Establishing Science-adequate Research Structures at Karlsruhe Institute of Technology – Risks and Opportunities Associated with the Reconcilement of Disciplines, Transdisciplinarity, and Competencies. An Essay[1]

(Dr. Dennis Nitsche and Vice-President Prof. Dr. Detlef Löhe – Karlsruhe Institute of Technology)

1. Summary

A clear research profile was developed by establishing KIT Centers and KIT Focuses, which bundle and strengthen activities existing in strategically important research fields. The Competence Network offers all KIT scientists a platform for open exchange of experience and ideas. Excellent conditions for science at KIT are complemented by the formation of a joint administration and the integration of science infrastructure services, such as the KIT library or KIT's Steinbuch Center for Computing (SCC). Chief Science Officers provide for the close interlinkage between research structures and the Executive Board. The range of responsibility of a CSO is referred to as department. Fakultäten are transformed into subject areas in charge of higher education.

2. Introduction

Modern research organizations strongly require clear structures, processes, and convergence of topics.[2] Complexity results from the two perspectives in understanding structures, processes, and convergence of topics: The classical disciplinary understanding that includes the well-learned theorems, practices, and technologies, for instance and the transdisciplinary understanding that focuses on networking, communication, mutual understanding, and new approaches resulting from a transfer of methods and applications. Obviously, both perspectives are necessary and indispensable. Thus, structures, processes, and convergence of topics need to be tailored to fit disciplinary and transdisciplinary desiderata at the same time. The classical disciplinary perspective still is the basis of higher education and professionalization, while the transdisciplinary perspective has proved to be crucial to cutting-edge multidisciplinary research and innovation. This dual perspective on structures, processes, and convergence of topics poses a major challenge to every research organization. At many places, this challenge has been neglected, as the persistence of "historically grown" bodies appeared preferable over the uncertainty or complexity arising from the demand for matrix solutions that is associated with this dual perspective. At KIT, no matter how our own position in this respect was in the past, action was required simply because it is an institution resulting from the merger of Universität Karlsruhe (TH) and Forschungszentrum Karlsruhe GmbH. Merging a classical university organization of disciplinary structure with a program-based, cross-disciplinary large-scale research institution means that the two perspectives have to be bridged. As organizational optimization is a permanent task even in science organizations, this essay will briefly describe the situation

[1] According to KIT's research profile, this essay will focus in particular on natural and engineering sciences. Social sciences at KIT mainly deal with the man – technology interaction and, thus, have a specific orientation.

[2] In this essay research organizations are considered specific social bodies. Consequently, structures, processes, and topical convergence (in analogy to polity, politics, and policy) have been selected as structuring means. The focus will be placed on structures and processes, as in-depth discussion of topic-based strategy obviously needs expert knowledge.

prior to the merger, before it will focus on the first conception and consolidation of new KIT research structures, processes, and convergence and outline how the shortcomings and insufficiencies detected have already led to first adaptations and revaluations. Admittedly, we already were somewhat experienced in the development of new, independent disciplines from interdisciplinary collaboration: Already when establishing the faculties of informatics, chemical engineering, and business informatics did we deal with disciplinary and transdisciplinary structures. Even the establishment of scientific engineering by Ferdinand Redtenbacher in the mid-19th century at the Karlsruhe Polytechnical School can be considered an early starting point of transformation and optimization of research organizations and the development of new disciplines. Nevertheless, the scope and complexity of building KIT research structures doubtlessly were and still are highly challenging – as it is always people who bring life to structures, live processes, and work on the pertinent topics.

3. The Initial Position

Universität Karlsruhe (TH) (short: UKA) was a university of the federal state of Baden-Württemberg. UKA's profile was characterized by engineering and natural sciences (mechanical engineering, chemical & process engineering, civil engineering & geo- and environmental sciences, chemistry & biosciences, physics, informatics, electrical engineering & information technology), supplemented by architecture, economics & business engineering as well as humanities & social sciences, and mathematics. These 11 Fakultäten[3] were responsible for the organization of higher education and, to a lesser extent, for research coordination. Regarding research organization, the role of the faculties mainly focused on appointment procedures and informal networking. Research strategies were coordinated only rudimentarily at the Fakultäten. This task was fulfilled mainly by the Office of the Rector, the Vice-Rector for Research, the dean of the Fakultät, and the scientific commissions in charge of appointment procedures. The backbone of UKA were the 120 institutes, some of which were quite small with scarcely a dozen scientists headed by a single professor, while others comprised over 100 scientists and were managed by a board of professors. Strong ties with industry characterized research at UKA. UKA was financed by the federal state of Baden-Württemberg.

