, the DoD, the NIH and other agencies. In that sense, the NNMI initiative is so far mostly held together by a network of persuasion, negotiation and executive orders. That notwithstanding, the administration keeps working towards obtaining additional, centralised funds: For the FY 2016 Budget NIST is requesting 150 million to support the NNMI (NIST 2015).

Formal administration for the existing five (plus three) IMIs as well as the responsibility to set up formal section processes for proposals regarding the remaining seven IMI to be set up until the end of the Obama presidency lies with the inter-agency Advanced Manufacturing National Program Office at NIST (cf. Figure IV-4). Despite in part fundamental resistance from a Republican congress the current White House is determined to reach the goal of establishing 15 initiatives in an inter-agency effort until the end of the current legislature in 2016 (NIST 2015). The administration's ambition is to negotiate co-investments with federal states that, by 2016, have become institutional realities that become hard to remove without substantial political cost at both the federal and the state level. The original aim of 45 centres, however, does only then appear realistic if the next Administration will be led by the Democratic parties. While the 15 created institutes may persist, it is unlikely that a Republican party would step up or even continue the funding effort in any targeted manner.

Once more, however, the IMI do not necessarily imply that industrial and governmental researchers will work side by side although it naturally involves a much stronger investment in infrastructure for use-inspired basic research than is the case in the framework of the I/UCRC Program. Despite substantial public engagement with respect to the design of the centres, the IMIs are for the moment still mostly new agents for mission-driven research sponsored by federal departments, most prominently DoE and DoD – even if the underlying ambition is to be substantially more applied in nature than NSF I/UCRC or ERC (see figure). In speeches on the design of the IMI, the Fraunhofer model has repeatedly been invoked as a point of reference. To eventually achieve this aim, most IMI have gathered broad support and membership from industry, although the actual amount of financial means committed by them is rarely published. The above-mentioned America Makes Institute, set up in 2012, today has 116 members, of which 63 are universities, 28 are large businesses and 25 are small and medium-sized enterprises. Furthermore, 44 states, 7 major defence contractors and 7 equipment manufacturers are engaged (Ratcliffe 2014). In that sense, all IMI reach out broadly across the nation, even if the centres themselves tend to be single-site.

Since industry has taken substantial stakes in the institutes as well (300+ companies are members and a total of $ 481 million in private funding has been invested so far; NIST, 2015), it is hoped that they will eventually take a stronger industrial turn in terms of their actual research and development programme. According to several interview partners, however, this may not yet be the case. For a lack of dedicated funding, most IMIs general thematic orientation and initial research programme was (and had to be) championed by the federal departments who commit their budgetary resources rather than responding to direct input from industry or industrial organisations. It is likely that this process will continue as four of the institutes to be set up in 2015 are once more earmarked as dedicated DoE or DoD institutes. At the same time, two open competitions for additional institutes on topics proposed by industry are planned for 2016, so there is cause for cautious optimism (NIST 2015).

Performance Metrics (AMNPO 2013a) and IP Guidelines (AMNPO 2013b) for the New Institutes have been issued by AMNPO (Advanced Manufacturing National Program Office) at NIST establishing a clear framework of reference for future centres. The selection process for the remaining seven centres will be politically prepared (states have to commit to match proposed funding which often requires persuasion at the level of the governor), administered by the AMNPO and finally decided by experts panels within the federal agencies who provide the bulk of the funding. Scoring systems attach weight to both the level of scientific excellence and the extent and scope of state-level and industrial commitment.

IPR regulations are defined less explicitly than in the case of the I/UCRC but instead make more general provisions such as (AMNPO 2013b):

- to encourage sustained membership and to discourage "fence sitting" or delaying involvement,
- to encourage smaller firms to participate,
- to promote institute sustainability beyond initial federal funding,
- to treat Federal Government rights in accordance with existing legislation (Bayh-Dole),
- to clearly define publication (delay), data management and export control issues.

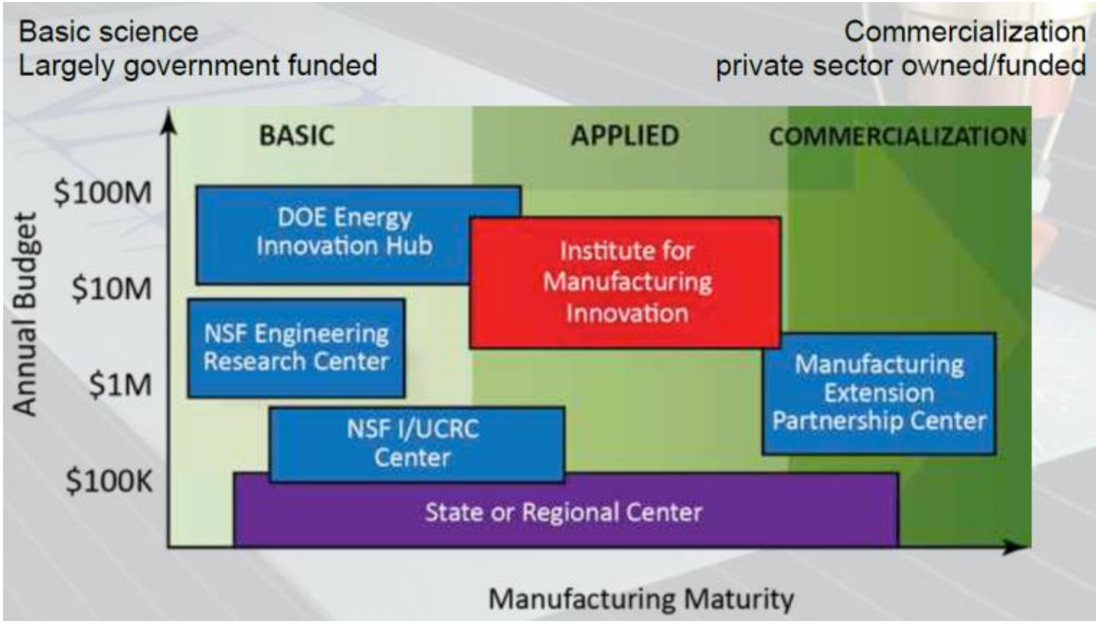
In more detail it is suggested that (AMNPO 2013b):

- Institutes shall receive royalty-free, non-exclusive research license to IP generated with institute or federal funding. Institutes shall have a continued ability to conduct research using such IP for research purposes and can grant commercial license to third parties,
- there must be an IP Management Plan submitted to the NNMI program as part of any application to become an Institute for Manufacturing Innovation,
- upon the dissolution of an institute, existing IP licenses must be treated according to the particular terms stated in the license agreements and the Institute's IP Management Plan,
- the Institute must be free to pursue non-government funded contract research for industry as a route to sustainability,
- the use of government-funded institute equipment/facilities during research conducted solely with industry funds should not create a government use right for resultant IP,
- the Bayh-Dole Act and regulations will apply to all members regardless of their nature (inventor may retain title to generated IP, not funder),
- foreign companies may become a member of an Institute and/or may participate in institute activities (only) when it is in the economic interest of the United States,
- impact on domestic manufacturing must be evaluated as part of any application to become an Institute or join the NNMI program,

- all institutes shall have policies that allow for the results of federally funded research to be made publicly available through publication following appropriate procedures of internal review.

Also, metrics for measuring the IMI's economic impact, their industry value, their contribution to education and workforce development, their portfolio structure, their financial soundness as well as their network contribution have been defined as documented in more detail in the Annex.

**Figure IV-3: Systemic Role of the NNMI in the U.S. Support System**




Source: Molnar (2014)

**Figure IV-4: Agencies Involved in the National Network of Manufacturing Institutes**


Source: Molnar (2014)

# 3 Execution / implementation of the I/UCRC programme

## 3.1 Agency responsible for the programme

From its inception in the late 1970s, when it was first pushed by the now famous Dr. Schwarzkopf, the I/UCRC Program has been administered and further developed by the National Science Foundation, most prominently its Division for Industrial Innovation and Partnerships in the Directorate for Engineering Division. In the 2000s, the Directorate for Computer & Information Science & Engineering and, to a lesser extent, the Directorate for Geosciences became key partners in the administration of the programme through contributing notable amounts of own funding (Gray/Rivers 2012; NSF 2013a; Gray et al. 2015).

To better understand the nature and motivation of the I/UCRC as well as the ERC Program, it is important to acknowledge that NSF's core mission is to a much stronger extent focused on basic, pre-competitive research than that of typical agencies responsible for science-industry collaboration in other countries. Hence, most of its programmes, even in the field of technology transfer, remain inspired by a knowledge-generation and/or science-push perspective. Applied research is, in principle, considered as outside the remit of the agency and will not be consciously supported by any of its programmes (although unplanned forays into this field will usually be accepted as long as in keeping with the technical provisions of the programme solicitations).

Within the NSF budget, the I/UCRC plays a finally negligible role. With little more than $ 20 million, less than 1% of the agency's overall appropriations (7.3 bn of which 5.8 bn for research in FY 2015, www.nsf.gov/about/budget/) are currently spent on the centres of the I/UCRC Program, even when including complementary contributions from other NSF project lines. Hence, the I/UCRC Program has been and will remain a small programme within an in budgetary terms relatively insignificant agency (see above) which does not usually attract much attention from high-level politics (i.e. Congress). Nonetheless, it is one of the agency's best evaluated programmes for which impact studies have confirmed average leverage effects of 1:6 for federal investment and 1:47 for the contributions of individual company members. In that capacity, the programme is very often used to underline the efficacy and effectiveness of NSF activities in external communications (NSF 2013a).

## 3.2 Target groups and their role

The I/UCRC Program targets and solely funds academic institutions. Its ambition of the funding is to provide seed support for the set-up of the centre as well as to support the management activities of the centre's director and the administrative activities of his/her support team. It is intentionally not aimed at covering the full cost of these activities. Moreover, NSF funding may not be allocated to actual projects which must be solely financed from member contributions (NSF 2013a).

Only U.S. academic institutions with graduate research programmes may apply. The Principle Investigator (PI) at any institution participating in an I/UCRC proposal must be a tenured faculty member. Any institution may submit multi-university centre proposals provided that they involve different disciplines and support different industries. Institutions that already have an active, single-university I/UCRC award are not eligible to apply for another single-university centre award; however, they may apply for a multi-university centre award. PIs can only submit one proposal per submission period. Co-PIs can only participate in one proposal per submission period (NSF 2013a).

According to the official solicitation "The centers are catalyzed by a small investment from NSF with primary support derived from private and public sector. The NSF takes a supporting role in the development and evolution of the I/UCRC, providing a framework for membership and operations as well as best practices derived from extensive center evaluation" (NSF 2013a).

## 3.3 Funding model and specific public funding in total, per model

### 3.3.1 Planning grant stage

To submit a full I/UCRC proposal, the aspiring I/UCRC director must first submit a **planning grant proposal** that includes a marketing plan, a staffing plan with a responsibility matrix, a draft membership agreement for industry partners, a draft agenda, a minimum of six letters of intent from potential centre members per institution, and a letter of evidence that the proposed research thrusts do not overlap with those in existing I/UCRC. The award amount for a planning grant is $ 11.500 per academic institution with a 12-month duration plus $ 3,000 for the evaluation for the lead institution. Awardees of planning grants must complete a series of NSF planning grant workshops and management training 'boot camps' before submitting full proposals. NSF will reimburse travel expenses. In general, these coaching activities are described as helpful by many centre directors and as crucial to the programme's success by most evaluators (NSF 2013a).

### 3.3.2 Full proposal stage

The I/UCRC program initially offers **five-year (Phase I) continuing grants**. This five-year period of support allows for the development of a strong partnership. A significant proportion of a centre's support is expected to come from industrial, state, and other funds. As a centre develops, it is expected to acquire additional members and external funding. After five years, centres that continue to meet the requirements may request support for a **consecutive five-year (Phase II) period**. Such Phase II grants are aimed at allowing centres to grow and to diversify their memberships and research portfolio. After ten years, a Phase III grant provides a **third five-year award for centres that demonstrate significant impact** on industry research as measured through a number of fixed indicators. All I/UCRC are expected to be fully self-sustaining after fifteen years of NSF funding.

In FY 2014 **Phase I** funding amounts to up to $ 65,000 annually for a single-site I/UCRC and $ 85,000 annually for sites of multi-university I/UCRC. Single-site I/UCRCs obtaining $ 400,000 in annual memberships straight away can receive up to $ 80,000 annually. **Phase II** funding still amounts to $ 45,000, $ 65,000, and $ 60,000 for the same categories whereas **Phase III** funding is already substantially lower with only $

25,000 for the lead and $ 15,000 for any other site. Moreover, applicant institutions can request recovery of indirect costs on evaluator support (NSF 2013a).

In FY 2014 41 of the 77 supported I/UCRC were supported as Phase I centres, 17 as Phase II centres and 18 as Phase III centres (Gray et al. 2015). Clearly, the emphasis, thus, is on early stage funding. In 2014, the median of Phase I Centre funding was around  1 million (of which around $ 246,000 were contributed by NSF), the median of Phase II Centre funding was around $ 1.25 million ($ 254,000) and the median of Phase III Centre funding reached over $ 1.5 million ($ 245,000). Due to several outliers, the averages for Phase II and Phase III centres reached about double the median values. As could be expected, the average number of members is lower in Phase I (around 12) than it is in Phase II (around 26) or Phase III (around 23) (Gray et al. 2015).

Cost sharing on the part of universities is required, provided through a limitation on indirect costs recovered on membership fees. The unrecovered indirect costs on the required minimum annual membership fee total constitute the minimum mandatory proposed cost sharing level. University recovery of indirect costs (F&A) shall be limited to 10% of all centre membership fees collected from each member organisation (NSF 2013a). This 10% rate applies to all membership fees collected under the terms of the centre membership agreement and is very favourable, given that most U.S. universities would typically charge between 40-70% overhead fees.

## 3.4 Selection process

### 3.4.1 Content of proposals and process

Letters of intent are invited twice yearly on the first Tuesday in March and last Friday in September.

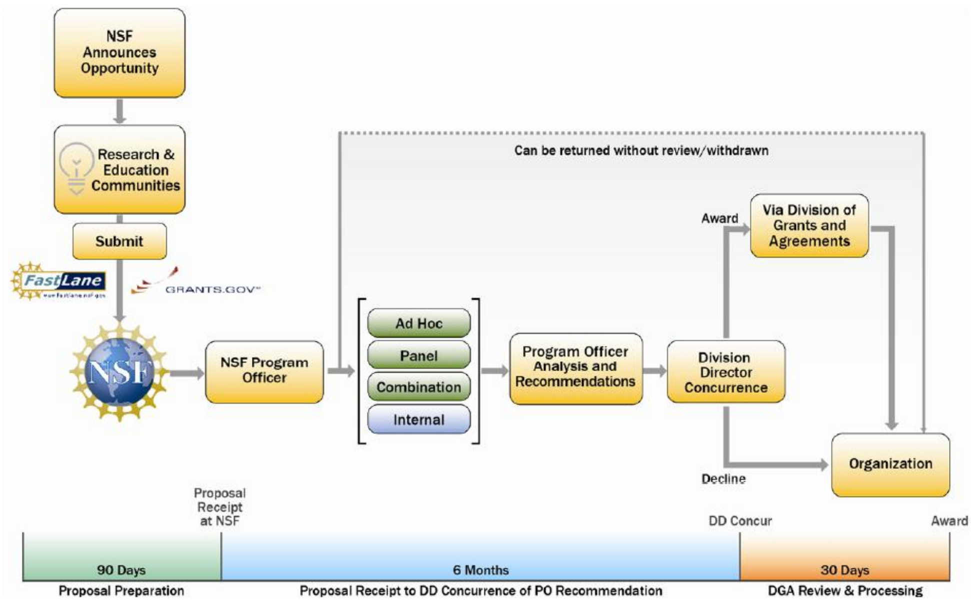
Full Centre Proposals for **Phase I** must include membership agreements for industry partners, lists of participating members and letters of financial commitment, lists of further collaborations, a list of key participants, and a marketing and growth plan for the next five years (NSF 2015a).

Full Centre Proposals for **Phase II** must include an evaluator's report for the final year of Phase I, membership certification for the fifth and final year of Phase I, commitment letters from potential members seeking to join, and a list of key accomplishments during Phase I (number of publications, graduated students trained and patents generated per year) (NSF 2015a).

Full Centre Proposals for **Phase III** must include an evaluator's report for the final year of Phase II, membership certification for the fifth and final year of Phase II, commitment letters from potential members seeking to join, and a list of key accomplishments during Phase I (number of publications, graduated students trained and patents generated per year) (NSF 2015a).

Proposals received by NSF are assigned to a relevant NSF Program Officer for acknowledgement and, if they meet all technical requirements, for review. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten external experts outside NSF either as *ad hoc* reviewers, panellists, or both. These reviewers are selected by the responsible program officers. Proposers are invited to suggest names of persons they believe to be qualified to review the proposal and/or persons they would prefer not review the proposal. In addition, programme officers may obtain comments from site visits before recommending final action on proposals. Furthermore, senior NSF staff will review recommendations for awards (cf. Figure IV-5). Proposals that do not exceed $ 100,000 in annual funding e.g. planning grant, Phase II, and Phase III proposals, in addition to proposals seeking to join an existing centre will usually be reviewed internally by two or more Program Directors at NSF (NSF 2015a).

Figure IV-5: NSF Project Selection Process & Timeline




Source: NSF (2013a), cf. also http://nsf.gov/bfa/dias/policy/merit_review/

### 3.4.2 Review criteria

Reviewers will be asked to evaluate proposals using two National Science Board approved merit review criteria (see below) and additional programme-specific criteria. A summary rating and comments will be submitted by each reviewer. Finally, the NSF Program Officer will consider the advice of the reviewers and will formulate a recommendation. Once a decision has been made, applicants receive feedback on their proposals. Verbatim, anonymised copies of the reviews as well as an explanation of the decision to award or decline funding will be provided (NSF 2013a).

NSF Merit Review Criteria: To identify which projects to support, NSF relies on a merit review process that incorporates consideration of both the technical aspects of a proposed project and its potential to contribute more broadly to advancing NSF's mission "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defence; and for other purposes." In detail the following three principles apply (NSF 2013a):

- projects should have the potential to advance, if not transform, the frontiers of knowledge **(Intellectual Merit)**,
- projects, in the aggregate, should contribute more broadly to achieving societal goals **(Broader Impacts)**,
- the planned assessment and evaluation of projects should be based on appropriate metrics **(Evaluation)**.

