

# **Determinants of Innovation Networks.**

## **The Case of the European Innovation Network for Radiation Dosimetry.**

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Engagement in innovation networks can increase a company's innovation potential more than by only exploiting its own R&D resources. Theory has recognized innovation networks' increasing importance by investigating their single components and their relation to others. But in order to help the practice to decide when, and in which form of innovation networks, engagement is needed, and when it is better to cut ties to prevent resources from being wasted, performance monitoring from an individual company perspective is needed.

The empirical background for this research was a six-month investigation of a well-established European innovation network for research on radiation dosimetry. This network aims to advance the scientific understanding of ionizing radiation dosimetry to promote dosimetric methods and instruments' technical development as well as their implementation in routine dosimetry, and to ensure the consistency of the dosimetric procedures used within the EU as well as compliance with international guidelines. This network consists of 47 European organizations in 31 different countries. The member organizations range from small to big laboratories (e.g., CERN in Switzerland), or research institutions (Institute of Nuclear Physics, Poland) to governmental institutions for radiation protection (National Agency for New Technology, Energy and the Environment, Italy) to companies that produce and sell dosimetric tools (ARC Seibersdorf Research, Austria). Beside the member organizations, which have different expectations regarding the value of and need for a network, other stakeholder like the European Commission and the governments of the single countries, which fund part of the network's activities, want a certain innovation outcome. These different perspectives make monitoring and demonstrating the network outcome increasingly complex. We are going to investigate the network and measure as well as illustrate its outcome for the different stakeholders in a three-year project. In the article, we present the performance indicators' first findings, based on interviews and questionnaires as well as on site visits and document analysis conducted in the first six months of the research project.

## 1. Introduction

Shorter innovation cycles, the escalating costs of industrial research and development as well as the dearth of resources force companies to find new ways of accelerating their innovation process (Prahalad & Ramaswamy, 2000; Hagedoorn & van Kranenburg, 2003). Participation in bilateral or multilateral cooperations can present various advantages and be initiated for different reasons (Gassmann & Fuchs, 2001). Hagedoorn and van Kranenburg (2003) point out that the number of cooperations between 1970 and 1998 increased by a factor of ten. Miotti and Sachwald (2003) illustrate the correlation between a company's innovativeness (based on the number of patents) and its number of cooperations. On average, 34% of all companies in Europe work by means of a cooperation (Eurostat, 2001), a method that is led by the electronic, aerospace and pharmaceutical industries (OECD, 2002). Although the total number of cooperations is still increasing, all relevant partners regard only 45% of all joint ventures as a success (Harrigan, 1988), this figure being 40-50% within research alliances (Spekman et al., 1996; Dancin et al., 1997; Duysters et al., 1999).

Nevertheless, cooperation, especially innovation networks as a form of cooperation, can have advantages. Networks enhance knowledge sharing and innovation within and across companies, therefore they are an increasing phenomenon in a knowledge-driven society (Tsai & Ghoshal, 1998; Kilduff & Tsai, 2003; Tsai, 2001; Inkpen & Tsang, 2005; Ritter & Gemünden, 2003). Whereas most recent literature focuses on inter-firm networks' structure, on outcomes and variables linked to competitive success (Bae & Gargiulo 2004; Baum, Calabrese & Silverman, 2000; Dyer & Nobeoka, 2000; Gupta & Govindarajan, 2000; Nishiguchi, 1994) as well as on networks' evolution (Venkantraman & Chi-Hyon, 2004; Soda, Usai & Zaheer, 2004), hardly any literature investigates performance measure and management mechanisms within networks or, more specifically, in innovation networks.

## 2. Innovation networks can have different impacts

Duschek (2002) defines innovation networks as a form of economic cooperation between innovation activities in which legally independent, but in terms of their innovation-related business relationships, financially dependent organizations link the market and hierarchy's coordination potentials in such a way that relatively stable social relations are established. The latter pursue the sourcing, development and commercialization of innovative products or processes through which (lasting) competitive advantages should be achieved in a co-operative manner and way. Innovation networks can furthermore be used to access additional technology and market knowledge, to co-develop standards, to create a

minimum (critical) size for a project, and to share innovations' costs and risks (Siebert, 1999; Hagedoorn & Schakenraad, 1989; Boehme, 1986). Wisseman and Euser (1991) differentiate three forms of innovation networks: structure-based, application-based and technology-based networks.

In structure-based networks, specially established institutions, focusing on companies' research, development and common information activities, cooperate. Such networks share the results of their studies with interested groups; their knowledge therefore becomes public good. The representatives of the companies and/or institutions involved choose the focus of the networks' research and development activities, while the network participants directly or indirectly fund the research.

On the other hand, companies are motivated to participate in application-based networks in order to develop a technology with which to solve a crucial and concrete problem. This network form could therefore combine a small number of companies to initiate one or more research projects that are exclusively focused on personal value, in order to jointly commercialize the results later. The research projects in these networks are jointly funded and decision-making is done collectively. Application-based networks are only temporary in nature and are dissolved after the targeted technology's successful development.

