



S3T Review Panel

Consensus Report

EUROCORES programmes like S3T fill the gap between locally organized fundamental science funding and funding by the EC instruments oriented towards the development of technology and industrial applications. The S3T programme has demonstrated significant scientific achievements thanks to efficient use of its potential of multidisciplinary and wide networking between the European research groups. It successfully combined the EUROCORES features, such as research and training, research funding and mobility reinforcement. The delivered body of results would not have been possible to achieve by uncoordinated efforts of single isolated teams. The programme can boast significant showcases, such as the deployment of prototype monitoring technologies for metro systems in three cities of different European countries and a substantial multiplier effect for funding as evidenced by the 17 M£ support to the future Innovation and Knowledge Centre for Smart Infrastructures and Construction, including 7 M£ funding coming from the side of industry. Impact of S3T extends well beyond the end date of this programme, as evidenced also by proposals submitted to the EU FP7 and the European Space Agency.

Scientific achievements

- Many of the scientific results would not have been achievable by isolated national teams; these results were achieved because the researchers could collaborate within the CRPs.
- Extension of the experimental capabilities (shared equipment, combined manufacturing capabilities for sensors and software synergies, training of next generation of researchers).
- Underground M3: crack monitoring tool with strain resolution of 20 nanostrains detected using MEMS devices and deployment of sensor networks in metro tunnels, commercialisable computer vision system for tunnel inspection using digital camera images to detect and locate cracks.
- MAFESMA: roundrobin SMA modeling - a benchmark comparing capabilities of various thermomechanical models to simulate the functional responses for applications in smart engineering structures. Assessment of the capabilities of

individual models to treat specific features of thermomechanical behaviors of SMAs. The teams involved in the benchmark originated from European and US laboratories.

- A new high frequency fatigue testing device for magnetic shape memory (MSM) materials has been developed. Several cycling tests made using this device on a Ni-Mn-Ga MSM material demonstrated 2×10^9 mechanical cycles fatigue life, which is the longest fatigue life for this type of materials reported till now; with a strain amplitude of $\pm 1\%$ it is currently the world record for any metallic materials.
- SMARTeR: construction and testing of large real-scale prototypes; SMA dumpers on cables reduced vibrations by 50%.
- A large diversity of subjects was covered by the projects, but not all projects managed to find synergy with other projects in S3T as a consequence of the breadth of the field.
- Collaborations within the CRPs were generally very efficient, although in two instances the collaborative content within CRP was too low, not exceeding that of a bilateral collaboration. Overall, the programme was very successful in offering excellent opportunities for a diversity of research activities, ranging from very fundamental science to technology development and deployment in near real-life conditions.
- The consortia managed to achieve significant scientific results despite substantial underfunding.
- Multidisciplinary of the programme was very high, and this type of programmes are very well accommodated in the EUROCORES scheme; truly multidisciplinary programmes are difficult to manage, and they need reinforcement like that provided by the EUROCORES. For example, evaluation of multi-disciplinary project proposals and programmes is one of the strengths of the ESF.

Networking

- One of the strengths of the programme was that, besides research funding, support to networking in terms of special funds and coordination support was available, which enabled the consortium to fully exploit the potential of collaborative research.
- The networking activities resulted in a number of highlights, for example the S3T school and symposium in Porto, that may be a model for future EUROCORES, with events combining a school and a workshop/conference held at the start of the programme rather than at the end.
- All types of networking have been used by the programme. For example, besides scientific meetings, some projects practiced a mobility type where a researcher was spending an extended period of time (several months) in another institution. Another example is the advanced course organized by SMORPH, which aimed at mutual presentation and exchange of course materials, including seminars organized jointly with NSF that involved many outstanding scientists. A four days advanced course on morphing aircraft was held in Lisbon, and it was cofinanced by sources other than ESF, which demonstrates the interest from outside the S3T programme consortium.

- MAFESMA features a number of prolonged visits around the ROUNDROBIN modeling, and there is a well managed website associated with this activity. It is evident that development of this type of complex models require long-term placement in different institutions.
- Mini-workshops organized by the PIs attracted people from outside S3T who were interested in the subject.

