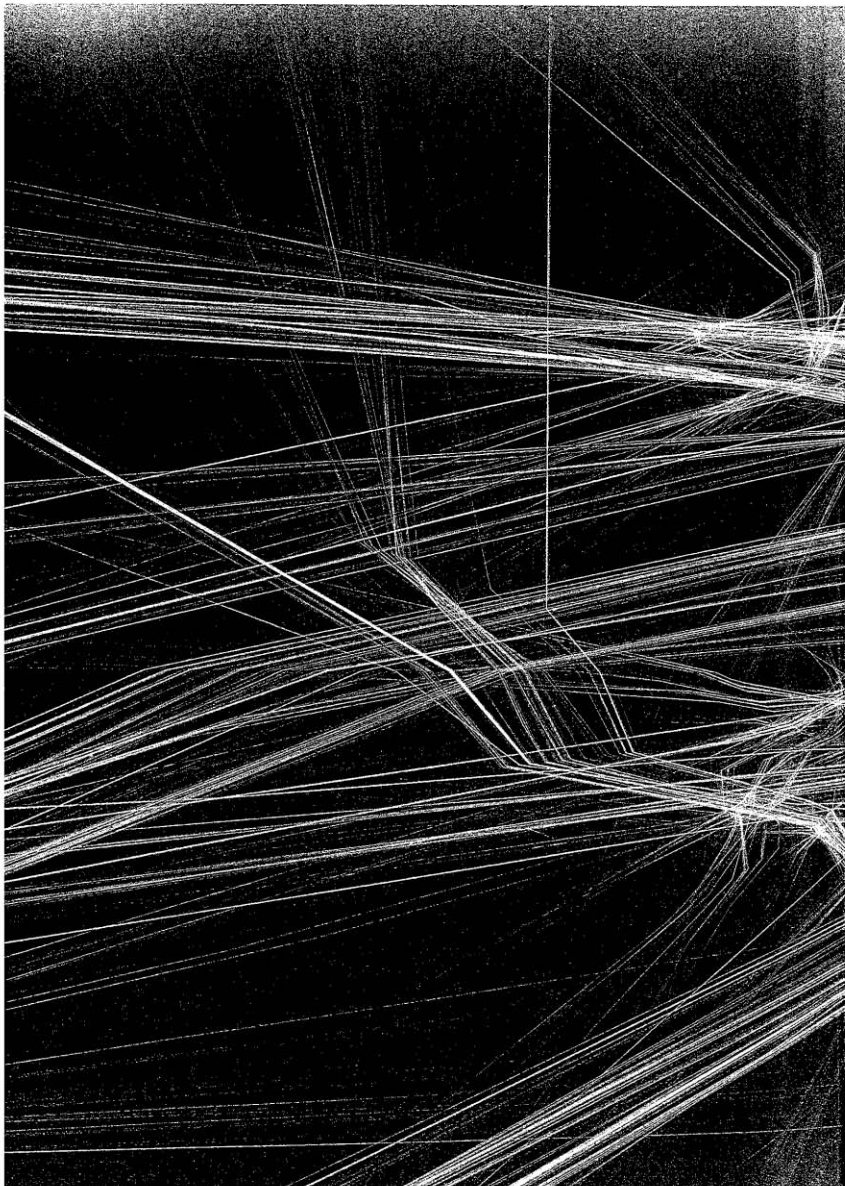




GOVERNMENT OF ROMANIA
MINISTRY OF EDUCATION AND RESEARCH
NATIONAL AUTHORITY FOR SCIENTIFIC RESEARCH

**NATIONAL RESEARCH, DEVELOPMENT
AND INNOVATION STRATEGY,
2007 - 2013**



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Introduction

The National Research, Development and Innovation (RDI) Strategy 2007-2013 is based on the vision of the Romanian society concerning the role of science, technology and innovation for the development of the knowledge society in Romania, targeting the economic and social progress. Taking into account the fact that Romania is member of EU from 2007, the RDI Strategy also provides the consistency with the main specific political documents at the Community level.

The Strategy valorises the results of a broad and unique exercise of Romanian society, which involved the communication and negotiations among the main stakeholders of the RDI system. The Strategy is the essence of a dialogue concerning the role of science in society, developed within the first national foresight exercise in science and technology, a systematic, collaborative and prospective exercise which took place in 2005-2006, at the initiative of the National Scientific Research Authority (ANCS). The consultation with the relevant institutional actors, generated several potential priorities for the public investment in research, which were obtained by identifying the main social and economic issues of Romania. Afterwards, more than 800 persons, from research institutes, universities, academies, enterprises, professional and employers' associations, NGOs, and representatives of the public central administration, participated to workshops. Over 5000 persons answered to electronic surveys. All prospective consultations led to a list of 25 priorities, grouped in areas, which are described in this document as public research investment priorities, and where the space and security area has been also introduced. The scientific community analysed the fundamental research areas where Romania has results, international visibility and potential for future development. Priorities in the reconstruction of the national RDI system have been identified and has been prepared a long-term RDI system vision document.

To prepare the Strategy, a broad analysis of the current state of the Romanian RDI system was performed too, including strengths, weaknesses, opportunities and risks, taking into account the actual national social and economic context, while also considering the globalisation and the integration into the European Union. Representative personalities in the fields of science and technology, economy, civil society, central and local public administration, and non-governmental sector were consulted, and they identified deadlocks in the system and directions for intervention. The statistical data have been supplemented with two polls, one concerning the RDI personnel activity and professional career (over 1000 persons: researchers, managers of RDI institutions and companies), and the other one concerning patenting in Romania (over 600 patent owners, natural and legal persons). The legal framework and the state aid issues were analysed. The result of the whole approach is a broad study concerning the current RDI status in Romania, including recommendations for future actions. More than 70 experts contributed to the preparation of the study.

Domestic and international studies and reports were consulted, success models of economic and social development, statistical data and RDI strategies and strategic plans were analysed. The result was a strategic study underlying this document. More than 40 experts participated to the preparation of the study.

While preparing the strategy, the complementarity, synergy and close connection to national economic and political documents, strategies, plans, including the National Development Plan and the National Strategic Reference Framework, were taken into account. The strategy in the field of education, in particular as regards the higher/tertiary education, will have to be correlated with the RDI Strategy.