Research at Forschungszentrum Karlsruhe (short: FZK), a member of the Helmholtz-Gemeinschaft Deutscher Forschungszentren (Helmholtz Association, short: HGF), was organized in the transdisciplinary research areas of energy, earth & environment, key technologies, and structure of matter. These areas follow the German federal research strategy, deal with strategically defined "major challenges and pressing issues facing society and develop sustainable solutions for tomorrow and beyond."[4] In these areas scientific advancement is pursued in 11 transdisciplinary programs and several unique large-scale research facilities. While the programs at FZK had a transdisciplinary, topic-related structure, the institutes of FZK were organized in a more discipline-oriented, but far from systematic manner. The institutes that often employ more than 200 scientists each are allowed to

[3] The term "department" in this essay is not used as an equivalent to "Fakultät". At KIT, both terms are used to describe different organizational structures. "Fakultät" designates an organizational disciplinary structure. "Department" means a new administrative-organizational structure covering Fakultäten (including university institutes), KIT Centers and Focuses, Helmholtz programs, and large-scale research institutes.

[4] See: http://www.helmholtz.de/en/research/ (August 20, 2012).

participate in several programs. Research strategy was coordinated by the Executive Board, together with program spokespersons and heads of institutes. Evaluation of the programs every five years and the resulting possibility of relocating funds had a major influence on the FZK research strategy. FZK was financed from federal and Baden-Württemberg state budgets at a ratio of 90:10.

The plan for a merger of UKA and FZK was outlined for the first time in the so-called Institutional Strategy I (Zukunftskonzept) submitted within the framework of the Excellence Initiative[5]. Unifying research organizations and processes of UKA and FZK was defined to be the major task. The easy way, i.e. complete dissolution of one of the two systems and its integration in the other system, was not viable for obvious reasons: Fakultäten were needed for the organization of higher education, as the study courses clearly follow the structure of Fakultäten. On the other hand, topic-based large-scale research programs of FZK as the major source of financing were not open for change, as they were compulsory for the Helmholtz Association as a whole. Moreover, scientists at UKA and FZK equally adhered to the well-established structures. Any reshaping of research structures had to cope with the challenge of taking along the employees without unintentionally sending out any kind of message that the existing cherished structures had failed or were old-fashioned, which would have worried the employees and endangered support of the still young and vulnerable idea of founding KIT. Nevertheless, we expected added value and synergies from developing a flexible and open research structure and bringing together university and large-scale research scientists. From our point of view, founding KIT was the unique opportunity for a complete shake-up of two long-standing institutions and a chance to reform any potentially existing encrusted and rigid structures, processes, and arrangements. Our purpose was to make use of the KIT impulse and to set up a completely new concept of transdisciplinary cooperation. This was expected to stimulate research and innovation. By integrating FZK scientists in higher education, the student-professor ratio at KIT was to be improved considerably. From our perspective, the chances of merging UKA and FZK by far outweighed the risks associated with the merger.

4. The Road to KIT

Well-practiced long-term cooperation between UKA and FZK, for instance by appointing top scientists professors at UKA and, at the same time, heads of institute at FZK or even heads of joint UKA/FZK institutes was the basis of mutual trust and understanding. The endeavor to found KIT was firstly described in the Institutional Strategy I (2006) of the Excellence Initiative: “In commitment to Humboldt’s ideal of excellent academic and scientific practice, the objective of our concept for the future is to create and sustain an environment in which knowledge and innovation can be created, developed, communicated, and spread.” For political reasons, in full awareness of the complex setting determined by the relationships between the federation and the federal state, the word “merger” was avoided in the Institutional Strategy I to prevent discussion in an early stage. For the two partners UKA und FZK, however, the merger was the clear destination at that point in time. Fortunately, both partners were largely equal in size, with both having about 4,000 employees and a

[5] The Excellence Initiative was a competition for special advancement of German top universities, which was launched by the Federal Ministry of Education and Research and the state ministries. For the plan of founding KIT, UKA was awarded the title of excellence university.

comparable budget of about EUR 300 million each. Thus, a merger of equals, not a takeover, was possible, which ensured support by the employees.

