

Centre of Excellence in nanotechnology

Slovenia

SYNTHESIS

In all major analyses of R&D and innovation systems in Slovenia, for at least the last decade one of the major obstacles to innovation output in the country has been the lack of cooperation between the public R&D sector and the business sector. Policy papers have also pointed to nanoscience and nanotechnology as priority research sectors for the near future¹. In 2003, the Government decided to support the establishment of centres of excellence by the Ministry of Higher Education, Science and Technology (MHEST) and to co-finance the centres of excellence with the resources available from the European Regional Development Fund (ERDF) for the 2004-2006 period.

The objective of support provided under the two public calls, co-financed by the ERDF, was two-fold. One of the calls provided the grant for the establishment of a centre of excellence and the purchase of the necessary research equipment and infrastructure. Under the second call, the research grants for the projects to be implemented within a centre of excellence were available to the participating institutions.

Among the selected proposals was the plan for the establishment of a centre of excellence in the field of nanoscience and nanotechnology. The creation of the centre of excellence provided an opportunity to bring together key researchers and their institutions in the area of nanoscience and nanotechnology as well as several members of the industrial community. Integrating the business sector early in the specific research projects was also proposed by the project team as a key objective of the centre of excellence. As of April 2007, there were six research institutes and research units within universities cooperating with the centre and as many as 26 enterprises. The centre is carrying out six major research projects, which are coordinated by representatives from the research institutions.

The research activities carried out in the Centre of Excellence in Nanoscience and Nanotechnology (CE Na&Nt) are interdisciplinary, since they join together physics, chemistry and electronics. This by itself is a novelty for Slovenia where public financing of basic and applied research is usually divided according to the scientific fields and little cross- or interdisciplinary research finds sufficient financial support. Another interesting feature of the project is that it merges research teams at research institutes, at universities and in business firms on equal footing: this multi-party cooperation results in business commissioning the research carried out at a single institute or research unit.

A welcome innovative element of the centre of excellence is the sharing of research equipment not only between the public research units, but in particular with the business community. Most of the high-tech equipment for research in nanoscience and nanotechnology is, by Slovenian standards, extremely expensive and only the development of such a centre and cooperation on such scale made it possible for the researchers to get access to this type of equipment.

¹ Slovenian National Research and Development Programme, Slovenian Development Strategy, National Reform Programme for achieving the Lisbon Strategy goals, etc

The existence of CE Na&Nt was beneficial also for the postgraduate students and young researchers who could use the sophisticated equipment for their research and participate in the on-going research activities of the centre.

Since this is a novel type of organisational scheme, there have been several implementation obstacles of which, some have been resolved and some still remain a difficulty. The most serious issue is a very complex administrative procedure regulating this programme and also the slow disbursement of financial resources.

Overall, the creation of centres of excellence, and in this context the establishment of the CE Na&Nt, has been a positive development in the Slovenian R&D system, which due to restricted national resources would not have occurred without the ERDF. In the medium term, the continuation of public support at this stage of development to sustain the Centre of Excellence on Nanoscience and Nanotechnology is important, especially for additional investments in the infrastructure of the centre.

Background information

Country: Slovenia
Project title: Centre of Excellence “Nanoscience and Nanotechnology” - Research and Development Project on Nano-Electronic Devices for Nanotechnology

Key words: Research activities and infrastructures

Duration of project: June 2004 – June 2007

Funding

Total budget	€3,421,795
ERDF contribution	€1,924,762
National budget	€641,587
Private contribution	€855,445

ERDF Objective: Objective 1

1. PROJECT DESCRIPTION

The initiative to establish centres of excellence was a policy response to one of the major challenges in the Slovenian R&D and innovation system. Several studies² have stressed insufficient cooperation between the relatively strong public R&D base and the business sector as an obstacle to more dynamic restructuring of the Slovenian economy and thus higher economic growth. This initiative combines research facilities (manpower, equipment) at different public research units (both institutes and universities). Financial resources go to research units, but co-financing must come from the business sector for each individual project. This new form of collaboration provides for closer cooperation and better utilisation of research results for economic development.

