



EUROCORES Programme

European Collaborative Research

Bio-inspired Engineering of Sensors, Actuators and Systems (EuroBioSAS)

EuroBioSAS Review Panel

Final Consensus Report

The objective of the EuroBioSAS programme was to “*uncover those fundamental organizational principles which underpin the performance of biological sensors, actuators and systems, and will use them as the inspiration for developing new technologies that push beyond the frontiers of today’s engineered systems in their capability and performance.*” This aim towards bio-inspired technology was understood in different ways by the three Collaborative Research Projects (CRPs) which resulted in approaches based on biochemical and cellular mechanisms on one end (ICS and NANOIOBIP) and macroscopic multi-agent swarming studies (H2SWARM) on the other end.

1. Progress in the Collaborative Research Projects (CRPs)

All teams have been productive and used EuroBioSAS EUROCORES support to achieve significant advances in their respective research areas and towards the programme goals. They produced a significant number of publications, as further detailed below. However, the EuroBioSAS programme has not been systematically acknowledged in all reported publications which resulted in diminished impact and visibility.

Scientific progress of **H2SWARM** has been excellent, with a substantial number of peer-reviewed publications (13), of which over half (7) have co-authors from two or more IPs. The integration and collaboration within this CRP has been exemplary, with most of the research being done on a collaborative basis by two or more IPs, and transfer of staff members and knowledge between institutions achieved through a visiting researcher programme and joint supervision and training arrangements.

Scientific progress of the **ICS** CRP has been excellent, with a substantial number of publications (29 in total) listed as published, submitted or in preparation, of which around half acknowledge the EUROCORES support. Integration and collaboration within this CRP has been very good with several team members spending extended period of time working at partner institutions. On the other hand, only one of the reported publications has co-authors from at least two IPs. Therefore, the integration within this CRP has yet to be demonstrated through joint publications.

The aim of **NANOIOBIP** was to develop a non-bio sensor to diagnose crop disease by mimicking odorant or pheromone binding protein sensing of insects. The extent of the actual scientific progress of this CRP is difficult to assess since amongst the 12 publications listed, only 3 are said to acknowledge the EuroBioSAS programme. Rather little information is provided on the level of collaboration within this CRP, although some exchange of personnel between Pisa and Gottingen groups has taken place.

Scientific highlights from the CRPs include:

- first demonstration of de novo evolution of self-organized division of labour within a swarm (H2SWARM)
- automatic method for designing control software for robotic swarms that outperforms other automatic methods and systems designed by humans (H2SWARM)
- first measurement of stimulus and cell behaviour with 3D positioning of cells on the developed bio-mimicking breadboard (ICS)
- development of microelectrodes that detect proteins with high sensitivity and large dynamic range (NANOIOBIP)

2. Programme Integration

Possible interactions between the three CRPs within the EuroBioSAs programme have been limited given that H2SWARM addressed the characteristics of natural systems at the level of organisms (i.e. at the level of individual and collective behaviour) while the other two CRPs operated at the cellular and molecular level. On the other hand, ICS and NANOIOBIP projects had several points of contact, in particular concerning organic electronics technology, fostering a common platform for discussion and exchanges including jointly organised or attended meetings and conferences.

Due to the different focus of H2SWARM, for this project it seemed both natural and appropriate to engage in collaboration with another EUROCORES programme (EuroUnderstanding – DRUST CRP) and with an EU project (ASCENS). This project has therefore benefitted from wider EUROCORES networking activities.

While individual CRPs have certainly benefitted from the EUROCORES research funding, it is less clear that the overall programme has achieved its initial goals in terms of cross-CRP collaborations.

3. Networking, Training and Dissemination

All of the groups engaged in networking and dissemination activities through conference attendance and presentations. The CRPs also actively organised meetings, workshops and conferences in order to disseminate the results to the wider community. Keynote presentations given by the Principal Investigators received significant interest.

Educational activities were not specially reported but all groups have had young researches working in the projects, and it is obvious that training has taken place.

Public outreach activities such as tutorials and guest lectures were reported within H2SWARM. Noteworthy are the educational activities by this group that included demos and talks in secondary schools. It is surprising that the other groups did not report this kind of outreach activities considering that the topics of the projects would be most interesting to the young generations, school children but also the general public.

4. General comments and other feedback

The EUROBioSAS programme was conceived as a pan-European programme that was intended to bring together project partners from a large number of participating countries including the key players from Germany, United Kingdom, France, Switzerland and the Netherlands. In the event, several of these key nations were unable or unwilling to participate, with the result that the eventual programme was at the very edge of viability when launched. EUROBioSAS has successfully achieved the (limited) potential with which it was left when launched, but has come nowhere close to achieving the aims of the programme as it was originally proposed. Thus, although the individual CRPs have made very good – and in some cases excellent – progress individually, the programme itself has proven to be only a little more than the sum of its parts. Had it been possible to launch the programme with the participation of most or all of the key players, then there would doubtless have been better integration among CRPs.

In conclusion, EUROBioSAS has worked as well as could have been hoped for at the time it was launched, but has not lived up to the hopes that its proposers had when the programme was first proposed. This represents no responsibility on the part of any of the CRPs, but rather reflects the structural difficulties inherent in integrating scientific activity across Europe's many nations. Nevertheless, it is clear that the EUROCORES scheme occupies a valuable niche within the European science base, and the reports of all 3 CRPs point to the benefits of facilitating transnational activity in the basic – as opposed to applied – scientific research, for which the EUROCORES Scheme provided.