KIT basic data		
Income (T EUR)	2006	2010
Total budget p.a.	565,249	732,380
Basic state funding	181,607	219,730
Basic federal funding	206,318	210,448
Third-party funding p.a.	177,324	302,202
University sector	108,640	178,694
Helmholtz sector	68,684	123,508
Staff (heads)	2006	2010
Total	7,795	9,211
University sector	3,815	5,160
Helmholtz sector	3,744	4,051
Students total	18,515	20,771

A major driving force of KIT´s development indeed was the success of the Institutional Strategy I in the Excellence Initiative and the following support by state and federal politics as well as by additional financial means. Shortly after the announcement of the decision on October 13, 2006, Minister Annette Schavan (Federal Ministry of Education and Research, BMBF), State Minister Peter Frankenberg (State Ministry for Science, Research, and the Arts Baden-Württemberg, MWK), and the two institutions UKA and FZK agreed on a White Paper ("Eckpunktepapier"). This included the development of a detailed joint concept until the end of May 2007 and its evaluation by the "International Advisory Board" (IAB) and by the two supervisory boards of the two institutions. Establishing the IAB was a requirement made by the German Council of Science and Humanities ("Wissenschaftsrat"). Moreover, it was necessary to conclude a cooperation agreement (so-called internal "founding contract" of the partners UKA and FZK) by the end of December 2007. A 100-page KIT Concept Paper was developed, discussed in detail with the IAB and the supervisory boards, and finalized in October 2007. This concept called for a merger in a much clearer way than the Institutional Strategy I had dared to: It included the vision of a complete merger of the two institutions into one legal entity with joint boards, infrastructure facilities, service units, and procedures as well as a concrete implementation plan. After the final evaluation by IAB and the supervisory boards, the cooperation agreement was signed as a first step on December 13, 2007. This founding contract stipulated close cooperation between the two legally still separate institutions.

It was shortly after signing the agreement that the ministers Schavan and Frankenberg agreed to dare the complete merger of both institutions into one legal entity. By extensive collaboration of the two leading ministries MWK and BMBF in the following year 2008, the constitutional requirements were verified, a law of the state of Baden-Wuerttemberg for the establishment of KIT was drafted, and the KIT Administrative Agreement was prepared. The KIT law was unanimously adopted by the state parliament on July 14, 2009 and the Administrative Agreement was signed by the ministers on July 30, 2009. After completion of the necessary legal steps – and after separation of the FZK Nuclear Decommissioning Division and transfer to the Reprocessing Plant Karlsruhe Ltd. –, the Karlsruhe Institute of Technology was established as a public corporation according to the law of the state of Baden-Wuerttemberg and governmental institution on October 1, 2009. Based on the administrative agreement, the federal and state ministers added another agreement in the form of a White Paper ("Eckpunktepapier", 2011) in April 2011. It envisages the complete legal autonomy of KIT, transfer of the capacity as an employer from the state to KIT, extensive transfer of all assets to KIT, and partial transfer of rights and responsibilities as a builder from the state to KIT. Full authority of KIT in appointments is included. By adoption of KIT law II, these provisions became reality on May 9, 2012.

5. Establishing Joint Research Structures, Processes, and Convergence of Topics

At KIT, we decided that the structural needs of classical discipline-based higher education, transdisciplinary research projects, research funding, networking of individual scientists, and effective governance could not be met by a single “one-size-fits-all” structure. We preferred flexibility and adaptability rather than strict hierarchy. Therefore, we decided to either preserve or newly establish structures that optimally meet a single demand. As a consequence, we had to accept a higher level of complexity. Consequently, it was necessary to establish an overarching system, called a moderated multi-agent arena, for the structures to cooperate. Effectiveness is ensured by defined processes, responsibilities, and coordination.

a. Institutes

The institutes make up the basic elements of the organizational structure of KIT. For historic reasons, the institutes differ remarkably in size. Currently, a process of concentration is leading to the formation of new, bigger KIT institutes including former UKA as well as FZK institutes. As an example, the Institute for Applied Materials (IAM) was established. At IAM, about 200 scientists work in six sub divisions.