The Strategy reaffirms the role of the state in the field of RDI, i.e. to lay down the conditions and to induce on the one hand the creation of knowledge, and, on the other hand, the application of knowledge for society's interest, through innovation.

The Strategy provides the ground for RDI system's organisation and defines the main areas and the way in which the public investment will be concentrated in research & development to support innovation in the coming years.

This strategy establishes the basic principles in the field of RDI: ex-ante evaluation of policies and actions; international evaluation of policies, programmes and projects implementation; international evaluation of public institutions (universities and research institutes); correlation between performance and institutional funding; career promotion based on internationally-recognised professional performance; support for researchers mobility; involvement of young doctoral students, post-doctoral researchers, and experienced, performant researchers of any nationality; increase of scientific cooperation connections with the Romanian scientific diaspora; development of international cooperation and support for the participation to programs and projects; support for innovation, also by increasing the public demand for innovation; increasing the share of state aid dedicated to innovation support; constant dialogue with society.

The Strategy will be implemented through specific instruments. Among them, the National Plan for Research, Development and Innovation has an important role. The evaluation of the Strategy's implementation will take place with an international participation and will contribute to its review.

With this strategy, Romania demonstrates its political decision to build a knowledge-based society, open to international values and competition. International cooperation and partnership in advanced research will be fostered, for the topics of general scientific and technological interest, emphasizing the fields where they can contribute by solving the national scientific and socio-economic problems, while providing the desired competitive level of the Romanian RDI system.

The Strategy has the main goal to eliminate the disparities as compared to the European countries and to prepare the Romanian RDI system for identifying and consolidating, through international openness, partnership and competition, those unique areas where Romania can excel.

1. Current status and challenges

1.1. International context

The creation and use of knowledge have become vital sources of boosting the global's wealth. Besides, knowledge is the central element determining competitiveness and, as such, the countries of the world, in particular the developed ones, have engaged for generating it in a systematic way, developing sophisticated national systems and international interactions.

The intensification of the globalization has led to an increased importance for the international cooperation and to the explicit exchange of knowledge and has created strong international scientific communities, without reducing the importance of the complex of local factors in adapting and using knowledge.

In that environment, both collaborative and competitive, the significance of excellence raised exponentially. The entities and individuals reaching the excellence level become extremely valuable, as they have the ability to attract resources and to influence both the scientific environment and the socio-economic systems. That is exactly the reason why the developed countries work hard both to attract brilliant scientists and engineers and for reaching the critical research mass in strategic fields.

Universities, RD public institutes, other entities involved in research play an important role for gaining excellence. They are challenged to turn into important actors on the knowledge market, attracting and developing top human resources and concentrating substantial research facilities. The involvement in research and the closer connections with the economic environment have generated not just additional income, but intrinsic elements of the education and training process too.

In the education-research-innovation knowledge triangle, the latter element is the one most closely associated with the impact on welfare, but in the same time the most problematic as regards the connected policies. Innovation, which is a process with many variables, is centred around the cooperation between research and industry. In the last decade, developed countries have proposed intermediary entities or forms of interaction and cooperation establishing bridges between these two sectors, providing those entities increased public financial resources.

The European Union made efforts to reduce the economic growth gap as compared to the United States, putting the RDI domain at the core of those efforts. The review of the Lisbon Strategy in 2005 reinforced the Barcelona target to allocate 3% of the GDP for research&development in the European Union. Most European states have already rallied behind that objective; however, the level of private investments is still seen as too ambitious.

Now, the main challenges for the European Union in order to enhance the capacity to innovate are related to the insufficient concentration in poles

of excellence able to compete at a global level, the poor integration of the elements in the knowledge triangle, the insufficient trans- and interdisciplinary research focusing on innovation needs, the absence of models of research and education governance and organisation at European level, the high patenting costs in the EU and the low level of researcher's mobility.

Starting with the Lisbon Program, the European Union has launched for the period 2007-2013 a set of initiatives regarding research and innovation, the global competitiveness of universities and research institutes, the development of entrepreneurial skills and the transfer of knowledge into goods and services. At Community level, the established policy guidelines have the correspondence in the programs provided within the Financial Framework 2007-2013, respectively:

- ☒ The Seventh Framework Programme for Research, the main instrument supporting research & development activities, transnational cooperation in the field, frontier research (coordinated by the European Research Council) and the networks of excellence, the European technology platforms (interest groups, mainly companies and research entities, defining together the strategic research agendas and which are able to launch Joint Technology Initiatives, involving substantial public and private resources).
- ☒ The Competitiveness and Innovation Programme, which supports innovation and development in SMEs, providing financial support (in particular for start-ups), for sustaining of transnational technology transfer network and many other initiatives, however without involving research or education activities.
- ☒ The Programme Education and Training 2010, offers the support for Member States for adjustment of the education and training system in order to achieve the Lisbon goals, including for this purpose a mobility and cooperation component.
- ☒ The economic and social cohesion programs, where the Member States or, more precisely, the regions are supported with substantial funds in order to reduce the structural gaps, and where the RDI area is a recommended priority.

1.2. Internal context

The Romanian RDI system went across a very difficult period after 1989: the underinvestment and delayed restructuring only permitted a connection to the global trends in science and technology in isolated cases, and the still fragile enterprise sector in Romania could not exert a real innovation demand. Practically isolated, the R&D system fragmented, as the various components tried to survive with the minimum available resources, mainly by public funding, within mostly formal and autarchic systems.

Due to chronic underinvestment, the number of researchers decreased drastically from 1990 to 2004, while the average age of scientists increased. The low attractiveness of the research career determined qualitative losses of the human resources and made it extremely difficult to attract top young people into research. Many performant researchers choose to leave the country. The low wages in RDI system might be considered as main reason for the low attractiveness, but in reality the reasons are complex, and they are connected to the delayed institutional reform, the poor quality of the research & development infrastructure, the absence of an evaluation system fostering and compensating the real performance – the excellence. One of the strongest reasons could be considered the absence of clarity and transparency concerning the professional career.

However, Romania still has human resources and long tradition in several areas of science and technology, and the current strategy creates the basis for recognition and fosters their development.