Questions for reviewers (based on NSF 2013a)

- What is the potential for the proposed activity to (a) advance knowledge and understanding within its own field, and (b) to benefit society or advance desired societal outcomes?
- To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
- Is the plan to carry out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
- How well qualified is the individual, team, or organisation to conduct the proposed activities?
- Are there adequate resources available to the PI (either at the home organisation or through collaborations) to carry out the proposed activities?

## 3.5 Thematic focus

I/UCRC exist in a number of different areas that are selected by and funded from a number of different directorates within NSF. The involvement of the CISE directorate in the funding of the centres has broadened the approach into the field of computer science. Currently, the official I/UCRC directory, includes the following major fields of activity (NSF 2015a):

- Advanced Electronics and Photonics,
- Advanced Manufacturing,
- Advanced Materials,
- Biotechnology,
- Civil infrastructure Systems,
- Energy and Environment,
- Health and Safety,
- Information, Communication and Computing,
- System Design and Simulation.

Due to the large overall number of I/UCRC (77 centres) (NSF 2015a), a complete list of all current and some graduated centres is included in the Annex.

## 3.6 Long-term perspective

As opposed to the ambition of most other support programmes studied in the case studies, a robust long-term commitment is neither required by NSF nor would it be acceptable for the majority of I/UCRC partners. In their letters of intent (see above), potential centre partners typically commit for one, at best two years and have in most cases the right to withdraw from the centre at three months' (90 days) notice every year. As the evaluations show, a typical I/UCRC's rate of member turnover (i.e. partners leaving and entering in any given year) is around three or 15% of total membership (Gray et al. 2015). While this leads to a steady fluctuation in membership, in most cases it does not undermine the overall sustainability of the centres. Interviews with different centre managers underlined that while exits of large corporations do occur (and on occasion may threaten the sustainability of centres), the large majority of membership fluctuations in I/UCRC results from the entry and/or exit of SME/spin-offs that only joined for one particular project effort in the first place. According to both centre directors and evaluators this type of temporary engagement is neither considered to be undesirable per se nor have any substantially detrimental effects been reported.

Overall, interviews with centre managers and evaluators underline that it can be very challenging to secure contributions from American industry, be they in cash or in kind, even if the level of commitment expected remains comparatively minor (e.g. $ 60-80,000 per member) and SME or spin-offs are typically offered even more favourable conditions (e.g. $ 20-40,000 per member). At least initially, companies are often predominantly motivated to join I/UCRC by the expected leverage of investment, i.e. an ambition related to cost saving and a strategic motivation entirely different from that needed for long-term commitments to create joint infrastructure.

Despite this legal principle of "being free to leave" at any time without further justification (which can to a large extent be attributed to U.S. business culture, see above) many industrial partners will for several reasons nonetheless stay with the I/UCRC throughout or even beyond the 15 year funding period now offered by NSF. In that sense, many I/UCRC indeed have a robust long-term perspective. Research by the team of evaluators around Prof. Gray at NCSU showed that one year after 'graduation' (i.e. end of NSF funding), more than 80% of all centres are still in operation. Likewise, 2009 and 2011 analysis showed that around 60% of all I/UCRC *ever* set up were still in operation (McGowen 2015a). Given that the I/UCRC Program has been in place since the 1980s, a close to two third long-term survival rate can be considered substantial.

## 3.7 Requirements regarding organisational form and internal governance

I/UCRC **do not and may not constitute separate legal entities** but remain subordinate units of their respective universities. Furthermore, the programme solicitation puts forward the following general stipulations for the organisation of a centre from the beginning of Phase I (cf. Figure IV-6):

- A formalised partnership among universities, industry, and other organisations based on (short-term) membership agreements and (annually renewed) financial commitments,
- an organisation led by a **Center Director** at the lead institution with site co-directors at the other universities, a diverse team of faculty and students,
- twice yearly **Industry Advisory Board** meetings at which projects are reviewed and research findings are presented, and at least one meeting at which new projects are selected,
- a cooperative operational model for the center that is consistent with I/UCRC Best Practices,
- a process based on I/UCRC Best Practices for the engagement of members in the cultivation, selection, funding and guidance of research projects,
- **Graduate Student** involvement in high-quality research projects, thus developing students who are knowledgeable in industrially relevant research,

Besides the Center Director (who retains certain veto rights), the Industrial Advisory Board is the I/UCRC's most central institution that on its biannual meetings defines the centre's annual research agenda and, based on elaborate voting schemes (L.I.F.E., Level of Interest and Feedback Evaluation Approach, McGowen 2015b), decides on individual research programmes and projects to be pursued or dropped. Project proposals to be considered during the IAB meetings can be submitted by any centre member (Gray/Walters 1998b).

The Industrial Advisory Board (IAB) is composed by (one or multiple) representatives of the centre's members who bring in their voting rights according to their financial contribution, which in many centres is split into several categories (in part predefined by the programme solicitation) (Gray/Walters 1998b). In terms of new full members, some centres give their current members 'first right of refusal' to additional membership applications, in case they are for example considered direct competitors.

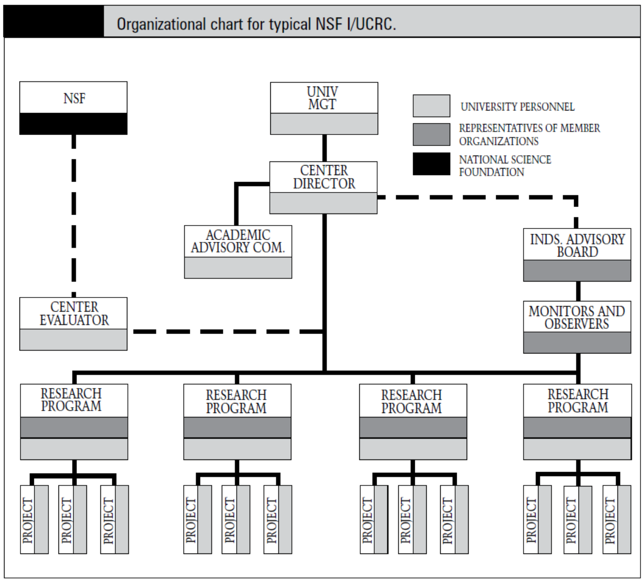
Should an obvious imbalance result or certain partners be in jeopardy of remaining entirely without any project of interest to them in a certain year, the Center Director has the right to intervene for strategic reasons and in a first step seek to find consensus-based solutions to nonetheless take into account this member's interests in the centre's annual strategy. If need be, he/she can in a second step intervene by means of a direct veto. Furthermore, organisations can be allowed to join the Industrial Advisory Board with observer partners as long as that is approved unanimously by all members proper. This right of veto may e.g. be relevant as granting observer status to one federal agency in legal terms automatically grants this observer status to any federal agency.

Example of an IAB Voting Scheme, Connected to Voting Rights (MIST Centre 2014)

| | | |
|---|---|---|
| Associate (SME only) | 20,000 annual contribution | 20 IAB votes |
| Full (1 unit) | 40,000 annual contribution | 40 IAB votes |
| Full (1.5 unit) | 60,000 annual contribution | 60 IAB votes |
| Full (2 unit) | 80,000 annual contribution | 80 IAB votes |

Beyond taking part in the strategic decisions, IAB members assign **Industrial Monitors and Observers** to individual research programmes and projects whose role differs, depending on the individual centre and research project. A continuous exchange between them and the researchers proper, however, is common and considered central to the I/UCRC model. Furthermore, the Center Director can convene an **Academic Advisory Committee** in case major issues arise with regard to the centre's operation or organisational positioning within the organisational/legal framework of the university. These typically meet less regularly on an ad-hoc basis, should the need arise (Gray/Walters 1998b).

**Figure IV-6: Standard organisational structure of an I/UCRC (according to programme solicitation)**




Source: Gray/Walters (1998b)

## 3.8 Role of spatial proximity

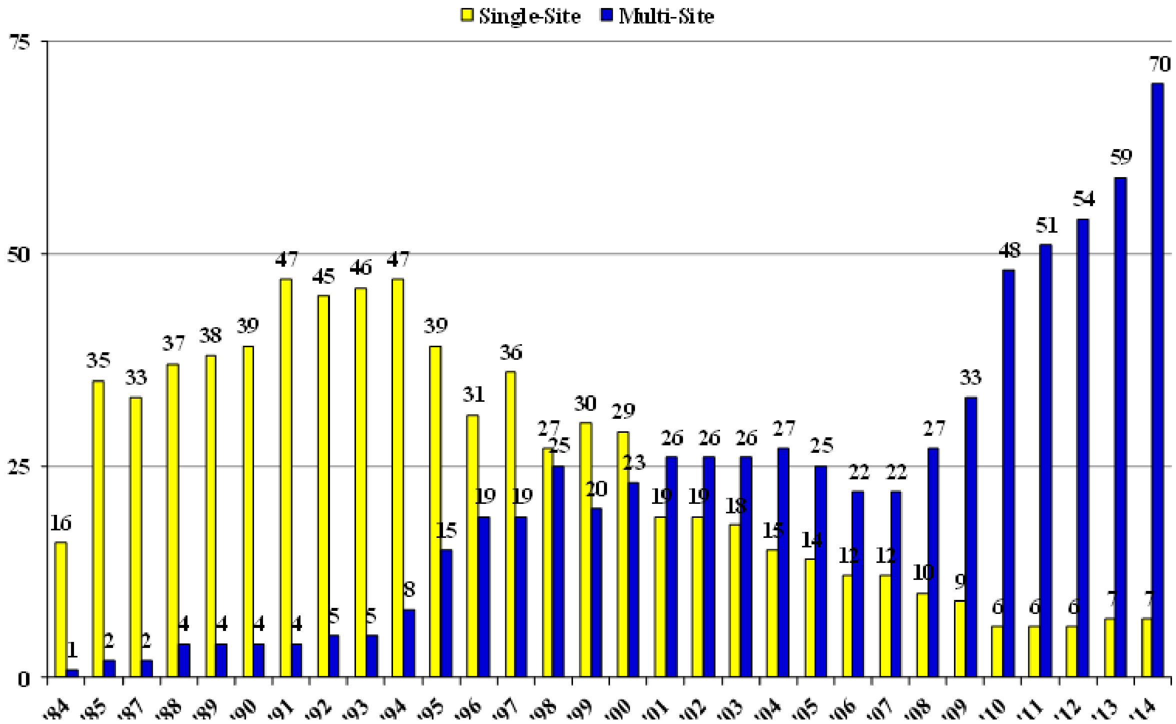
In recent years, NSF solicitation and internal communication has increasingly stressed the importance of setting up multi-site centres which, in the U.S., often inevitably implies bridging large distances. Nonetheless, these centres are often operated in such a way that individual universities focus on their specific, complementary strengths and all research equipment for a specific type of projects (e.g. under a specific research programme) is in fact located at one site (NSF 2013a).

In the course of the past five years, NSF has reinforced its push towards multi-site centres that originated in the mid-1990s. While in the 1980s and 1990s, the overwhelming majority of centres were single-site, the balance shifted around the year 2000 leaving a mere 7 single-site centres today, compared to now 70 multi-site centres (cf. Figure IV-7). In all cases, one university acts as the lead site. However, both lead and partner universities are expected to attract industrial support independently. Typically, today's multi-site I/UCRC involve three to four different universities (Gray et al. 2015).

According to discussions with centre directors and evaluators, there are different opinions on the desirability or even necessity of spatial proximity in I/UCRC. NSF argues that multi-university I/UCRCs are preferable to single-university I/UCRCs as they have a greater potential to help bridge fields and disciplines as well as to increase overall interaction among U.S. universities. At the same time, many centre managers and evaluators feel that the amount of administrative work and communicative effort that comes with large, geographically disperse networks creates substantial transaction costs that cannot adequately be covered through I/UCRC grant, even if provisions for particular challenges are made (cf. NSF 2013a; CAFS 2015). Nonetheless, all concede that in some disciplines, the formation of broad-based consortia will be inevitably bring together multiple capacities and achieve a critical mass for future-oriented research through recombination and networking.

While centre membership, in particular with regard to anchor members, will often involve regional players, this is not required. The NSF does not put any specific stipulations in this regard (NSF 2013a) and the individual centre's choices will depend on disciplinary requirements and personal orientation. As mentioned below, many I/UCRC actively attract members from across the U.S.

**Figure IV-7: Relation of single-site and multi-site I/UCRC across the programme's lifespan**




Source: Gray et al. (2015a)

## 3.9 Time Perspective of the Models

As outlined above, NSF support for an I/UCRC begins with a five year grant. After five years, each centre site may apply for a Phase II (years 6 through 10) grant if it meets the Phase II minimum requirements specified in the solicitation and can document that it has satisfactorily completed Phase I. After ten years a centre site may apply for a Phase III (years 11 through 15) grant if it meets the minimum Phase III requirements specified in the solicitation and can document that it has satisfactorily completed Phase II with notable impact (NSF 2013a).

All graduated centres that have successfully completed a Phase II award within the last 10 years may apply for a Phase III award. For this reason, some older centres have re-applied for funding when this opportunity was opened in 2011. According to the evaluators, this effect will remain temporary as the general aim of the solicitation is to support three periods in direct succession.

In general, all I/UCRC are expected to be completely self-sustaining after 15 years and will not receive any public funding after that (NSF 2013a). However, NSF has put some effort into keeping at least some connection with very successful centres associated with the programme for longer, to be able to draw on their experiences and best practices within the context of the programme.

## 3.10 Handling of IPR

All IPR that is generated in I/UCRC projects which have in any way been (co-)financed from membership fess has to be disclosed to the entire group of its members who will then decide about its further use (NSF 2013a). This remains the case when individual members decide to provide additional 'enhancement funds' to specific projects. As the basis of these projects is membership-funded activities, the resulting IPR will in the end have to be shared – irrespective of the fact whether some members have made a larger contribution than others. Still, an enhancement project can be kept secret as long as it runs so that the firm in question has an earlier insight into its emerging results than the centre's other members. In longer projects, this head start may be substantial. Also, single members can choose to terminate enhancement projects before any critical IPR results.

This strict imperative regarding the sharing of IPR has, according to the evaluators, led to substantial problems of the I/UCRC model in the biopharmaceutical industry where most corporations would see their patent portfolio at jeopardy and simply not join. In most other industries, firms, or at least divisions of firms, have found constructive arrangements with the model.

According to the most recent evaluation, the number of annual invention disclosures has increased substantially from around 60 in the early 2000s to around 160 today while, in parallel, a steady amount of 50-60 patents per year has been applied for (Gray et al. 2015). Nonetheless, some I/UCRC expressly underline that generating IPR is not among their central ambitions. While they concede that IPR can and does result from their activities at times they have argued that their clear objective is to focus on pre-competitive fields in which even direct competitors can collaborate without problems. Overall, this seems to be in line with the finding that more than 50% of all documented disclosures are reported by four key centres (of notable maturity).

In line with this, most interviewed I/UCRC directors and evaluators did not report substantial conflicts resulting from the strict shared IPR clause in practice. Some centres felt compelled to introduce a "first right of refusal" option for current members to give them an option to prevent their immediate competitors from joining at the Center Director's discretion. In practice, however, these provisions have rarely, if ever, been used.

Furthermore, the I/UCRC do not constitute separate legal entities, so that all equipment transferred to them in the context of projects or as an in-kind contribution to substitute membership fees will automatically become the property of the respective university as such. Consequently, all involved faculty are free to conduct separate, confidential contract research projects using these facilities. According to most Center Directors, it is not only tolerated but even encouraged that such projects are regularly pursued in close proximity of the I/UCRC, oftentimes using the same equipment. Strategically, it is considered a necessary step on the centre's way to developing a self-sustaining business model with a healthy mix of joint, pre-competitive and individual, more application-oriented projects. Some graduated I/UCRC that can already draw on a broad range of well-established university-owned facilities and equipment have even started to offer a full range of 'products' from knowledge creation to knowledge transfer, testing and fabrication through to new product development with a different degree of confidentiality and, consequently, student involvement (The Nonwovens Institute 2015).

## 3.11 Requirements regarding the research agenda

Regarding the research agenda the programme solicitation puts forward the following stipulations:

- Any application must demonstrate a unique research scope to avoid duplication and prevent centres from re-applying under different names after funding ends.
- Centres are free to define their research agenda as they see fit but must establish goals, objectives and a roadmap in collaboration with their membership.
- Twice yearly Industrial Advisory Board meetings at which ongoing projects are reviewed and research findings are presented to the membership.
- Implementation of best practices regarding the regular documentation of project scope, budget, duration, first year deliverables, and milestones.

- All centres must present a clear and effective plan outlining how they aim to recruit new and retain existing members as well as to build broader relationships in the coming years.

In the framework of the centres' annual evaluations (see below) the research agenda is subject to external scrutiny on a regular basis. Furthermore, its regular internal review by the biannual Industrial Advisory Board meetings provides an effective mechanism of self-control (NSF 2013a).

## 3.12 Requirements regarding reporting

For I/UCRC grants (as for all NSF grants in general), the principal investigator (i.e. Center Director) must submit an **annual project report** to the relevant programme officer at NSF at least 90 days prior to the end of the current budget period. The annual project report is used as a basis for assessing the annual performance and, on that basis, approves continued funding. Within 90 days of the expiration of the grant, the principal investigator has to submit a **final project report** for NSF as well as a **project outcomes report** for the general public (NSF 2013a).

The regular complete annual report consists of three main sections:

Firstly, the **Director's Report**, covering centre identification, research goals, documentation of collaborations with other universities and names of co-directors (in case of multi-sites), documentation of members currently committed and membership fees, documentation of major accomplishments, as well as detailed information on internal processes of communication and decision making.

Secondly, the **Evaluator's Report**, covering a general overview of the centre's status, an assessment of its technical and organisational goals and objectives, an appraisal of its industrial and institutional environment (i.e. major external changes to sectoral trends and or the involved universities), a documentation of changes in the centre's personnel, structure, policies, financial status or research programme, and a qualified evaluation of the centre's accomplishments and/or impact. Based on the information provided, the evaluator will assess the centre's "health and vitality" and provide an updated timeline of significant events and milestones.

