FP7 - Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007 to 2013)

Cognitive Systems & Robotics
FP7-ICT CALL 9
Q&A

ICT- Information and Communications Technologies

Workprogramme 2011 – 2012

Challenge 2, Objective 2.1, Target outcomes (b), (c) and (e).

European Commission
DG Information Society and Media
Unit E5 - Cognitive Systems, Interaction, Robotics
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http://cordis.europa.eu/fp7/ict/cognition/home_en.html

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1. Introduction

This Q&A provides additional background information on the scope, type, and size of projects expected to arise from FP7-ICT Call 9 under Challenge 2, Objective 2.1, Cognitive Systems and Robotics. The Work Programme text of Objective 2.1 is annexed to this document and is available in full from Cordis[1]. This Q&A applies only to ICT Call 9 and does not supersede the official Call documentation.

2. ICT Call 9 at a glance

Themes open in ICT Call 9		Funding Scheme
Target (b)	**Cognition and control in complex systems**	**- STReP - IP**
Target (c)	**Gearing up and accelerating cross-fertilisation between academic and industrial robotics research**	**- IP**
Target (e)	**Speeding up progress towards smarter robots through targeted competitions.**	**- CA (Coordination action)**

2.1. Target (b) Cognition and Control in Complex systems

Q: What is the main research requirement?

A: The main aim is to develop artificial cognitive systems (including but not limited to robots) that operate in dynamic real-life environments. Such systems must be capable of responding in a timely and sensible manner and with a suitable degree of autonomy to gaps in their knowledge, and to situations not anticipated at design time.

Cognition in this Call refers to implementing cognitive capabilities in complex systems. At an elementary level, such capabilities include establishing and recognising patterns in sensor-generated data. This is a prerequisite to higher-level operations such as scene interpretation, reasoning, planning, intelligent control, and complex goal-oriented behaviour. Learning, in appropriate modes, is essential at all levels.

Control refers to the general aim of making a system behave / perform in a desired way. Combining cognition and control should make a system more resilient and more autonomous in the presence of real-world uncertainties and surprises. No specific approach is either favoured or excluded *a priori*.

[1] ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/ict-wp-2011-12_en.pdf

In this call, **complex systems** refer to heterogeneous multi-component and multi-degree-of-freedom (and hence multi-parameter) systems. This notion includes (but is not limited to) robots in so far as they exhibit such characteristics. Such systems are expected to operate in real-world environments and be subjected to hard-to-predict perturbations. Without suitable control methods, such systems might exhibit undesirable and even chaotic behaviour, or not be able to live up to desired performance levels.

Perception and understanding would not be sufficient; control and action are also essential components of any complex systems expected from this Call. Issues related to monitoring, assessing, and controlling systems, where this hinges on implementing **cognitive capabilities,** are also in line with this Call.

Q: What type of research is called for: basic or applied?

A: Several types of research projects are possible, ranging from strongly basic-research-oriented or scientific proposals to more application-driven projects. However, in each case, RTD innovation, going beyond the state of the art, is the key element.

Q: What about applications?

A: The main emphasis of proposals is on scientific and technological advance – but with potential applications in mind. Such scenarios should require complex functionalities such as: exploration, monitoring, controlling all sorts of sensors, actuators and effectors, robust locomotion, navigation and obstacle avoidance, handling physical objects, and interaction with people.

Q: Should a project aim at ready-to-market products?

A: Not in the project lifetime. The development of ready-to-market products and the engineering of operational systems based on already available and proven technologies are not within the scope of the Objective 2.1 target outcomes. Rather, projects are expected to develop know-how needed to create new products and build systems that are desirable but cannot be built given our current know-how. But see the Q&A on exploitation later.

Q: How do I identify suitable research topics?

A: Generic research problems should be derived from demanding, yet realistic, current or prospective needs where even partial solutions would be of demonstrable and measurable benefit. The Workprogramme describes some of the key research issues. Annex 1 of this document contains a more detailed non-exhaustive list of relevant research questions.

Q: How ambitious should the proposal be?

A: Proposals are expected to be ambitious but realistic; therefore the proposal has to make the case for the soundness of the approach to achieve the goal. The proposal should clearly describe (a) what the state of the art is (b) what the contribution of the project will be to going beyond the state of the art and (c) how this will be achieved and measured. Where appropriate e.g. with regard to scientific / academic research, please reference the relevant literature.