Furthermore, the funding level had a negative impact on the maintenance and development of the research infrastructure needed for advanced research, for the achievement of valuable results at the international level and for the solving of complex problems of national interest in the economic and social fields. The impact was negative and affected mainly the international cooperation and the participation to European research projects and networks, generating isolation, disconnecting Romania from the main European research goals and reducing the access to performant products and technologies, necessarily to the Romanian industry and services. The managerial ability and the absence of minimal institutional resources for supporting research laboratories generated disfunctionalities even in places where there was a performant infrastructure. The low degree of utilization was also generated by the reduced capacity to provide requested services, especially to the economic operators.

The modest results and the weak international cooperation capacity are reflected in the low number of articles in mainstream scientific publications, and citations of the scientific results published by Romanian authors, and in the lack of interest towards the protection of intellectual property. The

extremely low number of patent applications with Romanian authors, both domestically, but in particular in Europe, USA and Japan confirms this situation.

Although the RDI system did not succeed to generate impressive examples in transferring research results into the social and economic field, it has managed to preserve or develop actors (among them universities, institutes, research teams) with a clear international visibility and that may become or already are poles of excellence.

The project-based funding, by competition, which was launched in 1995 and was expanded in 1999, generated essentially an increase of performance and a change of attitude regarding the access to resources. The evaluation criteria have been more and more directed towards a scientific performance proven by the researcher (articles in the mainstream publications at the international level, cited scientific papers, papers presented at top scientific conferences conferring a high professional prestige, patents, participations to projects awarded by international competition), and towards the novelty and credibility of the proposed research topic, with a potential impact on knowledge. In addition, the criteria are directed towards the institutional ability to provide the appropriate environment and infrastructure needed for establishing and developing strong research groups having an international visibility, providing the adequate framework to prepare young researchers through doctoral and post-doctoral programs.

The public funding of the Romanian research & development showed a radical changes starting with 2005, together with the first substantial increase in the GDP share assigned to that field. The GDP share of the public expenditures allocated to research & development was doubled in 2005-2006, with a subsequent increase target of 1% in 2010. The CEEX-Research of excellence program launched in 2005 by the National Authority for Scientific Research has contributed to direct public expenditures for research towards developing the Romanian Research Area and preparing the Romanian research&development community for the successful participation to the next EU Framework Research Programme, FP7, for the period 2007-2013. In the CEEX program, the priorities of the public R&D funding were those from FP7, and the projects focused on the creation of powerful consortia, the promotion of interdisciplinary research, the development of human resources, the international promotion of the Romanian RDI system, and the reinforcement and the development of infrastructures for conformity evaluation and certification. The program provides convergence with the European level and practices; however, it could not give sufficient focus for the public investment. The CEEX impact on the growth of the private R&D expenditures is expected to be important, but it cannot be estimated yet.

In a wider context, the innovation culture is still low, both in the enterprise

field and in the academic environment. The enterprise innovation level has not been consistently supported by an operational technology transfer system, and the risk capital may be considered absent. The overall level of in-house research & development activity is not known precisely, in particular due to disincentives for recording expenses. On the other hand, there are several examples of large companies which opened research centres and developed high-tech services in Romania, which represent an important asset for what this strategy aims to. As regards the interaction with the international environment, the considerable technological lags in comparison with developed countries foster the technology import, not innovation. Also, the risk that transnational companies, which purchased or developed production equipment in Romania, to delocalise their RDI activity is well known. The lower cost of research activities in Romania might be a short-term advantage, but it creates an additional risk related to the "brain drain" in the globalization context.

The high concentration of RDI institutes and enterprises in the capital city and the level of research in universities, far from the potential it could have, are the essential determinants of the regional disparities in the absorption of the public R&D funds.

Yet, the RDI system has real opportunities for the period 2007-2013. The EU integration creates a pressure directing competitiveness towards innovation, and the anticipated economic growth might support the involvement of the private sector in the field. The political commitment of 1% of the GDP for public R&D expenditures, a main commitment related to Romania's answer to Lisbon Strategy, is very important. The structural funds aimed to renew and develop the human resources are complementing the public investments in tertiary education and R&D and will have an important role in the social and economic development of Romania, including the reduction of regional disparities. The current Strategy proposes an essential contribution for establishing the regions of knowledge in Romania.

The educational system, due to its contribution to the development of the research and innovation interests and skills of the young people during their education in the field of science and technology, to the initial training of the researchers (emphasizing the number and quality of doctoral students), and to the quality of tertiary education, is an essential complementary component.

Starting from the national situation and the international background, the transformation of the RDI system in agreement with the long-term vision requires answers to challenges such as: development of the human capital to react to the need of RDI competitiveness; an increased attractiveness of the research career in order to attract performant researchers in the universities and public research institutes, and top young graduates in the

doctoral programs; a decreased fragmentation by fostering cooperation in a highly competitive environment; focusing of the public research investment; orientation of the RDI investments towards results at the frontier of knowledge and solving the issues of national relevance or with direct applicability in the social and economic practice; development of an adequate RDI infrastructure, and also an increased degree of its utilization; an improved success rate in international projects and an increased return of the investment to the EU framework research program as well as the development of international cooperation.

With the RDI strategy for the period 2007-2013, Romania intends to reach the European average for the basic indicators describing the structure and performance of the research, development and innovation system, laying down the bases to focus in the future on niche areas, where Romania would have the critical mass and the performance level needed for leadership. Meanwhile, the strategy intends to support the social and economic development of Romania, with a real opportunity to create a knowledge-based economy, competitive at the global level.

2. Vision

The RDI system will be the engine for the development of the Romanian knowledge society, with the capacity to sustain performance through innovation in all areas contributing to the welfare of the citizens, while reaching scientific excellence recognized at international level.

Romania builds a knowledge-based society, focused on solving problems arisen from the demand to innovate, as expressed by economy and society. To respond to that challenge, the RDI system will be open to the Romanian companies, to the international scientific environment, to the societal needs and the educational system.

Ensuring a real openness will depend on the way the knowledge demand will be concentrated and directed towards the RDI system, within the thematic priorities reflecting the medium- and long-term social and economic needs. Thus, the demand corresponding to the innovation needs in the economy will be expressed by mechanisms where the initiative belongs to the companies, while, as regards the need to filter the societal needs of innovation, mechanisms and interfaces, specific to the science-society communication, will be set up. The central and local public administration will be able to make specific innovation requests, according to the national, regional and local strategic objectives and priorities. The public procurement and the introduction of advanced technologies in various social and economic sectors will have a substantial contribution to the RDI development.

