Final Report Summary - SISTER (Strengthening the IST Research Capacity of Sofia University)

Executive Summary:

Publishable summary report

The main goal of SISTER project is to develop the Faculty of Mathematics and Informatics (FMI) of Sofia University as a Leading Centre in South-East Europe (SEE) in research, innovation and training in the area of Information and Communication Technology (ICT) and more specifically, in Software and Services (S&S), and Intelligent Content and Semantics (ICS). An overall goal of the project is to foster the integration of FMI in the ICT ERA and to contribute to competitiveness and growth of the SEE region and Europe as a whole.

In order to achieve the main goal, the following project objectives were defined:

1. to elaborate and further develop a strategic framework for FMI future development;
2. to strengthen the research capacity of FMI by enhancing the human resources capabilities of FMI and research integration with EU partners;
3. to strengthen the capacity of FMI for business exploitation of academic results and cooperation with industry;
4. to improve the research environment of FMI;
5. to build a strong long-term collaboration of FMI with leading research organisations and enterprises in EU and in SEE countries;
6. to make FMI a well-known research and innovation centre in SEE.

For strengthening the research capacity of FMI in Software and Services were implemented the following tasks:

Determining joint research agenda in S&S: The purpose of this task is to enable the FMI research group in S&S to capitalize on existing research capacities, while providing a strategy for harmonization of research focus. It identified topics of S&S research that (i) constitute research priorities at European levels NESSI (ii) map on local and regional interests and capacities, and (iii) according to the research focus of FMI research group. The target was to organize the research approach to bring broaden understanding of the objectives and future development.

Establishing S&S research infrastructure

The equipment obtained built a new SW engineering lab at FMI and for a PhD lab, as well as provided the needed infrastructure to host the FMI research database, training courses database, digital repository with online research publications. The infrastructure established was a driving force for research experiments in the area of software and services.

PhD students and young researchers in S&S field will further use the established labs.

Intensifying research potential: This task aims at creating a NW for international research co-operation in S&S between FMI and European organizations, to establish closer links between researchers, pooling of resources, and effective collaboration mechanism. The main efforts were focused on establishing Bulgarian NESSI platform and following the NESSI Europe initiatives and activities.

SISTER collaborated with 6 International projects, with 3 National projects and prepared 3 new project proposals.

Development of prototypes of intelligent tools supporting generation and maintaining of e-books: A vision of the e-books for the future was developed, that will facilitate the creation and use of a new generation of smart books: e-books that are evolving, highly interactive, customisable, adaptable, intelligent, and furnished with a rich set of collaborative authoring and
reading support services. The semantic technologies were incorporated in the SmartBook and become the key factor of making it smarter.

User friendly interface for readers was developed, which benefits from the integrated semantic annotation.

Creation of digital libraries: A new digital library for the University of Sofia was developed [http://research.uni-sofia.bg].

Information about research activities in the field of ICS was published into this digital library. The library was made accessible to the joint EC funded projects. This digital library was registered also in the European project DRIVER as the first such scientific digital library in Bulgaria.

Development of a prototype of Adaptive Intelligent e-Learning System: The Adaptive Hypermedia System model was developed and reported in numerous publications. It follows a metadata-driven approach, explicitly separating narrative storyboard from the content and adaptation engine. The triangular structure of the model divides in three each one of the learners, domain, and adaptation models. This is a new hierarchical organizational model for building adaptive hypermedia learning management system.

For strengthening the interdisciplinary skills of FMI staff and the technology environment were implemented the following tasks:

Enhancing the entrepreneurship, innovation and technology transfer capacity: This task aimed, first, at strengthening the CIST staff capacity in the area of technology transfer and innovation, and second, at developing interdisciplinary skills of FMI researchers. 9 training activities were organised, collaboration with 16 International and National organisations was established.

Focus on research networking with industry: FMI researchers were involved in industry-related activities and studies, as well as look to strategic collaboration in ICT research with industry. During the last project period was prepared a detailed report on Bulgarian environment for intersectoral mobility of researchers. An important part of this task was the establishment at Sofia University of a Technology Transfer Office, a special database was created of innovative Bulgarian companies, and the establishment of Knowledge for Innovation (K4I) independent platform enabling multiple stakeholders of the knowledge and innovation economy to meet and exchange their experiences with the common objective of improving Europe’s innovation performance. Workshops and projects with industry were organised.

Identification and transfer of business best practices: The focus of this task was on collecting business best practices and presenting it to a wider audience. The development of case studies, describing successfully implemented e-business solutions in Bulgarian enterprises, and the distribution of them among other SMEs that could benefit from the available good practices, is identified as a new opportunity for strengthening collaboration with industry.

Dissemination and promotion

The project devoted broad and expanding network for wide dissemination of the research results and knowledge obtained within this project. In order to improve the dialogue between university and other stakeholders and to disseminate the research results obtained in the SISTER project were used various dissemination channels, the most important being the newly launched within the project international Conference Software, Services and Semantics Technologies that held 3 times and nay parallel workshops and events.

In addition, information on project was presented at 9 large international and national events.

Individual researchers of FMI participated in more than 150 events (conference, workshops, seminars, tutorials, etc.). During the project more then 250 papers were accepted and presented at conferences, workshops and seminars. More than half of them were written by young and senior researchers. 34 papers were published in journals.

Project Context and Objectives:

Sofia University (SU) is the leading research and teaching university of Bulgaria, which is also an important resource bank of researchers for Bulgaria. Established more than a century ago, in the lecture halls of SU thousands of young people have studied Mathematics, Biology, Chemistry, Physics, Geology, Informatics, Economics, Law, Philology, etc. and afterwards have incorporated their professional skills into the building up of modern Bulgaria. The Faculty of Mathematics and Informatics (FMI) of SU has been developed as a leading institution in the field of Information and Communication Technologies (ICT) research and higher education in the last decades. With more than 150 researchers and more than students (BSc, MSc and PhD), FMI is among the largest departments of Sofia university. The Faculty has been involved in more than 30 ICT related projects under the EC RTD Framework Programmes, several projects funded by national funds, as well as in projects funded by World Bank,
PHARE and PHARE TEMPUS, Leonardo, Socrates, etc. These projects aimed at improving the quality of university research and training and to pave the way towards entering the European Research Area (ERA), the European Space of Higher Education and the European Area of Lifelong Learning. Within these projects FMI has developed as one of the most promising research centres in Bulgaria in the area of ICT. The main achievements of its researchers are in the areas of Technology-Enhanced Learning, Networked Enterprises, Software and Services, Intelligent Content and Semantics. In these fields FMI has achieved some European wide reputation and substantial research outcomes, the FMI researchers have published more than 200 papers in well known journals and conference proceedings, and many contacts with leading EU and international research institutions have been established. A number of successful activities have focused also on collaboration with other stakeholders like public bodies, industry, NGOs, etc. FMI has been recognised as a leading ICT centre in South East Europe (SEE), where it has built good partnerships, as well. A good indicator for the above said is that FMI hosted the Third Balkan Conference in Informatics (BCI2007).

Despite the above-mentioned successes, FMI has experienced some serious problems closely related to the general socio-economic and the research environment in Bulgaria:

- Emigration and migration to industry of highly skilled professionals. During the last 15 years more than 50 researchers from FMI left the university to join leading European and American companies.
- Insufficient research funding.
- Lack of sufficiently stimulating research environment.
- Lack of youth staff.
- Lack of stable and multiple bridges between research, development, education and training.
- Lack of traditions in university-industry-government cooperation.
- Fragmented nature of research activities and the dispersal and not effective use of limited resources.

Software and Services (S&S). Within the ICT area, the sector of software and IT services takes a significant share of the European economy and it is a growth engine in that it stimulates the creation of high added-value, sustainable jobs. Software and Services is one of the most strategic areas of research of FMI, but it also is considered as an area of the highest national priority. FMI has been involved in some S&S related EC RTD projects, such as: EXPERT, TENCompetence, WG-EQUA, PRIME, etc.

Strengthening the PhD level of S&S research at FMI is a main priority of SISTER, which will positively influence the BSc and MSc programs in Software Engineering as well. The cooperation with the Bulgarian and international ICT industry will be also strengthened for supporting the national strategy in ICT. BSc and MSc programs in Software Engineering attract many students each year for example for the last two years the competition was 7-8 people for 1 place.

In addition, CIST is the first NESSI member from Bulgaria. Due to the high quality of research and development in the field of Software and Services CIST was nominated by the Bulgarian State Agency for Information Technology and Communications as an official Bulgarian node of the NESSI European Technology Platform. SISTER will include a number of activities for strengthening the capacity of FMI towards the FP7 ICT Challenge 1- Pervasive and Trusted Network and Service Infrastructures, objective 2007.1.2: Service and Software Architectures, Infrastructures and Engineering as well as for establishing a national NESSI platform, which will further play a regional role as well.