In contrast, technology-based innovation networks focus on creating special forms of knowledge and transferring them to as many interested parties as possible. These networks should create knowledge that is related to a specific, crucial technology that is still under development. Technology-based networks therefore emerge in order to develop applications based on this crucial technology. The size of the network is not limited; the more parties that want to profit from participation, the better. Furthermore, most of these networks are publicly funded, based on idealism and are driven by enthusiasts within research institutions.

Although these categories give some indication of the value that these network forms should create, Wisseman and Euser (1991) do not explain how they should be managed, or how to measure their performance in order to take action if necessary. Funding is crucial for all these forms of innovation networks because it allows the required resources to be utilized as well as also determining the research objective. But without knowing whether, or being able to prove that the goals can be reached and the network is in-line, it is extremely difficult to convince any authorities - both public as well as private - to support network activities over a longer period of time. Furthermore, without such proof the institutions and/or companies involved cannot be sure that participation in such a network will achieve the anticipated value. However, if the network's management could monitor its performance, this could help to optimize its structure and activities, which would facilitate adapting to a changing environment or new challenges, thus enabling optimal impact.

The study illustrated in this article tries to fill this gap

by creating a model which links the outcome-related variables in order to deduce the elements that are crucial for value creation. The created model is subsequently used to analyze an existing innovation network called EURADOS.

### 3. The European radiation dosimetry network (EURADOS) case

The European Radiation Dosimetry group (EURADOS) was created in 1981 as a platform, bringing together scientists from various laboratories in Europe working in the field of radiation dosimetry and thus increasing “their opportunities for co-operation.” (Pihet et al., 2005, p. 1). The executive arm of this scientific society is embodied in the General Assembly that represents EURADOS members, currently 47 laboratories from 31 European countries (the European Union, Eastern and Central Europe). The members delegate individual scientists to participate in EURADOS activities and to contribute to various working groups. The network activities cover the fields of radiation protection, research and development topics and scientific knowledge for a wide range of stakeholders in numerous ionizing radiation and radiation protection applications. Among these are the European Commission, national research and expertise institutes, research groups, manufacturers of dosimetry instrumentation, regulatory bodies, the nuclear industry and medical facilities.

EURADOS has a long history of being funded by and thus working for the EU Commission. At the end of the 1960s, radiation therapy with neutrons received renewed consideration after the disappointing experiences of the 1940s. The International Commission on Radiation Units and Measurements (ICRU) initiated a neutron dosimetry report as well as the International Neutron Dosimetry Intercomparison. The European Commission subsequently supported the European Neutron Dosimetry Intercomparison Project (ENDIP) that took place in 1975. One salient conclusion of both intercomparisons was the need for more consistent sets of basic data on, for example, cross sections, stopping power, kerma, and mean energy expended per ion pair (W-values). Subsequently, a broad interest in collaborative research on dosimetry provided the motivation to found the European Radiation Dosimetry group. In September 1981, EURADOS was therefore initiated during a meeting in Homburg (Germany) of scientists engaged in contracts with the European Commission. It was decided that the EURADOS activities would focus on the collection, processing and dissemination of information on the research on all types of ionizing radiation dosimetry, on the practical coordination of ongoing research projects, and on the joint planning of future programs. The main aims of EURADOS, as proposed in its statutes, are to advance the scientific understanding of ionizing radiation dosimetry; to promote the technical development of dosimetric methods and instrumentation as well as their implementation in routine dosimetry; to ensure compatibility of the dosimetric procedures used within the EU and conformance with international

practices; to stimulate collaboration and the dissemination of results among European laboratories and similar associations in neighboring areas; and to maintain active links to and the exchange of information with the international community of dosimetry laboratories. Within its extended participation in the Framework Programme EURATOM, EURADOS progressively reoriented its activities from supporting research to the implementation of research results in radiation protection dosimetry, with an emphasis on harmonization, dissemination and training. One key activity in this Framework Programme is the promotion and organization of regular intercomparisons, meetings and publications.

Selected European laboratories involved in performing or promoting scientific research in radiation dosimetry form the EURADOS membership. They represent most of the major European radiation protection institutes, related standards laboratories as well as well-known university laboratories involved in the field. These institutions then delegate more than 120 scientists associated with different EURADOS activities to working groups. Four working groups are currently in operation. In addition, the network has a close relationship with almost 200 corresponding members.

The European Commission and the EURADOS membership fund its research. The members thus support the various tasks in which their scientists invest their efforts. This support has increased regularly, confirming the membership's commitment to the enduring network. Funding from the European Commission has so far been obtained through the Framework Programmes (EURATOM, FP 5 and 6). Although proposals submitted to past Framework Programmes provided general support of EURADOS activities, the new funding is only grant a very limited sum of money for selected working groups. This includes the limited funding of a study by an external research institution to assess the network's value when contrasted with the more generous funding of the new instrument “Network of Excellence” which the EU Commission supports. In this Networks of Excellence, funds will go to selected single institutions that have proven excellence in their field, and not to a network of institutions.