The correlation of the national need of innovation with the evolution of science and technology in the world will take place through research-action networks, where the multidisciplinary international cooperation will be targeted to the resolution of specifically identified problems. Brokerage centres and technology transfer and knowledge centres will provide the interface between the domestic need for innovation and the solutions that may be adapted from the global knowledge stock.

The companies will create their own research structures or only interfaces ensuring their integration in open innovation systems and the participation to centres of competence or technology platforms. The universities and public research institutes will develop their own structures capitalizing knowledge and ensuring its transfer into innovative products and services. The technology transfer centres and the high-tech incubators will foster the transfer of knowledge and the development of the entrepreneurial skills. The evaluation of the commercial potential of an idea, the protection and licensing of the intellectual property right will be common elements of innovation management.

The educational system will develop the specific abilities needed for research, in particular multidisciplinary research. Its interconnection with the RDI system will allow the selection, motivation and support of best young people for a research career, both in the public and private sectors. The international mobility will be a key dimension of researcher's training. The intersectoral mobility mechanisms will ensure an effective knowledge and expertise transfer between the public and the enterprise research. In the same time, the universities will be stimulated to establish excellence research institutes in strategic areas, doctoral and postgraduate schools.

3. Strategic objectives of the RDI system

The RDI system in Romania has the role to develop science and technology, in order to increase the competitiveness of the Romanian economy, to improve the social quality and to enhance the knowledge likely to be valorised and to be used for expanding the horizon of action.

To fulfil this role, the RDI system has three strategic objectives:

1. Knowledge creation, i.e. getting high level scientific and technological results, competitive on the global arena, targeting the increase of the contribution of the Romanian RDI system to the development of the global knowledge stock, the increased international visibility and the transfer of the results in the economy and society. Reaching that objective means the integration into the international networks and the full support for research excellence. Internationally recognized schools of excellence will be supported, having the critical mass and the needed facilities for high performance research, experience in training young researchers through doctoral studies, and good conditions for young post-doctoral researchers. Poles of excellence will be established, by financing projects proposed by personalities with the highest potential, recognized at the international level, in particular young ones. The training of young researchers in doctoral or postgraduate schools of excellence will be specifically emphasized, and that would provide them an appropriate training and the development of the ability to carry on advanced research. For that purpose, the schools will have to attract performant researchers, experienced in supervising young doctoral students, of any nationality.

2. Increase competitiveness of the Romanian economy through innovation having impact upon the economic operators and the transfer of knowledge into economic practice. This objective concerns the achievement of high level technological results, complex problem solving research of local, regional or national relevance, or requested by the economic operators, as well as the development of innovative technologies, products and services, with direct applicability. Partnerships between universities, research institutes and economic operators will be fostered. The competitive establishment of Centres of Competence and Technology Platforms will be supported, with medium-term financing and/or co-financing, from five to seven years. The financing schemes will consider the issues related to the state aid for RDI.

3. Increase social quality through the development of solutions, including technological solutions, generating direct benefits for the society. This category includes solutions to local, regional and national problems, to social cohesion and dynamics, an increased effectiveness of the policies and issues related to health, environment, infrastructure, land management and utilization of national resources.

For reaching these three strategic objectives, the following specific objectives will be considered:

Increasing performance

- ☒ Reaching scientific excellence results, reflected by an increased number of articles in mainstream publications; a ranking among the first 35 countries in the ISI-indexed publications (the rank from 1995 to 2005 has been 48);
- ☒ A 10 times increase of the EPO patents per 1 million inhabitants until 2013 (with a reference of 1.72 in 2003, compared to the EU25 average of 137);
- ☒ A three-times increase by 2013, as from 2006, of the patents registered by the National Office for Patents and Marks (OSIM) and an increased share of high-tech patents;
- ☒ A double share of innovative enterprises (which represented 19% in the period 2002-2004, according to the Community Innovation Survey).

Development of system resources

- ☒ A three-times increase of the number of researchers until 2013, together with the decrease of the average researcher age below 40 years;
- ☒ Provision of an average annual number of 2000 doctoral scholarships;
- ☒ An increased share of PhDs and doctoral students, up to over 50% of all researchers;
- ☒ An increased interest for the research career by providing access and career development facilities for performant researchers;
- ☒ Attracting experienced researchers, and young post-doctoral and doctoral researchers of any nationality, while turning Romania into a destination of interest for scientific excellence;
- ☒ An increased access to performance research infrastructures through the participation to large international research infrastructures, the development of research facilities of national relevance, and through support for establishing performant laboratories with multiple users.

Involvement of the private sector

- ☒ The increase of the private research & development expenditures up to 1% of the GDP until 2013;
- ☒ Stimulating the participation of the private sector in RDI activities, with a view to increase the capacity for innovation, technological development and industrial up-take of research results;
- ☒ Development of public-private partnerships in science and technology by establishing centres of competence, technology platforms, scientific parks and specialized interfaces between the RDI demand and supply;
- ☒ A simplified access of innovative enterprises to the RDI financing schemes directed towards co-financing and support for their cooperation with research done in universities and public research & development institutes.

Increasing the institutional capacity

- ☒ Reducing the RDI system fragmentation by fostering the cooperation and participation to national and international networks, thus providing the critical mass and valuable results at the international level.
- ☒ Transformation of the Romanian universities and public R&D institutes into actors on the international knowledge market and the increase of their capacity for being able to cooperate with the companies;
- ☒ Research management professionalization;
- ☒ International assessment of research performance for all public actors, universities and public research institutes;
- ☒ Reinforcement of the role of science in society through science communication, promotion of ethics and equal opportunities in the field of research, development of interfaces dedicated to science-society dialogue.

Expansion of international cooperation

- ☒ Expansion of international cooperation in programmes and projects;
- ☒ A better representation of Romania at the institutional and expert level in institutions and representative RDI bodies at the European and international levels;
- ☒ Participation of the Romanian scientific diaspora to research projects to promote the Romanian R&D sector, and for evaluating projects, programmes and policies.

4. Exploratory and frontier research

Romania will support advanced research, directed towards world-class scientific results, will encourage the development of the research career and the establishment of poles of excellence.