Developments in the area of nano-science and nanotechnology have attracted a lot of attention in the Slovenian science community and increasingly also in the business sector. The National Research and Development Programme 2006-2010, which is the key policy document in the area of science and research in Slovenia, lists the area of nanomaterials as one of the national R&D priorities.

The formation of the Centre of Excellence in Nanoscience and Nanotechnology (CE Na&Nt) provided an opportunity to join together key researchers and their institutions in the area of nanoscience and nanotechnology as well as members of the industrial community. As of April 2007, there were six research institutes and research units within universities cooperating in the centre and as many as 26 enterprises collaborating. The centre is carrying out six major research projects, which are coordinated by the representatives from the research institutions.

The research activities carried out in the CE Na&Nt are interdisciplinary as they bring together physics, chemistry and electronics. This by itself is a novelty for Slovenia where public financing of basic and applied research is usually divided according to the scientific fields. Consequently, interdisciplinary research has difficulties finding sufficient financial support. Another interesting feature of the project is that it twins research teams at research institutes, at universities and in businesses on an equal footing. This multiparty cooperation results in businesses commissioning the research carried out at a single institute or research unit. The progress achieved in the research projects is expected to help raise technology levels and foster improved competitiveness of Slovenian business.

Among the direct beneficiaries of the centre of excellence are the participating research institutes and cooperating business firms, who jointly engage in research and exploitation of new research equipment. Since the centre is located in close proximity to the Jozef Stefan International Postgraduate School, the students also benefit from contact with researchers and can perform some of their own research at the premises.

The centre has been able to invest significant resources in equipment and various measuring and testing devices, which are used extensively both for research as well as for development. This has opened possibilities for new, much more advanced research in the area of nanoscience and nanotechnology. Also, the participating institutions were able to

² See for instance the European Innovation Trend Chart reports for Slovenia at <http://www.proinno-europe.eu/>

engage in other research work, in particular, international research projects, on the basis of synergies provided by the cooperation of the research teams in the centre of excellence.

The close collaboration with industry, which is otherwise often missing in Slovenia, has a positive impact on the research focus as well since topics of specific interest to the business community are embedded in the programmes. The partners from industry regularly use the resources, notably the scientific equipment of the CE Na&Nt, for their own applied research, development activities and testing.

The centre is a gathering point for postgraduate students at the Jozef Stefan International Postgraduate School who show increased interest in the area of nanoscience and find the opportunity to participate in research an exciting prospect. This is meeting another important objective of Slovenian R&D policy: attracting more people to science, and in particular, to the area of technical sciences.

The support for the establishment of Centres of Excellence is one of the key new policy measures under NRDP 2006-2010, so the initiative would probably have gone ahead even without EU support. Yet due to the relatively limited additional public funding for R&D (due to already committed funds for basic research programmes until 2008) the initiative would have been launched later, and on a significantly more modest scale. It is fair to say that the support of the ERDF has been essential to attain the current scale of the initiative.

2. POLITICAL AND STRATEGIC CONTEXT

For a number of years, the lack of cooperation between the public R&D sector and the business sector has been stressed as one of the major obstacles to innovation output. The public R&D institutions predominantly focused on basic science and defined their research priorities in accordance with evaluation criteria favouring publications and citations. On the other hand, business needs (and abilities) were poorly understood, just as the capabilities and knowledge available in public R&D sector, were not known to businesses. The latter relied primarily on their own financial and human resources to resolve their technological development problems. The need to promote the formation of different types of linkages between the public and private sector was identified as a priority. The initiative to support the establishment of centres of excellence by the Ministry of Higher Education, Science and Technology (MHEST) and to also engage the resources available from the European Regional Development Fund (ERDF) was thus timely and welcomed by the research community.

The initiative is partly modelled on the “Networks of Excellence” introduced in the 6th Research Framework Programme (FP6)³, where several Slovenian R&D institutions took part, including some involved in national centres of excellence. The established centres of excellence combine research facilities at different public research units (both institutes and universities) with research units in the business sector. As mentioned above, the financial resources go to research units, but co-financing must come from the business sector for each individual project.