Thirdly, the report will include **formal certification of membership funds** for the recently completed reporting period. Membership fees beyond the minimum required are to be addressed in the annual and final project reports (NSF 2013a).

Prior to the start of a new annual funding period, the programme director, programme managers, and the division director will review the centre on a number of renewal criteria such as the degree of collaboration amongst sites, the extent to which the marketing plan is being pursued, the extent to which the industry/university collaborations are growing, the extent to which the industrial research program is developing; and the extent to which technology transfer is occurring from the centre to one or more of its members. If the review is satisfactory, the Program Director may recommend support for the next period of the continuing award (NSF 2013a).

The annual reports thus serve the purpose of continuously ensuring that a centre remains in keeping with the formal requirements of the programme solicitation. As soon as the amount of financial commitments or the number of memberships falls below the needed threshold, sites will be given **one year on probation** and then be **phased out of the funding, even during the 5-year period.**

### 3.12.1 Requirements regarding monitoring

In addition to the annual report, centres are required to provide data to NSF and its authorized representatives. These data are used for NSF internal reports, to identify historical trends, and to secure sufficient funding for the maintenance and growth of the I/UCRC Program within NSF. Data that a given centre provides as well as aggregate data across centres is communicated back to the centres as a management tool. Updates are required annually (a detailed list of NSF monitoring indicators is included in the Annex) (NSF 2013a).

### 3.12.2 Requirements regarding evaluation

All centres must have an independent evaluator from the beginning of their activities. The I/UCRC evaluation, which was begun in the early 1980s, is one of the **longest-standing evaluation efforts** in the United States which has not only regularly served to demonstrate the programme's utility, impact and effectiveness to both NSF and Congress but also served to broadly communicate existing good-practices across centres, make them criteria for future solicitation and even develop manuals (I/UCRC 'Purple Book', 1998) and training courses for aspiring I/UCRC. Over the years, it has become a **formative evaluation** in the best possible sense of the word, uniting different aspects of what in German terms would be designated 'Begleitforschung' (accompanying research effort). To an extent, it goes even deeper, as the central co-ordinator of the I/UCRC evaluation effort, Prof. Denis O. Gray, has throughout the years had many graduate and Ph.D. students who carried out in-depth research on multiple aspects of the I/UCRC Program (some of which co-funded by NSF). Hence, the I/UCRC model may well be one of the most closely studied and best-researched support programmes in the United States. So far, no comparable effort has been launched for the ERC (or any other) Program, even if it has been in force for a close to similar period of time (Gray/Walters 1998a; Gray/Rivers 2012; Gray et al. 2015a; 2015b; Gray 2015b).

The I/UCRC evaluation requires potential evaluators who seek to be assigned to specific centres to demonstrate that they have experience both with regard to conducting evaluations and with regard to industry-university cooperative research (ideally from prior engagement with the I/UCRC Program) as well as that they are fully independent from the centre being evaluated. Evaluators are paid by the lead institution with funds provided by the NSF using a fixed formula. These funds are intended to cover expenses and efforts expended by evaluators in the performance of their duties (NSF 2013a).

Overall centre evaluators are responsible for (NSF 2013a):

- Preparing an annual report of centre activities (see above),
- conducting a survey of all centre participants to measure satisfaction with the centre's activities,
- compiling a set of quantitative indicators to analyze the centre's management and operation,
- participating in I/UCRC's IAB meetings, Annual Meetings and the Annual NSF Evaluator Meeting,
- reporting bi-annually to NSF, consistent with NSF requirements and those of the evaluation program outlined on the I/UCRC Evaluation website, within a month of each IAB Meeting.

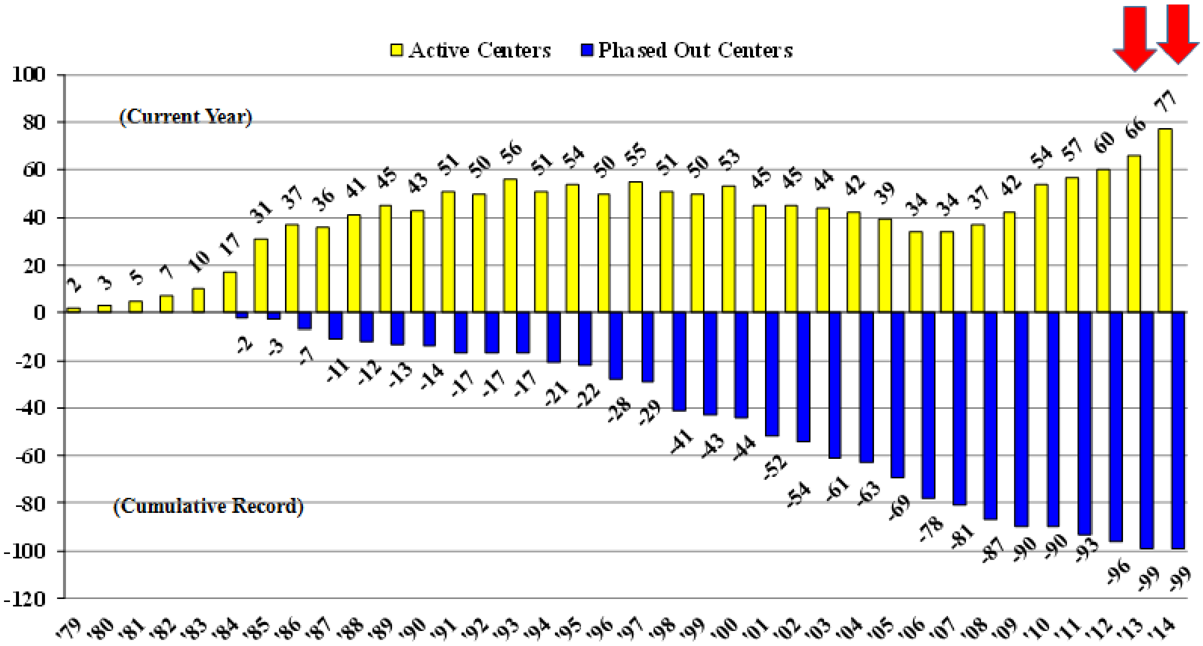
## 3.13 Overview of currently supported models (number and themes)

Currently, there are 77 IUCRC in operation, 52 funded from the NSF Engineering and 25 funded from the NSF CISE Directorate. Due to their multi-site structure they involve 214 U.S. as well as five international sites, one of which is located in Germany (Hanover). In total, more than 170 centres have been set up since the 1980s. Following a period with around 50 centres constantly in operation during the 1990s, the number of active centres slightly decreased to around 35 in the mid to late 2000s and more recently rose again, following increased investment by the NSF (cf. Figure IV-8).

Overall, nearly 1,200 industrial partners were committed to I/UCRC in 2014, up from around 700 in 2008. While, throughout the 1990s, the typical number of I/UCRC membership was around 12-15, it increased to nearly 20 in the late 2000s, dropping back somewhat to about 17.5 in FY 2014, after many new centres with still limited membership had joined in the early 2010s (Gray et al. 2015a).

Projects in a typical I/UCRC support the graduation of 2 B.Sc., 4 M.Sc. and 4 Ph.D. students per year. In fact, graduate and Ph.D. students constitute the majority of the factual workforce behind industry sponsored projects (NSF money may not be used to fund students). Very often, their self-motivated research ensures that I/UCRC can offer research results at competitive rates (Gray et al. 2015a).

**Figure IV-8: Overview of I/UCRC centres in operation since the programme's inception**

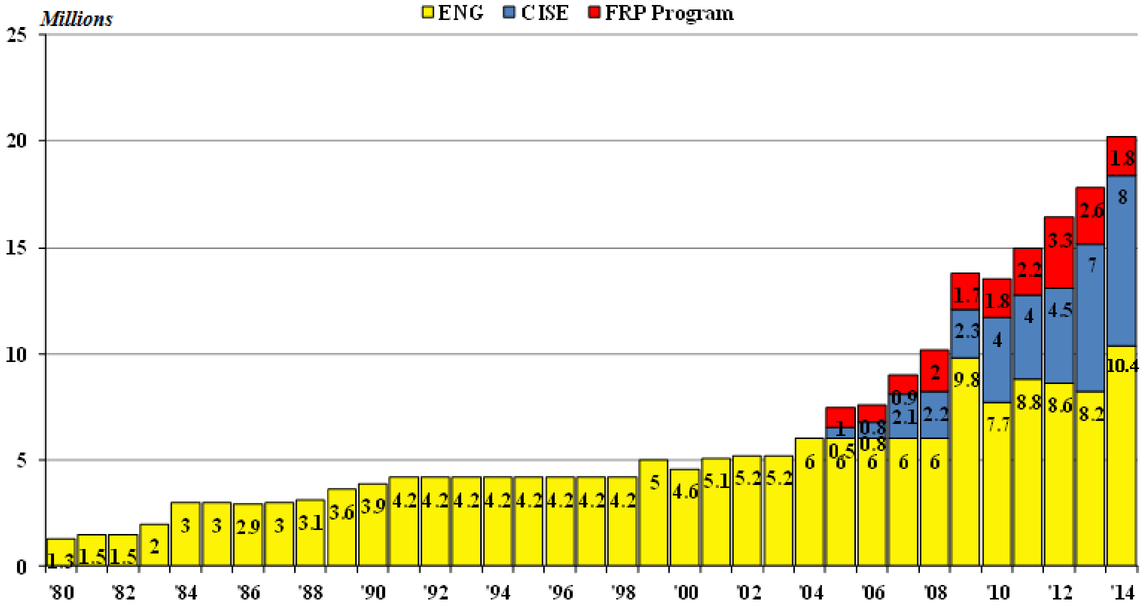



Source: Gray et al. (2015a)

Currently, two to eight full centre awards and four to six planning grants are awarded annually and the core budget allocated to the I/UCRC Program within NSF amounts to around $ 12 million in 2015, complemented by around 8 million from the CISE Directorate and a further $ 2 million from the basic research oriented FRP Program (NSF 2013a).

In line with the re-increasing number of centres set-up in the past five to ten years the amount of budget allocated from the I/UCRC Program has more than doubled from around $ 5 million in FY 2000 to around $ 10 million in FY 2014 (cf. Figure IV-9). Together with a substantially increased investment of the CISE directorate and additional funding through the FRP Program (both initiated in 2005), there has been a fourfold increase of exclusively I/URCRC-related NSF funding since FY 2000. Even if, in absolute terms the I/UCRC Program remains of minor relevance to the NSF as a whole, its core budget has come close to surpassing that of the previously much more high-profile and volume ERC Program in recent years (Gray et al. 2015a).

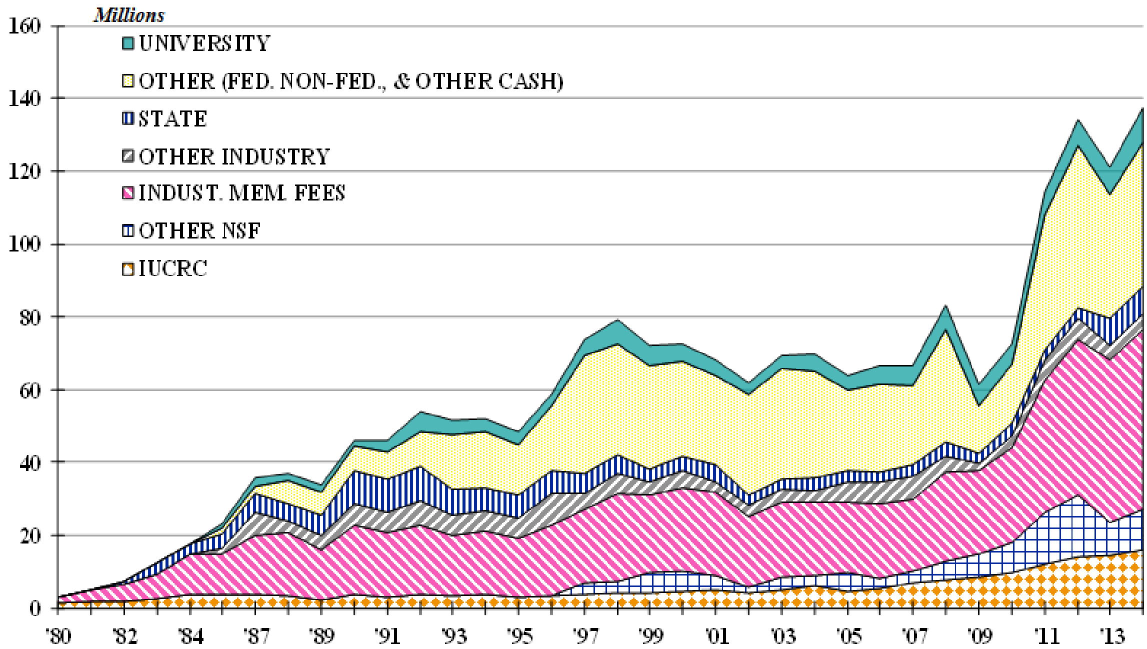
**Figure IV-9: NSF budgetary appropriation for the I/UCRC program FY 1980-2014**




Source: Gray et al. (2015a)

Interestingly, this substantial increase in funding is not confirmed as intentional by the NSF, nor does the federal government confirm that a stepping-up of I/UCRC efforts has been agreed with NSF under the framework of this or earlier administration's initiatives in the field of innovation policy. Possibly, this limited awareness may on the one hand be due to the minor share that the I/UCRC programme has in the total NSF budget (1-2%) and on the other hand to the fact that the absolute increase in I/UCRC project volume was to a much larger extent due to an increased investment from other federal sources and industrial members – rather than in core programme funding. In total, I/UCRC-related project volume has in recent years increased from $ 60 million in FY 2009 to close to $ 140 Million in FY 2014 (Gray et al. 2015a, Figure IV-10).

**Figure IV-10: Development of total I/UCRC-related project volume FY 1980-2014**




Source: Gray (2015)

## 3.14 Convergence versus heterogeneity of the different models

In a funding programme supporting a total of 77 initiatives, heterogeneity is a natural result of the diversity of scientific and industrial fields that it covers. Naturally, some fields will by their very nature require a network approach while others will have to rely on laboratories that accumulate a certain amount of critical mass of equipment. Some require at least two years time for projects to unfold while in the face of short business cycles in other fields even a year may seem long. In some sectors, industrial commitments are relatively easy to obtain, in others not at all. In the course of the interviews conducted for this study, numerous dimensions were identified in terms of which centres differ – in the attempt to adapt to concrete needs in the best possible manner.

That notwithstanding, the NSF defines very clear and unambiguous rules for the organisational framework of the centres of which few exceptions are granted. There are non-negotiable minimum thresholds for the number and commitment of industrial members, IPR must be shared no matter what the circumstances are, I/UCRC may not be legal entities, NSF money may only be spent for administration and management, there must be at least two IAB meetings per year, etc. Furthermore, mandatory evaluation and monitoring processes have been defined in detail and apply to all centres (cf. NSF 2013a). As a result, the I/UCRC Program may well be among the most homogeneous of all initiatives studied and – in the close to four decades of its existence – have come close to developing a standardised and well-proven 'product'.

# 4 Concrete shaping of the science-industry cooperation

## 4.1 Presentation of the models

As mentioned above, a detailed list of all 77 I/UCRC is included in the Annex, together with three one-page case studies of centre interviews in the context of this study.

## 4.2 Involved partners

According to the latest evaluation, contributing members of the I/UCRC Centers stem from multiple backgrounds, a process of differentiation that is often encouraged through progressive membership fees (see below). In FY 2014 slightly below 60% of I/UCRCs members were large corporations, slightly above 20% were smaller firms, while about 10% were federal (R&D) agencies including those from the area defence with a remaining 10% left to state agencies or other, e.g. non-profit, institutions (Gray et al. 2015). In line with this, many interviewed centre directors consider large corporations as the basis and/or framework of their membership with smaller firms playing a complementary role.

## 4.3 Research topics

As such there is no specific limitation on research topics to be addressed in the original I/UCRC proposals or along the way as the centres develop. Factually, research agendas usually develop in line with the industrial members' or main federal sponsors' interest as much as some relation to NSF policy cannot be excluded. By means of example, the joining of the CISE directorate in funding the programme directly has naturally shifted the focus somewhat in the direction of computer science. Likewise, co-funding initiatives from other federal departments may prompt specific developments such as the recent set-up of I/UCRC in forensics as a result of an initiative by the Department of Justice. In these and similar cases, the NSF publishes so-called 'Dear Colleagues Letters' which, issued by the thematically responsible NSF divisions, encourage potential applicants to consider applications in a certain technological field with priority – in part by offering substantial complementary funding opportunities. For example, a 'Dear Colleague Letter on I/UCRC Clusters for Grand Challenges' has recently been issued to support the current administration's 'Advanced Manufacturing' initiative by offering up to $150,000 per year for I/UCRC (max. $750,000 per cluster) that for partnership in fields such as advanced sensing, controls, and platforms for manufacturing, visualization, informatics & digital manufacturing, and advanced materials manufacturing (NSF 2015c). Naturally, however, potential applicants are free to take or leave this option.

Despite the general openness of the solicitation, all envisioned projects have to be presented and justified in detail in front of the IAB before they can hope to become supported. According to the solicitation such presentations must include information on their industrial relevance and appropriateness for the centre, their concrete objectives, the proposed team (management and staff) with plans to address broadening participation, proposed deliverables, project duration, milestones, and annual interim deliverables, concrete business needs identified, available research facilities; as well as envisaged time to completion and cost. Against this background, there is a strong and rigorous system of self-regulation within the centres that ensures that they keep addressing the 'right', i.e. practically relevant, research topics for their membership. Furthermore, all research agendas are annually reviewed by external evaluators (NSF 2013a).

## 4.4 Financing

Typically, and according to the programme's ambition, the largest share of centre finance is collected as membership fees which can be collected either centrally by the lead site or in a decentralised manner. Again, there are clearly defined NSF requirements with regard to the collection of membership fees, including a Sample Membership Agreement that defines membership rights and includes clear provisions on the use of shared intellectual property as well as rights to withhold or delay publication. A further, noteworthy detail is that the I/UCRC home institution may not charge more than 10% overhead (NSF 2013a), compared to between 40-70% which are common for individual university-industry projects. Thus, firms get more value for money even without leverage.