Taking into account the significance of fundamental research for knowledge development and the training of highly skilled human resources, the excellence, the interdisciplinarity and the international visibility will be emphasized. Complex research in frontier areas and the participation to international excellence research networks will be sustained. Following the scientometric analysis results, and in accordance with the situation of the current infrastructure in the poles of excellence and the capacity for increasing the scientific production with international visibility, such as they resulted from the consultation of the scientific community, the following traditional fields in the Romanian scientific research, also having a special potential, have been highlighted, namely: biology, genetics and medicine; chemistry, environment and material science; mathematics; physics and technological physics; geology and atmosphere physics. While concentrating the investments in these fields, the Strategy will also support new areas, where Romanian research teams already cooperate at the international level. Social sciences are concerned too.

The relevance of that type of research is for the long term. There are no priorities established for the funding of research topics, as the proposals would come from the researchers. The evaluation will be in the peer review system and the panels will include international participants. Advanced research may be directed towards strategic or technological priorities, as necessary for solving complex problems, with social and economic impact.

In this context Romania will aim the development of human resources able to integrate into the international scientific debate mainstream. That means attracting scientific personalities, adequately funding exploratory research, opening training opportunities in all stages of professional career development, providing access to adequate research infrastructure, but also intensifying the international cooperation.

Increasing the attractiveness of the research career, in particular for young people, is a critical element of the current RDI system, where the researcher / population proportion is only a third from the average of EU Member States. For the period 2007-2013, the goal will be to increase the interest for research career, in particular with scholarships and access to research grants during the initial training of the researchers through doctoral studies (fostering international co-tutelle and mobility), and with post-doctoral programs, mainly in interdisciplinary areas.

The consolidation of doctoral schools and the establishment of postgraduate schools will have an impact on the quality of doctoral programs and research, contributing to the preparation of research performers.

The crisis of human resources for research imposes as main priority both to attract young people for the research career, as well as to attract experienced researchers from abroad. Particular attention will be given to the Romanian scientific diaspora.

The training during the research career development will be directed towards stages in the country and abroad, always associated with research projects. In the same time, the cooperation with financing agencies from other countries in order to co-finance the doctoral and post-doctoral studies for promoting the return of the scientists at the end of the grant, will be considered. Funding mechanisms will be developed, for stimulating the research institutions to provide those researchers appropriate jobs.

In addition, for personalities with world-class scientific results, adequate financing will be provided, for establishing excellence centres in Romania.

The development of the research infrastructure will be supported, by increasing the degree of utilization and by expanding the existing infrastructure, as well as by establishing new facilities. Experimental equipment dedicated to research aiming at knowledge frontier is in general very costly and therefore the investments will be focused in those areas where there is an adequate potential for utilization, regional cooperation being included. For the areas where there are already research facilities at the European level, and where the internal need for utilization is not systematic, there will be funded projects ensuring the access of the Romanian researchers to those facilities.

During the period 2007-2013, the development of the research infrastructure will take place in particular by associating large experimental facilities to universities and public research institutes, in order to increase their contribution to the development of the human resources for research.

The world-class research has to be based on international cooperation, which is important not only for educational processes but also for the potential to produce intellectual property rights. Thus, during the period 2007-2013, the projects based on international partnership will be developed within international programs and also by using joint calls for projects launched together with other countries and based on common interest topics, as well as just within the cooperation projects launched by the scientific community.

The constant evaluation of the Romanian scientific journals and the support granted to the top journals, in order, among others, to co-publish together with publishing houses of international stature, to meet the conditions to enter the internationally indexed databases and, in the longer term, to increase their impact, are seen as prerequisites for increasing the international visibility of the Romanian scientific research.

There will be a strong focus on the better integration of the Romanian scientific community into the international scientific environment, through the broad access of the researchers to information resources, participation to international conferences, organisation of international scientific conferences in the country and, finally, through the participation to European scientific clusters and technology platforms.

Summary of strategic directions for action

- Fast increase of the number of researchers, by involving young people in research projects with training and education content and by attracting researchers from abroad
- Improving the integration of the research personnel into the international scientific community by ensuring the international mobility, the organisation and participation to international scientific conferences, an improved international visibility of the Romanian scientific publications and by providing a broad access to information resources
- Support of research projects with an international scientific relevance, in particular those involving international cooperation
- Provision of access to the research infrastructure through a combination of investments provided to the universities and public research institutes, an increased visibility of the existing infrastructure and the international mobility of researchers.

5. Priorities of the public investment in research & development

Romania will support complex research responding to clearly identified problems within the public research & development priorities.

The priorities of the public R&D investment reflect the result of the exploratory exercise, the first Romanian foresight exercise in science and technology, carried on from November 2005 to June 2006, with a broad national participation. There are nine priority domains having a substantial potential to lead to economic and social progress, and each comprising several priority themes.

Advanced research in strategic and technological directions will be financed, in particular of the problem solving type, with potential implications in innovation. The public investments consider the development of knowledge in relation to the strategic social and economic needs, and the research is evaluated according to its innovative capacity. Innovation is the one that fosters the establishment and preservation of multiple interfaces between science, technology, society, and the financial, information and political sectors in a knowledge-based economy. Most priorities of the public research-development investment are also relevant for fundamental research.

The development of poles of excellence will be targeted within the nine priority areas. That process will be completed gradually, based on competition, and the public investments will focus on projects having a major impact, while focusing the development of infrastructures and collaborative structures in the areas which can provide the best results.

The implementation of such complex projects will require a significant management effort regarding the organisation of research & development activities, contract management, financial management or intellectual property rights management. The professionalization of research management and administration in universities, public and non-profit research & development institutions will be targeted, e.g. by fostering the participation in European and global professional organisations providing an exchange of good practices, cooperation and transfer of knowledge.

The development of experimental facilities supporting the applied research will concentrate in those areas where the cooperation between the research entities and the beneficiaries may be ensured. The investments in equipment, in particular expensive equipment, will also have to consider the potential for utilization, the development of human resources and the complementarity with the facilities existing at European level.

The development of human resources in the context of national priorities will

aim at the achievement of an expertise level permitting the correlation of the knowledge regarding the global technical developments with the possibilities of national adaptation. The research projects will have to provide the necessary conditions for the exploitation of the performance related to research career stage of the participants, ensuring their further development, in particular through domestic and international training stages.

The establishment of poles of excellence in the form of interdisciplinary research networks and, in particular, centres of competence, will be a target. To avoid the formalism of such entities, a gradual financing strategy will be approached, on the project-network-centre of competence direction.