Training

- Training in terms of mini-workshops, summer schools, conferences, training courses are present in all CRPs.
- CISM courses on new trends in structural health monitoring organized by S3HM included course notes published in a book that has been made available to a broader community.
- One of the obvious strengths of EUROCORES is that PhD students are accommodated within an international research network.
- There are good examples of existing courses that have been augmented and delivered to S3T students.
- The fact that a number of students are co-financed from outside S3T indicates that the research activities started in S3T will continue after the programme's end date.

Dissemination

- Dissemination is primarily targeting peers, industry and stakeholder groups, while outreach to wider society was less developed. Examples of this include deployment of prototypes of wireless sensor networks and monitoring tools for detection and location of cracks in three metro systems.
- An SMA damper has been designed specifically for demonstration purposes by SMARTeR and as a part of exposition at the Musée des Arts et Métiers in Paris.
- The number of publications (journals, conference proceedings, books) is high for the level of funding of the programme, although in case of some CRPs it was difficult to assess to what extent they have resulted from S3T because the level of collaborative contributions to those publications has not been specified in the reports.
- It is recommended that ESF highlights the showcase of Underground M3: it has a large scale and very high international and societal significance and impact.

Realization of the S3T programme potential:

Level of interaction, pooling of resources and use of innovation potential

- There were good examples of pooling of software modules, pooling of experimental resources, extension of benchmarking algorithms, joint efforts towards gaining credibility in the eyes of industry, professionals, and public authorities.
- There has been a good multidisciplinary interaction within CRPs, while efficient cross CRP interaction remained limited to those projects that had significant topical overlap and established links between the consortia.

- EUROCORES has brought scientific knowledge to a strategic level where one can start initiating new spin-off enterprises and collaborations with industry.
- Underground M3 project has generated 17 M£, with 7 M£ coming from industry as a result of efficient use of the opportunities provided by the S3T.
- The example of S3T proves that EUROCORES is a suitable instrument for tackling complex problems which require inputs from different disciplines.

Future development

- There is a significant future development under way concerning applications in civil engineering infrastructures and space industry:
 - Underground M3 has established a centre of excellence as a result of S3T and will continue its activity in the future;
 - Members of SCMeRe have initiated a new project with the European Space Agency aimed at continuation of their collaboration.
- Some of the other CRPs have already begun to actively seek further funding opportunities via FP7 programmes. Several projects intend continuation of PhD work in a mutual collaboration.
- European competitiveness in science in general and in the field of complex engineering systems in particular depends on the availability of young talents and a pool of well trained researchers. By combining training and research in a multi-disciplinary environment, S3T has demonstrated that EUROCORES is one of the important instruments that provide Europe with people capable of taking up competition in the global innovation race.

Suggestions for future improvement of EUROCORES

- There is a serious problem that start and end dates of individual projects in different countries are not well synchronized, with dates differing as widely as 2 years. This jeopardizes the ability of IPs within CRP's to engage in efficient collaborative research.
- The actual level of funding may differ strongly from the initially requested amounts, which affects the work programs. Furthermore, in some cases national funding of individual projects was refused, often in disagreement with the ESF ranking, which makes management of the CRPs very difficult.
- The flexibility in terms of adaptation of work plans is essential, though a clearer procedure would be needed in order to approve amendments/modifications when they happen to an already running CRP. There should be a mechanism in place with appropriate enforcement mechanisms ensuring that the deviation from the original objectives is not too large.
- Several project leaders did not pay sufficient attention to follow the reporting guidelines, even though the report forms are not onerous. Such customer-friendly reporting doesn't mean that the requirements do not have to be fully respected, and PLs should treat this obligation responsibly. For example, when PIs are asked to identify co-authored papers or papers acknowledging ESF, in many cases it was not done. It is highly advisable that 10% of funding to PIs is retained until satisfactory approval of the final report.
- **All of the above problems can be resolved by introducing a common pot for funding of EUROCORES instead of the current *à la carte* contributions by the national funding agencies.**

- When PIs are identifying budget expenditures, they were asked to detail personnel funded by the project. In cases where no staff costs were indicated, it is not clear how the grant has been spent. Reporting forms should be updated to provide this information.