Likewise conditions and opportunity for receiving direct NSF funding are clearly defined in the programme solicitation. As these are very comprehensive and make detailed provisions for a number of rather specific cases, they have been included in an Annex to this study. In short, the minimum threshold for a single university centre is a contribution of at least $ 400,000 annually from at least eight *full* members. A multi-university Phase I centre must have $ 300,000 annually in membership fees, rising to a minimum of $ 350,000 for Phase II and Phase III. It must have a minimum of six *full* members with a membership fee of $ 25,000 or more per year. Initially, each site must obtain at least $ 150,000 annually from at least three *full* members. In-kind contributions are possible with NSF approval – but only as exceptions for a minority of partners. Multi-university Phase II and Phase III sites must have a minimum of $ 175,000 in cash membership fees and a minimum of three *full* members. Again, in-kind contributions are possible when limited. After the first year of any phase, any in-kind contributions must be approved internally by the IAB (NSF 2013a).

## 4.5 Formation of cooperation

As mentioned above, I/UCRC are only set up after having been prepared during a planning grant stage. The award amount for this stage is $ 11,500 per academic institution for one year, intended to cover planning expenses including travel to the mandatory "**Boot Camp**" for aspiring Center Directors. The camp informs planning grant awardees about the planning process, the I/UCRC model in general, member recruitment and centre operation consistent with best practices. For awardees planning to establish a new site of an existing centre, and boot camp attendance is optional. The planning grant lead institution will also receive $ 3,000 for the evaluator paid directly to that person. The evaluator will guide the aspiring centre directors in conducting a successful **Planning Grant Meeting** and attend the first planning meeting for a centre. NSF expectations for these meeting are that (NSF 2013a):

- Executive summaries of all potential research projects are sent to all prospective members.
- Each prospective member is asked to rank the research projects and send the list back to the PI.
- The top 5 research projects common to all sponsors are in a next step identified.
- The titles of these top 5 research projects are reported back to NSF and all potential sponsors.
- The top 5 projects are listed and adequately described in the full centre proposal.
- If a full grant is awarded, these top 5 research projects form the basis of the first IAB meeting.

## 4.6 Governance

A general outline of the internal governance scheme required according to NSF regulations has been described above in Chapter 3 (cf. also Gray/Walters 1998b). In brief, key instances include:

- The centre director at the lead university site who is responsible for all aspects of operations,
- co-directors that manage their university team's researchers and collaborate with the lead site,
- an Industrial Advisory Board (IAB) comprised of centre members, with an elected chair, that reviews and recommends all research activities funded completely/in part by membership fees,
- a university policy committee that facilitates the operation of the centre while ensuring operation within the policies of the universities.

In their proposals, aspiring directors must identify the following:

- Centre leadership, including director's background, qualifications, and management capability,
- a uniform and consistent policy for handling memberships across all sites of a centre,
- the membership agreement including:
  - intellectual property policies that permit non-exclusive, royalty-free licenses with an option for exclusive, royalty-bearing licenses if unanimously approved by all,
  - publication delay policies,
  - the planned membership structure including the role of members in the centre
- policies for graduate and other student involvement,
- potential issues that might hinder the centre and steps to counter them if needed,
- I/UCRC policies including processes for project proposal cultivation, selection, and monitoring,
- the proposed evaluator and plans for the centre to meet I/UCRC evaluation criteria,
- the envisaged membership of the university policy committee, and
- a plan to support participation of underrepresented groups in science and engineering.

Hence, no centre proposal will be approved without a detailed and well-considered outline of its internal governance structure and process (NSF 2013a).

## 4.7 Virtual versus spatial cooperation

According to the interviewed centre directors and evaluators, virtual cooperation necessarily plays a role in multi-site centres, in particular if they constitute large networks across the whole of the United States. Even in Informatics and the Computer Sciences, virtual cooperation is rarely the only type of cooperation that occurs in I/UCRC as the collaboration in teams and the joint development of solutions does play a central role for many; even if this does not involve corporate researchers. In any case, many centres are grounded in engineering disciplines that require a critical mass of facilities at one given site to perform meaningful research. Very often, virtual means of communication are used to interlink such facilities with different, yet complementary specialisations to create larger research networks. Sometimes, a single site's contribution can be of an exclusively virtual nature, e.g. with regard to simulation and will, in the context of an I/UCRC, be connected to a network of actual laboratories in which this expertise is required.

## 4.8 International partnerships

Even though it is not yet very common in practice (so far, five I/UCRC have chosen to set up international sites, including one in Germany), collaboration with international research entities is considered as conducive to I/UCRC objectives by NSF. Hence, an established I/UCRC may submit a supplement request for collaborative work with an international research entity constituting the formation of an international site of the I/UCRC (NSF 2013a). According to the programme solicitation, international site supplemental requests must include:

- A detailed plan to interact with the international research site,
- a description of the proposed joint research projects,
- a description of the infrastructure that is in place to enable collaboration,
- evidence that the international research entity has adequate partner funding in place,
- a formal agreement between the foreign and U.S.-based site that replicates the provisions for IP, copyrights, publication delays, etc. identified in the I/UCRC membership agreement,
- a letter from the I/UCRC IAB that endorses the international collaboration.

The international research site's supplement expires after one year and must then be extended. Each new supplemental funding request for continuation of the international partnership must address the partnership's outcomes and benefits realized during the prior award period. Each I/UCRC is limited to one supplement per country to support an international site. Furthermore, I/UCRCs may request funding for project-specific collaborations with international partners (NSF 2013a).

According to the interviewed centre directors and evaluators, moreover, I/UCRC membership very often involves international companies who contribute membership fees and provide venues to hold I/UCRC conferences their home countries. Technically, some of them enter as members through their U.S. subsidiaries while others provide funding and fees directly from their home countries.

## 4.9 Participation of SMEs

As stated above, contributing members of the I/UCRC centers stem from multiple backgrounds, a process often encouraged through progressive membership fees (see above). In FY 2014 slightly below 60% of I/UCRCs members were large corporations, slightly above 20% were smaller enterprises, slightly above 10% were other federal agencies including those from the area defence with a remaining 10% left to state agencies or other, e.g. non-profit, institutions (Gray et al. 2015a).

In recent years, NSF has encouraged the participation of SBIR funded small enterprises in I/UCRC by more or less covering their membership fees (NSF pays all but $5k for 2 years of membership). In 2013 72 SBIR/STTRs had taken 124 membership years in 26 centres. So far, results have been mixed. On the one hand, the opportunity has next to exclusively been taken up by a specific sub-group of Phase II SBIR awardees. Phase I awardees are too young to join a centre in a meaningful manner and/or obtain any concrete benefit by doing so. Overall, only 14% of eligible firms use the supplement. On the other hand, a large majority (85-95%) of those SMEs that have joined under the SBIR-I/UCRC provision would not have considered membership without subsidy, yet are happy with that choice and report that they have reaped substantial benefits from it (Gray 2015a).

## 4.10 Classification in European innovation policy

Cases in which I/UCRC benefit from FP7 or H2020 funding are neither known nor considered likely to occur on a very regular basis. They can, however, not be ruled out as US legal entities may participate in any action under H2020, unless explicitly restricted from doing so (cf. Regulation No 1290/2013).

# 5 Assessment based on evaluations and own investigations

## 5.1 Output and impact

Undoubtedly, outcomes of the I/UCRC Program have been substantial as has been comprehensively demonstrated in aggregate compilations of the monitoring data collected in the course of both self-reporting and external evaluation (Gray et al. 2015a; 2015b). Possibly most importantly, the centres have produced several thousands of M.Sc. and Ph.D. graduates with a 'university-industry mindset' over the past three decades. Moreover, a few hundred centre directors developed and improved their leadership skills in the field of managing complex science-industry relations. Finally, abundant intellectual property rights have been generated and constructively shared among their industrial membership. In the past decade, there has been a steady flow of around 50 patents annually from all centres and a similar amount of invention disclosures. More recently, the latter has risen to more than 160 (Gray et al. 2015a). Furthermore, about 10 annual spin-offs were documented in recent years. Overall, notable contributions to technology transfer have been made in various regards, for which the programme received the national award of the Technology Transfer Society of America – as early as 1998.

In addition, recent impact studies (Gray et al. 2012) have demonstrated remarkable economic leverage effects for public investment in I/UCRC. Aggregating results across three centres (admittedly some of the most dynamic and well-developed ones: IMS, BSAC, and IUCS) the analysis found realized impacts of around $ 1.28 billion in total, generated from NSF program investments of approximately $ 18.5 million in present value. Each dollar invested by NSF has thus helped to create $ 69.4 in benefits, with a net present value of $ 1.27 billion. With many technologies in the studied I/UCRC still in early stages, moreover, economic impacts were expected to multiply further in the course of the coming five to ten years (Gray et al. 2012).

Overall, the I/UCRC Program can thus be considered a success model that adds connectivity and dynamism to key interfaces in the U.S. national innovation system, not only through the centres' efforts as such, but also through its training component of 'raising' future lead researchers and corporate managers in the spirit of science-industry co-operation and thus forge a lasting communicative link between the two spheres. Arguably, however, it also finds its limitations, most notably in the comparatively limited size of the I/UCRCs themselves. In essence, it remains a support effort oriented towards broad-based networking rather than the targeted creation of larger-scale infrastructures and genuine collaboration at relevant systemic interfaces. In summary, it could be argued that while the I/UCRCs may have done a perfect job in maintaining momentum in the U.S. innovation system at large, they are neither intended nor suitable for prompting transformative change. More precisely, the I/UCRC Program appears to be a close-to-perfect(ed) tool to add momentum and connectivity to the middle echelons of the U.S. innovation system whereas it seems far less suited to promote large-scale, mission-driven projects or to on its own or to vigorously counter the challenges facing several of America's currently less vigorous and/or resilient industries.

## 5.2 Success factors

One of the success factors of the I/UCRC model from its outset was the relatively **low threshold for industrial players to engage** and the comparatively high likelihood that they would be able to substantially leverage their funding. This approach appeals to U.S. corporate decision makers without further explanation. Secondly, the model has from the outset been **highly attractive for entrepreneurial academics** with an interest in acquiring further leadership skills and to more fully leverage their capabilities. Finally, it is **attractive for students with an interest in increasing their employability** by getting acquainted with industrial challenges and routines at an early stage of their career and to incorporate them into their Ph.D. or M.Sc. theses.

After 30 years in operation, the programme has become based on effective or at least **well-proven administrative processes**. Today's I/UCRC solicitations follow an outline which in some respects has come close to a manual. Based on past experiences, they make detailed provisions not only for standard I/UCRCs but also for less common set-ups. In addition, actual manuals on 'how to set up a centre' have been available for more than a decade (Gray/Walters 1998a). Throughout the years, the system of project selection and support thus has become well-calibrated and constantly refined.

As the lessons learnt are constantly taken up by in a **formative evaluation** working closely with the individual centres in a decentralised approach, the I/UCRC Program has in a sense become not only a *learning* but also an *educating* programme with the capacity to train qualified future beneficiaries. Across the years, this targeted preparation of aspiring centre directors to their future tasks has become critical for the programme's ongoing success – and arguably the viability of its recent expansion. Few other funding agencies provide a similar amount of targeted coaching, leave alone one that is next to unanimously positively received by its target group.

A further condition for the programme's continued success is the **evaluation's research dimension**. Since its origins in the early 1980s, the effort has developed into one of the arguably most successful formative evaluations in American Science and Technology policy and many aspects of it have become highly professionalised. Beyond repeating a proven standardised monitoring on an annual basis, however, I/UCRC evaluation is known and renowned for its continuous research effort that takes up topical questions (Leonchuk 2015) and thus prevents the programme from becoming sclerotic. In the course of the past decades, numerous M.Sc. and Ph.D. theses have been developed by the team of Prof. Gray at North Carolina State University as well as other research groups. In part, this effort has been consciously sponsored by NSF Program Officers who expected (and received) further insights to guide their decisions on future programme design.

## 5.3 Lessons learnt

In brief, the following key lessons can be learnt from the I/UCRC experience in general terms:

- Funding programmes are not per se less potent just because their budget is small or the scope of individual awards is limited – as long as they address a pertinent gap in the innovation system.
- Support programmes' contribution towards educating the boundary spanners of the future may, in systemic terms, be well more important than the specific projects they facilitate.

- A long lifespan can help a programme to find a good balance between needed standardisation on the one hand and responsiveness to trends on the other, 'continuity matters'.
- A strong formative, yet research-based evaluation helps to achieve and safeguard this balance and can add substantially to the programme's overall impact and success.
- Once a *learning* programme runs long enough, it can strengthen its impact as well as outreach when it becomes an *educating* programme as well.

In more technical terms, it can be observed that:

- A clear and non-negotiable template for centres' internal governance structure and processes enables their set up without unduly far-reaching negotiations between prospective partners.
- A strictly "shared-IPR" based model for the core of pre-competitive activities is challenging to implement but feasible in all but a few sectors.
- Multi-site structures are feasible, even needed in certain fields, yet inevitably incur increased transaction costs – at times with limiting impacts on research activities proper.
- Centres that are not legal entities will inevitably have limited strategic mandates and would probably be less successful in building genuinely "joint" infrastructure (I/UCRC do not try).
- Evaluations can ascertain well-founded assessments by following a 'network approach' that assigns specific evaluators to individual centres who then report back to a lead evaluator.
- A too limited scope of public funding can be detrimental to centres' operation when it does not suffice to cover even basic operations and thus unduly exposes them to institutional politics.

## 5.4 Implications for research campus

Overall, it has to be concluded that the I/UCRC model is not very alike to the Forschungscampus (it puts neither of the key 'Forschungscampus stipulations': genuinely 'joint' research and long-term commitment). While the NNMI may come closer in terms of ambitions it is too young and possibly too politically contested to derive any substantial lessons for Germany at the current point in time. For the time being, therefore, I/UCRC (and arguably ERC) remain the key point of reference.

Furthermore, differences are to a certain extent due to the notably different academic and business cultures in both countries. The U.S. may well be stronger than Germany with regard to use-inspired pre-competitive research and 30 years of I/UCRC funding may well have played a substantial role in achieving this. At the same time, it is difficult to tell to what extent these achievements remain below their potential as U.S. government and business prohibits any extension of the programme to more applied ventures. In what it does, the I/UCRC Program has been very successful. It is impossible to know if more leverage could have been exerted through long-term commitments or 'joint' research.

In addition, there are three further, more detailed implications:

Firstly, one central lesson is how much can be achieved by creating a **mutual understanding between universities and industry through interaction and education**. The U.S. experience suggests that even when excluded from support as such, genuinely 'joint' research will grow on this (and only this) basis, if need be around the centres. Likely, it remains effective and useful that certain projects are pursued under university lead while others remain to a stronger extent in the hands of corporate researchers. While actual 'joint' R&D must become more central in the Forschungscampi (from the outset) than it can ever be in U.S. support programmes, other aspects of communication, coordination and training on which joint activities rest and flourish **should be given adequate, if not equal attention.**

Secondly, Forschungscampi need a **clear and defined legal structure**, precisely because they are different from I/UCRC. A centre that legally remains part of a university will have difficulties to restrict third-party access to its equipment, facilities, and intellectual property in its name – as long as the third parties are members of the university. As a consequence, in-kind contributions, leave alone substantial investments into infrastructure and equipment, will likely remain limited. In this regard, **the permeable and open structure of the I/UCRC visibly keeps them from developing a framework of reference to which industrial partners would commit for longer periods**. While, in the U.S., this may be by definition impossible, the Forschungscampus ambition must be different.

Thirdly, the Forschungscampus Initiative would with all likelihood **benefit from a continued formative evaluation with a strong research component**. As the case of the I/UCRC Program clearly demonstrates, continuity in such a process increases both the level of professionalization (i.e. quality) of the evaluation itself as well as its impact on the success of the initiative. Importantly, one major role of a long-standing evaluation is to exchange information between the different supported initiatives, invite external expert opinion and to communicate best practice. Furthermore, its research component can help to build political legitimacy on different levels and ascertain the programme's unimpeded implementation for long periods of time.

## 5.5 Future developments

Possibly, one further lesson besides the more general and technical ones listed above is that even a good support programme can only thrive when it is either actively backed or at least left alone by government and politics. As the example of the NNMI shows, high-profile programmes that become caught up in adverse political debates and hindered by controversies may become quite difficult to promote and implement.

As in the past 30 years, the I/UCRC Program – even if continuously expanded – will with great likelihood remain a small programme within a small funding agency. That notwithstanding, it will continue to demonstrate in multiple ways substantial leverage for every dollar of public money invested. Hence, it is unlikely to be touched by any future administration, even if Republican.

Within NSF, its relation to other programmes will have to be continuously developed. As some programmes have been aligned and integrated with the I/UCRC effort in the past (I/UCRC-CISE, I/UCRC-FRP, SBIR/STTR, I-Corps, GOALI), future initiatives in this regard are not unlikely. From an outside perspective, it appears remarkable that there is currently no clear link to the ERC Program – although I/UCRC could in theory well be used as a preparatory stage for later ERC.

Currently, there is no reason to assume that the I/UCRC Program will be discontinued anytime soon.

