



# Machine Intelligence Research and Application Centre for Learning Excellence

## Final Report

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# 1. Executive Summary

## 1.1 Objectives and Research Methods

The EU Centre of Excellence MIRACLE has been set up at the Department of Cybernetics, Faculty of Electrical Engineering, Czech Technical University in Prague, which is the oldest and largest technical university in the Czech Republic. The Department provides master and postgraduate courses in technical cybernetics, artificial intelligence, computer-integrated manufacturing, computer vision, pattern recognition, and biomedical engineering.

MIRACLE Centre includes two research groups – the Gerstner Laboratory for Intelligent Decision Making and Control, and the Centre for Machine Perception - which have been recognized as the leading centres for research in computer vision and machine perception, data warehousing, industrial production system integration and production planning information systems in the Czech Republic.

The principal project aim was to become an **internationally recognized Centre of Excellence in Machine Intelligence** by sharing our expertise and further improving the quality of our research through increased co-operation and networking with leading European institutions.

The specific objectives of the MIRACLE Centre were oriented towards the following subgoals:

1. To develop the Centre **towards an internationally recognized research body** in the following areas:
  - **Multi-agent Systems: System Integration, Knowledge Management, Teamwork**
  - **Diagnostics and Quality Control of Complex Systems (including Intelligent Software Diagnostics)**
  - **Machine Perception/Computer Vision**

The MIRACLE Centre has enabled research stays in the specific research areas. The wider presence of leading European researchers at the MIRACLE Centre contributed to achieving the goal.

2. To develop the Centre **towards an internationally recognized working place of Ph.D. and post-doctoral education** with focus on the 3 research areas mentioned above. The lecture stays of leading European researchers at the MIRACLE Centre, the summer schools/intensive courses organized by the Centre enhanced the training opportunities for both doctoral and post-doctoral students.
3. **To intensify an interdisciplinary approach to research and education in Biocybernetics.** The research topics currently include Biocybernetics and Biomedical Engineering with the focus on medical informatics, intelligent processing of biological data and signals, medical decision-support systems, modelling of human-operator behaviour. We aimed at establishing twinning collaboration with the International Research Centres in Biocybernetics in Austria/Germany, and sharing the international expertise in this field.
4. **To support education of professionals for technology transfer** suitable for university-industry co-operation in the Central and East European countries. We focused on demonstrating our experience of successful co-operation with industry by organising local workshops/conferences in co-operation with Regional Chambers of Commerce and other professional bodies. These events presented relevant case/feasibility studies of technology transfer solutions.
5. **To improve our skills required by network-centric research.** Most activities supported by the MIRACLE Centre were of collaborative nature. Research and knowledge sharing were performed over the Internet requiring new ICT skills, tools and formulation of workflow; it also included a number of novel social & psychological as well as security aspects. To achieve

this goal, an intensive co-operation with the Czech Society for Cybernetics and Informatics, with important European organisations (ECCAI, CEPIS etc.) and international professional organisations were pursued

In order to achieve these objectives of the MIRACLE Centre the specific activities included:

- Organising international conferences and series of workshops
- Providing training stays of Ph.D./post-doc students, and long-term research stay
- Twinning and networking arrangements, exchange visits
- Performing joint research projects
- Centre presentations in conferences, exhibitions, trade fairs.

All the performed activities of the MIRACLE Centre have been tightly connected with the current research areas and have been in line with the department's research efforts, its further strategic development and integration into the European Research Area. Such approach provides a sustainable background towards future development of the Centre and supports increased involvement of the MIRACLE staff in professional European networks, and societies, in European projects and scientific events.

In the field of education, a special support has been provided towards the development of Biomedical Engineering courses at the CTU, Faculty of Electrical Engineering. The syllabuses in Biomedical Engineering courses were regularly consulted with experienced EU lecturers at international universities offering these courses. In 2003 the curricula structure was modified according to Bologna Declaration (3-5-8 model). Thus the Biomedical Engineering courses (and all other courses at CTU FEE) were updated reflecting both the structural changes and the experience from the previous years. Additionally, the new ICT innovative technologies have influenced classical approaches to education by using e.g. tele-education equipment and innovative tools. All MSc/ Ph.D. courses provided by the Department are currently taught in both Czech and English.