Since its creation, EURADOS has produced a library of publications and proceedings documenting its scope and results in order to contribute to the solution of dosimetry problems, which, in actual workplace situations, are known for their difficulty. Various working groups and workshops have extensively investigated a variety of such problems, e.g. the dosimetry and spectrometry of mixed neutron-gamma fields, the dosimetry of cosmic rays for aircrew radiation protection monitoring etc. (for more detailed information see Pihet et al., 2005).

Beside these results, there is no information on achieved or expected individual or corporate values, because there is no performance measurement in place with which to monitor the network performance. Consequently, EURADOS management does not as yet have enough knowledge on how and where the network can be optimized. Also, triggered by the unexpected reduction of funding within the newest EU Framework Programme, which is regarded as a crucial survival factor,

as well as the more focused support, the board requires proof of the EURADOS network's impact. The board wants to answer the questions: Who is gaining what value from the EURADOS network? And, subsequently: Who is responsible for funding its activities? The last question is: Where should the network be improved in order to increase its impact?

#### 4. Methodology

In order to deduce the determinants responsible for value creation, and therefore crucial for performance measurement, we built on Hage and Hollingsworth's (2000) theoretical model of an idea innovation network. We adapted and operationalized it according to the theory and the first interview results as well as the developed hypotheses in order to test it within an actual innovation network's context. In order to extract network performance indicators, the unit of analysis was the innovation network.

Our research was conducted in two phases, in each of which different data gathering methods were used. After gathering general information on the EURADOS network, its goals and members through document analyses and the first interviews with important stakeholders within the network, we set up the research design. Supported by the network's management board, we presented the design to the network members at their annual general assembly in Krakow (Poland) in January 2005 in order to increase the motivation for participation. After receiving a positive feedback, we drew up a semi-structured interview guideline for the management. In a first phase, we conducted 10 interviews with the network's management board in Vienna (Austria) in April 2005. This board, called the EURADOS network council, is largely comprised of the 12 most experienced EURADOS members, and our aim was to gather general information from them as well as to adapt the members' questionnaire in respect of their specific terminology. Because the council members invest more time in network activities than the other members, we asked them about their motives for participating in the network and the values they gain, besides asking general questions on the network's organization and history.

In a second phase, the members' questionnaire was made available as an online questionnaire on the internet to facilitate response. We included printing possibilities to make it even user-friendlier for those members who wanted to fill out the six-page questionnaire while traveling or using it offline. In total, 33 questions were asked on the motives for participation, the approach within the network as well as the quality of the relationships between the network members. We also included three questions that would allow us to conduct a social network analysis in order to follow the communication patterns and links between the network members. After a pre-test with a representative sample, the questionnaire was made available online at the beginning of March 2005. Supported by a letter of introduction from the EURADOS council, we sent all 158 registered network members the address of the link. We

increased the response by sending a general email reminder one week before the deadline was due. A second, personal email reminder was sent the day after the deadline to all members who had not yet answered. We received a response rate of today 60% (95 valid questionnaires returned). We are still in the process of increasing our response rate by phoning all the members who did not answer. Those who answered the questionnaire are on average experienced network members (median greater than 10 years), have voting member status (64%) and spend little of their working time on EURADOS activities. For more than half of the respondents, the time horizon for commitment is on average up to ten years or unlimited.

The preliminary findings presented in the next section are based on the interview results, whereas the findings of the survey are used for the force-model presented later.

#### 5. What determines the performance of innovation networks?

Based on the model of Hage and Hollingsworth (2000), we developed the following model (Figure 1) to assess the EURADOS innovation network's performance. Whereas Hagen and Hollingsworth combined the two variables 'shape of the network' and 'connectedness of arenas' within their theoretical concept of an innovation network, we divided the variable shape of the network into two, more detailed, variables (shape of the network and connectedness of members). The importance of these factors for network performance is illustrated in the following network literature analysis. Because the EURADOS network has special requirements, which were deduced from the interview analysis of the first phase of this study, we added two more variables (funding of network activities and the member's home institution called lab for radiation dosimetry). In the following section, all the factors are explained in more detail as well as adapted to the specific case through the use of the interview results and the data analyses of the first research phase.

In summary, our innovation network model includes four variables influencing the network performance. These are the variables: funding, shape of the network, member connectedness that leads to a direct innovation outcome codified in publications and, finally, an indirect innovation outcome realized through the members' institutions (here the 'lab for radiation dosimetry'), influenced by their institutions' absorptive capacity and the EURADOS representative's connectedness with research and development arenas within the members' institution. We hypothesize that there is a correlation between these factors and the network's innovation impact. Subsequently, an innovation network performance measurement needs to monitor the network in order to optimize it if necessary.