Intelligent Content and Semantics (ICS) is one of the most strategic areas of research of FMI. FMI has been involved in some projects, such as: TENCompetence, DIOGEN, Larflast, ILPnet2, Digital Preservation and Access to Cultural Heritage, etc. The project SISTER will support FMI in strengthening its capacity in FP7 ICT Challenge 4: Digital Libraries and Content. The project team, supported by the EU partners, will focus on research and technologies that will facilitate the creation and use of a new generation of intelligent and semantic annotated content which will allow using highly interactive, customizable, adaptable, intelligent, and furnished with a rich set of author- and reader-supporting book-related services. Another area of support is in building a set of tools and ultimately integrate them into a proof-of-concept intelligent framework for collaborative book writing and reading. Using ontologies and their semantic annotation for intelligent search is also among the important research areas for FMI where some substantial support from the partners is expected.

Strengthening the PhD level of ICS research at FMI is also an important priority of SISTER, which will positively influence the BSc and MSc programs in Artificial Intelligence, Mechatronics and Robotics, Bioinformatics, Information Systems as well. The cooperation with the Bulgarian and international ICT industry will be also strengthened for supporting the national strategy in
ICT. The students in MSc programs in Artificial Intelligence, Mechatronics and Robotics, Bioinformatics, Information Systems are selected from the top 10% of candidates for all MSc programmes at FMI.

Industry-academia collaboration, and in particular, increasing knowledge transfer between academia and industry is a key goal of the Commission innovation plan, and a vital component of the European Research Area. In the Community Strategic Guidelines on Cohesion the need for encouraging innovation and knowledge transfer is emphasized in order to strengthen the regional dimension of the knowledge economy. Acquiring key competences for life and work in the knowledge economy, including entrepreneurial and innovation skills is considered as one of most important actions for boosting innovation in several policy documents. For researchers, a basic tool in obtaining the necessary competencies for work with industry, in addition to the training courses, is the mobility between sectors and countries. Looking closely into academia-industry collaboration in Bulgaria, it could be pointed out that there is a limited culture of movement from academia to industry and vice versa. Statistics in Focus also highlights that the jobs-to-jobs mobility of researchers is much smaller in SEE than in the other European countries.

However, a lot of effort is needed in order to meet the challenges of knowledge transfer between research organisations and businesses. Therefore, the SISTER project will focus on the interdisciplinary skills of FMI researchers, and on training researchers to obtain skills which will help them to collaborate with industry, to communicate research results, build successful spin-offs or Technology Transfer Institutions (TTI) or just use the assistance of the existing ones, protect Intellectual Property Rights (IPRs), etc. The need of such skills at a Community level is well recognized; however, as outlined in the Lambert review of University-Business collaboration, the market for training in technology and knowledge transfer is very small in order to attract private training providers. Therefore, one of the SISTER work packages will be devoted to strengthening the FMI interdisciplinary skills and introducing Masters Course on technology entrepreneurship and innovation in IT. Joint research and collaboration with industry at different levels will be another task of the project aimed at future strategic partnership with industry. By establishing a successful framework for knowledge and technology transfer FMI could contribute to the implementation of the goals of the EC Structural Funds for strengthening the competitiveness of the national economy. In addition, the project could build a data base of best practice cases for intra-enterprise collaboration using ICTs. Second, SISTER will focus on strengthening FMI research capacity related to developing SMEs tools and technologies, Knowledge Management technologies, etc.

The main goal of SISTER project is to develop FMI as a Leading Centre in SEE in research, innovation and training in the area of ICT and more specifically in Software and Services, and Intelligent Content and Semantics. An overall goal of the project is to foster the integration of FMI in the ICT ERA and to contribute to competitiveness and growth of the SEE region and Europe as a whole.

In order to achieve the main goal the following project objectives are defined:
- to elaborate and further develop a strategic framework for FMI future development;
- to strengthen the research capacity of FMI by enhancing the human resources capabilities of FMI and research integration with EU partners;
- to strengthen the capacity of FMI for business exploitation of academic results and cooperation with industry
- to improve the research environment of FMI;
- to build a strong long-term collaboration of FMI with leading research organisations and enterprises in EU and in SEE countries;
- to make FMI a well-known research and innovation centre in SEE.

The first project objective will underpin all project activities, as it will outline where to make strategic investments in human resources, networking and capacity building. It will provide the strategic framework for future networking and research activities, for two-ways transnational mobility and exchange of knowledge and expertise in ICT, as well as the directions for workshops, seminars and conferences envisaged in the project for spreading excellence and disseminating project results. The human resources capacity building will be achieved through schemes of learning-by-doing for a longer period in leading EU research organisations, as well as through targeted training seminars and short-term visits abroad. Joint supervision of PhD students will be one of the action lines for developing new research capacity and integrating into EU research streams. Post Docs and more experienced FMI researchers will also benefit from mobility schemes in order to strengthen their research and innovation skills, and focus their future research on European strategic areas.
The overall FMI capacity building will be supported by renewal of technology and research environment, obtaining software and books, access to scientific on-line libraries and information resources. Building Research, Innovation and PhD databases of the Faculty will be related to greater transparency of FMI research and innovation for industry and future partners.

Taking into account that one of the call objectives is developing strategic partnerships (including twining), for each of the selected research areas will be chosen 1-2 strategic partners, with which collaboration already exists. The objective will be to extend the existing partnerships for the mutual benefits of the organisations, their researchers and students. During the initial phase of the project they will collaborate with FMI for developing a joint action plan for research and networking in the respective ICT area (within work packages WP2a and WP2b). This will help significantly for strengthening the FMI research capacity. In addition, a special focus will be placed on identifying strategic industrial partners and technology transfer institutions, as well as to launch new spin-off projects targeted at collaborative research in ICT, academia-industry long-term collaboration in research or building Initial Training Networks for young researchers in ICT, and last but not least strengthening the research capacity in SEE.

SU has succeeded recently to win a grant for building a Technology Transfer Office (TTO) at its premises, and CIST staff will set up the new TTO. However, CIST researchers need to strengthen their capacity for innovation and technology transfer. Obtaining IPR and knowledge management, entrepreneurial, science communication skills, etc. are also essential for FMI staff in order to develop further as entrepreneurial university department. Therefore, SISTER puts an objective for strengthening the human resources capabilities in innovation, management, entrepreneurship and other interdisciplinary skills where certain needs exist.

The project specific objectives could be presented in measurable and verifiable terms through the following overall achievements envisaged:
- an ICT RTDI Strategy of FMI developed by month 9;
- increase of PhD students by 10%, employment of 8 new ICT researchers, whereas 5% more women researchers;
- increase of mobility visits of researchers and the exchange of personnel with EU research organisations and industry with 20%;
- increase of collaboration of academia and industry 10% new joint projects;
- growth of training and research seminars with 4 yearly;
- increase of employability of PhD graduates by 20%;
- increase of research publications with 20%;
- renewal of technological base of FMI, a PhD computer laboratory established and functioning by month 10;
- increase of specialised literature at FMI, 100 new volumes;
- two scientific conferences with international participation carried out.

Project Results:
Definition of an ICT RTDI Strategy of FMI
The FMI team considered the following prerequisite steps for developing the RTDI strategy:

Define the broad strategic agenda. The strategic agenda describes a set of high level priorities that signal the critical areas for alignment across the organization. It serves as a foundation for developing scorecards at all levels. It is the responsibility of the organisation to set the strategic agenda. How specifically the strategy can be described depends on the type of organization.

Assess the current organisational structure. Since strategy should dictate organisational structure (not vice versa) each unit must be viewed through the lenses of the strategic agenda in order to determine if the organization is currently configured in a way that optimally supports strategy execution.

The formulation and planning stage of the FMI RTDI strategy development started with an assessment of the existing environment and the definition of a strategic directions for its improvement. The following methodology was implemented for this purpose:

The first phase was focused on the analysis of the ICT state-of-the-art, the needs and the available
resources. More specifically, the following was undertaken:

Environmental scanning of European and national reports, web sites, scientific literature, media publications, etc.

SWOT analysis of FMI its strengths and weaknesses, positioning in the area of ICT in Bulgaria and the region, and the opportunities and threats for its further development and integration into the European Research Area (ERA) and the European Higher Education area.

Carrying out a survey on a large number of enterprises, policy makers and local authorities in Bulgaria, as well as among FMI researchers and ICT end-users in order to determine the large societal and economic needs for research and training in ICT.

The studies conducted during the first phase provided the basic inputs for the preparation of the RTDI strategy. The reports based on environmental scanning, SWOT analysis and issue survey outlined above, were used for identifying the short term (achievable within the project) and long term (for strategic development and partnership) research, innovation and education priorities of FMI in ICT.

For the purposes of the FMI strategy, two strategy maps were developed the first one devoted to the education and consists of five perspectives:

Student education;
Financial;
Stakeholders;
Internal processes;
Learning and growth.

The second strategy map is centred on the FMI R&D and consists of four perspectives:

Stakeholders;
Internal processes;
Learning and growth;
Financial.