Q: What kind of measures of progress do you mean?

A: Typical factors to assess progress and success in complex systems are measured for instance in terms of improved performance, precision, robustness or advanced functionalities and behaviours or cost-effectiveness and users acceptance.

Proposals should put forward concrete, achievable targets, benchmarks and performance indicators which allow the evaluation of key system properties objectively, depending on the particular R&D

issues and application scenarios addressed. In some cases, new benchmarking methods or metrics may be needed and in this respect the project should clearly state how it intends to do this.

Q: What about multidisciplinary research?

A: Cognitive systems and systems control theory research draws potentially on several different scientific disciplines and technical domains, and new combinations can provide interesting lines of approach. However projects should draw on those (and only those) scientific and engineering disciplines that are needed to achieve the project's specific goals.

Q: How do neuro- and behavioural sciences fit in here?

A: Objective 2.1 is part of a technology programme. Input from and experimental validation of the neuro-, behavioural, and human cognitive sciences can contribute towards achieving this goal – for example, by informing biomimetic or biomorphic designs, as well as design and implementation strategies. But please note that bio-research for its own sake is not within scope.

Q: What about ethical issues?

A: In this field, the most relevant potential ethical issues are linked to research involving human or animal experiments, data protection or potential dual use. Careful handling of potentially serious ethical issues is critical and proposers are strongly advised to take into account the corresponding requirements and follow the guidelines[2].

2.2. Target (c): Gearing up and accelerating cross-fertilisation between academic and industrial robotics research

Q: What is the strategic aim of Target outcome (c)?

A: It aims specifically at encouraging industry (mainly robotic manufacturers, but also users) and research institutions to work together more closely on an operational level, developing small research projects and to support technology transfer with tangible results. The broader aim is to have a systematic bidirectional exchange of views and opinions about robotic research trends, needs and technology developments.

Q: What is a project expected to do exactly?

A: Projects are expected to address a suitable mix of the following items:

(a) Propose mechanisms to reinforce synergies between academic and industry through cooperation on specific research topics of shared genuine interest in line with the EUROP Strategic Research Agenda (http://www.robotics-platform.eu).

(b) Provide a specific facility and organisational support for sharing infrastructure, encouraging and developing new cooperative projects, joint experiments, and performance evaluation.

(c) The exchange must be bi-directional. For instance, industry should provide equipment and/or scenarios to drive the research and in return benefit from research results to strengthen their competitiveness. Academia should also take advantage of this mechanism to exploit their research results, evaluate scientific progress and use it as a source of interesting research questions. Technology

[2] http://cordis.europa.eu/fp7/ethics_en.html

transfer, mutual exchange and benefit for all participants are key ingredients to be clearly spelled out in the proposal.

One possible mechanism to implement this target (c) could be to propose developing an infrastructure to organise calls for smaller projects implementing such experiments. In this case selection mechanism (and if possible selection criteria) should be outlined in the proposal and should demonstrate openness and transparent process. The evaluation, selection and monitoring process should respect the principles applied in the EU FP7 Cooperation Programme.

This kind of project also requires a carefully thought out governance model, to be described in the proposal.

Stronger partnership between the industry and academia is expected to result from this initiative.

Q: What type of "experimentation" (small research projects) could be funded within the proposed projects?
A: The projects could allow for joint enabling technology development, technology transfer, feasibility demonstration and pilots. Experiments can be proposed by industry, academia, or both.

Q: Are there any examples of how this will work?
A: Yes. See ECHORD project[3], which is one possible example but the call is not restricted to that single type of mechanism.

2.3. Target (e): Speeding up progress towards smarter robots through targeted competitions.

Q: What type of activity can be carried out under this target?
A: This target calls for Coordination Action; therefore, funding the coordination mechanisms and support tools are possible but not funding the research per se.

Q: What do you mean by "smarter" robots?
A: This is a key issue. Target (e) is not aimed at a 'nuts-and-bolts' engineering contest but it is aimed at demonstrating scientific progress.