The priority areas, while not being ranked according to the importance, are as follows:

a. Information society technologies

The information society technologies are both a transversal support for all economic sectors and an industry (Information Technologies and Communications – IT&C) having an extraordinary dynamism. Therefore, the initiative i2010 – A European Information Society for Growth and Employment recommends the Member States to double their IT&C research. Although there is a several-year gap between the Romanian and the EU information societies, the software sector has proven to be very active, as it has become one of the most competitive economic sectors. In agreement with the objectives in the National Export Strategy concerning the IT&C area, the period 2007-2013 requires an increased capacity of the RDI Information Technology and Communications sector to cater to the needs of the Romanian industry to provide new goods and services and to take advantage of the gradual outsourcing trends of the international customers as regards the design and innovation activities, gradually moving from small value software and service export to the design of new IT goods and services with a high added value. In addition, the research will have to support an involvement of the IT&C sector in closing the gap in the development of the Romanian information society.

The research objectives will consider the development of technologies and tools for the achievement of effective, opened, heterogeneous, scalable, failure-tolerant IT systems and applications with a good connectivity between users and resources, the development of support technologies needed for the establishment of an integrated national communications infrastructure, the development of artificial intelligence methods and systems, the achievement of products based on research in nanoelectronics, photonics, micro- and nanosystems, in the range of intelligent components and systems.

b. Energy

The Romanian energy sector, an integrant part of the infrastructure, decisively influences the national economic and social development. The European Union has proposed the goal according to which, by 2010, 21% of the electricity would be provided by renewable sources, while a new directive aims for a 9% reduction of the energy intensity in the following years. According to Romania's 2006-2009 Energy Policy document, the Romanian energy intensity is about four times higher than the EU average. Romania has a substantial potential of renewable resources: hydroelectric power, biomass, solar, wind and geothermal power. The connection to the European objectives, but also the direct interest in solving those complex problems, require an RDI effort complementary to the direction of action "Increased energy efficiency and sustainable development of the energy systems" included in the National Strategic Reference Framework 2007-2013.

The research objectives for 2007-2013 concern the preparation of designs, technologies, goods contributing to the meeting of the energy needs at the lowest possible price, also through the use of new energy sources and an improved decision-making process, an increased technology expertise and the promotion of knowledge and technology transfer in the energy field, in order to meet the energy needs of a modern economy and a high living standard, while safeguarding the food quality and safety requirements and observing the principle of sustainable development.

c. Environment

The economic development generates an enormous environmental pressure, and the decoupling of the two involves more and more complex technical solutions, which have become itself an industry. Innovation may contribute to a lower pollution and to the attainment of the Kyoto Protocol objectives Romania has committed to, i.e. an 8% reduction of greenhouse emissions in the period 2008-2012 (compared to 1989). Research on the influence of climatic changes on the hydrologic cycle will be supported, as provided in the National Flood Risk Management Strategy. Research and development will be able to contribute to the attainment of the National Waste Management Strategy objectives. While preparing and implementing the National Plan for Protected Area Management, the substantial contribution of the research & development to the fulfilment of the established goals will be taken into account. R&D may contribute to a balanced spatial development also through integration and cooperation within the European research system in the field, which is coordinated by the ESPON programme (European Spatial Planning Observatory Network).

The research and development objectives for the period 2007-2013 regard the following: development of clean product and process technologies, applicable in particular to constructions, transportation and energy production, and of economic and social mechanisms for their implementation; development of new environmentally efficient technologies of waste management, by using the product life cycle analysis in assessing the environmental impact; development of scientific

and technological support for the preservation, reconstruction and reinforcement of biological and ecological diversity; stimulation of sustainable land management for a correlated and coherent socio-economic development; the impact of various policies and strategies by creating national and regional spatial scenarios having as objective the European territorial cohesion.⁹

d. Health

Health is a dimension with a particular social impact, as regards both the involvement in the quality of life and the contribution to the employment level of the population. The still high proportion of public expenses to ensure the quality of life for chronic patients (cardiovascular, cerebrovascular, neurodegenerative etc.) particularly presses the research activity with very precise targets. The attainment of those targets of "applied research" is impossible without an adequate development of the research concerning the fundamental biopsychological processes. The objectives of biomedical research for the period 2007-2013 in Romania largely correspond to the European and international objectives and concern more and more the integration and observance of the standards in the European research area. For the attainment of a European competitiveness level, a first stringent need of the Romanian research is the development of areas where there are human and material resources confirmed by the results obtained and recognized according to the international criteria and then to approach those new areas as soon as possible. To make research more effective, of particular concern remains the development of the infrastructure, human resources and communication and a careful choice of research directions.

For the period 2007-2013, research will be oriented towards the development of human integrative biological system knowledge; human body mechanisms of adaptation to the dynamic of biological and psychosocial environment factors; investigation and intervention methods based on molecular and cellular medicine, genomics and proteomics; development of modern therapies directed to chemical, genetic and cellular support and their standardisation according to bioethical standards; development of brain-machine interface for investigation and recovery in neurological diseases; implementation of new prevention and intervention methods at the national level, connected to the European operational area.

e. Agriculture, food security and safety

The Romanian agriculture and food industry have a remarkable potential. Romania is ranked among the first places in Europe as regards the agricultural and arable land and, although almost 40% of the active population works in the agriculture, its contribution to the GDP only approaches the 13-15% level. Meanwhile, over 14,500 companies operate in the Romanian food industry (5% of the workforce). The sustainable agriculture should be economically viable, responding to the requirements for healthy and high quality food, while guaranteeing the preservation

and rehabilitation of natural resources. The agricultural scientific research, due to its focus – soil, plant, animal – has to provide high quality biological products, raw materials, adequate technologies and knowledge, thus contributing to the promotion of sustainable agriculture and rural development, to an increased food security and safety in accordance with the general and specific market requirements.