At the second phase of the strategy development process, an external expertise was used. In order to support the vision creation process at FMI, an Expert panel was composed of experienced researchers, representatives of EU partners, industry and public authorities. The panel work followed two stages:

A brainstorming session during the first Expert panel meeting provided FMI staff with external inputs for identifying its strategic priorities and the related actions for RTDI in ICT in Bulgaria.

The second panel meeting focused on validation of the first draft of the FMI RTDI Strategy in ICT. At this meeting the draft action plans for implementation of the strategy in selected areas were presented and scenarios were developed by the participating experts for the FMI future development.

Formal strategic planning is a relatively new phenomenon at Sofia University. Therefore, the FMI team follows the best practice and benchmarking of the university leaders. During the preparation of the strategy, the following major issues were decided:

**FMI Vision:** Creating a Faculty community that becomes locally and internationally recognized in research, teaching and service, and recognized nationally for student excellence. This will establish a reputation of being more valuable to all stakeholders.

**FMI Mission:** Provision of a flexible, multi-disciplinary environment for high quality informatics research and education using latest technologies and world expertise, and achieving excellence in research and teaching within the university, country and international IT/IS communities.
FMI Strategic Objectives: The Faculty mission and vision require more stakeholders-oriented decisions. The FMI strategic plan focuses on specific goal and objectives to advance the mission and to attain the vision.

The FMI strategy set the following goals:
1) Undertake continuous efforts to increase the quality of FMI education, training, research and information services to gain programme competitiveness, ensure high level of achievements and knowledge.
2) Ensure that education and research services are relevant to the needs of Bulgarian citizens, laborforce, industry, local and state government.
3) Provide an access to education, training and information services for individuals of all ages in order to develop their competences and to become globally competitive workers, responsible citizens, capable for lifelong learning.
4) Ensure efficient operation and management of the education and research system, and investments in ICT focused on student learning, in order to reach greatest possible benefit from education and research resources.

The priorities of the FMI RTDI strategy in ICT could be presented in four different point of views on the basis of a Balanced Scorecard Methodology - Financial, Stakeholders, Internal Processes, and Learning and Growth.

The Financial priorities were the same for all areas: Education, R&D and Innovation, and they comprise:
- Revenue growth for all activities;
- Improve cost structure at FMI;
- Increase foreign financing (EU / non EU);
- Enhance industry support (Grant, Commercial).

The Internal processes priorities were common for all areas:
- Facilitate operations;
- Support collaborative activities at FMI;
- Improve collaboration.

The Learning and Growth priorities were common for all areas and include:
- Champion leadership at FMI;
- Faculty members competences development;
- Development of lifelong learning culture;
- Equal access to technology and Innovation.

The Priority Areas for ICT Research in FMI were identified having in mind the results of the analysis of EU policy in ICT, the SWOT analysis and the survey of Bulgarian stakeholders. The brainstorming at the Expert panel meetings also supported to determine the following priority areas for ICT research:
- Fundamentals of Computer Science;
- Intelligent systems (incl. Intelligent Content and Semantics);
- Information systems;
- Information security;
- IT services;
- Software intensive systems;
- Bioinformatics;
- Computer graphics;
- e-Learning.

The Priority Areas for ICT Innovation in FMI came out of the analysis of the innovation policy trends and challenges for Bulgaria, as well as of the surveys carried out. The project team identified
the following priority areas for FMI innovation:

Promoting innovations in education and R&D with a special focus on commercialisation of results;

Expanding the cooperation with stakeholders for educational practice and fellowships;

Promotion of a flexible and open innovative solutions in all areas;

Creation of efficient technology transfer mechanism;

Increasing the collaboration with Bulgarian and European stakeholders;

Building flexible culture by better usage of lessons learned;

Expanding technology entrepreneurship education at undergraduate, graduate and postgraduate levels.

1.3 Strengthening the Capacity of FMI in Software and Services (S&S)

For strengthening the research capacity of FMI in Software and Services, the following tasks were implemented:

1.3.1 Determining joint research agenda in S&S

The purpose of this task is to enable the FMI research group in S&S to capitalise on existing research capacities, while providing a strategy for harmonisation of research focus. It identified topics of S&S research that (i) constitute research urgencies at European levels (NESSI) (ii) map on local and regional interests and capacities, and (iii) were in the research focus of FMI research group. The target was to organise the research approach such that will bring the most of benefits to the group.

The work within this task was held through the following steps:

agree on common understanding about terms Software and Services and selection of classification frame;
creation of methodology to apply;
collection of data;
applying the methodology on the gathered information;
discussion of the results and determination of future research agenda.

It was considered that the results obtained until now were a sound basis for determining the research priorities of FMI. The research priorities identified were:

D.2.2 Design Tools and Techniques;
H.3.5 Online Information Services, incl. Commercial services and Web services;
D.2.9 Management [of software development];
D.2.4 Software/Program Verification;
D.2.11 Software Architectures;
D.2.5 Testing and Debugging.

The task was implemented during the first project period, and the main results envisaged were achieved, e.g. a shared view about current efforts in Bulgaria in the Software and Services and shared strategic vision about future priorities were provided.

As the duration of this task was planned for the first project year it was concluded with an internal report Research agenda in S&S. During the third project period, because of the project extension, this task was also extended. The team, therefore, focused on refining the methodology for identification of research priorities, and respective papers and presentation, into several directions. The best practices from other European countries in defining their research agenda in S&S were discussed on work meeting with participants from software companies, SU St. Kliment Ohridski, and professional organisations.

1.3.2 Establishing S&S research infrastructure

The task was targeted on the creation and establishment of a physical as well as organisational infrastructure that will support research and educational activities in S&S.
The equipment obtained was for building a new software engineering lab at FMI and for a PhD lab, as well as for providing the needed infrastructure to host the FMI research database, training courses database, digital repository with online research publications (including research reports, scientific papers and other publications, MSc and PhD Theses, student projects, etc.), online course management system for lifelong learning of researchers, MSc and PhD students and the new FMI research portal.

The infrastructure established was a driving force for research experiments in the area of software and services. The PhD lab has been used mainly to provide working environment for both PhD students and post-docs in FMI. More specifically the mobile lab helped to improve the capacity of FMI staff in the areas of embedded software systems and service-oriented software architectures.

The experiments held were in the following main directions: Software reliability, verification and validation of the software platform for testing of BPEL processes. As a basis for further research work, the mobile lab is going to be used as a test bed for experiments with different software architectures for embedded software systems. PhD students and young researchers in S&S field will further use the established labs.

1.3.3 Intensifying research potential
This task aims at creating a network for international research co-operation in S&S between FMI and European organization, to establish closer links between researchers, pooling of resources, and effective collaboration mechanism. The objectives of this task were:
- strengthening the human resources research capacity in FMI
- strengthening and enlarging the network of RDT partners

The main efforts were focused on establishing Bulgarian NESSI platform and following the NESSI Europe initiatives and activities. In relation to this the concrete accomplished steps were following:
In addition to establishing Bulgarian NESSI platform and following the NESSI Europe initiatives and activities the main efforts were focused on cooperation and collaboration of FMI researchers with European organizations. A joint research programme with Malardalen University, ATOS Origin, and University of Bozen was drafted. For expanding and enlarging the joint research activities with FMI partners Universities 5 joint research papers with authors from Sofia University and Malardalen University were published, 2 with CNR (the Italian National Research Council) and the leader of the Software Engineering Research Laboratory at the ISTI - Istituto di Scienza e Tecnologie dell'Informazione A.Faedo in Pisa., and some more were under preparation.

During the SISTER implementation the members of S&S research group at FMI were part of the research teams of the following research projects:

International projects where members of SISTER team were involved:

**SEAMLESS (Small Enterprises Accessing the Electronic Market of the Enlarged Europe by a Smart Service Infrastructure)** - The SEAMLESS project develops and experiments an embryo of the Single European Electronic Market (SEEM) network where a number of eRegistries were maintained in different countries and sectors. The main project activities were devoted to define a collaboration framework and proper business models, realize evolving sectored ontologies, and develop a technological infrastructure and a number of applications and services on top of it.

**STASIS (SofTware for Ambient Semantic Interoperable Services)** - The STASIS project researches and develops intelligent semantic transformation services, based on usage of Web services. The result is a technology solution that enables the semantic alignment of the information exchanged between electronic systems in and between enterprises for both structured and unstructured documents, in the same or different format - standard or nonstandard.

**SOA4ALL (Service Oriented Architectures for All)** - SOA4ALL aims at realizing a world where billions of parties were exposing and consuming services via advanced Web
technology: the main objective of the project is to provide a comprehensive framework that integrates complementary and evolutionary technical advances (i.e. SOA, context management, Web principles, Web 2.0 and semantic technologies) into a coherent and domain-independent service delivery platform.

SMARTMUSEUM (Cultural Heritage Knowledge Exchange Platform) Creation of a platform for managing digital content and knowledge transfer in the area of cultural heritage.