Q: Are any specific targets or topics aimed for?
A: No, but proposals should ideally delineate the competition domain as concretely as possible, where meaningful reference scenarios or benchmarks can be developed and applied, and where comparable results can be obtained from competing approaches and systems.

Q: What are the key elements of the competition(s)?
A: Competitions primarily target researchers, but having an industrial take-up dimension would be a plus. Private sponsorship is welcome.

Open participation and transparent governance are essential. Evaluation mechanisms, and if possible criteria, should be clearly spelt out in the proposal in order to demonstrate the openness and fairness of the process. Proposals should clarify on which basis the competition will select the benchmarking scenarios, e.g. in the context of any internationally recognised and / or reproducible benchmarking scenarios.

[3] http://www.echord.info/

Competitions should be highly visible and include marketing activities. The European added-value needs to be clearly demonstrated.

The proposal should describe what impact is expected from the project (support to the community, demonstration of scientific advance, reaching out to the general public, increasing the competitiveness of European industries, etc.).

Q: **What about existing competitions?**

A: If based on current existing competitions, the project should clearly add value to these, insist on the EU dimension and justify the need for EU funds.

Q: **What about prize money?**

A: Prize money is not excluded; however it must be appropriate to the circumstances. EU funding should not be used as direct cash prize.

3. Practical hints

3.1. Proposal concept and objectives

Q: What kind of added-value are you looking for in this domain?

A: Projects should aim at work that is highly innovative, cannot be carried out at national or regional level and possibly can bring together different disciplines which have not worked closely together before. More specifically for Target(c) projects have to reinforce links between academia and industry and for Target(e) they should increase interest and visibility of the field.

Q: What key hints can you give for writing a proposal?

A: Explain WHY the research is needed – what is missing in the state of the art? WHAT will it do exactly and HOW you can progress beyond the state of the art. Emphasise what has / has not been achieved already (by you and / or by others), what you propose to overcome the shortcomings and – most important – what methodology you follow to reach your aims. Cite the key papers in the domain.

TIP – not explaining sufficiently HOW a project will reach its goal is the No 1 reason for proposal failure. Don't forget to describe also how you will assess the project's progress (including metrics)

Q: How important is system integration?

A: Integration is a major challenge, in particular for projects with different disciplines, different types of hardware, cooperating systems, novel combinations of components etc. Especially if your proposal addresses more downstream robotic systems prototypes ensure you describe concretely how you will achieve systems integration. Specify the S&T integration methodology, but also include concrete management mechanisms.

The interdependencies between work-packages and tasks need to be carefully explained (including timing when results are transferred between them).

TIP: Lack of attention to project integration is a major cause for failure.

Q: What about literature survey and system requirement definition?

A: Avoid including an extensive literature survey as a task within the proposed project, unless to investigate a completely new research topic or sub-topic. Likewise, proposals should be able to convince that they will not need open-ended or heavy investment in developing system specifications and requirements. High level requirements and specifications should be defined in the proposal.

Q: Do I need to include demonstrations?

A: Yes. Demonstrations or test scenarios in the RTD projects can help to illustrate in sufficient details what can be realistically achieved and can also be used as a way to measure scientific progress and inform and drive further research. Simulations are not encouraged, except as an intermediate step for the preparation of real-world demos.

Q: Are follow ups to previous projects or proposals allowed?

A: Yes, but above all, explain clearly the new added-value of the follow-up and how to reach the expected progress. It should not be a mere continuation of the previous project.

Proposal resubmissions are treated like all other (new) proposals. But you are strongly advised to take into account (1) the (new) context and aims of the Call for Proposals and (2) if still relevant and applicable, the comments from the previous ESR.

3.2. Project implementation

Q: How do I demonstrate the project's "value for money"?

A: By spelling out the costs of and need for personnel effort, equipment (durable and consumables), travel, subcontracting if any, and your own resources which will be provided to the project. The concrete role and level of involvement for personnel involved, including senior investigators, should be spelt out.

Q: Should I propose a STReP or an IP?

A: Further clarifications are given in the Annex 2. This choice should be based on the scope and content of the project rather than the size or budget. The research scope of a STReP is usually narrower and more focussed than an IP. No upper limits are applied but it is important to remember that IPs do not need to have a large consortium.

Q: How do I select consortium partners?