We have a long-term tradition and experience in cooperation with industry, which has achieved internationally competitive results. The current approach of educating Ph.D. students with respect to the particular needs of industrial partners was extended based on European practice and experience. The current needs of the knowledge-based society require to increase IT literacy on all levels including education of professionals for active participation in the network-centred (virtual) organisations. Therefore our focus has concentrated on design and development of suitable methodologies aimed at collaborative networked organisations.

MIRACLE research results and experience were disseminated via the following channels:

- Publication of results in international scientific journals, at national and international conferences/workshops,
- Integration of results into Ph.D. courses on Artificial Intelligence for Ph.D. students at the CTU, Faculty of Electrical Engineering,
- Prestigious European Network of Excellence or other prestigious international organizations (e.g. AgentLink, EUNITE, ECCAI, FIPA, IFAC)
- Providing consultancy or tailored solutions to industrial partners both locally and internationally.

## 1.2 Major Results and Achievements

Major results and achievements arising from the project are summarized in the following outcomes:

- **Extending networking and research collaboration with key European universities.**

Research stays of the European researchers in our Centre have shown to become an efficient tool for the scientific integration and networking processes within European Research Area. New research collaboration and networking has been facilitated with leading European academic bodies, like the University of Cambridge, Cardiff University, University of Southampton, University of Sussex, KU Leuven, Technical University of Vienna, INRIA Rhone-Alpes, DKFZ Heidelberg, University of Milano. As an indirect benefit, many overseas institutions targeted their interest to our Centre, and many contacts have been also explored with the institutions outside Europe (Auckland University of Technology, N.Z., Tokyo University of Technology, IHMC – University of West Florida, etc.). In addition to organisation of several international conferences (CEEMAS 2003, DEXA 2003, HoloMAS 2003, ECCV 2004), 22 workshops were successfully held including 80 invited key speakers. These events attracted more than 1000 participants from academia, industry and public sector.

- **Increased involvement in the European RTD projects**

Based on the development of new international contacts and research collaboration we have been invited to join the consortia for new project proposals both in the 5<sup>th</sup> and the 6<sup>th</sup> Framework programmes. Within the FP5 we participated in 16 different EU research projects and networks. Our successful participation in the FP5 programme boosted our reputation within the European research community and contributed to our further involvement within the preparatory phase for the FP6 programme. We have been quite successful in the FP6 calls, as the Centre currently participates in 5 projects (2 Networks of Excellence, 1 Integrated Project, 1 STREP, 1 Coordinated Action) as the core consortia members, and 2 projects are at the EC negotiation stage. This has enabled Czech young researchers and Ph.D. students to participate in the internationally recognized research performed at their home institution. It has also resulted in the increased number of Ph.D. students applying for positions in the Department. Currently there are more than 40 Ph.D. students enrolled in the Ph.D. courses on Artificial Intelligence and Biocybernetics, which we coordinate.

- **Training place for European Ph.D. students**

The Centre of Excellence label has helped to increase the international reputation and visibility of the institution and has become attractive to foreign researchers and Ph.D. students. The EU funding of the MIRACLE Centre enabled training of many European Ph.D. and post-doc researchers: in total we hosted 15 Ph.D. students, and 33 post-doc researchers or lecturers from 9 EU member states. The long-term stays facilitated further research collaboration and brought new and different ideas that enriched our own work. This has helped to increase the quality of submitted Ph.D. theses (it was possible to set up a rule that a leading expert from abroad was involved as one of the referees of the submitted Ph.D. thesis). The educational courses and programmes were modified according to the Bologna Declaration (3-5-8 model). In 2003 the bachelor and master courses offered by the faculty were updated to reflect both the structural changes and experience from the previous years and can be taught both in Czech and English.

- **International scientific recognition of the Centre**

The Centre of Excellence award has significantly motivated the staff members of the Centre towards excellent performance. The notion of excellence and the sense for international competitiveness have led the staff members towards the internationally competitive level and resulted in the following awards:

- **2003 AgentCities Agent Technology Competition: 2nd prize** for software development of **X-Security package** (“Communication Security in Multi-Agent Systems”) was awarded to the team of the Gerstner Laboratory - Agent Technology group.