REMICS (REuse and Migration of legacy applications to Interoperable Cloud Services) collaborative project under FP7, under Challenge 1 Pervasive and Trusted Network and Service Infrastructures, Objective 2.1 Internet of Services, Software & virtualisation. The goal of REMICS is to develop advanced model-driven methodology and tools for REuse and Migration of legacy applications to Interoperable Cloud Services.

The work on national projects that were funded by the National Science Fund and are still under an implementation:

ADEEES - Engineering Approach Towards the Development of Embedded Software Systems;

ADOPTA - main goal to design and create an ADaptive technOlogy-enhanced eduTainment platform (ADOPTA) for building edutainment (education+entertainment) services for both Universities and industry the focus is on the application of contemporary software methods and tools for platform development for example SOA architecture;

ARECS PostDoc research project; the main goal is to establish an effective approach for calculation of embedded Component-Based Software Systems reliability;

The following new project proposals were prepared and submitted, waiting for result by the end of November 2011:

Applicability of Agile Methodologies for Software Development the project will survey and analyze software development SMEs in Bulgaria with respect to their ability to apply agile methodologies. This will allow to define the problems in this area, specific to Bulgarian software industry. The main goal of the project is to define guidelines for application of agile methodologies.

Adaptive Web-Service Compositions, Based on Quality of Service the project aims to develop a framework that supports adaptive web-service compositions, based on advanced methods for evaluation and modeling of their quality characteristics.

Adaptive Educational Serious Games the project aims to develop and test the application of serious games in adaptive e-learning systems, which will enhance the area of applicability of serious games to education and lifelong training of individuals.

The main research results obtained were in the following areas:

Quality of Service (QoS);
Testing of service-oriented applications;
Reliability models for software systems;
Embedded software systems and architectures.

As a result of the research efforts of the S&S team, 63 papers were published within the project duration.

1.3.4 Advancing education in S&S

The goal of this task was to harmonise the educational efforts within the areas of S&S with the current best practices at local as well as world-wide level.

In order to advance the training of young researchers in the field of Software and Services a number of workshops and seminars were organised by SISTER team.

The existing training modules were analysed and compared to other SISTER partners universities and leading universities in order to identify commonalities and differences and to identify best
practices that can be applied in Bulgarian context. The new training modules developed were following the research agenda in the Software and Services defined within the project.

Module on Requirements engineering;
Module on Reliability testing;
Module on Testing history and perspectives;
Module on Patterns writing;
Software Architectures;
Service-oriented architectures (SOA);
Cloud computing.

1.4 Strengthening the Capacity of FMI in Intelligent Content and Semantics (ICS)

From the main objective formulated in this area the team derived the following two main goals:
initialise new collaborative research with EU partners in intelligent content and living books;
extending the existing joint research in areas of knowledge management, lifelong competence development and digital libraries.
The specific focus of work was focused on the following objectives:
Increase the human resources research capacity in FMI;
Build networks with EU research partners;
Increase the number of joint research projects in the area of ICS;
Build new digital libraries with both educational content as well as with the content related to culture and society.

1.4.1 Determining joint research agenda in Intelligent Content and Semantics (ICS)

A joint research agenda in the area of ICS was determined, in parallel with the FMI strategy preparation, which underpinned the Post Docs and PhD research activities, the special seminars and workshops in the area, as well as was targeted at a joint FP7 research project in ICT. The Agenda included the following research topics:

Knowledge resources sharing and management;
Designing highly interactive, adaptable and intelligent book-related services;
Developing new generation of intelligent and semantically annotated content;
Using ontologies and semantic annotation for intelligent search engines;
Creation of digital libraries with intelligent content;
Development of new methods for semantic annotation of the learning content in the repositories;
Development of intelligent learning models;
Implementation of pedagogically-driven and semantically-enhanced adaptive learning systems.

1.4.2 Raising the scientific competence of FMI researchers

Under this task of the project, the following main activities were performed:

Four young researchers were appointed to work for the project, another one was appointed as an assistant professor at FMI.

Five new PhD students were appointed to work in the field of Technology-Enhanced Learning (TEL) and ICS, and two PhD students successfully achieved their PhD degree at FMI.

Expanding and enlarging the joint research activities in the frame of ShareTec and TENCompetence projects

We organised joint workshop with specialists and experts in the area of ICS from TENCompetence and ShareTEC projects in Sofia (30-31 October 2008). All approved
papers were published in the workshop proceedings. Best of them were published in a special issue of the International Journal of Continuing Engineering Education and Life-Long Learning (IJCEELL) in June 2009: Volume 19 Number 4/5/6, special issue on Stimulating Personal Development and Knowledge Sharing.

o Three young researchers were financed to participate in the TENCompetence winter school in the field of ICS in Innsbruck, Austria, from 1 to 6 February 2009. One young researcher was financed to participate in the JTEL winter school in the field of Advanced Learning Technologies as a part of the Doctoral School activities within the Building next generation research capacity theme of the Stellar Network of Excellence, from 1 to 6 February 2010.

o Based on the TENCompetence results, new collaboration with Bulgarian Chamber of Commerce was started with the active participation of four researchers from FMI. This joint activity aims to establish new competence standards for several industrial areas, to develop competence development programs and competence assessment structures.

o ShareTEC system was successfully demonstrated during several workshops to more than 120 teachers from all over the country. So we start to build network of teachers and teacher trainers aiming to support the lifelong training for teachers in Bulgaria.

o ShareTEC system is supported after the end of the project to assist the lifelong teacher training all over the Europe.

Organisation of mobility visits (for courses, research and implementation activities)

Twenty two mobility visits from SU-FMI to EU partners were organized and seven visits from EU to Sofia.

Researchers from SU-FMI in the field of Intelligent Content and Semantics (ICS) visited 85 international conferences where they presented a total of 210 papers. Additionally 41 papers were published in journals, with two special issues prepared under the main involvement of SU-FMI researchers as editors.

Organisation of research workshops, seminars and winter / summer schools;

o Eight experts from EU partners organised nine research workshops followed by intensive discussions, and organised several individualised sessions with young researchers in the field of TEL and ICS.

o Software, Services, Intelligent content and Semantics Workshop, held in conjunction with the anniversary 10th edition of the CompSysTech conference, 19 June 2009, Rousse, Bulgaria, was organised, with 4 papers from young PhD researchers presented.

o A workshop for PhD students was organised on 3rd September 2009 (as part of AIMSA09 International Conference), with 8 papers from PhD students approved and published in a special issue of the magazine Cybernetics and Information Technologies, ISSN: 1311-9702.

o Two tracks in the first, second and third SISTER International conferences S3T were organised in the frame of WP2b Intelligent Content and Semantics and Technology Enhanced Learning. In general, these two tracks attracted many researchers from SUFMI and from abroad. Total of 127 papers were submitted and 65 from them were approved. Five keynote and four invited lecturers also participated in these two tracks of these conferences.

o International ELDE conference was organised in the frame of WP2b together with two national projects. 72 papers were submitted and 46 from them were approved. Two keynote and one invited lecturer participated in the conference.

o Six additional workshops were organised as a follow-up activity of the S3T conferences, with 7 invited lecturers and 3 project presentations and 62 PhD students and young
Fifteen additional training seminars and workshops were visited by different young researchers and PhD students from SU-FMI.

Preparation of new research proposals:
- A joint research programme with OUNL, ATOS Origin, University of Reading and University of Bolzano-Bozen was developed, updated and is constantly executed.
- Eight new research projects proposed from SU researchers in the area of ICS were approved for financing from Bulgarian MES.
- One new research project proposal in the area of digital libraries was approved for implementation from the Sofia University research program.
- Fourteen new research project proposals with participation of SU-FMI as project partner or scientific coordinator were prepared and submitted for various European research programs and three of them were approved for implementation.

1.4.3 Development of prototypes of intelligent tools supporting generation and maintaining of e-books

We develop a vision for the future of the e-books. The vision entails further development of technologies that will facilitate the creation and use of a new generation of smart books: e-books that are evolving, highly interactive, customisable, adaptable, intelligent, and furnished with a rich set of collaborative authoring and reading support services. The set of tools was designed and integrated into an intelligent framework for collaborative book authoring and experiencing called SmartBook.

The semantic technologies, intensively developed recently in connection with the Semantic Web initiative, were incorporated in the SmartBook and become the key factor of making it smarter. The book authoring environment enables the integration of knowledge and data in e-books, incorporating rich multimedia and hyperlinks, and adding references to different resources. The system architecture contains three main components: web interface, knowledge base (KB) and Information Extraction (IE) module. We provide a practical user interface, which stimulates authors to include semantic data into their work. This includes the following aspects:
- Suggestions and autocompletion of KB instances while typing;
- Browsing and modifying the KB;
- Modifying annotations and adding new ones.