network to give their best in their working groups, both have to be taken

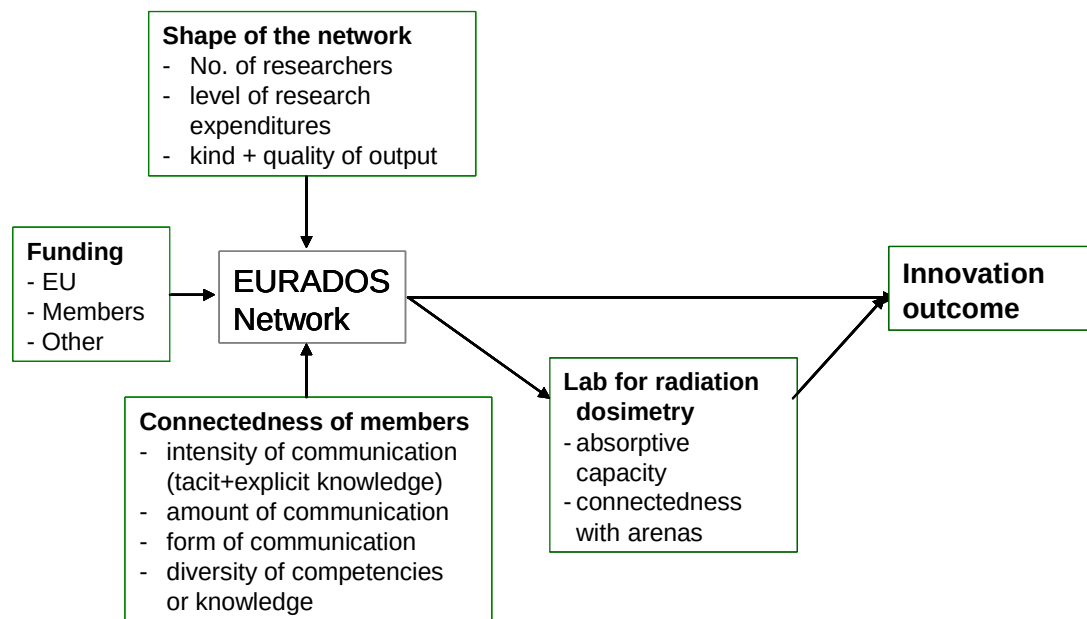


Figure 1: Research model of the innovation network EURADOS

### 5.1. Funding

Resources are crucial for the set-up and running of a network. Ritter and Gemünden (2003) mention four kinds of relevant resources: financial, physical (e.g. computer, phones, and rooms), personnel and information resources. As mentioned in the EURADOS description above, funding has a crucial role in the network. Until the end of 2004, the funding, in other words, the covering of members' traveling expenses, came from the European Commission, while the members' institutions covered their working time. The European Commission's reduced funding from 2005 onward has resulted in traveling costs being substantially reduced as well as a more focused support for selected working groups and their activities. Funding is not only important for what it can provide, but also for the implied management (Commission) support that is shown through the funding of activities.

Funding is an important factor for measuring an innovation network's impact, because with the funding comes responsibility for goals connected to this funding. As the interviews reveal, EURADOS members enjoyed higher recognition for their network activities within their home institutions when the EU Commission regarded their work as important enough for funding (no matter how much). Furthermore, the members' home institutions have a better chance of acquiring national research funds if they participate in EU-funded projects. As mentioned above, EU funding is now connected to specific and clearly defined goals that the European Commission regards as important. These goals reflect European research interest and help scientists to prioritize their research activities. Because personal motivation as well as the goals set by their home institution (which are funding their working time) trigger scientists in the EURADOS

into account when defining the EURADOS goals that have to be measured. For the EURADOS network, this proposition means that the goals connected to the network funding need to match the member institutions' goals as well as the individual members' personal goals.

### 5.2 Shape of the network

In investigating innovation networks, a variety of variables may be selected to study the network's structure (Gilsing, 2003; Wissema, 1991). Theory does not provide clear proof regarding which shape is the best for innovation networks, but some authors have described single elements that seem to be the best. The following can operationalize the shape of the network: the size of the network and/or the working groups within the network (Pyka, 1999; Staber, 2000; Swan 1999), the network boundaries (Prange, 1999; Krebs & Rock, 1997), the member composition (Conway & Steward, 2000), their spatial range (Koschatzky & Sternberg, 2000; Oerlemans, 2001), and the entry or exit barriers (Duschek, 1998; Staber, 2000).

The transfer process within the network itself can also influence a network structure and its outcomes. Elements like the tacitness or explicitness of the knowledge shared (Sydow & van Well, 1999), the network knowledge (Duschek, 1998), the formality of the content (Hämäläinen, 2001; Pitaway, 2004; Pyka, 2002), the intensity, such as the frequency of contact (Echeverri, 1999; Hage, 2000), the network relationships' durability (Echeverri, 1999), the outcomes in terms of radical or incremental innovation (Lambooy, 2004; Oerlemans, 1998) and the innovation complexity (Oerlemans, 2001, Sydow & van Well 1999) are important factors too.

Because of network roles' structural influence and their support of networks' outcomes, they have also been widely discussed in network research. Gatekeepers (Hamel, 1989), radial individuals (Valente, 1995), company-spanning individual (Van Aken, 2000), or organizational experts (Zündorf, 1997) and relationship promoters (Walter & Gemünden 2000, Müller, 2004) are just some of roles found. Authors subsequently recognized some industry elements, like the industry structure (Marceau, 1999; Sydow, 1999b; Pitaway, 2004), production forms (Lambooy, 2004), technological maturity (Robertson, 1994), and the industrial or professional associations (Pitaway, 2004; Swan, 1999), as important influencing factors on networks' activity and their management, because they determine the members' background and demands. Some authors have recognized that the active management of networks is crucial for success (Inkpen, 1998; Ritter & Gemünden, 1998, Kappelhoff, 2000), others such as Walter and Gemünden (2000) derived outcome variables with which to measure network performance and focus on management by objectives (see also Mensch, 1986), while Wissema and Euser (1991) as well as Harris (2000) identified performance factors, but only a few concepts are based on actual empirical evidence and provide the practice with help.