b. KIT Competence Network

The Institutional Strategy I proposed six research areas, subdivided into 24 research fields, to represent the complete scope of research of UKA. These research areas were planned to match the HGF programs of FZK. Practical implementation, however, revealed that the network had been designed from UKA’s perspective, but did not fully reflect the FZK portfolio. With the participation of UKA and FZK scientists, six competence areas with a total of 30 competence fields were defined. This network was to serve as a platform for exchange of experience and ideas and for the development of new joint research activities. Spokespersons were elected by the scientists in 2008.The competence areas and fields did not represent “rigid” structures, but served as networking platforms for transdisciplinary exchange, bringing together scientists from different disciplines in grass root projects. Within a short period of time, it became evident that the competence areas and fields were able to serve as networks, but would not be able to fulfill their initially intended role as joint research structures for various reasons: Firstly, nearly half of the UKA scientists (mostly, natural scientists) did not find any scientific “counterparts” in the FZK sector. Secondly, the scientists had been allowed to register for up to three competence fields to account for their broad set of competencies, but it became clear that no effective governance structure could be established for these multiple interaction lines. So far, about one third of the KIT scientists have registered. Thirdly, the approach to identifying competencies proved to be effective for the enhancement of individual skills and e.g. exchange on methods, but was not able to display the project dimension at large, as the topics still are driven mainly within the institutes and not across the institutes. In early 2012 (in the context of the development of Institutional Strategy II within the framework of Excellence Initiative II), the KIT Executive Board decided to develop the competence areas and fields towards a Competence Network that is designed by its scientific members with the support of an intranet-based social interaction platform, workshops, and other networking activities. The Competence Network is meant to initiate and support bottom-up collaborations and, thus, to give interdisciplinary and integrative stimuli. It can be regarded a networking platform and nucleus giving rise to new project

ideas. Consequently, other structures were needed for governing research. To meet this demand, the KIT Centers and KIT Focuses were designed (see below).

c. Helmholtz Programs

The Helmholtz programs persisted at KIT, as they correspond to the Helmholtz program-oriented funding scheme. Management of the Helmholtz programs was slightly modified to secure compliance with other KIT structures. The former full-time program spokespersons were replaced by Chief Science Officers (see below).

d. Fakultäten/Departments

The role of the Fakultäten was elaborated regarding the organization and quality management of higher education as well as the advancement of the disciplinary profile of KIT, mainly by their involvement in appointment procedures. Hence they influence the research profile to some extent. Currently, internal discussion is heading towards a conversion of Fakultäten (which still consist of institutes of former UKA only) into bigger units comparable to departmental structures at US universities which will consist of disciplinary related institutes irrespective of their former affiliation to UKA or FZK. Very much like the current Fakultäten, the departments will be in charge of studies and higher education, quality assurance, and further development of scientific disciplines, subjects (especially by participating in appointment procedures) as well as academic life. Institutes from different departments contribute to the individual courses of studies. In the future, contributions by KIT's research sector will be increased. All matters relating to study programs and higher education as well as examinations will be dealt with by the corresponding committees under the direction of the Vice-President for Higher Education.

e. KIT Centers and Focuses

As early as in 2007, KIT Centers and KIT Focuses developed as structures reflecting the big research activities at KIT. These "holdings" make the research activities visible both internally and externally. In principle, all institutes may contribute to research activities of a KIT Center or KIT Focus, if the topics fit. KIT Centers cover the areas of Energy, Mobility Systems, Climate & Environment, Elementary Particle & Astroparticle Physics as well as NanoMicro. The KIT Focuses COMMputation, Humans & Technology, Optics & Photonics, and Anthropomatics & Robotics are smaller in size. KIT Centers and Focuses comprise topic-related projects, Helmholtz programs, graduate schools, and DFG collaborative research centers (Sonderforschungsbereiche). They are headed and represented internally and externally by a scientific board and a spokesperson. It became evident that a topical approach was very favorable, especially for cooperation with industry. We consider the success in acquiring the KIC (Knowledge and Innovation Community) InnoEnergy in the competition launched by the European Institute of Technology a first confirmation of the value of these new topical structures. In the future, the KIT Centers and Focuses will examine and evaluate their strategic orientation and further development strategy by regular foresight processes. The first foresight process started by the KIT Energy Center yielded valuable results regarding the positioning and future course of activities. Criticism on KIT Centers and Focuses refers to them being blind for all those research activities that cannot be included under these prominent headings. On the other hand, enhanced internal and external visibility clearly led to an increase of reputation for KIT as a whole.

f. Case Study: KIT Energy Center and KIT NanoMicro Center

As many as 58 institutes and approximately 1,100 staff members participate in the KIT Energy Center. The seven topics cover aspects of engineering and natural sciences, but also of economics, the humanities and social sciences as well as law. The KIT Energy Center comprises nearly the whole spectrum of energy research, including renewable energy, efficient energy use, and energy systems analysis.