For the purpose of browsing and modifying the KB we will customize the Javascript Infoviz Toolkit (http://thejit.org/). In the first prototype of our system the ontology is not modifiable through the web interface.

The useful interface for readers was developed, which benefits from the integrated semantic annotation. The user can create his/her personal extension by adding annotations and by editing the KB.

The authors interface consist of two parallel screens, one for writing text and one for viewing and editing the KB. When a sentence is written in the text editor, asynchronous call-backs tell the IE module to annotate it. The mentioned annotations are highlighted and their instance URLs are sent to the KB editor. The graph visualization engine is browsing through the KB for the mentioned instances and adjusts towards them. Authors see the mentioned instances highlighted in the graph screen and are able to follow relations away from what is mentioned. They are also able to manually mark a piece of text and annotate it, providing an instance from the KB.

Readers are able to browse the KB through the graph visualization tool and have limited editing permissions. Clicking on a mentioned instance directs them to the respective place in the text.

A survey motivated by the idea of making e-books more intelligent, in particular enabling them to answer users queries was implemented. To find the needed information user usually do not want
to spend long time searching or browsing or skimming books. He/She will be happy to have a guru in the area that can provide him/her with the right answer almost simultaneously. For this purpose we had a close look on the area of automated text summarization.

1.4.4 Creation of digital libraries
The main goal of this particular activity is to develop FMI institutional research infrastructure from digital repositories in the field of ICT. This infrastructure will be used from all researchers, educators, public bodies and companies who need contemporary scientific and education information and resources in the field of ICT. This will foster the integration between Academia, Public sector and Industry, as well as will strengthen the institutional links between all major research and education organizations (Universities, Institutes from Bulgarian Academy of Sciences and other) in the country in the field of ICT.

We start with the development of the new digital library for the University of Sofia. Information about research activities in the field of ICS was published into this digital library. The library was made accessible to the joint EC funded projects TENCompetence and ShareTEC. The process was automated with special emphasis on metadata search and generation. This digital library was registered also in the European project DRIVER as the first such scientific digital library in Bulgaria.

We provide transparent and free access to all national scientific and educational resources in the field of ICT through the development of specific University portal, playing the role of gateway for providing links to the national research infrastructure as well as to the European infrastructures, and for providing flexible, individualized interface for each user, with possibility to rank, comment and classify each resource, as well as additional services based on the ideas of Semantic Web and Web 2.0.

Below we will shortly describe the main tools and components developed as digital libraries and the corresponding digital content made available.

Research Digital Library
Research Digital Library was initially developed and maintained by assistant professors from the Department of Information Technologies. It was expanded and became the main research Digital Library for the University of Sofia. The maintenance is provided by special unit of the University Computer Centre, and this digital library is available at the following address: http://research.unisofia.bg. Each university professor has her/his own account and will be able to publish information in the research database, which will be approved by the special person responsible for the correct and high quality information on the database.

The design of this digital library was described in the Deliverable D4.4.

This repository becomes the officially recognised research digital library of the University, with a special statute approved by the Rectors council.

In order to raise the quality of services and to align to the national requirements, this digital library was improved by providing the following additional services and features:

- The software product used for the implementation of the library was fully localized in Bulgarian language.
- The standard metadata set was enlarged with new specific features like the number and type of citations (Google, ISI, Scopus), type of the source of the publication (refereed, with impact factor, etc.) and new types of publications regarding the rules accepted at the University.
- The process of publications and quality control was improved.
- New Frequently Asked Questions section was developed (see Figure 4).
- New learning modules how to work with the library were prepared in Bulgarian and made available to all users.
New materials describing Intellectual Property Rights were prepared and published.

Digital Library supporting Lifelong Competence Development services

In the framework of the SISTER project we designed and developed one new digital library in the area of competence development, extending the open source system LearnWeb2.0 (system stimulating knowledge sharing and knowledge management).

This digital library includes several hundreds of digital resources related to individual lifelong competence development and can be accessed using the following address:

http://phpcake.it.fmi.uni-sofia.bg/

In addition, we started to develop new lifelong competence development services in the area of business and management education. The goal is to provide access to content related to competences in the field of business and management education through respective competence services, integrated into the existing digital library infrastructure. For this reason a special collection called Competence Catalogue was developed, and its respective Competence Services was created.

The existing implementation of the digital library was extended to provide an interface to different content repositories as well as existing Learning Content Management Systems.

Digital repositories supporting various domains

In the frame of other internal research initiatives we developed digital repositories for the domains of History, Teacher Education, E-Learning and others. Our main objectives related to the implementation of these digital libraries are:

1. To organise and build a virtual network of institutional repositories in the field of ICT.
2. To assess and implement state-of-the-art technology, which manages the physically distributed repositories as one large-scale virtual content resource.
3. To assess and implement a number of fundamental user services, with main focus on search and primitive personalized services.
4. To identify, implement and promote a relevant set of standards used for interoperability in distributed environments.
5. To prepare the future expansion and upgrade of the Digital Repositories infrastructure in order to support other scientific disciplines, and to make it possible to link it with the available infrastructures from Digital Repositories across Europe and to ensure widest possible user involvement.
6. To deliver advanced end-user functionalities and develop tools aiming in the support of scientific exploration through the use of complex digital objects.

In this way we delivered research infrastructure providing transparent access to heterogeneous distributed scientific resources. The final users, i.e. academics, students, business companies, government and non-government organizations and ordinal people, are able to search and discover scientific objects from the ICT domain that are located in distributed repositories.

We continue to further improve the framework with adding new functionalities related to Web 2.0 and social web to our digital repositories.

The new Web portal provides the required integration through the User Interface offered. It provides access to all system components (developed as a Web services). So, each end-user of the system can use the Web browser of choice in order to have access to the research infrastructure.

An adaptive wizard based on the ontology model and individual user history will enhance interaction with the system, increasing the effectiveness of users queries by making their tacit, contextualized knowledge explicit. User profiles will be organized into homogeneous categories to capture and support typical patterns of behaviour. To this purpose, both automatic data collection and explicit user feedback will be used.

Proposed approaches include collaborative filtering (user ratings), social bookmarking, and
collaborative tagging (folksonomies). The user interface will be fully multilingual. The multilingual aspects may be supported by the use of various open source multi-lingual editing tools and approaches, as well as from the Open source Web portal frameworks. We tested successfully this framework in the area of ICT Teacher training. We have several hundred own resources available, while the repository gateway have links to several thousands of digital assets.

1.4.5 Development of prototype of Adaptive Intelligent e-Learning System

The Adaptive Hypermedia System (AHS) model was developed and reported in numerous publications. It follows a metadata-driven approach, explicitly separating narrative storyboard from the content and adaptation engine (AE). The triangular structure of the model divides in three each one of the learners (or, generally speaking users), domain, and adaptation models. This is a new hierarchical organizational model for building adaptive hypermedia learning management system (LMS). At first level, the model is based on a precise separation between learner, content and adaptation model, while at second level each of these sub-model is divided into three others submodels. The core of the model is the adaptation engine (AE) which is responsible for generating the actual adaptation outcomes by manipulating link anchors or fragments of the pages content before sending the adapted pages to a browser. The AE uses an event-driven mechanism for controlling the storyboard execution based on the storyboard rules applied to the inputs from the learner model. AE selects the best storyboard WP within the graph by evaluating weight coefficient of the pages within the WP for the given learner style.

The software architecture of the adaptive hypermedia system (called ADOPTA) was developed as component based, and also has been reported in various research publications. The platform itself incorporates three main modules: authoring tool, instructor tool and adaptation control engine, all communicating through central content repository. The platform follows the traditional four layers Internet architecture where the client layer is to be implemented in Flex, the Web layer by Java Web services, the business layer- by using EJB, and the data layer by using MySQL database server.

The three modules have been implemented as prototypes and tested separately by using unit tests. Later on they were integrated into the single platform. Following this integration, a functional tests of the integrated platform were performed. We started to create courseware content by the authoring tool, adaptive narrative storyboard and adaptive courseware delivery. On the base of this first integrated prototype, we started usability testing and assessment of the platform with delivering the adaptive course to selected students.

1.5 Strengthening the interdisciplinary skills of FMI staff and the technology environment

For strengthening the interdisciplinary skills of FMI staff and the technology environment were implemented the following tasks:

1.5.1 Enhancing the entrepreneurship, innovation and technology transfer capacity

This task is aimed, first, at strengthening the CIST staff capacity in the area of technology transfer and innovation, and second, at developing interdisciplinary skills of FMI researchers.

On bases of surveys for the training needs of FMI researchers during the project were carried out several training activities:

- Training for advanced science communications, Dubrovnik, 2-4 April 2009, conducted by a team of University College London, UK.
- Training seminars on science communications: for beginners and advanced training, Velingrad, 10-16 September 2009, with lectors from ESOneT.
- Training seminar How Ideas Evolve, Sofia, 23 October 2009, linked to the Open System
of Living Labs Community (established on 20 March 2009 in Brussels, Belgium).