³ <http://cordis.europa.eu/>

The concept of centres of excellence was introduced first in the draft of the National Research and Development Programme (NRDP) when being prepared in 2004 and 2005 and finally in the resolution adopting the NRDP for 2006-2010. The centres of excellence were introduced as one of the key measures to achieve the objectives of NRDP, that is to focus research on business needs and forge cooperation between public research and the business sector. Thanks to ERDF support, eight centres of excellence were funded during the period 2004-2006 with financing extended into 2007 as well.

Moreover, the Slovenian Development Strategy (a key policy document determining the development objectives for Slovenia to 2010) and the National Reform Programme for achieving the Lisbon Strategy goals, stress the need to foster industry-science cooperation and both identify centres of excellence as a measure to contribute to this objective.

3. IMPLEMENTATION

3.1. Project design and planning

The concept of each individual centre of excellence needed to respond to the prerequisites of the call for proposal of the Ministry of Higher Education, Science and Technology (MHEST). The research units applying needed to prove firm commitment from enterprises, not only in terms of expressing interest in the research area, but also in financially supporting the centre and the on-going projects. The public call targeted nanoscience and nanotechnology among other priority areas.

The extent of the interest expressed by industry when invited to join the project establishing a centre of excellence in the area of nanoscience and nanotechnology surpassed the expectations of the project promoters. The research units had sent out invitations to business firms with which they had prior contact and explained the principles of cooperation as well as suggested fields of research projects. According to the industry representatives involved in the pre-planning exercises, very few production systems are at the level of sophistication required by nanotechnology. Given this, the business sector sees a clear need to develop this competence in the future. On the other hand, the science representatives viewed the current level of quality of research undertaken in public institutes as much more advanced than the technological level of the industry.

With the partners from industry, the research units formulated the proposals for six research projects, which were to form the core of the activity of the centre of excellence. In identifying the areas of research, the on-going research already funded from national and international resources was considered, as well as the possibility for industrial applications.

The projects are focusing on different specific areas within nanoscience/ nanotechnology:

- nanoelectronics and equipment for nanotechnology;
- synthesis of nanoparticles and nanocomposites;
- nanomaterials in electrochemical systems;
- nanostructured surfaces and layers;
- synthesis of 1D inorganic nanostructures and bionanostructures;
- characterisation on nanometric scale.

For each of the proposed projects, partners from industry participate in the design of the research at all stages. Moreover, co-financing from industry is arranged for each project to match the ERDF contribution.

Equally important was the ability to use the ERDF resources for the research infrastructure of the centre, which enabled the purchase of several new units of modern equipment. The equipment purchased is jointly used for the research purposes of the public research units as well as by industry for development and testing purposes.

3.2. Management, monitoring and evaluation system

The centre of excellence is structured around the research projects. Each of the project leaders plus the head of the centre forms the internal management board, which monitors the progress of the research projects and the activities at the centre. The head of the unit of nanoscience in the Jozef Stefan Institute was nominated for the project manager position both due to his reputation as a scientist and to the key role played in the initiation of the project proposal. Research projects have their own teams of researchers and coordination scheme. According to the head of the centre, the communication between the partners in the projects is very intense and daily contacts are common practice.

Regular reporting is required by the MHEST so the activities of the centre as a whole, as well as of each individual project, are continuously monitored and evaluated. Internal, as well as external evaluations are undertaken on a periodic basis, coinciding with the timing of reports. The evaluation reports are circulated to all of the partners in the centre as a way of exchanging information or to collect additional information. The reporting includes provision of information on scientific results (publication of articles, participation at conferences, patents), applications of the results (transfer to business units), and the number of man-months spent on different activities. This is perceived as an administrative burden and poses significant demands on the time and resources of the R&D personnel. Participants consider that more efficient methods need to be devised for monitoring.

The Centre also maintains a web site with links to all individual research projects. Since the reports are all publicly available, anyone interested can get information on the on-going research and results.