Under the circumstances, the research objective is to develop technologies covering the entire food chain (from the soil to the consumer – "from farm to fork") and to respond to the specific consumer demands ("from fork to farm"), through scientific solutions and concepts in accordance with the principles of sustainable agriculture and ensuring the appropriate nutrition and food safety.

f. Biotechnologies

The biotechnology will mark the 21st century through its particular impact on both the development of knowledge and the development and quality of life. The research will be targeted towards deciphering the cellular mechanisms, a deep understanding of natural intelligence and towards an effective interfacing with nature. Starting from the food requirements to human health care, biotechnology will provide clean instruments and technologies for a sustainable development of the human species. The food industry, agriculture, environment, pharmaceutical industry, health, bioeconomy generally will benefit from the inter- and transdisciplinary research in the field of biotechnologies.

The research in the field of biotechnology and bioengineering will open new knowledge fronts regarding the life mechanisms affecting the new bioengineering systems, intelligent and cognitive systems for the modelling, management and monitoring of complex processes. The interaction of the biotechnology with the main fields of knowledge will generate new interdisciplinary research with a major impact on the sustainable global development.

The main biotechnology research areas, considering the current level of knowledge, target as follows:

- ▣ design and development of new medicines having both maximum effectiveness and minimal side effects;
- ▣ preparation of diagnostic protocols and medical treatments with impact on the health state and the increase of the life expectancy;
- ▣ development of new technologies for the production of foods with a maximum safety as regards the human health;
- ▣ design and development of advanced technologies in the field of pharmaceutical products and biocatalytic groups, and for the realisation of new enzymes and micro-organisms;
- ▣ research and development of bioinformatic systems for the modelling and monitoring of cellular activity and processing mechanisms at the biological level, including the cognitive level.

g. Innovative materials, processes and goods

The transition from the competitiveness based on factors (labour, natural resources) or investments to the competitiveness grounded in innovations requires the development of research capacities in high-tech areas determining a high -added value, with the potential to generate exports and involve other productive sectors. Areas such as the following belong to this category: advanced materials, advanced technologies for industrial process management, high precision mechanical technologies and products, mechatronic systems and innovative products and technologies in the field of transportation.

The research goals for the period 2007-2013 will involve the development of new advanced materials, able to provide an improved product and equipment performance; an increased competitiveness of goods and processes through automation and integrated design; design and development of new technologies and high-precision mechanical products and mechatronic systems, competitive on the international market; an increased effectiveness and efficiency of the transportation system by improving the performances of the components – infrastructures, means of transportation, computer systems – achievable through the development of technologies in accordance with the temporal and spatial features of the transportation demand, while considering the intermodality as a solution for integration.

h. Space and security

The research and technological development in the space and security areas are new fields with a deeply interdisciplinary character, whose development and alignment are generated by both the technological developments and the reconfiguration of the global security in the recent decades. Together with the aerospace and military techniques, they are high-ranking capacities of the large and medium countries, while they are priorities treated together in the EU and NATO. In Romania, the existence of a significant industrial, technological and research sector, catalyzed by the membership of the country as a Cooperating State in the European Space Agency (ESA) and the uniform representation in the Euro-Atlantic organisations, represents both a market and a driver for the effective and long-term orientation of the research and technological development topics. The European Space Strategy, correlated to the common security and defence policy, made necessary to inclusion of the European space program into the Constitutional Treaty and the funding of the two topics within the Seventh Framework Programme for Research and Technological Development of the EU, in connection with ESA and respectively EDA. Besides the contribution to the development of science and national scientific capacity, the resulting goods and technologies have a specialized market for competent public institutions and through applications in commercial services such as location/ navigation / geographic information / personal security, and in the aeronautic industry and air traffic sectors. The European programs GMES (Global Monitoring for Environment and Security), Galileo (satellite navigation)

and LPIS (control of agricultural subsidies through aerospace information) provide support and are constant customers for research in those areas.

The research goals include the achievement of exploratory research, space and security applications and technologies, determined by the major international programs, by specific needs of national use and by the development of identified technological niches. The specific objectives of the multidisciplinary research lead to the development of scientific, technological and socio-economic products through the exploration and utilization of space and to the development of space, aerospace and security technologies oriented towards relevant areas contained in the national and European strategies.

i. Socio-economic and humanities research

The medium and long-term development of a country involves, beyond the provision of technologies and goods, the elaboration of concepts and approaches ensuring the structural balance necessary for equal treatment, optimum use of resources and, in general, for the sustainability of its subsystems. Romania, a country having committed to a fast pathway towards the socio- economic convergence with the European Union, requires the contribution of the socio- economic sciences to ensure a quick adjustment in the educational system, in the quality of employment and housing, organisational culture and an adequate technology absorption capacity, while observing the principle of equal treatment.

In the period 2007 – 2013, the research in the area will have to consider: the identification and resolution of the main social issues in the fields of education, housing and employment for the preparation, implementation and assessment of local, community, regional or national development projects, centred around an increased individual welfare; preparation of models for the reduction of social and human inequalities and regional disparities; use and development of the national cultural heritage, with a particular impact on cultural tourism and creative industries; analysis of the social and cultural impact of the technologies, in particular communication technologies; preparation of new management, marketing and entrepreneurial development methods for an increased organisational competitiveness; identification of the main micro-, meso- and macroeconomic problems Romania is facing in the context of internationalisation and preparation of models and methods directed to their resolution.

Summary of strategic directions for action

- Focusing the research efforts towards clearly identified problems, by involving demand representatives in the RDI projects, in particular the private demand, but also the demand of the national or regional public authorities
- Support for RDI resource concentration (human, infrastructure, organisational) in poles of excellence, able to compete at international level and involve the Romanian companies in research activities
- Incentives for maintaining the cooperation structures besides the horizon of a single project, by setting up dedicated entities

6. Innovation

Romania will support innovation projects launched by the private sector and the development of the public research entities' ability to respond to these initiatives.

Innovation is the main engine of business competitiveness, in particular in a highly competitive market, as the European one. Statistical data show large gaps between Romania and the EU concerning the innovation rates; however, the 2013 objective is to bring the share of companies introducing innovative goods or services closer to the EU average.

Innovation is in fact an outcome, where research may be just one of the sources, along with other factors such as experience, communication, marketing etc. Therefore, a consistent innovation policy needs a transversal coordination at national level.

The RDI Strategy supports that type of innovation which includes a research component, while also aiming the complementarity with the structural funds allocated to innovation. Through all proposed measures, the better articulation of the national innovation system will be targeted, as a part of the process of building a knowledge-based economy, with a consistent competitive potential.