Training seminar on patterns writing, Sofia, 30-31 October 2009, with lectors - members of the European patterns community

Training on Intro to Process Improvement (PI) & Introduction to CMMI trainings, 19-22 July 2010, Sofia, with lectors from European Software Institute Bulgaria and Carnegy Melon, USA.

1st Living Lab Summer School on Collaborative Innovation through Living Labs, 25-27 August 2010 in Paris

Summer Academy, 27 June 22 July 2011, Koblenz, Germany

Training seminar Enhancing Success in European Proposals, 4 - 7 July 2011; Sofia

Training on IPR and Technology transfer management and exploitation, Sofia, 27-28 September 2011, with lector from FORTH, Greece

Within this task some FMI researchers were working on research topics related to knowledge management, innovation, entrepreneurship, etc. During the project, some team members entered a new activity linked to Living labs as an evolving open innovation concept, especially in the area of ICT. Some of them were also involved in the newly launched MSc programme on Technology Entrepreneurship and Innovation in IT (TEIIT), and shared their experience in interdisciplinary education at several events in Bulgaria and abroad.

FMI researchers had the opportunity to exchange knowledge and experience with other researchers at several events in Bulgaria and abroad. During the events, several scientific contacts were established with Bulgarian and European researchers and experts, coming from both, academic community and industry, in the areas of Knowledge Management, Innovation, Business Intelligence, Data Mining, IT, etc. The participation in the conferences, seminars, and workshops was a very valuable experience, providing opportunities for gaining access to leading researchers in the areas for exchanging knowledge and information, for getting in touch with the recent scientific achievements, for getting realistic and valuable feedback about the presented own research results and identifying future research steps.

As a follow-up of the enhanced capacity of the FMI team, a joint publication on Knowledge management was initiated. The team agreed upon the structure of the book and the template to be followed by each author. The preparation of all chapters was delegated to some FMI researchers active in the area. The book is expected to be published in 2012 with the financial support of the National Science Fund at the Ministry of Education, Youth and Science under an on-going project.

The target audience of the monograph will be researchers, PhD students and practitioners in the area of Knowledge Management.

In order to strengthen the capacity of FMI researchers in the area of innovation, entrepreneurship and technology transfer, some bilateral mobility visits of researchers took place, as well as joint events with EU partners were organised. Some of the partners with which was undertaken longer collaboration are:

- ATOS Origin: joint project proposals
- UNINOVA, Portugal: networking in business intelligence, knowledge management, and joint project proposals
- CERTH, Greece: joint projects in the area of career and mobility of researchers
- Solent Southampton University, UK: ERASMUS contract concluded
- University of Passau, Germany: ERASMUS contract concluded
- University of Koblenz-Landau, Germany: networking and collaboration in the field of Knowledge management, and joint project proposal
- SIEMENS AG, München, Germany: targeted at future industryacademia collaboration
- INTEROP-VLab, Belgium: Considering the possibilities for the creation of an INTEROPVLab
Pole in Bulgaria and participation in new research projects related to enterprise interoperability issues and problems. University of Birmingham, UK, Microwave Integrated System Laboratory - established contacts and collaboration activities, new research project proposals development. Knowledge for Innovation (K4I) Foundation: Innovation Union flagship initiative European Software Institute - Center Bulgaria: train-the-teachers programme Bulgarian Industrial Association participation of SU-NIS researchers in the R&D project focused on the development and implementation of an information system that will support the application of a competence-based approach for Human Resources assessment and development ICT cluster in Bulgaria: exchange of knowledge and experience in industry-academia collaboration GIS Transfer Center at the Bulgarian Academy of Sciences (BAS): identification of barriers and consequent measures for industry-academia collaboration Joint Innovation Centre at BAS: identification of barriers and consequent measures for industry-academia collaboration, and Charter and Code implementation The activities of the project team focused also on building partnership in the SEE region. Therefore, a Brokerage event for FP7 People IAPP collaboration between Bulgaria and Greece was held in Thessaloniki in April 2009.

1.5.2 Focus on research networking with industry

The objective of this task is to involve FMI researchers in industry-related activities and studies, as well as look to strategic collaboration in ICT research with industry. The team prepared in support of the strategy building process a report focused on Challenges for industry-academia collaboration. During the last project period was prepared a detailed report on Bulgarian environment for intersectoral mobility of researchers.

An important part of this task was the establishment at Sofia University of a Technology Transfer Office (TTO), which was initiated by the CIST staff under a PHARE project. The TTO focused its activities to fill the existing gaps in academia-industry linkages of SU. It is working as intermediary between SU research departments and enterprises, and as a promoter of innovation and new ideas of SU researchers. In order to facilitate the innovation process, the TTO has undertaken targeted activities focused on:

- allocation of new knowledge results that could be further developed in new products, materials and services by the industry and thus commercialised;
- raising awareness of the researchers on the business needs for research inputs.

The TTO launched a systematic screening of the scientific outputs of SU and the industrial needs. The development of TTO tools web site, data bases and services will help for establishing transparency of research results and building awareness on industry needs. Further activities supporting technology transfer and innovation are the feasibility analysis, the development of a demonstrative/promotion tool of research results, and the enterprise technological needs assessment.

An important activity of the TTO is the promotion of its services, and the training for building entrepreneurial culture and innovation management skills.

The initial focus of the TTO was on the R&D outputs of the following research units of SU:

- Laboratory of chemical physics and engineering
- Centre of Information Society Technologies (CIST)
- Plasma and gas discharge physics group
- International Bioscience Centre for Education & Technology Genesis

On a later stage, the TTO work will be extended to all SU departments and their R&D outputs. The general aim is to establish conditions for TTO sustainability, and to enhance its capacity and
activities. The SISTER team supported the TTO team and launched some joint activities focused also on ensuring the TTO sustainability after the end of the PHARE funding. SISTER staff is maintaining the web page of TTO, as well as built a joint team for preparing a successful project under the National Scientific Fund on Establishment of a Centre of Excellence at Sofia University.

A special database was created of innovative Bulgarian companies interested to work with the faculty under national and European programme initiatives. The database included companies with R&D units or activities, and the ones that participated in the National Innovation Fund activities. The companies are coming from different industry sectors, most of them being in ICT, Electrical Engineering, Electronics, Biotechnology, Chemical Industry, and are of different size micro (with up to 10 employees), small and medium enterprises. Although its size is not very big (37 companies) the team will continue working for finding such companies and to support the work of the Technology Transfer Office at Sofia University.

Important activity of the FMI team was related to the participation at the establishment of Knowledge for Innovation (K4I) Foundation in 2008. Knowledge4Innovation (K4I) is a not-for-profit and independent platform enabling multiple stakeholders of the knowledge and innovation economy to meet and exchange their experiences with the common objective of improving Europe’s innovation performance. Membership in the Knowledge4Innovation platform gives privileged access, through regularly scheduled meetings with Members of the European Parliament and representatives of the other EU institutions; exchange of knowledge and best practices with leading business entrepreneurs and science experts; participation in a high profile, high visibility European-based organization open to global cooperation and opportunity to contribute to EU policy developments with expertise and information.

Several events were organised by the SISTER team for fostering industry-academia collaboration:
- Workshop Challenges for career and mobility of researchers in Bulgaria, 28 October 2010, Sofia
- Second Workshop of the Networking Initiative for ICT Related Projects, 10 - 11 September 2010, Varna
- SISTER brokerage event for a joint ITN project, 13-14 December 2010, Sofia
- European Day of the Entrepreneur 2011, 26-27 September 2011, Sofia
- Industry-academia partnership seminar, 27 September 2011, Sofia

In order to enhance the collaboration of FMI with industry, some successful projects were launched in collaboration with other Bulgarian and EU partners:
- FP7- COH-2007-2.2-OMC-NET I-SEEMob project (Inter-sectoral mobility of researchers in South-Eastern Europe)
- FP7 project EURAXESS T.O.P. (Enhancing The Outreach and Effectiveness of the EURAXESS Network Partners)
- FP7-ICT-2009-4 project UNITE (Upgrading ICT excellence by strengthening cooperation between research teams in an enlarged Europe)
- FP7 project EURAXESS T.O.P. II (Enhancing The Outreach and Effectiveness of the EURAXESS Network Partners) where SU is in charge of tasks for industry-academia collaboration
- FP7 projects REACT and RECSES for organizing innovation stands of SMEs during the Researchers Night 2010 and 2011
- Bulgarian Industrial Association R&D project focused on the development and implementation of an information system that will support the application of a competence-based approach for Human Resources assessment and development participation of SUNIS
1.5.3 Improving the research and technology environment at FMI

During first months of the project an analysis was made of the current needs of FMI. This involved several meetings with other work-package representatives and consultations with project partners. Based on discussions made during these meetings and according to preliminary specifications, made in SISTER proposal a specification of the needed equipment was prepared.