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NSF (2015c): Dear Colleague Letter: I/UCRC Clusters for Grand Challenges, a Collaborative Opportunity for Research; www.nsf.gov/pubs/2015/nsf15034/nsf15034.jsp

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**Interviews:**

**16/02/15**

11:00-12:30 Deutsche Botschaft Washington, Bereich Wissenschaft und Technologie; Andrea Noske (Referatsleiterin), Herr Dr. Karsten Hess

14:00-15:30 Information Technology and Innovation Foundation, Dr. Stephen Ezell, Senior Analyst Director of Global Innovation Policy

**18/02/15**

11:00-12:30 National Science Foundation; Maija M. Kukla, Office for International Science and Engineering; Dr. Rafaella Montelli, Program Director I/UCRC; Kelsey D. Cook, Acting Section Head, International Science and Engineering; Joseph E. Hennessey, Senior Advisor SBIR/NSF-NIST Interaction; Shashank Priya, I/UCRC FRP Program; Rathindra (Babu) DasGupta, Program Director for Innovation Corps Programs

15:30-16:30 Office of Science and Technology Policy, Executive Office of the President; Daniel Correa, Senior Advisor for Innovation Policy, Doug Rand, Assistant Director for Entrepreneurship, Dr. Mahlet N. Mesfin, Policy Advisor for International S&T

**19/02/15**

08:30 – 09:45 Denis O. Gray, Principle Investigator, I/UCRC Evaluation Project and Team Members; Department of Psychology; NCSU, Raleigh

10:00 – 11:00 Eunkyoung Shim, Research Assistant Professor, Nonwovens Institute; NCSU, Raleigh

11:00 – 12:00 Elizabeth C. Dickey, Director, Center for Dielectrics and Piezoelectrics; NCSU, Raleigh

13:00 – 13:50 Stephanie B. Jeffries, Deputy Director, Lisa Schabenberger, Center Manager Center for Advanced Forestry Systems; NCSU, Raleigh

14:00 – 14:00 K.P. Sandeep, Site Director, Center for Advanced Processing and Packaging Studies; NCSU, Raleigh

15:00 – 16:00 Michelle L. Grainger, Managing Director, Tim Michaelis, PhD Candidate Psychology Center for Innovation Management Studies; NCSU, Raleigh

16:00 – 16:30 Sami H. Rizkalla, Site Director, Center for Integration of Composites in Infrastructure; NCSU, Raleigh

**20/02/15**

I/UCRC Center for Multi-functional Integrated Systems Technology (MIST); UCF, Orlando

15:45 – 16:30 Jiann-Shiun (Peter) Yuan, Site Director

Laser-based manufacturing I/UCRC, University of Virginia, Charlottesville

14:15 – 15:00 Sharad D. Bhagat, PhD student at Laser-based manufacturing I/UCRC

15:00 – 15:45 Avik Ghosh, Associate Professor at the Department of Electrical and Computer Engineering

15:45 – 16:30 Barry Horowitz (Chair of Systems Engineering Department, Director of WICAT I/UCRC)

17:15 – 17:30 John Lach (Chairman of Electrical & Computer Engineering Department, part of the leadership team of ASSIST ERC)

**List of currently active I/UCRC**

ADVANCED ELECTRONICS AND PHOTONICS

Berkeley Sensor & Actuator Center (BSAC);
University of California Berkeley, University of California Davis

Center for Advanced Vehicle and Extreme Environment Electronics (CAVE-3)
Auburn University

Center for Design of Analog Digital Integrated Circuits (Phase III) (CDADIC)
Oregon State University, Washington State University, Univ. of Washington, Univ. of Tennessee

Center for Dielectric Studies (CDS) - Disabled
The Pennsylvania State University, Missouri University of Science & Technology

Center for Dielectrics and Piezoelectrics (CDP)
North Carolina State University, Pennsylvania State University

Center for Electromagnetic Compatibility (CEMC)
Missouri University of Science & Technology, University of Houston

Center for Freeform Optics (CeFO)
Univ. of Rochester, Univ. of North Carolina-Charlotte, Univ. of North Carolina-Charlotte

Cooling Technologies Research Center (CTRC)
Purdue University

Multi-functional Integrated System Technology (MIST)
University of Florida, University of Central Florida

## ADVANCED MANUFACTURING

Center for Advanced Design and Manufacturing of Integrated Microfluidics (CADMIM)
University of California, Irvine, University of Cincinnati

Center for Assembly Research (CAR)
University of Michigan, Michigan Technological University

Center for Friction Stir Processing (CFSP)
Brigham Young University, University of North Texas, University of South Carolina, South Dakota School of Mines and Technology, Wichita State University

Center for Particulate and Surfactant Systems (CPaSS)
University of Florida, Columbia University, Dharmsinh Desai University (International Partner Site)

Laser and Plasma for Advanced Manufacturing (LPAM)
Univ. of Virginia, Southern Methodist University, Univ. of Illinois, North Carolina State University

Membrane Science, Engineering and Technology Center (MAST)
The New Jersey Institute of Technology, Univ. of Colorado, Univ. of Arkansas at Fayetteville

NSF I/UCRC on Intelligent Maintenance Systems (IMS)
Univ. of Cincinnati, Univ. of Texas at Austin, Univ. of Michigan, Missouri University of S&T

Smart Vehicle Concepts (SVC)
The Ohio State University

## ADVANCED MATERIALS

Advanced Composites in Transportation Vehicles (ACTV)
Mississippi State University, University of Alabama in Huntsville

Advanced Processing and Packaging Studies (CAPPS)
The Ohio State University, UC Davis - Participating Site, North Carolina State University

Center for Advanced Non-Ferrous Structural Alloys (CANFSA)
Colorado School of Mines, University of North Texas

Center for Energy Harvesting Materials and Systems (CEHMS)
Virginia Tech, The University of Texas at Dallas, Leibniz University Hannover

Center for Integrative Materials Joining Science for Energy Applications (CIMJSEA)
The Ohio State University, Lehigh University, University of Wisconsin, Colorado School of Mines

Center for Metamaterials (CfM)
The City University of New York, Western Carolina University, University of North Carolina at Charlotte, Clarkson University

Center for Novel High Voltage/Temperature (HV/T) Materials and Structures
University of Denver, University of Illinois at Urbana-Champaign, Michigan Technological University, University of Illinois at Urbana-Champaign

Center for Rational Catalyst Synthesis (CeRCaS)
University of South Carolina, Virginia Commonwealth University

Center for Tire Research (CenTiRe)
Virginia Tech, University of Akron, Planned - University of North Texas

Ceramic, Composite and Optical Materials (CCOMC)
Clemson University

Computational Materials Design (CCMD)
The Pennsylvania State University, Georgia Institute of Technology

Wood-Based Composites Center (WBC)
Virginia Tech, Oregon State University

BIOTECHNOLOGY

Bio Energy Research and Development (CBERD)
North Carolina State University, University of Hawaii at Manoa, State University of New York - Stony Brook, South Dakota School of Mines and Technology

Center for Arthropod Management Technologies (CAMTech)
Iowa State University, University of Kentucky

Center for Biophotonic Sensors and Systems (CBSS)
Boston University, University of California at Davis

Center for Bioplastics and Biocomposites (CB2)
Iowa State University, UMass Lowell, Washington State University

Center for Computational Biotechnology and Genomic Medicine (CCBGM)
University of Illinois, University of Chicago, Mayo Clinic

Center for Innovative Instrumentation Technology (CiiT)
University of Illinois at Urbana-Champaign

Center for Pharmaceutical Development (CPD)
Georgia Institute of Technology, University of Kentucky

CIVIL INFRASTRUCTURE SYSTEMS

Center for Electric Vehicles - Transportation and Electricity Convergence (EV-TEC)
The University of Texas at Austin, Texas A & M University

Center for the Integration of Composites into Infrastructure (CICI)
West Virginia University, Rutgers, the State University of New Jersey, North Carolina State University, University of Miami, University of Texas at Arlington

ENERGY AND ENVIRONMENT

Center for Advanced Forestry Systems (CAFS)
North Carolina State University, Auburn University, University of Georgia, University of Idaho, University of Maine, University of Washington, Virginia Tech, North Carolina State University, Oregon State University, Purdue University, University of Florida

Center for Electrochemical Processes and Technology (CEProTECH)
Ohio University, Washington University in St. Louis

Center for Fuel Cells (CFC) – Disabled
University of South Carolina, University of Connecticut

Center for Geothermal Energy Resources (CGER)
University of California, University of Nevada, Reno

Center for Resource Recovery and Recycling (CR3)
Worcester Polytechnic Institute, Colorado School of Mines, KU Leuven

Grid-Connected Advanced Power Electronic Systems (GRAPES)
University of Arkansas Fayetteville, University of South Carolina

I/UCRC in Energy-Smart Electronic Systems (ES2)
Binghamton University: The State University of New York, University of Texas at Arlington, Villanova University, The Georgia Institute of Technology

Next Generation Photovoltaics (NGPV)
Univ. of Texas at Austin, Colorado State University, Univ. of Tennessee, Texas A&M University

Power Systems Engineering Research Center (Phase III) (PSERC)
Arizona State University, University of California at Berkeley, Carnegie Mellon University, Colorado School of Mines, Cornell University, Georgia Institute of Technology, Howard University, University of Illinois at Urbana-Champaign, Iowa State University, Texas A&M University, Washington State University, Wichita State University, University of Wisconsin-Madison

Silicon Solar Consortium (SiSoC)
North Carolina State University, Georgia Institute of Technology

Water and Environmental Technology (WET Center)
Temple University, The University of Arizona, Arizona State University

Water Equipment & Policy (WEP)
University of Wisconsin-Milwaukee, Marquette University

Wind Energy, Science, Technology and Research (WindSTAR)
University of Massachusetts Lowell, The University of Texas at Dallas

HEALTH AND SAFETY

Center for Health Organization Transformation (CHOT)
Texas A&M Health Science Center, Northeastern University, The Pennsylvania State University, Georgia Institute of Technology

Child Injury Prevention Studies (CChIPS)
Children's Hospital of Philadelphia, The Ohio State University

Science Center for Marine Fisheries Science (SCeMFiS)
University of Southern Mississippi, Virginia Institute of Marine Sciences

INFORMATION, COMMUNICATION, AND COMPUTING

Advanced Knowledge Enablement (CAKE)
Florida International University, Florida Atlantic University, Dubna International University

Broadband Wireless Access & Applications Center (BWAC)
The University of Arizona, Univ. of Notre Dame, Auburn University, Univ. of Virginia, Virginia Tech

Center for Identification Technology Research (CITeR)

Clarkson University, Univ. of Arizona, West Virginia University, Univ. at Buffalo, Michigan State

Center for Research in Intelligent Storage (CRIS)
University of Minnesota, University of Minnesota

Center for Smart Ocean Technology (CSOT)
University of Connecticut, University of Washington

Center for Surveillance Research (CSR)
The Ohio State University, Carnegie Mellon University, Wright State University

Center for Unmanned Aircraft Systems (C-UAS)
Brigham Young University, University of Colorado Boulder

Center on Optical Wireless Applications (COWA)
The Pennsylvania State University, Georgia Institute of Technology

Cloud and Autonomic Computing (CAC)
University of Florida, Mississippi State University, Rutgers University

Configuration Analytics and Automation (CCAA)
University of North Carolina Charlotte, George Mason University

Dynamic Data Analytics (CDDA)
Rutgers University, SUNY Stony Brook

Embedded Systems (CES)
Arizona State University, Southern Illinois University at Carbondale

Experimental Research in Computer Systems (CERCS)
Georgia Institute of Technology, Ohio State University

Hybrid Multicore Productivity Research (CHMPR)
Univ. of Maryland, Baltimore County, Univ. of California San Diego, Georgia Institute of Technology

Net-Centric and Cloud Software and Systems (NCSS)
University of North Texas, University of Texas at Dallas, Southern Methodist University, Arizona State University, Missouri University of Science and Technology

NSF Center for High-Performance Reconfigurable Computing (CHREC)
Univ. of Florida, Brigham Young University, George Washington University, Virginia Tech University

Safety, Security, Rescue Research
Univ. of Minnesota, Univ. of Denver, Univ. of Pennsylvania, Univ. of North Carolina - Charlotte

Security and Software Engineering Research Center (S2ERC)
Ball State University, Iowa State University, Virginia Tech, Georgetown University

Spatiotemporal Thinking, Computing, and Applications (STC)
George Mason University, UC-Santa Barbara, Harvard University

Visual and Decision Informatics (CVDI)
University of Louisiana at Lafayette, Drexel University

Wireless Internet Center for Advanced Technology (WICAT) – Disabled
Polytechnic Institute of New York University, University of Virginia, Virginia Tech, Auburn University, The University of Texas at Austin

SYSTEM DESIGN AND SIMULATION

Advanced Space Technologies Research & Engineering Center (ASTREC) – Disabled
University of Florida, NC A&T State University

Center for e-Design
Iowa State University, University of Illinois at Urbana-Champaign, University of Massachusetts Amherst, University at Buffalo-SUNY, Brigham Young University, Wayne State University, Oregon State University

Center for Excellence in Logistics and Distribution (CELDi)
University of Arkansas, Clemson University, University of Missouri, Virginia Polytechnic Institute and State University, University of California, Berkeley

Telecommunications (Connection One) (C1)
Arizona State University, The Ohio State University, University of Hawaii, Rensselaer Polytechnic Institute, University of Arizona

GRADUATED I/UCRCs

Industry/University Center for Biosurfaces (IUCB)

Queen's University Environmental Science and Technology Research Centre (QUESTOR)

(and many more)

**Case Study 1: The Nonwovens Institute, NCSU, Raleigh, Graduated I/UCRC**

THE NONWOVENS INSTITUTE

**Set-up and Structure:** 1991 (State I/UCRC), graduated 1999, One Site, 50+ Members

**Lead Institution:** North Carolina State University, Raleigh, NC

### Centre Mission and Rationale

The Nonwovens Institute (NWI) is the world's first accredited academic programme for the interdisciplinary field of engineered fabrics. Based at the Centennial Campus of NC State University in Raleigh, the NWI is an innovative global partnership between industry, government and academia.

### Members

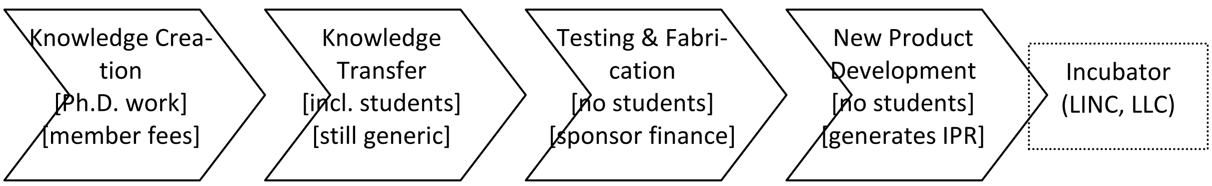
Currently, the centre has 51 full members, the overwhelming majority of which are industrial firms. Additionally, it has 11 affiliate members and 6 partner organisations. Annual Membership Fees are differentiated as follows: Full Member I $50,000, Full Member II $25,000, Affiliate Member $10,000 (SME only), Start-up Member $5,000, Emeritus Member (free), Partner Organization (free). Other than in young I/UCRC, companies commit for 4 years with an annual opt-out clause[5].

### Research Programme

Core Research Competencies include Nonwovens Materials & Process Technologies (Fibres, Additives, Coatings, Material-process-performance Interactions), Surface & Bulk Engineering (Controlling functionality e.g., ion-exchange, Controlling behaviour –e.g., shape memory), as well as Micro and Macro Modelling (Structure modelling, Performance modelling, etc.)

### Further Findings from Interviews

The institute has grown out of the I/UCRC model since graduation in 1999 to become the largest industry co-operative research centre in the U.S.. In its current form, it was established in February 2007, remaining a sub-unit of NCSU. Across the years, the NWI has developed an elaborate and explicitly communicated business strategy to respond to both long- and short-term research needs of its members and balance them in its portfolio (see below). The institute houses state-of-the-art facilities for product development, analytical services, materials testing, analysis and evaluation that is valued at over $30 million dollars. On that basis it receives $3-4 million per year from memberships as well as for research and product development services. Current presentations mention 35+ public projects which are complemented by an at least similar range of confidential activities.




Currently, NWI supports over 50 graduate students, more than 130 alumni are working in various branches of industry. While most standard centre projects are heavily based on student involvement and Ph.D. thesis, more confidential work in the area of testing and fabrication or new product development does not allow any student involvement. Moreover, faculty engaged at the institute offers ten different courses in the nonwovens field. While there is no specific 'Nonwovens M.Sc.', students are offered a 'Graduate Certificate in Nonwovens' if they have attended at least five of the abovementioned classes. The certificate has already obtained a certain regard in relevant industries.

5 http://www.thenonwovensinstitute.com/Documents/NWI_Membership_Agreement_Template.pdf

**Case Study 2: MIST Center Site, UCF, Orlando, Phase I I/UCRC**

**Full Name:** Center for Multi-functional Integrated System Technology

**Set-up and Structure:** 2014, Two Sites, 10 Members

**Lead Institution:** University of Florida, Gainesville, FL

### Centre Mission and Rationale

The MIST Center's mission is to facilitate the integration of novel materials, processes, devices, and circuits into multi-functional systems through research partnerships between university, industry, and government stakeholders. Such innovation is driven by the need to enhance the functionality of integrated systems. The centre brings together diverse expertise from academia and industry to catalyze innovation at the intersections of materials, micro/nanofabrication, magnetics, acoustics, photonics, wireless communications, devices/electronics, micro fluidics, MEMS/NEMS, power/energy, and system architectures.

### Members

Currently the centre has 10 members of which three are public or non-profit players, including the U.S. Army and seven are companies. Among the involved companies, one is Chinese although it has joined through its U.S. registered branch. Annual Membership Fees are differentiated as follows: Full Member (2 units) $80,000, Full Member (1.5 units) $60,000, Full Member (1 unit) $40,000, Associate Member $20,000 (SME only).

### Research Programme

The MIST Center is motivated by three major research/industry opportunities:

- Stepping beyond the challenge of continued conventional scaling of integrated circuits
- Exploring new "smart systems" in healthcare, smart grid, automotive, aerospace, etc.
- Integrating nanomaterials and nanostructures into micro/nanosystem manufacturing

Research at the MIST Center focuses on the development of new materials, manufacturing processes, devices, and systems at strategic intersections. More precisely, it focuses on the intersections between processes and materials, materials and devices as well as devices and systems. Details of specific research activities are formulated in ongoing interaction between the centre participants.

### Further Findings from Interviews

The MIST is a young I/UCRC that only had its full grant approved last year and is still working on the consolidation and extension of its membership base. According to the site director, setting up an I/UCRC is predominantly attractive to researchers in the later stages of their career to develop their leadership skills and to put their institutes on a new platform. As such, it is hard-earned money that does not always cover the needed expenses and effort to the full extent. However, NSF is perceived as very supportive of aspiring directors on their way towards a full application and the management training that they receive adds to the attractiveness of the programme.