Administrative support is provided to all the project leaders and the head of the centre. This is particularly important, since the reporting procedure required by MHEST requires a very exact monitoring process of accounts. The centre has decided to outsource the formal preparation of the financial reports required by the MHEST to an outside consultancy firm, even though resources for this were provided from outside the project. The main reason for such a management decision has been the extreme complexity of the reporting procedure, which would require giving up research time for the administrative reporting tasks. Unfortunately, none of the these reporting and accounting activities are considered justified expenditure from the point of view of the ERDF funding, so outside resources had to be found to pay for this relatively large workload. Moreover, the financial control activities were excessive, not relying on the usual spot-checks but insisting on 100% monitoring of all expenditures, irrespective of amount. Alignment of ERDF financial control and auditing practices with those foreseen for the European Commission's 7th Research Framework Programme (FP7) would be welcomed by the scientific participants.

3.3. Governance: partnership and leadership

In total, there are 31 partners in the centre of excellence, among them are three research institutes, faculties from three different universities (Ljubljana, Maribor, Nova Gorica), small firms as well as several larger enterprises. Their motivation for participating varied. On the side of public research units, the interest lies in the research projects they are cooperating in, since the centre provides good linkages between different, more specialised, researchers in their specific areas (physics, chemistry, electrical engineering, etc.). R&D units in the business sector see an interest in being able to access research equipment and participate in or follow closely the research projects.

Initially, the research projects to be carried out were presented to the business partners for comments and guidance regarding the potentially relevant applications. Business partners in the projects are both funding providers and potential end-users. In some cases, the researchers from business R&D units also participate in research.

The members of the centre of excellence receive priority treatment for financial support from the national authorities through other R&D programmes as well (from the Slovenian Agency for Science, for example, in the case of applied research projects). Also, during periodic reporting, the MHEST, as the representative of the authorities, has supported the project team in advocating to the Government the simplification and streamlining of the procedures of the programme. This was effective in removing some rather cumbersome procedures and helped to clarify the reimbursement process.

The governance of the centre of excellence has been kept throughout the project at a relatively informal level. Since the majority of the participants know each other and meet regularly, the amount of such contact is sufficient to allow for the smooth running of the project. Communication through an active web page contributes to prompt information sharing.

3.4. Innovative elements and novel approaches to implementation

The most welcome innovative element of the centre of excellence is the joint sharing of the research equipment not only between the public research units, but in particular with the business community. Most of the high-tech equipment for research in nanoscience and nanotechnology is, by Slovenian standards, extremely expensive and only the creation of such a centre and cooperation on such a scale made it possible for the researchers to have access to this type of equipment.

According to the head of the centre, several units of equipment are used on a round-the-clock basis, with researchers from industry and from the public research units sharing the use. The ability to have access to such equipment proved to be a key motivational factor on the side of industry to participate in the project in the first place.

Due to the regular presence of researchers from industry on the premises of the centre (located within the largest Slovenian research institute, Jozef Stefan), more links, both informal and formal, have been established. The latter concerns, in particular, joint work on research topics; as well as active suggestions of areas of research defined by industry as being of key priority. Even though partnership with industry had been practiced by the research units before the creation of the centre of excellence, there is a substantive

difference in the type of relationship. It has developed from a previous form based more on a buyer-supplier relationship, to a truer partnership where priorities and research work are coordinated, decided and implemented jointly.

Another innovative element of the project is the communication strategy among the partners in the centre as well as between the centre and a wider public. The centre of excellence prepares an annual conference, where all of the participating research projects present their results. So far, two conferences have been organised. This conference is especially important for younger researchers and post-doctoral students who have the opportunity to present their work to their senior colleagues, not only from other research units in research institutes, but to participants from industry as well. It has also become standard practice to involve participants from abroad (several members of the centre of excellence cooperate in FP6 projects) with the aim of receiving international feedback on the research carried out within the centre. A special section within the programme is devoted to the applied research results, where mostly the researchers from the industry present their work. The latter also represents a new innovative practice, which proved to be a welcome addition.

The existence of the centre of excellence was beneficial also for the postgraduate students and young researchers who could use the sophisticated equipment for their research and participate in the on-going research activities of the centre.