The KIT NanoMicro Center combines the competences of 800 KIT scientists in the fields of science and technology on the nano- and microscale. It comprises the Center for Functional Nanostructures (CFN), the Karlsruhe School of Optics and Photonics (KSOP), the Helmholtz NANOMICRO and BioInterfaces programmes, and large-scale research infrastructures, such as the Karlsruhe NanoMicroFacility (KNMF) and the ANKA synchrotron light source. A major structural element of the NanoMicro Center is the BELLA (Batteries and Electrochemistry Laboratory) joint laboratory operated together with BASF SE.

g. Chief Science Officers

Every institute, KIT Center and KIT Focus, Fakultät, and program is assigned to one of six departments. The departments are headed by a Chief Science Officer (CSO). The CSO acts as a direct personal link and the department as a structural link between the subordinate structures and the KIT Executive Board. The CSOs regularly participate in the meetings of the Executive Board as consultants. Moreover, the CSOs maintain direct personal contacts to the heads of institutes. In the future, Fakultäten will probably be transformed into departments and the CSOs will assume a position comparable to that of a dean at US universities.

h. Internal Quality Control: Council for Research and Promotion of Young Scientists (CRYS)

Of course, this merger process caused concerns among former UKA scientists, as they feared that the Fakultäten and they themselves – would lose their weight in the new institutional setting of KIT compared to the scientists of the former FZK. It took some time to communicate that even if the responsibility of the Fakultäten was focused on higher education, research organization, of course, relied on their acting in new research organization structures together and completely on par with their colleagues from the research sector. It must be noted that the same critical perception prevailed among former FZK scientists, who became aware of a rather large number of professors at former UKA and the importance of higher education and, thus, feared to lose their influence. Communication of the top management therefore was of highest importance to prevent the emergence of anti-KIT-pockets of defense. This was supported by two joint bodies – CRYS and the KIT Senate. The establishment of CRYS as an internal scientific council with equal numbers of UKA and FZK members turned out to be an important tool for building mutual trust and understanding. After the success in the Excellence Initiative I, the Council for Research and Promotion of Young Scientists (CRYS) was installed. CRYS has evaluated and prioritized all proposals for funding research from the Excellence Initiative funds. Today, CRYS is responsible for quality control in research. It conducts evaluation processes and advises the Executive Board on the acceptance of proposals funded from KIT means. In the future, it will also be responsible for quality assurance of research projects financed by the recently established KIT-Stiftung (KIT Foundation). CRYS significantly helped reduce reservations as

did the excellent cooperation of former UKA and FZK personnel in the KIT Senate, the KIT body for employee participation. There still are employees who are taking a critical look at KIT. Nevertheless, support of KIT is overwhelming, especially among young scientists who grew up in the new KIT system and use the advantages and values added as a matter of course.

6. Long-term Perspective: Objectives in Research and Strategy

The change processes took place on a rather short time scale of a few months. The biggest challenges were and still are information and communication. The process of growing together, however, is far from being completed and remains a big task for the years to come. Lack of orientation, the challenge of bringing life to new structures and avoiding pointless actions, problems resulting from parallel structures and specific scientific cultures hamper the efficiency of the new research structures at KIT. In spite of these problems and challenges, KIT scientists are increasingly observed to live these structures without prejudice and to easily use the capacity and effectiveness of the best structure available the best process to trigger. From our point of view, making use of classical discipline-related and complementing transdisciplinary structures and individual networking are means to foster top-level research. The extent to which we will reach our ambitious long-term objectives in research as outlined in our Institutional Strategy II will serve as proof of concept at large for the success of our newly established research structures. These objectives include:

- Assuming a leading position worldwide in energy research extending from the investigation of fundamental scientific issues to implementing science-based knowledge in large-scale projects and pilot plants.
- Assuming an internationally leading role in the research areas defined through the KIT Centers and KIT Focuses as well as cutting-edge positions in selected topics.
- Assuming a nationally outstanding role in research dealing with the complex interaction between man and technology and the future development of technologies in our global society.

7. Conclusion

KIT offers a unique range of prerequisites for conducting research on all relevant time and resource scales. A well-established flexible, transparent, and dynamic research structure enables KIT to react quickly and with adequate resources to scientific or societal challenges. By establishing matrix structures following different organizational logics, we want to provide a vibrant atmosphere for research at KIT. It is very clear to us: It is not the structure doing research, it is the scientists. Structures just give orientation and provide the minimum order necessary, they cannot guarantee success. Whatever the starting point of individual scientific interest may be, may it be topic-related, may it be methodical, there’s a way to group with others at KIT and to get the project started. It is all about allowing for creativity and freedom of thinking. Structures and processes regularly have to be evaluated, whereas convergence of topics is naturally secured by scientists’ daily work.