As the MIST case demonstrates, however, even young I/UCRC are hardly run in isolation from other cooperative activities. They form a new core around prior (confidential) work for industry continues as well as a basis for further one-on-one projects to develop. In the initial stages of setting up a centre, it appears next to impossible to obtain meaningful in-kind contributions from industry – industrial members have to be won with promises of leverage, not further demands. In the beginning, most faculty that are listed on the centre publications have committed to it but still have to begin actual projects.

**Case Study 3: WICAT I/UCRC Site, UVA, Charlottesville, Disabled I/UCRC**

**Full Name:** Wireless Internet Center for Advanced Technology

**Set-up and Structure:** 2004, Five Sites, 34 Members

**Lead Institution:** Polytechnic Institute of New York University

### Centre Mission and Rationale

This centre focuses on the technologies needed to enhance the capacity, usability and wide adoption of the wireless internet. It specifically creates flexible, efficient, and secure wireless networks to satisfy communication needs of businesses and individuals. The programs help the sponsoring industries to increase the value of their investments in wireless technology by providing them with insights into leading edge technologies, and strategies for leveraging technology investments.

### Members

Of the centre's 34 members, around 25 are from U.S. industries, about three are international firms while more than six are public agencies (mostly defence R&D labs & Department of Defense).

### Research Programme

- Cooperative Wireless Networks
- Cross-Layer Optimization of Coexisting Heterogeneous Systems
- Millimetre Wave wireless communications
- Optimization of Wireless Dominated Large Scale Enterprise Systems

### Further Findings from Interviews

WICAT was initially established at the Polytechnic Institute of NYU with support from the New York State Office of Science, Technology and Academic Research in 2001. It received a planning grant from the NSF in 2003 and was established as an I/UCRC in September 2004 along with Columbia University. The University of Virginia joined WICAT in the year 2006 followed by Auburn University in 2007 and later by Virginia Tech and the University of Texas at Austin. The University of Virginia originally planned to establish a separate I/UCRC in systems engineering, but was advised by the NSF to join the existing WICAT centre with locations at NYU and Columbia. The three locations thus joined forces in Systems and Electrical Engineering, which allowed for a slight shift of focus and a more interdisciplinary approach. The UVA site mostly promotes individual research efforts which cater to the needs of specific companies in the consortium, more in a sense of contract research than a collaborative research effort. NSF had pointed out this issue, but did not draw any consequences, probably because the centre was immensely successful in attracting membership fees. The centre management advised the companies to stop pursuing research topics within the I/UCRC as soon as they saw serious IP potential arising from the project results. The companies should instead set up a confidential collaboration outside the I/UCRC to avoid that the IP becomes available to all the other members.

As the topics of the I/UCRC are highly interdisciplinary and newly joining students did not have the necessary skills to perform this kind of research, a new undergraduate program as well as a graduate technology leaders program was set up at UVA to implement the needs of an industrial approach into teaching. In the course of these programs PhD graduate students involved in research at the I/UCRCs would also prepare and mentor undergraduate students. Overall the NSF was perceived as very supportive and dedicated to helping make the I/UCRC a success. The program director of the WICAT I/UCRC, Prof. Barry Horowitz, will himself join the NSF in mid-2015 for several years and provide his hands-on I/UCRC and substantial industrial experience. Notably, inviting experienced academic leaders with significant business experience to work for NSF for a couple of years is very common.

### Metrics for I/UCRC

Quantitative information from the most recently completed fiscal year such as:

- Number and diversity of students, faculty, and industrial members involved in the centre,
- Degrees granted to students involved in centre activities,
- Amounts and sources of income to the centre, and
- Lists of patents, licenses, and publications created.

Operating Budget and Total Funding

- Total funding,
- NSF I/UCRC funding received,
- Other NSF funding received, and
- Additional support broken down by contributor (e.g. industry, state, university, etc.).

Capital and In-Kind support

- Equipment,
- Facilities,
- Personnel,
- Software, and
- Other support.

Human Resources

- Researchers (number of faculty scientists and engineers, number of non-faculty S&E),
- Students (number of graduate, number undergraduate),
- Administration, number of full and part time professional and clerical staff, and
- Information about broadening participation on the above, including plans to increase it.

Centre Director Descriptors

- Position and rank of the Director,
- Status of tenure,
- Name and position of the person to whom the Centre Director reports, and
- Estimated share of time Center Director devotes to tasks (e.g. administration, research, etc.).

Centre Outcomes

- Students receiving degrees and type of degree earned,
- Students hired by industry by type of degree, and
- Publications
    - number with centre research,
    - number with IAB members, and
    - number of presentations.

Intellectual Property Events

- Invention disclosures,
- Patent applications,
- Software copyrights,
- Patents granted and derived or both,
- Licensing agreements, and
- Royalties realized.

### Metrics for NNMI

Impact

- Success stories and case studies
- Number of jobs created and retained
- Number of Institute technologies reaching commercial production
- Transitioning efficiency through the TRL / MRL levels

Industry Value

- Level and quality of co-investment by non-federal sources
- Trend of co-investment by non-federal sources
- Ratio of received to originally committed co-investment
- Total number of partner companies
- Number of partner companies by size (small, medium, and large)
- Trend in total partner companies
- Growth in partner companies by size
- Total number of retained partner companies
- Number of retained partners by size
- Investment by partners in advanced manufacturing innovation
- Number of companies making use of Institute facilities (example)
- Number of spin-off companies created
- Supply Chain Engagement and Development

Education and Workforce Development

- Number of professionals participating in research, education, and training
- Number of university students participating in research, education, and training
- Number of community college students participating in research, education, and training
- Number of K-12 students and teachers participating in research, education, and training
- Number of veterans participating in research, education, and training
- Number of certification and degree programs created in collaboration with colleges etc.

Portfolio

- Number of projects in the portfolio
- Number of project-level metrics achieved
- Number and value of IP products produced and licensed

Financial

- Ratio of membership dues income to Institute expenses
- Level of fees for services or publications
- Level of non-federal funding
- Level of non-NNMI federal contracts and grants
- Level of Intellectual Property (IP) revenue

Network Contribution

- General Interaction with the larger Network of Institutes
- Number of referrals of projects or partners to other Institutes in the Network (example)
- Number of projects or partners received from other Institutes in the Network (example)
- Institute participation in Network governance

## Financing Opportunities for I/UCRC according to Programme Solicitation

*Full Centre Awards - Continuing or Standard Grant*

*Phase I - First Five Year Centre Award*

Multi-site proposals are given preference over single-site proposals. The initial Phase I I/UCRC award to a centre has a potential duration of five years. NSF support is intended to augment the support that a centre receives from industry and other sponsors. The I/UCRC program uses the following funding formulas; Multi-institutional centre sites with an annual industry membership participation between 150,000 to 300,000 can receive up to 65,000 annually. Multi-university research sites with 300,000 or more in annual memberships can receive up to 85,000 annually. Single-university I/UCRCs obtaining 400,000 or more in annual memberships can receive up to 80,000 annually.

*Phase II - Second Five Year Centre Award*

Continuing I/UCRC Program support is available for centres fully meeting the official operational and membership requirements. Multi-institutional centre sites with yearly memberships between 175,000 and 350,000 will receive 45,000 annually. Multi-university centre sites with over 350,000 in annual memberships will receive 65,000 annually. Single-university I/UCRCs obtaining over 400,000 a year in memberships will receive 60,000 annually.

*Phase III - Third Five Year Centre Award*

I/UCRC Program support is available for current and graduated multi-institutional centres that continue to fully meet I/UCRC operational and membership requirements. For the purpose of this solicitation, a graduated centre is one that has successfully completed a Phase II award within the last 10 years. Research sites with memberships at or above 175,000 a year will receive 15,000 annually. There will be 25,000 available for the lead institution in a multi-university research centre.

*Additional Supplemental Funding and Support for the Lead Institution*

The lead institution is defined by the I/UCRC Program as the institution that assumes primary coordination, general management and operations responsibilities including marketing, communications, dissemination, and evaluation of a multi-university centre. Additional funds may be requested by the lead institution in a centre proposal to help support these functions.

*Multi-University Centre Coordination*

The lead institution for a Phase I and Phase II centre receives an additional 10,000 per year for each added institution in the centre to offset the added administrative functions. The lead institution of a Phase III centre receives a fixed amount of 25,000 independent of the number of sites.

*Centre Operations and Communications*

The lead institution for a Phase I and Phase II centre receives an additional 20,000 (inclusive of applicable IDCs) in years 1 and 2, and 10,000 (inclusive of applicable IDCs) in years 3 through 5 to support innovative and effective centre operations and communications, including dissemination and marketing consistent with established program best practices.

*Evaluator Support*

NSF will provide the lead institution with annual funds for an evaluator for Phase I and II awards as outlined below. The following evaluator direct costs, plus applicable indirect costs are to be budgeted: a one-site centre receives 9,000, a two-site centre 15,000, a three-site centre 18,000, and a four or more site centre 21,000 for the evaluator.

The evaluator uses these funds to attend the bi-annual IAB meetings, write annual and semi-annual IAB highlight reports, and attend the annual directors' and evaluators' meetings. These fees are intended to cover expenses and efforts incurred by the evaluator.

*Deputy Director Support*

At NSF's discretion, a centre with eight or more sites may submit a request for supplemental funding to help support a deputy director. The "Deputy Director" request for supplemental funding must outline specific responsibilities that are measurable and which will benefit all sites within the centre. The funding level (inclusive of applicable IDCs) of these requests is based on the centre phase and annual award for the lead institution as shown below:

- Phase I centre with a  55,000 annual award may receive  33,000.
- Phase I centre with a  80,000 annual award may receive  45,000.
- Phase II centre with a  40,000 annual award may receive  25,000.
- Phase II centre with a  60,000 annual award may receive  35,000.
- Phase III centre with a  15,000 annual award may receive  12,000.
- Phase III centre with a  25,000 annual award may receive  18,000.

*International I/UCRC Support*

To advance I/UCRC goals within the global context, a I/UCRC may receive a  25,000 supplement annually for an international site or collaboration. These are to be used for expenses related to the international activity including site director(s) and evaluator travel, as well as support for research visits by U.S. students and junior researchers. NSF funds cannot be used by non-U.S. participants.

# Zusammenfassung der internationalen Fallstudien

## Australien: Cooperative Research Centres Program

Im Vergleich des CRC-Programms mit der Forschungscampus-Initiative können folgende Schlussfolgerungen gezogen werden:

- **Administration:** Die Programmverwaltung liegt beim Ministerium für Industrie und Wissenschaft. Ein Projektträger wie der PtJ existiert nicht. Das Äquivalent zur Forschungscampus-Jury ist der CRC-Ausschuss. Der Ausschuss gibt Förderempfehlungen an den Minister, koordiniert das Leistungsmonitoring der CRCs und des gesamten Programms. Damit übernimmt der Ausschuss Aufgaben, die in Deutschland zumindest teilweise beim PtJ liegen.
- **Nicht Industrie- sondern "Endnutzer"-Orientierung:** Ein Unterschied zum Forschungscampus-Programm – zumindest in der Formulierung – ist die Verwendung des Begriffs 'Endnutzer'. CRCs sind nicht Gegenstand einer Kooperation zwischen Wissenschaft und Wirtschaft, sondern haben die Forschung für sogenannte Endnutzer zum Ziel. Endnutzer sind private Organisationen und öffentliche Einrichtungen, die in der Lage sind, den Transfer der Forschungsergebnisse in die wirtschaftliche, ökologische und/oder soziale Anwendung zu leisten.
- **Auswahlprozess:** Die Programmrichtlinien beinhalten ein explizit beschriebenes Auswahlverfahren und entsprechende Auswahlkriterien. Damit wird bereits vor Bewerbungsbeginn deutlich gemacht, nach welchen Kriterien die CRCs ausgewählt werden.
- **Verpflichtungen:** Alle Partner in einem CRC, auch die "wesentlichen Partner", müssen sich nicht für die gesamte Förderperiode zur Teilnahme und zum finanziellen Engagement am CRC verpflichten. Obwohl verlässliche Verpflichtungserklärungen wichtig sind, können die Partner das CRC jederzeit verlassen.
- **Organisationsmodell:** Für die CRCs gibt es nur die Möglichkeit, sich als Gesellschaft ("incorporated entity") oder Einzelunternehmen ("unincorporated entity") zu organisieren. Andere Varianten sind nicht möglich. Damit bestehen Unterschiede zur freien Wahl der rechtlichen Organisationsform, wie sie bei den Forschungscampi möglich sind.
- **Zeitperspektive:** Vergleichbar mit den Forschungscampi werden Fördergelder für einen Zeitraum von bis zu fünf Jahren mit der Möglichkeit einer dreifachen Verlängerung (maximal 15 Jahre) gewährt. Eine langfristige Perspektive ist somit auch ein grundlegendes Merkmal des CRC-Programms.
- **Gegenfinanzierung der öffentlichen Förderung:** Wie im Forschungscampus-Programm muss auch bei den CRCs der öffentliche Mitteleinsatz in mindestens gleicher Höhe durch private Mittel ergänzt werden. Diese privaten Mit-

tel können in Form einer Barleistung, aber auch durch Sach- und Personalmittel eingebracht werden. Dafür sind für bestimmte Funktionsträger in den Programmrichtlinien Jahressummen angegeben. Damit soll abgeschätzt werden, ob die von privater Seite eingebrachten Mittel den öffentlichen Fördersummen entsprechen.

- **Interne Steuerung:** Alle CRCs müssen ein Governance-Modell einsetzen, das von der australischen Börse (Australian Stock Exchange Corporate Governance Council) entwickelt und auf die CRCs angepasst wurde. Es enthält acht Steuerungsprinzipien.
- **Führung:** Führung und Führungsqualität sind wichtige Kriterien bei den CRCs. Daher ist es notwendig, dass alle Programmleiter und Führungskräfte mehr als 50% ihrer Arbeitszeit für die Steuerung/Leitung des CRC aufwenden.
- **Beschäftigungsmodell:** Das CRC Personal wird in der Regel durch das CRC-Management-Unternehmen eingestellt und dann an die CRC-Teilnehmerorganisationen abgeordnet (vorwiegend an die Universitäten).
- **Ausbildung:** Ausbildung und Qualifizierung sind wichtige Ziele des CRC-Programms. CRC werden u.a. bezüglich ihres Beitrages zur wissenschaftlichen Ausbildung (Master und Doktorarbeiten) und der erfolgreichen Ausbildung von industriegeeigneten Absolventen (industry-ready graduates) beurteilt.
- **Internationale Perspektive:** Fördermittel sollten in Australien verausgabt, können aber auch für Ausgaben außerhalb von Australien verwendet werden, wenn dies einen Nutzen für Australien darstellt. Partner in einem CRC, sowohl von der Forschungs- als auch von der Endnutzerseite, können ebenfalls aus dem Ausland stammen. Dies ist bei größeren Unternehmen, aber auch bei Hochschulen und sonstigen Forschungseinrichtungen der Fall, da sich zu den Themen der CRCs passfähige Forschungskapazitäten oftmals im Ausland befinden (z.B. Verlagerung betrieblicher FuE großer Unternehmen an ausländische Standorte).
- **Monitoring und Evaluierung:** Der Rahmen für das Monitoring der CRCs ist bereits in den Programmrichtlinien näher erläutert. Es besteht aus einem Begrüßungsbesuch, einer Bewertung des ersten Jahres, drei- bis vierjährigen Leistungsüberprüfungen und einer Abschlussbewertung durch den CRC-Ausschuss.
- **Nachhaltigkeit:** CRCs müssen einen Nachhaltigkeitsplan bereits zu Beginn ihrer Tätigkeit und eine endgültige Strategie zur Sicherung der Nachhaltigkeit nach Auslaufen der staatlichen Förderung spätestens im vorletzten Jahr der Förderung vorlegen. Dennoch ist es nur sehr wenigen CRCs gelungen, ihre Aktivitäten im Anschluss an die Förderung weiterzuführen.
- **Proximität:** Eine Verpflichtung, ein CRC in räumlicher Nähe aller Partner bzw. unter einem Dach zu organisieren, gibt es nicht. Dies ist einer der Hauptunter-

schiede im Vergleich zur Forschungscampus-Initiative. Das 'Unter-einem-Dach-Konzept' ist themenspezifisch manchmal möglich, wegen der Größe des Landes und fehlender nationaler Forschungs- und Verwertungskapazitäten oftmals aber nicht realisierbar.