- **CIA 2004 System Innovation Award** (at the 8th International Workshop for Cooperative Information Agents, September 27-29, 2004 in Erfurt, Germany): The award has been granted for the **A-Globe lightweight multi-agent platform** providing inaccessibility support developed by the Gerstner Laboratory - Agent Technology group.
- **2004 special award of the jury in the competition “Česká hlava”** (in English “Czech Head”) was granted to the system for **PC control by eye movements (I4Control)** developed by the Gerstner Laboratory - Biocybernetics group. The “Česká hlava” project and related competition are aimed at supporting excellent research work and innovations in the Czech Republic.

The publication activity in important international journals has increased and many joint contributions with internationally recognized experts have been accepted to conferences. The recognition of the Department as a Centre of Excellence increased the visibility, reputation and respect of the Department in the country and led to a broader involvement of the staff members in the R&D preparatory and decision making activities within the country. As an example, we have participated in the foresight for the oriented research on a national level, our experience helped to formulate the Czech standpoints concerning the 6<sup>th</sup> Framework programme, etc.

- **Strengthening university/industry cooperation and technology transfer**

The technology transfer results were channelled and promoted via the MIRACLE active participation (in the form of a separate booth) at the European IST exhibition in 2001, EuroChina 2002, and EuroIndia 2004 Cooperation Forums on the Information Society. Since 2000 the Department of Cybernetics has exhibited at Brno International Engineering Fair, which is the largest industrial fair in Central and Eastern Europe. As a recognition of the high standard of our research work, several European companies contacted us to establish a direct cooperation (Vitatron Medical B.V., NL; Robert Bosch GmbH, DE; TDE Electronics GmbH, DE; Gedas/VW, CZ), but also large US-based and Asian-based companies (Honeywell, Samsung Electronics Co.).

- **Dissemination and promotional activities of the Centre**

The Centre of Excellence label and the EU support helped the Department to get the opportunity to organize significant research events, e.g. the DEXA 2003 multi-conference (approx. 550 participants), the European Computer Vision Conference ECCV 2004 (approx. 500 participants) as well as smaller, but also important events like the “3<sup>rd</sup> Central and East European Conference on Multi-Agent Systems” CEEMAS 2003 (120 participants) or the “1<sup>st</sup> International Conference on Industrial Applications of Holonic and Multi-Agent Systems” HoloMAS 2003 (60 participants). Also the ECCAI Summer School on Multi-Agent Systems for 170 Ph.D. students from 16 countries held in 2001 represented a promising networking event from the long-term perspective. These events provided a stimulating environment to present and summarise the state-of-the-art in the specific areas of research, and to develop mutual contacts between the participating researches, professionals, developers, and Ph.D. students. The conference presentations were published in conference proceedings (in total 7 proceedings) by Springer Verlag (within the LNCS/LNAI series) or Kluwer Academic publishers under the MIRACLE support.

### 1.3 Conclusion

To sum up, all the MIRACLE objectives have been successfully accomplished, some of them have been even enhanced. The MIRACLE project has been very beneficial for our Department and it has strengthened the integration of our research in the specific areas into the European research and networking in line with the ERA concept. This proved to be a very useful and an effective instrument in the pre-accession phase and the EU enlargement process.

The Centre of Excellence label should continue in motivating the staff members towards achieving excellence, towards extending the international cooperation and networking. We would like to keep the high standard as the Czech leading centre for promoting excellence in research and

development in the field of machine intelligence. We expect to be more pro-active in all the activities helping to direct appropriately the R&D on the national level and to catalyse relevant discussions.

We intend to continue in leveraging the advantages offered by the Centre of Excellence recognition. Therefore we plan to continue hosting and organizing important scientific events (conferences, workshops, summer schools) and we aim at producing top-quality scientific publications.

We would like to leverage the presence of the leading experts and to enhance the cooperation with leading scientists/institutions in the field of Artificial Intelligence. Hosting each year several high-quality visiting professors or researchers for a longer period of time (over 3 months) is expected in order to complete transformation of our Department into an internationally recognized centre of research and education.