To summarize, we operationalize the variable 'shape of the network' in the number of members, the selection of members, their roles, the network's management, the level of research expenditure and the kind and quality of the output.

The EU support for the EURADOS network is clearly connected to the fact that the network includes all important research institutions in the European Union. This is because the EU defined harmonization of the EU research on radiation dosimetry as one of their main conditions for supporting EURADOS. A precondition is therefore the selection of member organizations that include all major EU research institutions. In order to have a higher impact, also small but innovative companies as well as service providers, and institutions outside the EU should be EURADOS members. Accordingly, the member composition should create a natural facilitating environment for knowledge transfer and creation. The network's management, the EURADOS council, which is elected by the all the members, and which is mostly regarded as consisting of engaged and important members within EURADOS, tries to facilitate these knowledge processes by structuring the activities by means of working groups, by supporting knowledge exchange and creation by means of publications, newsletters and an EURADOS website as well as by means of proposals for funding or exploring other funding sources. The council also recruits new members, or discusses members' status (that of affiliated members who are informed about activities, or that of affiliated members who can participate in working groups' activities as well as that of voting members who can lead working groups and have a vote in the council). Because the council is responsible for the EU funding and for reporting on the funds provided, it needs to monitor the working groups' activities and optimize them if necessary. The outcomes of the working groups' activities can be publications in

refereed journals, intercomparisons, databases, methods developed, training courses etc., depending on the working groups' goals. The EURADOS council also undertakes the integration of the network's gatekeepers into important network activities (like hosting a general assembly, or heading a working group).

### 5.3 *Connectedness of members*

Whereas the variable 'shape of the network' includes the 'hard facts' of the network structure and management, the variable 'connectedness of members' describes the relationships between the network members. The theory has pointed out factors like centrality (Valenta, 1995; Siebert, 1999; Weber 1997), density and integration (Gemünden & Heybreck, 1997; Ritter & Gemünden, 1998; Koschatzky, 2000), and transparency (Hamel, 1991) that influence the relationships. But also the relationship's stability (Sydow, 1992), the kind of transfer (Herschel, 2001; Sydow & van Well, 1999), the relationship's flexibility (Gomez, 1995; Fusco, 2003) as well as the hierarchy (Goh, 2002; Koschatzky, 2000), or symmetry of relationships within the network (Van Aken, 2000; Moverly, 1996), and the redundancy in relationships (Pitaway, 2004; Hämmäläinen & Schienstok 2001; Prange, 1999) define the quality of the relationships within the network.

Even harder to operationalize are what is termed the 'soft facts', such as the network members or the management's intention and motivation (Hamel, 1989; Gemünden & Heydebrek, 1997); cultural aspects like trust (Goh, 2002; Ingham, 1998; Wurche, 1997; Loose & Sydow, 1997; Bachmann, 2000; Pitaway, 2004; Harris, 2000), openness (Goh, 2002, von Krogh, 1998), socialization (Gomez, 1995), network culture (Staber, 2000; Ruigrok, 1999), and reciprocity (Powell, 1996; 1990). The theory has only recently recognized cultural diversity as a supporting factor of innovation within network structures (Conway & Steward, 2000; Lambooy, 2004; Pitaway, 2004) as well as of networks' innovation capacity (Szeto, 2000). As the theory reveals, the relationships between the members, based on their connectedness, is a crucial success factor for the networks' innovation outcome.

The interview results revealed that the council members believe that they have very open and trusting relationships with the membership. They also stated that the members' constellation is perfect and does not need to be improved. Although the network is not an egalitarian one, due to the council's power of decision, smaller members seem to be able to express their needs and set up working groups with the council's support. On analyzing the documents, it became apparent that it was not easy to identify EURADOS activities and structures, or important members due to a lack of transparency, which is especially disturbing in the light of the network's goal to facilitate young researchers' learning. Although the council only organizes one general assembly per year, the council members maintain that there is frequent and intense communication within EURADOS, besides the working group activities. Ironically, networking and learning were mentioned as a major personal motivation for joining EURADOS.

#### 5.4 Laboratory for radiation dosimetry (member's home institution)

This variable describes the influence of the members' home institution on the network-related innovation outcome. Besides the direct value created by the network, like publications or methods and processes, innovation can also occur in the members' institutions when the members return and integrate the knowledge gained in the network. A precondition is the connectedness of the network member to his home organization as well as the linkage between the different departments (arenas) where the network knowledge can be applied and lead to new innovation. Hage and Hollingsworth (2000) point out that the better the network member is linked to his home organization, and the better the different arenas are linked with one another, the better the knowledge can be applied and manifest itself in new products or processes. The operationalization of connectedness follows the elements already described in the previous section. But also the influence of organizations' absorptive capacity and, therefore, networks' influence on the home institutes' innovation need to be taken into account to a significant degree (Cohen & Levinthal, 1990; OECD, 2001; Fusco, 2003; Pyka, 1999; Zahra & George, 2002). Harris (2000) points out that companies need to develop network management competence in order to increase the innovation impact.