A: The selection and number of partners must be exclusively driven by the project's needs in order to achieve its goals. Therefore, selection is dictated by the job at hand, based on partners qualifications, scientific track record (include their top few most relevant publications), and their ability to complement each others roles, skills and experience, compared with the expertise needed to achieve the project's goals. Make sure to have enough partners to do the job but not more than needed.

TIP: Lack of substantiation of the relevant expertise and experience of key personnel is a common cause for proposal failure. Present the Consortium through a short description of the institution, short biographies with the relevant experience and selected publications of the key personnel, plus their expected level of involvement in the project.

Q: What role would industrial partners have in a proposal?

A: They could have several roles: carry out research, provide infrastructure/tools, provide challenging application scenarios, which would be used as a source of research questions – giving access to their facilities or real test-cases scenarios in order to assess scientific progress. In all the cases, they have to show they are stakeholders in the work and its results, in particular through demonstrating a sound commitment and strategy to exploit the project results.

Q: What about end users?

A: Whilst scientific research often does not call for this, end user participation, particularly in more downstream systems integration projects, is very welcome. However, as for any partner, their role should be clear in the proposal.

Q: What about geographical balance?

A: Geographical balance is definitely NOT an evaluation criterion. Select your partners based on the needs of the project, not on their location. The minimum requirement in this Challenge is three mutually independent partners from 3 different countries (check the FP7 Rules of participation for the exact terms[4]).

Q: Is there a "standard" management structure?

A: Make sure that the proposed management structure fits your project needs. It is not encouraged to adopt typical structures blindly. Keep the management as lean as possible. Specify how the integration of partners is achieved.

TIP: management costs are primarily for administrative and financial coordination. Scientific coordination belongs under the RTD costs category.

Q: Is risk assessment important?

A: Definitely! Explain both (a) the typical project management risks and (b) specific risks due to the technology approach, in a realistic and concrete way. In all cases, provide a credible contingency plan.

Q: How many deliverables / milestones?

A: Keep the list compact. Milestones should be *major* achievements and make sure that to each milestone corresponds measurable success criteria (e.g.: expected advance in functionalities, behaviours, performance) which allow to verify the progress of the RTD work which contributed to them. Avoid intermediate, consortium internal deliverables and reports. Reading the milestones and deliverables lists, one should understand the project and its major steps.

TIP: keep the number of deliverables manageable and make the deliverables and milestones definitions concrete and measurable

Q: What kind of legal and financial viability checks occur for retained proposals?

A: A description of the rules for the "verification of the existence and legal status of participants, as well as their operational and financial capacities" is available on Cordis (http://cordis.europa.eu/fp7/find-doc_en.html) and is a must-read. For-profit organisations (usually enterprises) who act as Co-ordinator and / or request more than 500 K€ undergo an automatic financial analysis. This analysis is compulsorily based on their latest audited company accounts. Weak results can lead to the Commission imposing precautionary measures, ranging from increased monitoring to deferred pre-financing. In extreme cases, changes in the consortium may be requested. Participants can run their own non-binding checks using tools available on Cordis.

3.3. Impact

Q: What kind of impact are you looking for?

A: The Workprogramme text (see Annex II) describes the expected impacts sought. Any individual proposal is not expected to address the whole list. They should spell out what can be realistically be expected from the project in terms of (a) scientific / technical impacts and/or (b) more directly industrially relevant impacts, reinforcing Europe industrial competitiveness and/or (c) socioeconomic and societal aspects

[4] http://cordis.europa.eu/fp7/participate_en.html

Be concrete about which project results are likely to lead to innovation and impact and which concrete actions will be carried out during the project to achieve such impact.

Q: What kind of dissemination do you expect?

A: There are two considerations here. Firstly, projects with a longer-term, scientific or academic bias are expected to have a very pro-active and well targeted dissemination plan and include a high number of public deliverables and public-domain results (including sharing of databases, software, tools, if possible via open-source). Secondly, projects with more industrial dimensions do not necessarily need to make all deliverables public. The proposal should make this clear and describe its plans to protect or exploit such results – e.g. through patents, licensing or technology transfer. Also of course, the FP7 rules on IPR (Intellectual Property Rights) assure that "Ownership of background is not affected by participation in a FP7 project".[5] In both cases, ensure you describe the main target audiences, venues and channels for dissemination / exploitation.