The equipment was obtained for building a new software engineering lab at FMI and for a PhD lab, as well as for providing the needed infrastructure to host the FMI research database, training courses database, digital repository with online research publications (including research reports, scientific papers and other publications, MSc and PhD Theses, student projects, etc.), online course management system for lifelong learning of researchers, MSc and PhD students and the new FMI research portal (Deliverable 2.1. Report on the S&S infrastructure set up and establishment of PhD research lab).

1.5.4 Identification and transfer of business best practices

The focus of this task was on collecting business best practice and presenting it to a wider audience. The development of case studies, describing successfully implemented e-business solutions in Bulgarian enterprises, and the distribution of them among other SMEs that could benefit from the available good practices, is identified as a new opportunity for strengthening collaboration with industry. Therefore, an idea for the development of a database for business best practices and case studies appeared at FMI. The database will be accessed freely from SMEs which could find examples of successfully implemented e-business decisions in similar enterprises. The described good practices could encourage and support SMEs in introducing new IT solutions and to increase their competitiveness. Another positive effect will be the increased SMEs confidence in the academic research impact on industry.

The first activity within this task was related to transfer of German and Swiss practice in case studies writing. Therefore, on 26 May 2008 was carried out a workshop for Case Study Writer with lecturers from Switzerland. Later, a training seminar was organized for PhD students and senior researchers on 24-25 September 2008 in Koblenz, Germany, in conjunction with the Conference KoFoBis 2008 (23 September 2008). At the seminar participated 7 Bulgarian and 5 German researchers. Another training workshop for preparing case studies was organized in December 2010. Afterheat some FMI researchers and students were involved in the real implementation of the eXperience methodology and description of cases of Bulgarian organization where some knowledge management initiatives are launched. The plan comprised at least 10 cases to be prepared until September 2012, whereas the first 4 were reported during a seminar at the European Day of Entrepreneurs 2011.

Subsequently, a database has been developed in which all case studies are being published. The Case studies were developed, following the previously adopted Swiss eXperience methodology for case study writing and dissemination. The case studies describe successfully implemented ebusiness solutions in Bulgarian SMEs. They were popularized among SMEs, IT vendors and academic institutions with the main idea to support the SME competitiveness improvement and to increase the academy-industry collaboration.

Some follow-up events were organised focused on business best practices in research and collaboration with research organisations:

Seminar for preparing successful proposals for FP7 programme People 2 April 2009, Sofia University, Sofia

Seminar Enterprise Interoperability, Sofia, 27 October 2009

Workshop Challenges for industry-academia collaboration, Sofia, 23-24 November 2009

Research seminar Best Practices for Knowledge Management in the Bulgarian SMEs, 30
Potential Impact:
Strategic impact
Information and communication technologies have been seen by the EU as one of the core elements driving Europe to become the most competitive and dynamic knowledge-based economy. It is recognized that the Information Society in the EU is moving now from a pilot phase towards a phase of wide deployment. With the revised Lisbon strategy and the i2010 initiative, the EU is facing the challenges of the contemporary ICT development, and making the most of taking the opportunities for its businesses, citizens and the society as a whole. At the same time, RTD in Europe shows a high emphasis on ICT for their development is devoted the biggest part of FP7 budget. ICTs take an important place also in other EU programs and worldwide research, innovation and training programs as one of the pillars of the knowledge society. With full awareness of ICT present trends, SISTER will face the main EU challenges in ICT research and will contribute to further developing content and IS services, public services and skills, utilizing more the technology convergence, providing broadband access and improved security of the communication networks, etc.

In relation to the Capacity programme, the outcomes of SISTER could be summarized as follows:

? contribution to RTDI capacity building in an EU convergence region by strengthening human resources and technology environment at FMI, by enhancing research-industry collaboration and technology transfer in ICT, and fostering increased industry investments in research and scientific training.

? enhanced participation of Bulgaria in the 7th Framework Programme and integration into ICT ERA by networking with other research centres and industry, and building new consortia;

? increased scope of FMI based on the European and inter-sectorial collaboration, as well as the linkage of its activities with the present economic and social environment,

? increased networking with European research and industry units by enhancing human resources mobility, exchange of information and knowledge, better visibility of research and innovation results of FMI;

? better carrier and job opportunities for young scientists by matching the university curricula to industrial needs and including industrial specialists in the PhD training;

? overcoming and minimizing weaknesses in ICT skilled labour force and thus support building of i-Bulgaria as part of i-2010 European initiative.

? reinforcing the competitive advantages of Bulgaria in ICT and increasing the competitiveness of the ICT industry in EU.

FMI has taken a leading position in ICT and mathematics research with high impact on the Bulgarian economy, science and society. Its scientific staff has found recognition not only in Bulgaria, but also in the EU, USA, Western Balkans and Russia, where more than 100 scientists have worked as guest professors or participated at scientific events for the last five years. Having in mind that the Faculty is one of the 16 faculties of Sofia University, the biggest and most prestigious Bulgarian university, it might be expected that SISTER would have substantial impact at:

? Faculty level
? University level
? National level
? European wide level

The expected impact would not be achieved without relying on external funding and the envisaged project measures, such as:

building human resources research capacity; improving the scientific and technology environment of FMI; developing a Faculty ICT research strategy; enhancing the networking with other EU research and academic organizations; mobility of ICT researchers; partnerships with leading EU organizations in FP7 ICT related projects and in other EC programs and initiatives; know-how, technology and research management capacity transfer from EU partners; etc.

Impact at Faculty level
The ICT RTDI strategy for FMI will create a framework for better organization and carrying out of research at FMI, and will contribute to more effective usage of the financial and human resources and better responding to industrial and societal...
needs. Thus, SISTER will facilitate linking FMI scientific activities with defined national and European priorities in ICT, and building stable and multiple bridges between research, development, education and training. It will assist in strengthening the capacity of FMI for business exploitation of academic results and cooperation with industry which will result in opening more channels for funding of FMI.

SISTER will contribute further for strengthening the research capacity of FMI in areas where some substantial expertise is accumulated, and will open also opportunities for further developments in areas of strategic importance. Another important impact of SISTER is for strengthening the human resources of FMI through researchers and S&T management visits, research and training seminars, new job offers, etc. SISTER will contribute also to strengthening the network of RTD partners of FMI. The project will ensure more favourable advanced technology environment for research and training at FMI. It is well-known that the availability of state-of-the-art research infrastructure is essential for making the best use of knowledge and skills available. It is an enabling factor for the progress in research and training. In SISTER project, the availability of advanced research facilities, supported by sufficient financial means, would stimulate young people to enter a research career and stay in research which has an important impact on reducing the ageing of researchers and university professors. The availability of a computer lab for PhD students would support further their research efforts and would increase the success rate in obtaining PhD degrees. At the same time, the access to high-speed networks will facilitate the communications between research centers, the exchange of knowledge and research results and building of virtual teams in ICT across Europe aimed at research excellence. Furthermore, SISTER will enhance the partnership with well-known research centers in Europe, such as ATOS Origin, the Open University of the Netherlands, the Mälardalen University, Västerås of Sweden, etc.

Finally, through the training and research seminars, SISTER will contribute to improve the skills of FMI researchers. The project activities will have a general impact on FMI for achieving better quality of education and training at BSc, MSc, PhD and PostDoc levels, since the project will harness the expertise of the MS experts and get access to the best EU practice. FMI was among the first university departments, which introduced the European Credit Transfer System (ECTS) and actively participated in Erasmus students and teachers mobility projects. The ICT research activities positively influenced all other faculty activities of FMI. The SISTER measures and activities, as well as the substantial external expertise involved will help FMI to strengthen the new BSc programme on Computer Science and MSc in Information Systems and Software Engineering according the ACM/IEEE Computing Curricula 2001 (CC2001) methodology and standards, and on the variety of ICT related MSc programmes, such as: eLearning, eBusiness, Computational Science and Engineering, Artificial Intelligence, etc. In such a way a solid ground for attracting new PhDs and young researchers to the ICT RTD projects and initiatives will be built. Such measures will increase the prestige of FMI and the visibility of ICT research outcomes.

Impact at University Level

SISTER will strongly support FMI in its ambition to become an entrepreneurial university organization . With its activities, although targeted at FMI, the project would indirectly contribute to strengthening the steering core of Sofia University, expanding its partnerships, especially those with the industry, diversifying its funding base and finally developing higher entrepreneurial culture of its research and management staff.

Since most of the ICT strategic objectives imply interdisciplinary research, SISTER will strengthen the research capacity of the whole university and will create an environment of cooperation of FMI with other university faculties and departments. For instance, the research in Intelligent Content and Semantics provides opportunities for FMI to cooperate with the Faculty of Pedagogy, Faculty of Pre-school and Primary School Education, the Department for Information and In-service Training of Teachers; and the industry-academia project activities open doors for cooperation with the Faculty of Economics and Business Administration and the Faculty of Philosophy (which hosts education in Public Administration). Eventually, SISTER would support the research capacity not only in the field of ICT, but also in almost all other FP7 thematic priorities, by inviting to the SISTER seminars participants from other university faculties and departments. Thus, the overall participation of SU in the FP7 would be increased. Through the project all the university research computing environment will be improved and made more secure for virtual collaboration.