In EURADOS, the individual members are representatives of their home institutions. Because of the knowledge that their members bring back to the home institution, the home institutions support their network members (funding their working time). This knowledge is needed for new methods, processes or products to be created within the laboratories, but only if the not-invented-here syndrome can be overcome.

If all propositions are true, the network is able to create maximum value, but it is not possible to monitor the current value creation. Therefore, the elements need to be combined in a different way.

### 6. Centrifugal and centripetal forces performance measurement model

Our performance measurement model is based on the hypotheses that a network's centrifugal forces should have to have less influence in the network than its centripetal forces.

**Hypotheses: Only when the centrifugal forces have less influence on the network members than the centripetal forces, can the network reach its desired outcome.**

The single elements that can be clustered according to the centrifugal and centripetal forces are derived from the model discussed in the previous section.

#### 6.1 Centrifugal forces

Centrifugal forces are negative influencing factors on the value creation of the network members. These forces

make members drift away from the network. Some elements of which these negative factors are comprised, are: the battle for funding, research direction given by the different funding sources not in-line with the members' goals, individual interests, the council's interests, hierarchical decision making. Figure 2 illustrates the influence of centrifugal forces.

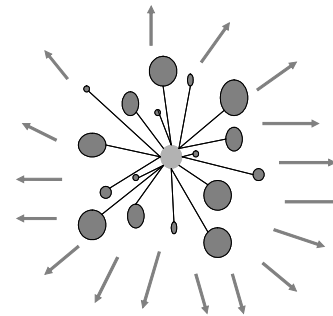


Figure 2: Centrifugal forces on the network members

#### 6.2 Centripetal forces

Whereas centrifugal forces make members drift away, centripetal forces glue the network members together. Elements of which this centripetal force is comprised, are: the strength and quality of relationships within the network (weak and strong ties), gatekeepers, a common vision, the realization of individual and corporate goals, benefits in respect of 3<sup>rd</sup> parties, shared resources, complementary resources and competencies. Figure 3 illustrates this force.

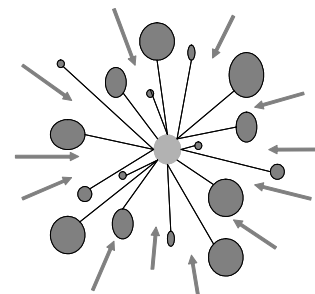


Figure 3: Centripetal forces on the network members

#### 6.3 Innovation network performance measurement model

The performance of the EURADOS innovation network is revealed by its innovation outcome as realized in the direct outcome in publications, new methods and processes (e.g. according to the status of the journals in which the results are published, or according to the number of a new method's users) described etc. as well as in the indirect outcome realized by integrating the EURADOS members' knowledge and using their contacts in the members' home institutes (this will be investigated in the third phase of this research). However, the knowledge created in the heads of the members as well as the quality of contacts created through cooperation in the

network cannot be measured easily.

Whereas measuring the outcome of the network only illustrates the network activities' past impact and not the current one, network managers need an instrument with which to monitor current factors influencing the network's performance. Our performance measurement model monitors the elements that influence the networks performance positively or negatively as depicted in table 1. The centripetal forces therefore need to overwhelm the centrifugal forces in order to guarantee adequate performance in future.

| - Centrifugal forces                                                                                                                                                                                                                                                                                                                                                                                                                         | + Centripetal forces                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• battle for funding and recognition</li> <li>• too strong influence of the council or the EU Commission or the members' institutions</li> <li>• no realization of personal interests/personal goals for participation</li> <li>• relationships characterized by mistrust and hidden agendas</li> <li>• rather hierarchical decision making, little influence by smaller member institutes</li> </ul> | <ul style="list-style-type: none"> <li>• right balance between strong and weak ties, gatekeepers</li> <li>• common vision</li> <li>• a rather egalitarian network and democratical decision making, sufficient influence by smaller member institutes</li> <li>• benefits in respect of 3<sup>rd</sup> party, shared resources, complementary resources and competencies</li> <li>• relationships characterized by trust and openness</li> <li>• realization of individual and corporate goals</li> </ul> |

Table 1: Performance measurement model

## 7. Preliminary Findings

Due to the ongoing data collection process, we are only able to present preliminary findings. We analyzed them first according to their frequency and will later test the correlations with the higher response expected within the next few weeks.

**Members' three main reasons to join:** the overwhelming majority of members (75%) participate because they find the right partners for further collaboration, this is followed by the value of improving their own knowledge in the field of dosimetry (68%) and because they can access state-of-the-art research (48%). Less important reasons for joining are to promote coordination among dosimetry facilities (43%) and to improve their own products and processes (27%) as well as to be present when standards are set (24%), or to access state-of the art facilities (20%), and reasons concerning their career (6%).