3.5. Key implementation obstacles and problem-solving practices

Since this is a novel type of organisational scheme, there have been several implementation obstacles, of which some have been resolved and some still remain a difficulty. The most serious issue, present not only with this centre of excellence but with the others as well, is a very complex administrative procedure regulating this programme, resulting mostly from the national interpretation of the ERDF regulations. Already the call itself required significant efforts on the side of the project team to meet all the (administrative) requirements of the funding agency. It is fair to say that if the links between the research infrastructure and industry had not been as developed as they were prior to the call, the proposal would not have been successfully prepared on time.

It was suggested that in the future, better use should be made of the existing administrative and evaluation procedures for applied science projects by the EU's Research Framework Programme, perhaps adding some additional categories relevant to a proper implementation of the ERDF, rather than invent new procedures from scratch.

The fact that the research units of the centre of excellence are involved in several other research projects, both nationally and internationally, proved to be crucial since it enabled the management to cover the expenditures of the centre with other resources. Liquidity would otherwise have been an even more serious problem. For most of the public research units, the practice of receiving the funds only after the final approval of the mid-term reports (which especially during the initial year were often returned for additional clarification or missing data due to insufficient instructions from different supervisory bodies) is a serious and continual problem.

Some of the stipulations of the call proved to be rather prohibitive as well. The partners from industry were allowed to participate only in a single centre of excellence. For some of the larger firms with broader research interests, this proved to be a significant barrier, since

it forced them to choose which research they value more, even though in principle they would be prepared to financially support two centres of excellence. One such example is a large pharmaceutical company, which wanted to be in both the centre of excellence for nanotechnology as well as the one for biotechnology, but had to choose only one. The problem was reported to the authorities and it is expected that the new round of calls for new financial support will no longer stipulate this.

Another example of a barrier is the fact that once the project has been approved, no new partners from industry can join. The positive results of the activity of the centre of excellence have stimulated several other businesses who wanted to join, but due to the regulations, could not do so. Here a more flexible approach would be welcome and is likely to be introduced in the new round, which will take a longer time, and thus will have to allow for more flexibility of entering and exiting.

4. INNOVATION RESULTS

The very concept of centres of excellence is an innovation for the Slovenian research community. The idea of introducing a mechanism, which will stimulate collaboration within a specific scientific area, where expertise from different science fields is combined with linking research closer to the industry needs, responds to an often-voiced need for more inter-disciplinary Slovenian research as well as a need for closer industry- science links. The centres of excellence are expected to be an effective mechanism in this regard.

Within the activities carried out in the centre, several of them represent direct or indirect support to innovation. Even though much of the research is closer to what would be in scientific terminology called basic research, this is targeted, basic research, anticipating the future needs of the industrial partners. Close involvement of researchers from industrial units serves as a continual two-way knowledge flow: on one hand new possibilities of scientific work are explored, on the other, possibilities for applied development are identified. The regular practice of joint exploitation of scientific equipment on the premises of the centre has successfully contributed to increased informal links between researchers from different units and laid the ground for growing technological support coming from public research. Also, productive links with postgraduates have been established, leading to employment of some in the business R&D units.

The ability to share the modern testing equipment has increased the motivation on behalf of the partners from industry, who in the past often viewed cooperation with research institutes as more of a burden than a benefit (most of the financial resources went to the public research units, and the administrative burden often overshadowed the benefits derived from joint projects). According to the head of the centre, the partners from industry value the opportunity to use the scientific equipment and the advice and support of the research team as the most positive direct results of the project. Additionally, such joint operations increase the innovation linkages, contribute to raising skills of researchers coming from industry, provide grounds for participation in research for postgraduate students and young researchers, and in general, stimulate the mobility of people from public research units to business sector and vice versa. All four impacts provide significant indirect benefits and stimulate innovation.

The research teams involved in the centre participate in three major research projects within FP6, have secured additional research funds through 24 other research programmes and projects, provided 20 applied measurements for industrial partners and have produced 50 international scientific publications (papers, contributions at conferences and books). A more pronounced direct support of innovation in terms of support for products and processes is expected in the later stages of the on-going research projects.