- **Regelung der IPR:** Es existiert kein festes Modell, wie die Sicherung der geistigen Eigentumsrechte zu regeln ist. Sie können insofern flexibel geregelt werden, wenn Vorteile für Australien, das CRC und alle Partner maximiert werden. Gemäß den Programmrichtlinien soll die IPR-Verantwortung bei der Teilnehmerorganisation liegen, die dafür die größte Kapazität/Kompetenz hat. Die Maxime der Vorteilsmaximierung könnte als Regelung auf 'Augenhöhe' interpretiert werden, aber die Übertragung der geistigen Eigentumsrechte an die 'fähigste Organisation' ist eher eine praktische denn rechtlich begründete Lösung, zumindest im Vergleich zur deutschen Situation. Normalerweise ist die 'fähigste Organisation' das CRC-Managementunternehmen. Vergleichbar zu Deutschland gibt es auch in Australien unrealistische Erwartungen in Bezug auf die möglichen Lizenzeinnahmen bzw. Verwertungserlöse aus den Erfindungen. Evaluationen des CRC-Programms haben empfohlen, dass nicht die CRCs selbst die Kommerzialisierung ihrer Schutzrechte übernehmen sollten, sondern Unternehmen bzw. andere Endnutzer, die in der Lage sind, den CRCs angemessene Renditen aus den Schutzrechten zu garantieren.
- **Teilnahme von KMU:** KMU-Beteiligung ist notwendig, aber schwierig. Australischen KMU sind kleiner als deutsche KMU (ein australisches Unternehmen mit mehr als 200 Mitarbeitern ist bereits ein großes Unternehmen) und verfügen oftmals nicht die finanziellen Mittel, sich in einem CRC zu engagieren. Ihre Beiträge sind daher meist nicht-finanzieller Natur (Einbringen von Personalkapazitäten oder auch Anlagen).
- **Geistes- und Sozialwissenschaften:** Die geringe Beteiligung der Geistes- und Sozialwissenschaften in den CRCs ist auch in Australien ein Thema. Es wurde daher 2008 in der Evaluation des Programms empfohlen, dass Wissenschaftler aus diesen Wissenschaftsgebieten besonders ermuntert werden sollten, sich an CRCs zu beteiligen. Zumindest einige der CRCs der letzten Ausschreibungsrunden gehören diesen Wissenschaftsgebieten an.
- **Verwendung des CRC-Logos:** Nach Beendigung der Förderung können die CRCs auf Antrag ihren Namen und ihr Logo behalten.
- **Allgemeine Wirkungen:** Aufgrund der langen Laufzeit und trotz Änderungen in den Programmrichtlinien wird das CRC-Programm in Australien als "öffentliches Gut" angesehen. In den geführten Interviews wurde gesagt, dass die australischen Universitäten das Programm als grundsätzlich verfügbare zusätzliche Finanzierungsquelle nutzen würden. Allerdings sehen die TOP 8 Universitäten CRC-Mittel, die der schlechtesten Drittmittelkategorie 4 entsprechen, deutlich weniger attraktiv an als Mittel des Australian Research Council. Diese stellen Kategorie 1-Drittmittel dar, da sie aufgrund der Ermöglichung

von Grundlagenforschung in den internen Hochschulevaluationen ein viel höheres Gewicht aufweisen. Demgegenüber spiegeln Kategorie-4 Mittel eine hohe (z.T. für die Hochschulen unattraktive) Anwendungsorientierung der Forschung wider. Die derzeitige australische Regierung ist der Ansicht, dass sich die CRCs mehr unter der Kontrolle der Universitäten befinden und weniger Interesse an den Bedürfnissen der Endnutzer, vor allem der Unternehmen, haben. Eine Antwort auf diese Einschätzung ist die Implementierung der Industry Growth Centers Initiative. Abhängig von den Ergebnissen der aktuellen Evaluierung des CRC-Programms wird politisch entschieden, ob das Programm ausläuft oder mit reduziertem Budget weitergeführt wird. Ein Hinweis auf entsprechende Entwicklungen ist, dass im Rahmen des Bundeshaushaltes 2014/15 die Regierung beschlossen hatte, die Mittel für das CRC-Programm um 80 Mio. AUD gegenüber den ursprünglichen Planungen zu reduzieren. Darüber hinaus wurden in der 17. Auswahlrunde (2014) keine neuen Bewerber aufgenommen. In Bezug auf die wirtschaftlichen Auswirkungen des CRC-Programms ergab eine Wirkungsanalyse im Jahr 2012, dass zwischen 1991 bis 2017 das Programm zur einem zusätzlichen durchschnittlichen jährlichen BIP-Wachstum von 0,03% beiträgt. Die Hebelwirkung beträgt 1: 3,1. Dies bedeutet, dass 1 AUD Förderung einen wirtschaftlichen Nutzen von 3,1 AUD ergibt.

### Österreich: Programm COMET – Competence Centers for Excellent Technologies

Das Programm COMET – Competence Centers for Excellent Technologies – fördert den Aufbau von Kompetenzzentren, deren Herzstück ein von Wirtschaft und Wissenschaft gemeinsam definiertes Forschungsprogramm auf hohem Niveau ist. Die **strategischen Zielsetzungen** von COMET sind der Aufbau neuer Kompetenzen durch die Initiierung und Unterstützung einer langfristig ausgerichteten Forschungszusammenarbeit zwischen Wissenschaft und Wirtschaft auf höchstem Niveau sowie der Aufbau und die Sicherung der Technologieführerschaft von Unternehmen. COMET versteht sich als Weiterentwicklung der österreichischen Kompetenzzentren-Programme und wurde im Jahr 2005 ins Leben gerufen.

Innerhalb der österreichischen Innovationsförderarchitektur spielt COMET eine zentrale Rolle und ist das "Flaggschiff" im Aktionsfeld "Kooperation Wissenschaft-Wirtschaft". So betrifft ca. die Hälfte aller Förderzusagen der mit dem COMET-Programmmanagement betrauten Österreichischen Forschungsförderungsgesellschaft FFG das Programm COMET. Mit einem jährlichen Budget des Bundes für COMET in Höhe von 50 Mio. Euro fließen etwa 10% aller FFG-Förderungen an die COMET-Zentren.

COMET setzt sich zusammen aus **drei Programmlinien**: K-Projekte, K1-Zentren und K2-Zentren. Die Projekte und Zentren aller Programmlinien zeichnen sich durch hohe Forschungskompetenz und Wissenschaftsanbindung bei gleichzeitig hoher Umsetzungsrelevanz im Unternehmenssektor aus. *K-Projekte* verfolgen das Ziel, hochqualitative Forschung in der Zusammenarbeit Wissenschaft – Wirtschaft mit mittelfristiger Perspektive und klar abgegrenzter Themenstellung mit künftigem Entwicklungspotenzial zu initiieren. *K1-Zentren* verfolgen das Ziel, hochqualitative Forschung in der Zusammenarbeit Wissenschaft – Wirtschaft mit mittel- bis langfristiger Perspektive zu initiieren. *K2-Zentren* haben die langfristige Bündelung existierender nationaler Kompetenzen und die Zusammenarbeit mit den weltweit besten Forscher/-innen, wissenschaftlichen Partnern und Unternehmen in gemeinsamen strategischen Forschungsprogrammen auf höchstem Niveau zum Ziel. Damit wird eine langfristige Stärkung und deutliche Erhöhung der internationalen Attraktivität des Forschungsstandortes Österreich angestrebt.

COMET ist zwar als **thematisch offenes Programm** angelegt, beinhaltet aber dennoch eine Reihe von **Vorgaben**, die sich auf die Antrags- und spätere Umsetzungsphase beziehen. Neben den COMET-Kriterien, handelt es sich schwerpunktmäßig um Aspekte wie Rechtsform, Eigentümer, strategische Ausrichtung, Organisation & Management, Humanressourcen und Zielgrößen. Gemäß Programmrichtlinien müssen Kompetenzzentren als **eigene Rechtspersönlichkeiten** implementiert werden. Als Rechtsform für Zentren ist eine GmbH oder eine vergleichbare Rechtsform vorzusehen. Um die geforderte Sichtbarkeit und Attraktivität der K-Zentren zu erreichen, sind die Forschungsarbeiten entsprechend zu konzentrieren. Es ist mehr als ein Standort möglich, solange der Zentrumscharakter gewahrt bleibt.

Einen Überblick mit zentralen Strukturmerkmalen der drei COMET-Programmlinien stellt die folgende Abbildung dar:

| | K-Projekte | K1-Zentren | K2-Zentren |
|---|---|---|---|
| Anzahl (über alle Calls) / Mitarbeiter | 46 genehmigt ("multi-firm-Proj.") | 26 genehmigt (rd.50 VZÄ) | 5 genehmigt (>100 VZÄ) |
| Öffentliche Förderung (max. Bund & Land) | 35-45% | 40-55% | 40-55% |
| Förderungsintensität Unternehmenspartner (min.) | 50% | 45% | 40% |
| Förderungsintensität wissenschaftliche Partner (min.) | 5% | 5% | 5% |
| Förderungshöhe Bund | max. 0,45 Mio.€ /Jahr | max. 1,7 Mio.€ / Jahr | max. 5,0 Mio.€ / Jahr |
| Förderungshöhe Bund & Land (2:1) max. | 0,675 Mio.€ / Jahr | 2,25 Mio.€ / Jahr | 7,5 Mio.€ / Jahr |
| Laufzeit | 3-4 Jahre | 8 Jahre (4+4) | 10 Jahre (5+5) |
| Partnerstruktur | min. 1 wiss. Partner & 3 Unternehmen | min. 1 wiss. Partner & 5 Unternehmen | min. 1 wiss. Partner & 5 Unternehmen |

Derzeit sind 35 K-Projekte, 16 K1-Zentren und 5 K2-Zentren in der Förderung. Im Vollausbau werden rund 1.500 VZÄ in den Zentren beschäftigt sein (Mitte 2013: 1.300 Beschäftigte, davon rd. 1.000 Wissenschaftler/-innen). Das finanzielle Gesamtvolumen von COMET beläuft sich mit Stand 10/2014 auf 1,479 Mrd. Euro, davon stammen 465 Mio. Euro vom Bund, 233 Mio. Euro von den Ländern, 708 Mio. Euro von den Unternehmenspartnern und 103 Mio. Euro von den wissenschaftlichen Partnern (siehe FFG Fokus 2013). An den K-Zentren sind 1.100 Partner beteiligt, davon 830 Unternehmenspartner und 270 wissenschaftliche Partner.

Ein wichtiges Programmmerkmal von COMET stellt die **Wettbewerbskomponente zwischen existierenden und neuen Projekten bzw. Zentren** dar. Die Auswahl von neuen Zentren und Projekten erfolgt auf der Basis von Anträgen im Rahmen regelmäßiger Calls. Die existierenden Zentren werden auf der Grundlage von Zwischenevaluierungen verlängert oder beendet. Im Falle einer negativen Zwischenevaluierung der Zentren ist folgendes Procedere vorgesehen: Wird ein K1-Zentrum bei der Vierjahresevaluierung negativ evaluiert, so tritt ein maximal 1 Jahr dauerndes sog. **Phasing-out** in Kraft. Dasselbe gilt bei Auslaufen eines K1-Zentrums nach 8 Jahren im Falle einer erfolglosen Wiederbewerbung.

**Räumliche Nähe** spielt bei den K-Zentren aufgrund der Existenz physischer Einheiten eine wesentliche Rolle. Jedes Zentrum hat einen geographischen Mittelpunkt. Es finden in seltenen Fällen aber auch Kooperationen über 2-3 Standorte hinweg statt (auch in verschiedenen Bundesländern). Um die Idee von Zentren als physische Einheiten mit einem räumlichen Schwerpunkt zu stärken, wurde festgelegt, dass mindestens **60% der Kosten an dem jeweiligen Hauptstandort** anfallen müssen. Technologische Schwerpunkte der Zentren/Projekte bestehen in den Bereichen Produktion, Life Sciences, IKT, Mobilität und Energie/natürliche Ressourcen. Nach Wissenschaftszweigen dominiert der Maschinenbau/Instrumentenbau, gefolgt von der Chemie, der Informationstechnologie und Elektrotechnik/Elektronik.

Im Vergleich zur BMBF-Initiative „Forschungscampus" hat sich das COMET-Programm aufgrund seines nunmehr 10-jährigen Bestehens, aber auch aufgrund seiner großen Bedeutung für die österreichische Innovationspolitik, zu einer **eigenständigen „Säule" im nationalen Forschungs- und Innovationssystem** entwickelt. Das große Budget des Bundes für COMET in Höhe von 50 Mio. Euro jährlich sowie die Tatsache, dass nahezu alle Universitäten in Österreich eingebunden sind, verdeutlicht den hohen Stellenwert des Programms. Neben den verschiedenen Programmlinien sind als weitere Unterschiede zur BMBF-Initiative die Rechtspersönlichkeiten der Zentren als GmbHs, die Möglichkeit des Aufbaus polyzentrischer Strukturen sowie die Auswahl neuer Zentren/Projekte im Wettbewerbsverfahren zu nennen. Perspektivisch könnte mit Blick auf die Weiterentwicklung der Forschungscampus-Initiative die Integration weiterer nationaler Zentren in die bestehenden Forschungscampi – und damit die Schaffung polyzentrischer Strukturen – einen interessanten Ansatz darstellen. Auch wären Überlegungen hinsichtlich wettbewerblicher Verfahren zur Identifizierung neuer Forschungscampi denkbar, wie auch das Auslaufen im Falle erfolgloser Wiederbewerbungen bestehender Campi (analog zum *Phasing-Out Ansatz* bei COMET).

### Schweden: VINN Excellence Center Programme

Aktuell werden durch VINNOVA 18 VINN Excellence Center finanziell unterstützt, in denen insgesamt neun Universitäten mit mehr als hundert Unternehmen und öffentlichen Forschungseinrichtungen zusammenarbeiten. Dabei werden die 18 Zentren in vier Stufen für maximal zehn Jahre finanziert. Vor jeder neuen Stufe wird eine internationale Evaluierung der Tätigkeit als Ganzes für jedes Zentrum durchgeführt. Ein Teil des Erfolgs der Zentren ist auf die bedeutende finanzielle Unterstützung der Industrie in Form von Geld- und Sachleistungen zurückzuführen, die oft über die erforderliche Höhe hinausgeht. Abschließend kann von einer signifikanten Teilnahme der Industriepartner gesprochen werden, die sich aktiv an dem Erfolg der grenzüberschreitenden Forschung beteiligen; so gelingt die produktive Übersetzung der Wissenschaft an die Unternehmen, wenn auch Innovation und Technologieentwicklung in der Regel bei den Unternehmen verbleibt. Daneben ist auch die Einstellung von Absolventen der Zentren durch die Unternehmenspartner üblich und ein guter Indikator für den Erfolg einer exzellenten Ausbildung in den Zentren, wovon die schwedische Industrie sehr profitieren kann.

Im direkten Vergleich zu unserer Forschungscampus-Initiative kann weiterhin festgehalten werden, dass sich die drei zentralen Merkmale fast vollständig auf das VINN Excellence Center Programm übertragen lassen:

- Beide Förderprogramme **bündeln Kompetenzen bzw. Forschungsaktivitäten** von wirtschaftlicher und öffentlicher Forschung **an einem Ort**, möglichst auf dem Campus einer Hochschule oder Forschungseinrichtung. Auch wenn das Forschen an einem Ort innerhalb der schwedischen Förderinitiative nicht explizit vorgeschrieben wird, müssen sich die Center jeweils **an einer Universität** ansiedeln, so dass auch hier eine räumliche Komponente gegeben ist. Außerdem war die räumliche Dimension in der ersten Evaluation ein deutliches Erfolgskriterium. Inzwischen suchen die Center jedoch gezielt auch internationale Kooperationspartner. Begründet wird dies damit, dass Schweden als ein Land mit einer geringen Bevölkerungszahl so seine Kompetenzen vergrößern und seine internationale Sichtbarkeit verbessern kann.
- Beide nehmen **neue Themen** im gemeinsamen Interesse von Wissenschaft und Wirtschaft mit einer **mittel- bis langfristigen Perspektive** auf und bearbeiten sie gemäß ihrem spezifischen Forschungsprofil, im Idealfall auf Basis eines ausgewiesenen Forschungsprogramms.
- Beide werden durch eine **verbindliche öffentlich-private Partnerschaft** getragen. Diese öffentlich-private Partnerschaft wird durch maßgebliche Eigenbeiträge der beteiligten Partner unterlegt, die im Aufbau des Forschungscampus/VINN Excellence Centers vorausgesetzt werden. Diese Eigenbeiträge sollen durch Sach- und Barleistungen erbracht werden.

Insgesamt werden mit beiden Förderinitiativen neue Forschungsfelder von hoher Komplexität, mit einem hohen Forschungsrisiko und/oder besonderen Potenzialen für Sprunginnovationen wirtschaftlich nutzbringend erschlossen. Es wird beabsichtigt neue Technologie- und Know-how-Führerschaften zu ermöglichen, denn die Forschungsfelder zu den Technologien und Dienstleistungen "für übermorgen" zeichnen sich häufig durch einen neuen Zuschnitt, starke Interdisziplinarität sowie eine frühe Bedarfsorientierung aus.

Hinsichtlich zu übernehmender Empfehlungen ist unter anderem die Intensivierung auf der **internationalen Ebene** zu betonen. So wurde unter anderem vorgeschlagen, Kooperationen mit international führenden Organisationen zu etablieren, internationale Finanzierung und Studenten anzuwerben, und die Teilnahme in der weiteren internationalen wissenschaftlichen Community zu intensivieren. Auch diese Thematik wurde bereits innerhalb der Forschungscampus-Initiative als der bedeutend eingestuft. Die Gutachter schlugen hier eine unabhängige Gruppe von Experten vor; so könnte zum Beispiel die **Bildung eines internationalen Scientific Advisory Board** (ISAB) von wesentlicher Bedeutung sein. So wurde auch während der zweiten Evaluation erneut ein intensiveres internationales Recruiting als Programm-Verbesserung empfohlen. Darüber hinaus könnte es auch für die Forschungscampus-Initiative sinnvoll sein, wenn eine Reihe von **Leitlinien** erarbeitet werden (z.B. internationale best practice/Vereinfachung der Finanzberichterstattung), an denen sie sich für ihr weiteres Fortbestehen orientieren können und die gleichzeitig ihre Arbeit erleichtern.

Daneben sah man einen Bedarf in allen Zentren für eine **formelle Beratungsgruppe**, die sich auf die kontinuierliche Entwicklung des gesamten Forschungsprogramms konzentriert. Die neu gebildeten Gruppen sollten sich aus hochrangigen Wissenschaftlern der Center und leitenden Wissenschaftlern oder Ingenieuren von Partnerunternehmen zusammensetzen. Die Gruppe sollte als Beschluss fassendes Organ für die Ideenfindung sowie Entwicklung, Priorisierung und Überprüfung von Projekten sowie für die strategische Analyse des Zentrums verantwortlich sein. Auf diese Weise kann die Gruppe durch den Bericht an den Direktor Einfluss gewinnen und konstruktiv an der erfolgreichen Weiterentwicklung der Zentren mitwirken.

Darüber hinaus wurde sehr schnell festgestellt, dass Schwierigkeiten hinsichtlich der **Regelung gemeinsamer IPRs** entstanden sind, so dass es als sinnvoll erachtet wurde, wenn VINNOVA signifikanten Input zur Lösung der jeweiligen Probleme in den Centern beisteuert. Daraufhin veranlasste VINNOVA die Erstellung einer Modellvereinbarung in Bezug auf die Regelung der IPRs.

Da kulturelle Unterschiede zwischen der Industrie und der Wissenschaft immer noch eine große Rolle spielen, ist ein gut funktionierendes Management-System besonders wichtig für das Fortbestehen der Center. So erscheint es als besonders empfehlenswert, **leadership training für die Zentrumsmanager** anzubieten, um unter anderem die Denkweise von Wissenschaft und Wirtschaft weiter zu vereinen und gleichzeitig beide Seiten für die jeweiligen Belange zu sensibilisieren. Auch eine formelle Beratungsgruppe kann von Bedeutung sein, die sich auf die kontinuierliche Entwicklung des gesamten Forschungsprogramms konzentriert.