**Decision making** within the network: the majority of the members describe the network as more egalitarian than hierarchical, which is supported by the fact that a small majority of the respondents mentioned that small (less prominent) institutes can also participate in the network's decision making (32%), whereas 26% believe that they have little or no influence.

We obtain a very clear picture from the **relationships**

within the network. Whereas 70% of the respondent describe the general working relationship between the member as neither close nor distant, the personal relationships within the networks are characterized as totally or mostly predictable and reliable (84%), never or rarely shielding knowledge (78%) and 86 % of the network members feel that most of their colleague in the network are willing to maintain their good relationships. 91% of the respondent describe the atmosphere in which dialogs with other network members take place as very or mostly positive. On characterizing the three major features of their personal relationships with other members, only 1% describe these relationships as involving a low level of trust and hidden agendas. 70% describe them as respectful, very trustful (51%) and even as personal friendships (53%). 33% mention a high reciprocity in their relationships.

**Management structures:** 60% of the members mention that the working group structure and their aims are very or rather transparent for a new member or outsider.

**Gaining individual value:** 48% of the members frequently apply or further develop knowledge gained from the working group activities in their home organization. 24% state that they rarely or never do so. 49% of the respondent rate their ability to distribute knowledge gained in EURADOS to their home institutions as good or very good. Only 20% mention that they are not often or never able to do so. 39% mentioned that they are sufficiently supported by their management, whereas 22% state that they are rarely or never supported. For the majority of members, the most valuable knowledge that they gain from the network are scientific know-how and contacts (both 46%), while more tacit knowledge, like publications from working groups (32%), or data from surveys (6%) are regarded as less valuable. 65% of the respondents believe that there is some or even a lot of knowledge that they or their home institute are able to access by being a EURADOS member. Only 13% see little or no advantage in this.

**Member composition:** 59% of the members think that the complementarities between the network members' resources and capabilities have a positive influence on their work.

**Competence of members:** The EURADOS member institutes are experts in their field of radiation dosimetry. 65% of the members judge their institute's knowledge as outstanding or state-of-the-art. 38% rate their institutes' knowledge as well founded, while only 4% regard this as sizeable or not very developed.

**Value for institute:** 41% of the members state that their integration in EURADOS has improved their institute's ability to generate innovations (improving or newly creating products or processes through invention or a new combination of knowledge) very much or considerably. 24% mention that participation in the network has done so only to a small degree or not at all. Cost reduction is not an important value that has been realized within these institutes. Only 8% of the respondents state that they have realized cost reductions, e.g. costs associated with research or service activities, or costs for the education of new employees, as a result of participating in the network. 19% mention some cost reduction, but 67% little or no cost saving at all. The institute mainly realizes value

through improvements in quality, either in processes or in products, as a result of the membership. 61% state that they have realized improvements to a high or considerable extent. 14% realize some improvements and 13% few or no improvements in quality. 38% additionally realized a high or considerable reduction in time as a result of research (increasing, e.g., the number of publications, or providing data on analyses) as result of membership. 28% state some, and 23% only slight or no reduction in time. A considerable improvement in the fulfilling of tasks or services as result of membership is mentioned by 57% of the respondent, 24% state some, 12% little and 5% no improvement at all. The network membership does not improve the institute's ability to create radical innovation: 58% mention little or no improvement, 18% average and 21% some or a lot of improvement.

**Funding** is, to a certain extent, important for the network members. Being given a research project from the EU, and being connected with the funding is more important for 25% of members than the amount of money itself. 26% would not be prepared to pay their own traveling expenses which is now funded by the EU and for 11% the funding of all work for the network should come from the EU Commission. Only 11% of the members state that neither funding, nor traveling expenses, nor working time matters for them.

**Sociometrical findings:** On analyzing the communication structure of the network, it becomes clear that there are important gatekeepers who can be asked professional advice as well as a strong informal network for social interaction and questions regarding working group or network matters. The social map (Figure 4) shows that for professional advice, associated as well as voting members mainly approach council members, or previous council members. This illustrates that the network's management board is composed of experts in their field as well as of people willing and able to give professional advice.

## Analysis of the results

On analyzing these preliminary results, it becomes clear that the forces working on the network are mainly centripetal forces. When examining the single elements summarized in our performance model, the sociogram reveals that the council members are gatekeepers, because they provide help with professional problems, and give advice when asked due to their long experience and extensive interaction with the network members. Whether the general working relationship between members is close or distant, the personal relationships are described as trustful, open, respectful, and with close personal interactions to the point of personal friendships. The partners are reliable and predictable in common activities and the working atmosphere is very positive. The majority of those members who have the same goals are able to find partners for further collaboration and to improve their own professional knowledge. An examination of the results gained reveals that these endeavours have indeed satisfied. The majority of members state that scientific know-how and contacts are the main knowledge assets they have gained, mainly due to their EURADOS membership. Beside personal values, corporate values too are satisfied, mainly by improving the own institute's ability to innovate, although the institute's knowledge is already characterized as outstanding or state-of-the-art. A significant improvement in quality and a considerable improvement in the execution of services and tasks are additional corporate values gained from being a EURADOS member. A considerable advantage in respect of 3<sup>rd</sup> parties can therefore be realized. Small member institutes' integration into decision making furthermore guarantees that the network focuses on activities that has value for everybody. Because 62% of the membership state that funding (of traveling expenses or all work) is important for them, an even more reduced or focused funding from the EU Commission would have a negative