The co-financing of pre-competitive research projects launched by companies, in particular those involving the cooperation with the universities and research institutes is the core of the actions supporting the innovation. The objective of those projects is to provide new and commercially viable products and technologies. In order to increase the capacity of companies to prepare such projects, the establishment of flexible financing schemes will be targeted, and a national portal dedicated to enterprises, especially to SMEs, will be set up, along with a partially-free training system in the field of innovation management.

Innovation will also be promoted in relation to the transfer of research outcomes, namely the turning of patents or know-how developed within complex projects into goods and services. For that purpose, the establishment and development of technology transfer entities will be supported, in particular within public research institutes and universities. Due to the cooperation relations they are developing, those centres are the key element promoting the formation of scientific and innovation clusters. Although the international practice shows that such centres cannot become important sources of revenue, the services provided lay the basis for the intersectoral researcher mobility, the use by companies of the experimental facilities in the universities and R&D institutions, and for increased chances regarding innovation and spin-off within those institutions. The success of technology transfer centres depends on the quality of specialized human resources, and, in order to support their complex training, the establishment of a system of international exchanges and sharing of good practices will be encouraged.

The innovation based entrepreneurship is another important component to be fostered in the period 2007-2013, which will be supported by the establishment of a risk capital fund, the development of innovation incubation services and the decrease of the barriers for the establishment of spin-offs. The establishment of a risk capital fund will have to be based on the principles of transparency and adequate risk management, thus involving private co-financing on the medium and long term.

The support for incubation activities will have to diversify the assistance services and, as for the technology transfer centres, they will have to better share the good practices. To create spin-offs, an objective will be the preparation of a favourable legal framework, which would maintain the academic and researcher status of those involved in such projects, thus decreasing the risks of such initiatives.

An important innovation component is the cooperation between companies and between companies and the R&D entities. Therefore, the innovative networks, the participation to European technology platforms and the development of national technology platforms in strategic areas will be encouraged. The investments in the innovation infrastructure will be focused however for the establishment of science and technology parks, in particular those benefiting from the support of large companies or universities.

The public investments in the field of innovation are essentially an element destined to involve private investments. In order to achieve, during 2007 - 2013, a more rapid increase rate for private RDI investments than that of public investments, fiscal incentives will be introduced, with a view to fiscal deductions related to projects achieved in partnership with universities and institutes. The implementation of such tools will be based on the development of mechanisms and tools making easier to more clearly record and emphasize the private investments in scientific research and technological development.

The policy in the field of innovation will aim, in the period 2007-2013, at integrating the progress anticipated at the European level in areas such as innovation in services, new regulations on RDI state aid, including those for stimulating innovative clusters, European patenting and intellectual property rights for digital content.

Summary of directions for actions

- Sustaining enterprise pre-competitive research through adequate financial and support tools
- Stimulating universities and public R&D entities to establish and develop entities of interaction with the private environment, where the experimental basis for joint projects, as well as the framework for technology transfer and personnel exchanges, will be provided.
- An increased cohesion of the innovative entities from the public and private sectors, through the development of innovation networks, participation to technology platforms and the development of science and technology parks
- Support for the innovation based entrepreneurship by developing services in innovation incubators, by improving the access to risk capital and by providing training in the field of innovation management
- Fiscal incentives for RDI investments of firms, along with an adequate mode of recording those expenditures
- An increased access of SMEs to information related to research results, to funding and cooperation opportunities, through dedicated support services

7. Implementation of the Strategy

When implementing the Strategy, the major principles of RDI governance will be observed: (i) *Social responsibility*, the provision of public funds to the RDI system has to be taken as an investment serving the wider societal interests; (ii) *Transparency*, public access to information on the policies, instruments and results obtained; access to the information on RDI funding opportunities from public funds, the development of RDI related e-governance included; simplicity and clearness of the procedures for obtaining public finance for RDI (iii) *Performance*, assessing the degree to which the objectives have been achieved, in comparison to the investments deployed.

The monitoring, evaluation and correction mechanisms will ensure the capacity to adjust and adapt the strategy in accordance with national and international developments.

The ex-post evaluation of the implementation will take place both at mid-term, in 2010, and at the end of the implementation period. The evaluation will be made independently, preferably on an international basis. The evaluation of the impact following the implementation of the strategy will provide the information needed for the formulation of future policies.

Institutional framework

The correlation of the main RDI actors' policies for the achievement of the strategy objectives and the integration of the RDI policies into the medium and long-term development strategies of Romania will be entrusted to the National Council for Science and Technology Policy. The correlation between the development of the R&D capacity and the innovation potential with the industrial development will be taken into account. The coordination during the implementation of the Strategy by various structures with roles and responsibilities in the field of RDI is a prerequisite for the achievement of its objectives.

The Strategic Planning will be provided by the National Authority for Scientific Research, which has the mission to prepare, implement, monitor and assess the policies in the RDI areas. For achieving its mission, the National Authority for Scientific Research will cooperate with the main Ministries contributing to the development of the governmental policy in the RDI area and with the Romanian Academy, with branch Academies and with the Agencies specialised in strategic domains.

In order to fulfil its tasks and to develop the level of scientific coordination, implementation and monitoring, the National Authority for Scientific Research will reinforce the institutional framework of the consultative bodies and will establish intermediary bodies financing the research, development and innovation area,

which will also ensure the implementation of the National Plan for Research, Development and Innovation. For that purpose, three public institutions will be set up, i.e. the Research Council, the Technological Development Council and the Innovation Council, evolving from the current institutional framework. Both the continuity of the activities and the reinforcement of the institutional capacity of these bodies will be ensured, with a view to the professionalization of the management, the development of the framework for international cooperation and representation and to the capacity of those bodies to become quickly operational. Transitional measures will ensure the activity during 2007.

The Romanian Academy, the Ministries and the branch Academies will prepare their own plans for the implementation of this RDI strategy.

Monitoring and evaluation

The monitoring and evaluation of the Strategy will be based on the performance indicators of the subsequent implementation plans, and on the indicators of the whole RDI system, corresponding to the specific objectives of the Strategy.

Annually, a report will be prepared and published, which would monitor the achievement of the objectives; the independent mid-term evaluation report will be published in 2010, and a post-implementation and impact study will be prepared at the end of the implementation period.

The correction of the strategy will be based both on the evaluation of the results achieved, on the system evaluation, and on prospective elements related to the development of science and technology.