In diesem Zusammenhang sollte auch darüber nachgedacht werden, wie die Industrie noch stärker für die Forschungsarbeiten involviert werden kann und wie insbesondere **Anreizmechanismen** entwickelt werden können, die ein **größeres Engagement von KMU** bewirken. VINNOVA wurde zum Beispiel dazu aufgefordert ein Instrument zu entwickeln, in dem Best Practices ausgetauscht werden können im Hinblick auf Praktiken für eine intensivere Einbeziehung von KMUs. Ein renommierter Preis an herausragende Partnerschaften zwischen Wissenschaft und Wirtschaft könnte zudem dazu beitragen, Innovationen weiter zu stimulieren. Hinsichtlich der Nachhaltigkeit der Forschungscampi erscheint es ebenfalls sehr wichtig, dass sie frühzeitig Pläne entwickeln, wie sie nach Ende der Förderung arbeiten wollen, welche Ziele sie sich setzen, wie sie diese erreichen und wie sie sich selbst finanzieren wollen.

## USA: Industry/University Cooperative Research Centers Program (I/UCRC)

### Ergebnisse und Effekte

Ohne Zweifel hat das I/UCRC Programm in vielerlei Hinsicht substanzielle Ergebnisse erzielt, die durch **kontinuierliches Monitoring** und verschiedene Evaluationen detailliert belegt werden können. Ihr vielleicht wesentlichster Beitrag seit Einrichtung des Förderprogramms liegt dabei in der **Ausbildung** mehrerer Tausend Master- und Ph.D.-Kandidaten mit einer positiven Grundeinstellung zu und einem soliden Erfahrungswissen bezüglich wirtschaftlicher Fragestellungen. Darüber hinaus haben die Zentren auch auf der Leitungsebene (Direktoren) dazu beigetragen, dass mehrere hundert Professoren und andere Akademiker die Fähigkeit entwickeln konnten, **komplexe Kooperationsprojekte zwischen Wissenschaft und Wirtschaft** voranzutreiben und weiter zu entwickeln. Schließlich hat das Programm dazu beigetragen, dass in großem Umfang **geistige Eigentumsrechte** generiert und zum Nutzen aller zwischen den Mitgliedern der Zentren geteilt werden konnten. Während des letzten Jahrzehnts wurden aus allen Zentren gemeinsam in der Regel 50 Patente jährlich angemeldet, begleitet von einer ähnlichen Zahl anderweitig veröffentlichter Erfindungen. Kürzlich hat sich die letztere Zahl sogar auf über 160 Veröffentlichungen erhöht. Darüber hinaus wurden in jüngerer Vergangenheit jährlich ca. zehn **Spin-offs** gegründet. Zusammenfassend ist der Beitrag des I/UCRC Programms im Hinblick auf Technologietransfer somit nachweislich beträchtlich. Fallstudien zeigen darüber hinaus, dass Investitionen in I/UCRC auch in ökonomischer Hinsicht wesentliche Hebeleffekte erzeugen. In drei der am weitesten entwickelten Zentren ließen sich im Rahmen einer Studie wirtschaftliche Effekte in Höhe von 1,28 Milliarden Dollar feststellen, bei im Laufe der Jahre erfolgten öffentlichen Investitionen in Höhe von lediglich 18,5 Millionen Dollar.

Insgesamt kann das I/UCRC Programm somit als ein Erfolgsmodell angesehen werden, dass die Interaktionsdynamik an zentralen Schnittstellen des amerikanischen Innovationssystems gestärkt hat. Als wesentlich hierfür haben sich dabei nicht nur die eigentliche Projektarbeit der Zentren, sondern insbesondere auch ihre Ausbildungsaktivitäten erwiesen, die seit vielen Jahren dazu beiträgt, sowohl jetzigen und zukünftigen Lehrstuhlinhabern als auch F&E-Mitarbeitern in Unternehmen eine positive Grundhaltung zu den Möglichkeiten wirtschaftlich-wissenschaftlicher Kooperation zu vermitteln, und so ‚über Köpfe' eine nachhaltige Brücke zwischen beiden Bereichen zu etablieren.

Trotz allem hat das Programm auch Grenzen, nicht zuletzt durch die vergleichsweise **geringe Größe der einzelnen Zentren**. Im Wesentlichen bleibt es eine **Vernetzungsinitiative**, die die Schaffung gemeinsamer Infrastrukturen und wirklicher Kooperationen ‚unter einem Dach' weder erreicht noch anstrebt. Während die I/UCRC somit einen exzellenten Betrag dazu leisten, die Dynamik in gut etablierten, sektoralen Innovationssystemen der USA zu erhalten und weiter zu entwickeln, erscheint es zweifelhaft, ob sie geeignet wären, zu einem wirklich nachhaltigen Wandel bestehender Wirtschaftsstrukturen beizutragen. Durch ihre lange Geschichte haben sich die I/UCRCs zu einem nahezu perfektionierten Instrument für die die Vernetzung des amerikanischen Innovationssystems auf mittlerer Ebene, d.h. zwischen Partnern entwickelt, die in wissenschaftlich-wirtschaftlicher Hinsicht nicht notwendigerweise führend sind. Exemplarisch hierfür ist die relativ geringe Präsenz kalifornischer Universitäten im Programm. Demgegenüber erscheinen sie weniger geeignet, missionsorientierte Großprojekte voranzutreiben bzw. auf substanzielle wirtschaftliche Herausforderungen, z.B. im Bereich aktuell stark geschwächter Industrien zu reagieren.

### Erfolgsfaktoren

Einer der wesentlichen Erfolgsfaktoren des I/UCRC Programms war von Beginn an die **relativ geringe Beteiligungsschwelle** für industrielle Akteure und die relativ hohe Wahrscheinlichkeit, dass im Rahmen einzelner Projekte **wesentliche finanzielle Hebeleffekte** erzielt werden konnten. Dieser Ansatz steht in unmittelbarem und offensichtlichem Einklang mit der auf kurzfristigen Erfolg hin orientierten Mentalität US-amerikanischer Manager und stellt daher eine zielgerichtete und nachweislich erfolgreiche Anreizsetzung dar. Zweitens ist das Modell attraktiv für den in den USA weit verbreiteten **Typus des 'unternehmerischen Akademikers'**, d.h. für Professorinnen und Professoren, die ein eigenes Interesse daran haben, praxisorientierte Forschungseinheiten zu etablieren, nicht zuletzt um in diesem Rahmen auch ihre eigenen Managementfähigkeiten weiter zu entwickeln. Schließlich ist das Modell für Studenten interessant, die durch eine frühzeitige Auseinandersetzung mit industriellen Bedarfen und Herausforderungen bessere Chancen auf dem Arbeitsmarkt erlangen.

Nach einer Laufzeit von mehr als 30 Jahren kann das I/UCRC Programm darüber hinaus auf effektive und **umfänglich erprobte Verwaltungsprozesse** zurückgreifen. Die Gliederung der aktuellen Ausschreibungen hat in vielerlei Hinsicht Charakteristika eines Handbuches angenommen und trifft auch für außergewöhnliche Fälle klare Festlegungen. Darüber hinaus liegen spätestens mit Gray/Walter's Zusammenfassung bisheriger Erfahrungen im 'Purple Book' (1998) eine Reihe von Handbücher zum Thema "How to set up a centre" vor. Diese stellen über die Vorgaben der Ausschreibung hinausgehend etablierte und erprobte Vorgehensweisen zur Projektauswahl und -umsetzung innerhalb der Zentren vor. Diesbezüglich erlangte Erfahrungen nicht nur bei der Formulierung neuer Ausschreibungen berücksichtigt, sondern fließen in eine kontinuierliche **formative Evaluation** ein, die in dezentraler Weise eng mit den einzelnen Zentren arbeitet und ihnen bei Bedarf beratend zur Verfügung steht. In diesem Rahmen hat sich das I/UCRC Programm **von einem *lernenden* in ein *ausbildendes* Programm weiterentwickelt**, das über die Fähigkeit verfügt, potenzielle Fördernehmer, d.h. insbesondere angehende I/UCRC-Direktoren, aktiv auf ihre zukünftige Rolle vorzubereiten. Dieses gezielte Coaching derer, die das Programm in der Praxis umsetzen und die beabsichtigt Rolle und Funktion der Zentren in ihrer täglichen Arbeit mit Leben füllen, ist nicht zuletzt im Rahmen der jüngsten Expansion (vgl. Budgeterweiterung s.o.) zu einem wesentlichen Erfolgsbestandteil des I/UCRC Programms geworden. Diese Aktivitäten werden seitens der Zielgruppe fast durchgängig positiv bewertet.

Ein weiterer wesentlicher Erfolgsfaktor ist die **Forschungskomponente der begleitenden Evaluation**. Seit ihren Anfängen in den frühen 1980ern hat sich diese zu einer der vermutlich erfolgreichsten und professionellsten Evaluationen im Bereich US-amerikanischer Forschungspolitik entwickelt. Neben der regelmäßigen Zusammenstellung von Monitoringzahlen leistet sie mittels zielgerichteter Forschungsarbeiten einen zentralen Beitrag zur Einbeziehung aktueller Herausforderungen in das Programmdesign. Auf diese Weise stellt sie die Flexibilität und Anpassungsfähigkeit einer bereits lange bestehenden Programmlinie sicher.

Diese begleitenden Forschungsaktivitäten erfolgen teils auf Basis der Eigeninitiative des Evaluationsteams um Prof. Denis O. Gray, sind in der Vergangenheit allerdings auch häufig von Seiten der NSF finanziell unterstützt worden.

**Lessons Learnt**

Zusammenfassend lassen sich aus einer vertiefenden Analyse des US-amerikanischen I/UCRC Programms folgende **übergreifende Schlussfolgerungen** ziehen:

- Zentral für den Erfolg und die systemische Relevanz von Förderprogrammen zur Stärkung von Kooperationen zwischen Wissenschaft und Wirtschaft ist deren **präzise Ausrichtung auf einen tatsächlichen Bedarf**, weniger der Umfang ihrer Ausstattung mit Fördergeldern.
- Der Beitrag, den solche Förderprogramme zur **Ausbildung der ‚Brückenbauer der Zukunft'** leisten ist in vielerlei Hinsicht mindestens ebenso bedeutsam und nachhaltig wie die direkt messbaren Effekte gemeinsamer Projektarbeit.
- Eine **lange Laufzeit** ermöglicht es einer Förderinitiative im Hinblick auf inhaltliche Vorgaben und administrative Umsetzung eine gute Balance zwischen erforderlicher Standardisierung und Anpassungsfähigkeit im Hinblick auf Trends zu entwickeln, 'continuity matters'.
- Eine starke, formative aber gleichzeitig **forschungsorientierte Evaluation** kann dazu beitragen diese Balance zu erreichen und zu erhalten und auf diese Weise erheblich zur Wirksamkeit und Effizienz eines Programms betragen.
- Wenn ein *lernendes Programm* lange genug etabliert ist, lohnt es sich, die Ergebnisse dieses Lernens nicht nur den administrativen Programmeignern, sondern im Sinne eines *ausbildenden Programms* auch aktuellen und zukünftigen Fördernehmern zugänglich zu machen.

In stärker umsetzungsorientierter Hinsicht lässt sich festhalten, dass

- Eindeutige, nicht verhandelbare **Vorgaben bezüglich der internen Governancestrukturen und -prozesse**, wie die neuen Zentren zu etablieren sind, vereinfachen Ver- und Aushandlungsprozesse mit Industriepartnern.
- Das I/UCRC **Modell der Offenlegung und Teilung allen geistigen Eigentums** zwischen den am Zentrum beteiligten Partnern ist nicht immer einfach durchzusetzen, hat sich aber, gerade aufgrund seiner Eindeutigkeit, in den meisten Sektoren als realisierbar erwiesen.
- Zentren, die über keine eigene Rechtsform verfügen und damit stets unter dem einseitigen Steuerungsvorbehalt ihrer Universität stehen, haben es schwerer, Unternehmenspartner zu umfangreichen Investitionen zu bewegen.

- Ein Netzwerkansatz, der **jedem Zentrum einen spezifischen Evaluator** zuteilt, der dann an ein zentrales Evaluationsteam berichtet, ermöglicht auch in breit angelegten Förderprogrammen eine angemessen detaillierte Würdigung einzelner Fälle.
- Die **Schaffung von Zentren, die sich auf mehrere Standorte verteilen**, ist in den meisten Bereichen möglich, in einigen sogar erforderlich, führt jedoch zu erheblichen Transaktionskosten, die die für die eigentliche Arbeit verfügbaren Ressourcen verringern können.
- Ein **zu geringes Fördervolumen**, das nicht einmal grundlegende Verwaltungstätigkeiten abdeckt, **kann ein an sich gutes Anreizsystem nachhaltig in Frage stellen**, da Zentren in diesem Fall allein vom Wohlwollen ihrer Universitäten abhängig und nur begrenzt strategiefähig sind.

**Implikationen für die Forschungscampus-Initiative**

Zusammenfassend lässt sich festhalten, dass das I/UCRC Programm der Forschungscampus-Initiative **nicht** im engeren Sinne **ähnlich** ist. Es setzt langfristige, wechselseitige Committments bzw. eine Zusammenarbeit ‚unter einem Dach' in gemeinsam geschaffenen Infrastrukturen weder voraus noch strebt es sie an. Dennoch bildet es unter allen in den USA zurzeit umgesetzten Förderprogrammen aktuell den wesentlichsten Referenzpunkt für diese Studie, nicht zuletzt, da sich andere Programme, wie die NNMI Initiative, noch in einem sehr frühen Stadium der Entwicklung befinden.

Darüber hinaus ergeben sich die zu identifizierenden Unterschiede nicht zuletzt aus der **von der deutschen abweichenden, universitären, politischen und Unternehmenskultur der Vereinigten Staaten** und einer sich daraus folgerichtig ergebenden abweichenden Ausrichtung nationaler Förderprogramme. Im Hinblick auf Amerikas Herausforderungen im Bereich vorwettbewerblicher Industrieforschung ist das Programm als zielgerichtet anzusehen und es steht zu vermuten, dass es zur Erreichung des aktuellen Zustands relativer Stärke beigetragen hat. Ob eine Öffnung des Programms hin zu stärker angewandter oder gemeinsamer Forschung weitere Potentiale erschließen würde, wird sich dagegen nie mit Bestimmtheit sagen lassen, da ein solcher Ansatz mit Blick auf die bestehenden politischen Rahmenbedingungen auf absehbare Zeit ausgeschlossen bleibt.

Darüber hinaus lassen sich drei weitere, detaillierte Implikationen festhalten:

Erstens zeigt das Beispiel des I/UCRC Programms, dass **bereits ein Ansatz, der über Interaktion und Ausbildung in allgemeiner Weise Brücken zwischen Wissenschaft und Wirtschaft schlägt, erhebliche Effekte erzielen kann**. Das US-amerikanische Beispiel legt nahe, dass nicht zuletzt dieser ‚weiche' Ansatz eine notwendige Grundlage für etwaige spätere ‚Forschung unter einem Dach' bildet, selbst wenn diese nicht durch das Programm selbst gefördert wird, sondern sich lediglich außerhalb der Zentren oder später, in Folge einer I/UCRC Förderung ‚ergibt'. Darüber hinaus zeigt sich, dass manche industrierelevante Projekte in der anwendungsorientierten Grundlagenforschung auch erfolgreich unter Federführung der Universität vorangetrieben werden können. Wenngleich Forschungscampi also bereits von Anfang an ‚Forschung unter einem Dach' sicherstellen müssen und damit, anders als die I/UCRC, Industrieforscher stärker mit einbinden müssen, legt das amerikanische Beispiel nahe, dass ‚Forschung unter einem Dach' auf jeden Fall auch durch ‚weichere' Formen der Kooperation und des gemeinsamen Lernens begleitet werden sollte. Auch jenseits der Kernprojekte ‚auf Augenhöhe' sollte die Möglichkeit für weitere gemeinsame Projekte bestehen, in denen die Universität eine führende Rolle einnimmt.

Zweitens benötigen Forschungscampi **eine klare und eindeutig definierte rechtliche Struktur mit der Konsequent klarer Eigentumsregelungen, gerade weil sie sich in Auftrag und Zielsetzung von I/UCRC unterscheiden**. Im I/UCRC verfügt jeder Angehörige der beteiligten Universität über Nutzungsrechte an allen Geräten, Laboren und Infrastrukturen der I/UCRC, was in der Praxis zumindest von Fakultäts- oder Institutsangehörigen auch durchaus genutzt wird. Unter rechtlichen Rahmenbindungen, die jeden Beitrag zum I/UCRC ausschließliches Eigentum der Universität werden lassen, sehen sich die meisten Unternehmen nicht in der Lage, umfängliche Investitionsmittel zur Verfügung zu stellen. Die offene und durchlässige Struktur, die den I/UCRC in mancher anderen Hinsicht nutzt, stellt in dieser Hinsicht ein merkliches Hindernis dar. Ambitionierte, auf groß angelegten gemeinsamen Infrastrukturen basierende Vorhaben wie die Forschungscampi, lassen sich auf dieser Grundlage nur schwer verfolgen.

Drittens würde auch die Forschungscampus-Initiative mit großer Wahrscheinlichkeit **von einer kontinuierlichen, formativ und wissenschaftlich orientierten Begleitforschung bzw. Evaluation profitieren.** Wie der Fall des I/UCRC Programms zeigt, erhöht eine Kontinuität in Prozessen der Evaluation und Begleitforschung nicht nur den Professionalisierungsgrad und die Qualität dieser Prozesse selbst, sondern auch die Wirksamkeit und Effizienz der Förderinitiative insgesamt und wird von den Fördernehmern als wichtige, unterstützende Maßnahme begrüßt. Eine zentrale Rolle solcher begleitenden Aktivitäten ist dabei deren Mittlerfunktion zwischen den verschiedenen geförderten Zentren, die Bereitstellung externer Expertise sowie die Vermittlung erfolgreicher Lösungsansätze (good practice). Darüber hinaus können sie mittels einer forschungsorientierten Komponente auf unterschiedlichen Ebenen zur Legitimierung des Programmes und seiner Anpassung an aktuelle Herausforderungen beitragen.

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