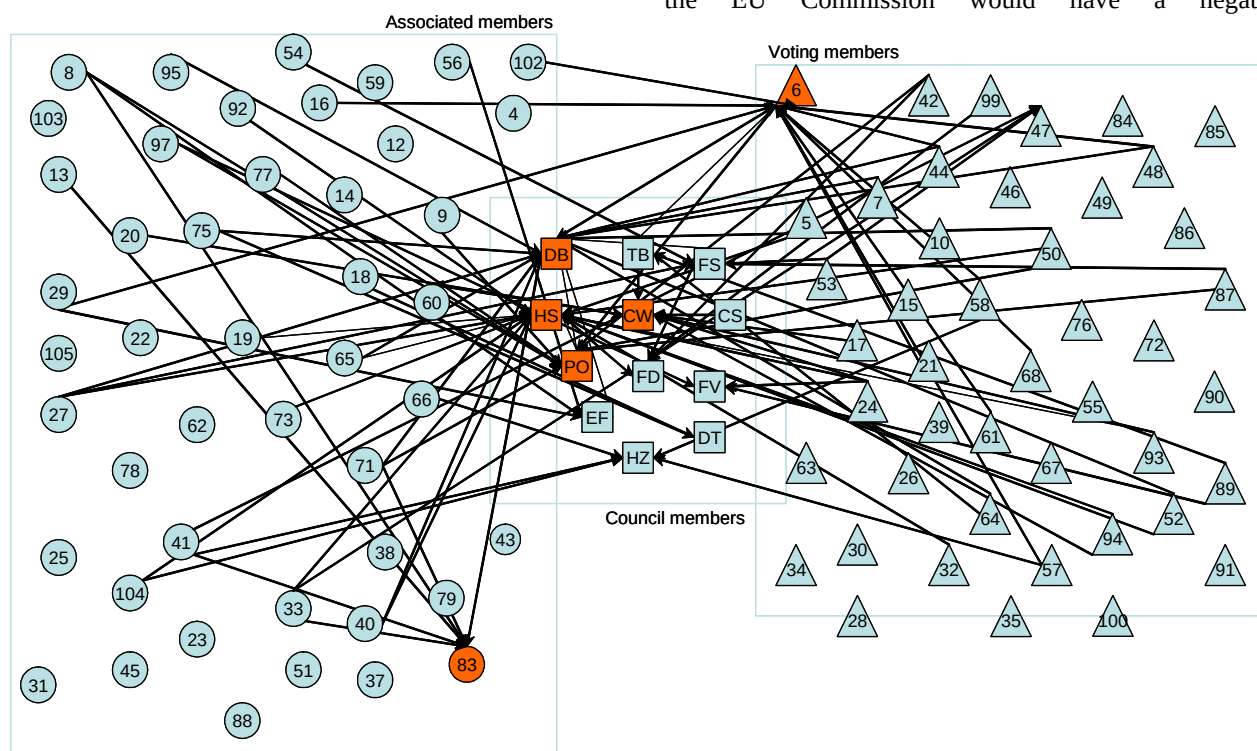


Figure 4: Who is asked for professional advice within the network?

influence on the network, and is the only centrifugal force that can be identified at this moment.

## 8. Conclusions

At present, the questionnaire's frequency analysis reveals that not only do the network members find the results directly gained from the network (new scientific know-how, contacts, publications, methods etc.) satisfying, but also that the indirect value gained for their institutes (knowledge to increase the rate of innovation, the improved quality of products and services as well as the better fulfillment of projects or tasks) can create a significant advantage in respect of competitors that are not network members. Furthermore, the forces influencing the members' activities and relationships, and therefore the value to be created in future, are mainly centripetal forces, glueing the members together instead of driving them from the network.

## 7. Limitations and Outlook

As mentioned before, we have not as yet established a correlation between the different elements, which we describe as forces, by means of statistical methods, but will do so in the next step of our research. The next phase of the study will also provide an even clearer picture of the corporate value gained as well as the motivation of the institutes' managements for participating in the network. In the third phase of the study, which starts in July 2005, we will conduct semi-structured interviews with selected institutions and/or organizations that are EURADOS members. The interviews will focus on the impact that these organizations' management experience or envisage. Whereas the questionnaire in phase two was aimed at the directly involved participants, the interviews in the third phase will focus on their integration within the home institutions and these institutions' ability to adapt the knowledge gained from the network and include it in their internal processes. Besides questioning member institutions' management, important external stakeholders, such as the members of the EU Commission involved in the funding of the network and members of other networks in the same research field, will also be questioned in order to compare EURADOS with other networks' outcome and structure. The results are expected by December 2006. Further research is also necessary to test the model in other contexts and prove its general applicability.

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