5. SUSTAINABILITY AND TRANSFERABILITY

5.1. Sustainability

It is expected that the Slovenian authorities will continue to support the centres of excellence in the National Development Programme for 2007-2013 under the Operational Programme of Strengthening of the Regional Development Potentials (Priority 1: Competitiveness of Enterprises and Research Excellence). The continuation of public support at this stage of development and existence of the Centre of Excellence in Nanoscience and Nanotechnology is important, especially for additional investments in infrastructure.

It can be expected that provided the ERDF and government's support for the period 2007-2013 will be of a sufficient level, the Centre of Excellence will, by the end of the period, be sufficiently strong to compete for research funding independently. Already at this stage, the high cost of R&D equipment dictates cooperation in its use and thus stimulates other forms of cooperation as well.

5.2. Transferability

The organisational structure of the Centre of Excellence in Nanoscience and Nanotechnology with its research projects and intensive participation of partners from industry, both at formal and informal levels, can be used as a model for the setting up of similar centres in other areas of research in the future. The structure of the partnership is working very well due to sufficiently well defined roles of each partner, and requires little formal management. Since several partners have cooperated before or are working jointly also in other projects, the level of mutual trust and openness of communication is strong. Such practice when establishing any type of similar cooperation arrangements should be followed. Moreover, the centre organises an annual conference to present research results to all of the members of the centre as well as to an outside audience.

For strengthening links with industry, shared use of facilities proved to be essential. This practice could be transferred to other similar projects, where the promotion of the cooperation of the two sectors is an important objective. As for the transferability of project results, it is a bit early to judge, since the project is not completed yet. However, the strong presence and financial support of the business sector suggests the research sector is paying attention to potential application and transferability of the results.

A high level of participation of partners from industry is an impressive characteristic of the Centre of Excellence on Nanoscience and Nanotechnology, especially since industrial potential in the area is currently well below the scientific results. This means that the research carried out in the centre is, at the moment, still primarily concentrated on basic research. Even so, the research teams have been able to motivate the business partners by involving them in the conceptualisation of research and focusing on the issues where

industry sees its interest in the future. This approach is something worth transferring to other projects where science-industry links are not yet well developed.

Another important indirect innovation support measure is the practice of regular involvement of postgraduate students and young researchers in the research projects within the centre of excellence. This way, the training of human resources for the research in the area of nanoscience is carried out. Such an approach can be relatively easily transferred to other centres of excellence.

However, what is important to realise is that both cooperation with industry and the attractiveness of the research in the centre of excellence are the result of a relatively well equipped and sophisticated research infrastructure, at least by Slovenian standards. The possibility to use this equipment, which they cannot afford on their own, was stressed several times by the head of the centre as one of the most important reasons for strong support from industry partners.

6. CONCLUSIONS: MAIN SUCCESS FACTORS

Novelty of the research field

The network of participating partners was more open to interdisciplinary and cross-disciplinary research than in some of the more traditional fields.

Building on good existing links

Links amongst public research units in the area of nanotechnology were strong and links were already established with industry. The business community showed a high interest to participate in such a cooperation arrangement.

Early and regular involvement of the business sector in defining the objectives of research projects

This helped to convince the business sector that the proposed scheme would deliver results in the areas that industry identified as important for their future development as well.

Provision for modern infrastructure and research equipment for the centre

This proved to be one of the most important factors, contributing to the current development of the centre. While the researchers joining the centre have been very successful in raising money for research, they lacked more sophisticated research equipment. The opportunity to use the sophisticated equipment drew the industrial partners closer to the centre and in parallel, initiated closer research collaboration.

Secured additional financial resources

This enabled research teams and the partners in particular to bridge the liquidity problems and to implement the research projects within the planned time frame.

Strong political support

The measure as such, was assessed as one of the best programmes financed through the ERDF during the 2004-2006 period and enjoyed significant political support.

The efforts and creativity of the director and the team

This confirms that in many instances, it is the human factor that matters most. Finding appropriate (innovative) solutions (securing additional human and financial resources, flexible organisational and administrative arrangements, helping the partners, etc.) to unexpected barriers and in particular, keeping sufficient interest and motivation of all partners at all times was very challenging. This required skilful management, which was available thanks to the vast experience of the core team of the centre of excellence in different types of projects.

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