The activities within SISTER would contribute to the development of interdisciplinary skills of the university researchers who are also lecturers. A vision for the strategic development of FMI will be created which will go beyond the FMI scope and will pave the way for introduction and wider use of interdisciplinary programs at the University, and thus responding to the contemporary requirements of economy and society, e.g. the ones related to the e-skills gap in Europe. In addition, the
contacts with European TTI will help CIST for exchange of information, experience and good practice in the technology
transfer process, and will support the process of establishing a scientific park at SU for better academia-industry collaboration
in research and innovation.

Impact at National Level

Beyond the objectives for strengthening the ICT research capacity of FMI, the project SISTER would have an impact on ICT
research in Bulgaria, and for meeting EU wide goals for building a knowledge society. This will be achieved by harnessing the
large network of FMI partners in Bulgaria, which will be involved in most of the SISTER activities, such as: seminars,
conferences, etc. SISTER will have an impact on society by contributing to integrating the three basic tasks of the university -
teaching, research, and service to the community. An entrepreneurial university strives towards more effective education and
research and thus also towards fulfilling its third task service to the community.

First, SISTER would contribute to structuring the national research area and strengthening the academy-industry linkages in
ICT. The overall aim is to go beyond personal communications in research and innovation and to achieve stable institutional
links and establish a common shared vision for ICT development with industry. Subsequently, involving industrial specialists in
the research activities of FMI, and vice versa, will enhance the intersectorial mobility of researchers (between university and
ICT industry) and the joint research and applied projects. The SISTER project will help also improving the innovation capacity
and the technology transfer with the domestic industry. An indirect effect for the research system could also come out of the
linking the academy with industry increasing the industrial contribution in research.

Second, the activities of SISTER would contribute to a certain extend to responding to industrial needs and creating better job
and career opportunities for young scientists. This will be achieved by improving the FMI research technology environment,
promoting the career in industry for young researchers, etc. The dialogue and common actions with the ICT industry will
increase the employability of young people and help them to stay in Bulgaria, thus avoiding the severe brain drain of young
ICT professionals. Subsequently, the project will address the return mobility issue while offering jobs for scientists and especially young professionals. SISTER will also contribute to overcome the e-skills weaknesses in Bulgaria. It will address the
need for well-educated and skilled people to take maximum advantage of the new technologies, not only in the high-tech
industries but also in all other economic sectors. Subsequently, the availability of highly skilled professionals would increase
the attractiveness of Bulgaria for foreign investors, and raise the competitiveness of the domestic industry, and ICT industry in
particular.

Finally, the Bulgarian government has made a strong commitment to build an Information Society for all in the country, and
thus contributing to the Lisbon goals. Strengthening the ICT research capacity of FMI would contribute to meeting the
respective objectives of i-2010. On the one hand, SISTER will raise the research capacity of FMI in advanced ICT research
areas. On the other, the project will seek to positively influence the study-design-development-implementation-evaluation
cycle and will reflect the complexity of the knowledge domains involved. In particular, the design, implementation and delivery
of the respective ICT services and tools will involve the relevant social, education, industrial and economic players and will
foster building a cohesive and inclusive knowledge-based society within a competitive economy.

Last, but not least, SISTER will contribute to developing Bulgaria as a region of knowledge, and improving the competitiveness
of the local industry on the wide European market, as well as its positioning in Western Balkans a neighbouring market to be
explored by Bulgarian industry. In addition, the focus on better linking industry needs and research results will help for
increasing demand by industry of local research supply which on its side will boost the research production, and will have a
positive impact on the research system.

Impact at European wide level

The SISTER project will have a wide European added-value as it focuses on research integration of a centre at the most
prestigious university in Bulgaria with strong European institutions in ICT research and innovation. The project would not have
the expected impact without relying on EU funding for FMI researchers, their mobility and training, as well as the envisaged
dissemination activities for transfer of knowledge and experience. Subsequently, the project will contribute to the
development of the European Research Area (ERA) first, building a pool of scientists in the area of ICT needed for the
European knowledge society, and second, extending and deepening collaboration and networking of researchers and industrial
representatives, and their organisations in Europe for solving common problems in the ICT area.
In line with the EU and national actions focused on researchers career and academia-industry collaboration, the SISTER project will facilitate them. The project will have a substantial impact not only on research training and careers of young researchers, but also on the exchange of knowledge and experience between the participating countries and the events participants on theory and practices of research and project management, industry-academia collaboration, technology and knowledge transfer, entrepreneurship, etc. It will facilitate, especially, the transfer of knowledge in the area from more experienced EU members to Bulgaria, and building the necessary skills of researchers in the latter, thus trying to bridge the gap between research and innovation in more intensive regions and those which are lagging behind. Nurturing a new generation of scientists is essential to improving the quality of life of European citizens and enhancing the economic competitiveness of Europe.

An important effect of SISTER project will be to promote the mobility of young researchers in Europe, and thus to contribute to the practical implementation of the EU mobility strategy with a particular focus on intersectoral mobility of researchers. The project takes into account also the new FP7 action lines, and will foster academia-industry collaboration at both individual and organizational levels within it. It will equip researchers with the knowledge about opportunities for research and innovation within EU programs, their rights and obligations according to the Code and Charter, as well as with skills to better communicate their research results, and collaborate with industry. Thus, the project will also contribute for building a genuine European market for researchers. Last, but not least, it will have also a structuring effect by putting an emphasis on the research and training needs in Bulgaria, thus probably encouraging further knowledge and experience transfer and exchange going to the whole SEE region.

SISTER will provide mechanisms that ensure wider influence of the European research policy on other national and EU policies and programs, such as: i2010, Bologna Declaration, the European e-Skills Summit Declaration, the National Scientific Programs for Research and Innovation, etc. It will generally support the EU integration process, both strengthening and enhancing linkages between new and old EU member states, and strengthening the capacity of SU, and of the Bulgarian industry to withstand the competitive pressure of former EU members. Evidence shows-consistently, and over time-that countries that invest heavily in education and skills transfer (training) benefit economically and socially from that choice. For every euro invested in attaining high-skilled qualifications, taxpayers get even more money back through economic growth\textsuperscript{23}. The above mentioned ensures that SISTER economic impact to Europe is positive and the added value high in any case. In addition, taking into consideration that some of todays researchers are tomorrows professors, R&D managers or even business executives. As a result training of young researchers today will have multiplying effects tomorrow with strong economic impact.

Finally, within the SISTER project will be provided grants for attending its conferences and training courses to researchers coming from Western Balkan countries which integration in research is considered as a special EU priority. They will gain more knowledge about European research and innovation in ICT, and the theory and practical models of academia-industry collaboration in Europe. The researchers will have the opportunity to establish new partnerships which may assist they future mobility. Thus, the project will support also closer international research collaboration, especially with researchers coming from Western Balkans. The goal of SISTER project to foster industry-academia collaboration, and its subsequent objectives, would have a substantial impact on further strengthening the European competitiveness. First, the project will build new knowledge and competences of researchers for knowledge and technology transfer with industry, for establishing new support structures, for better utilization of research results, and transforming scientific results into new products, processes and services. Second, it will enhance the collaboration between research and industrial organisations and networks in Europe. All this would result in achieving the goal Europe to become the "most dynamic and competitive knowledge-based economy in the world". SISTER will enable the FMI researchers to integrate to biggest extend to the partners research projects and to contribute to value-adding advance research on European level. The research topics including systems interoperability, technology convergence, new business models and Internet services are crucial for reinforcement of European capacity in the field of ICT. The researchers of FMI will work as well to improve the access and mastering of digital content, migration of content and more efficient technologies implementation in the processes of TEL and knowledge acquisition, competences and skills, improving productivity of the European knowledge workers.

SISTER focuses on several dissemination activities, which will contribute to sharing knowledge and experience in the ICT.
research and practice. On-line and off-line tools will be used in order the on-going work and the achieved results to be spread out of the limited scope of the research unit. Several scientific events (seminars, conferences) will serve as an important tool for dissemination of scientific information and results and facilitating the communication between ICT research teams and industrial partners in the country and in Europe. Through the dissemination activities the impact of SISTER on other audiences will be made more operational. SISTER will provide a broad forum for discussions on ICT research with public authorities, SMEs, professional associations, researchers, etc. Within the dissemination activities, the project will focus also on strengthening the international linkages, not only with MS, but also with the Western Balkans, Russia and the NIS countries, and building stable linkages for enhanced participation in the FP6. At the same time, the dissemination activities will help increasing the visibility of the ICT research results not only among scientists, but also in industry and society.

List of Websites:
http://www-it.fmi.uni-sofia.bg/sister/index_en.htm

Related information

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