Q: How important is the exploitation plan in this domain?

A: Projects with a more industrial approach should concretely describe the path towards exploitation (including joint exploitation by the partners) of transferable results from the work. However, developing business plans is beyond the scope of this RTD funding programme. Projects with a more scientific approach should still make clear what the eventual exploitation outcomes and impact on the scientific community will be, including re-use of scientific results in further research. Proposing concrete mechanisms to ensure such re-use would be a plus. In either case, exploitation strategy should include identifying potential exploitable results and target users, as well as a mechanism for attracting them.

[5] ftp://ftp.cordis.europa.eu/pub/**fp7**/docs/**ipr**_en.pdf

4. Annex I – Pertinent research topics

The following non-exhaustive list serves to indicate the type and range of problems that may be at issue under the target outcomes of Objective ICT 2011.2.1.

- **Architectures and machines:** *How can we translate models, requirements and interpretation strategies into viable system architectures, integrating cognition and control; and into specifications for largely autonomous machines that are robust and open to adaptation and self-improvement? What do these machines have to "know" by design, what are they supposed to learn, for instance through training and interaction? How can that knowledge be represented?*
- **Autonomy**: *How can complex systems achieve goals in a largely unsupervised way? How general can these goals be? How should they be set? How proactive can or should such systems be? Are there "degrees of autonomy"? What are the limits of autonomy?*[6]
- **Behaviour representation / interpretation:** *How can we represent / specify the behaviour of robots in an environment so that they can be unambiguously identified?*
- **Collective behaviours:** *How can we integrate the functions of many individual subsystems (for instance robots or intelligent sensors) to form highly autonomous systems (for example: "swarms") capable of cooperating towards achieving a common goal and performing tasks with attention to context?*
- **Dependability and safety**: *What reliability and safety requirements do different environments and usage scenarios impose on complex systems? In what environments and for what types of usage is the timing of action or reaction crucial? How can dependability requirements be translated into verifiable design and implementation options, related to hardware and software? How can a robot recognise and identify safety critical situations and find appropriate actions? What use can or has to be made of advanced sensor, actuator, memory, and control elements in order to achieve key dependability features?*
- **High-level cognitive skills**: *How can we integrate high-level cognitive competencies in complex systems (for example, for reasoning, planning and decision-making, for active environmental modelling)? What should they be based on? How can we make systems recognise, understand, adapt to and appropriately respond to human behaviour (e.g., implicit intentions, emotions) and needs, or unexpected situations in their environment? How can we make such systems improve their services and better respond to users needs (through increased competences/functionalities/performance)?*
- **Learning:** *What dynamic structures can/should learn (or adapt to) what, and at what cost, in a given dynamic environment? How can a robot improve the quality of its service(s) through interaction with its operating environment or its users,? What is the relationship between different learning algorithms, and which should be used when? How can we transfer what is learned for one task to improve learning in other related tasks? Can machine learning theories and algorithms help explain human learning?*
- **Manipulation and grasping**: *What are the specific requirements on robots that are supposed to handle, individually or jointly, tangible objects of different shapes and sizes? What use can be made of new materials and hardware designs to achieve a higher degree of dexterity? What is needed in terms of sensing, manipulation and grasping capabilities, to make a robot learn and recognise what it can do with the objects in its environment?*

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[6] Here, autonomy is to be understood in its technical sense as "independence of external control". The ultimate responsibility for technical systems such as robots is with their designers and/or users.

- **Mathematics**: *What can various branches of mathematics offer towards providing a solid theoretical underpinning of a scientific foundation for engineering cognitive systems? Where would "new mathematics" (i.e., mathematical research motivated by problems arising in Artificial Cognitive Systems research) be required? In this call, mathematics can be very instrumental to combining control theory and cognitive system research.*
- **Modular architectures:** *How can we translate requirements into complex systems architectures*[7] *that cater for modular designs with standardisable module interfaces (hardware and software)?*
- **Novelty detection and prediction:** *How can complex systems find and make sense of new patterns in data streams generated in some environment, or how do we detect points that don't fit a hypothesis? How can such systems predict (and anticipate) future events in their environment (including, where relevant, the behaviour of other agents - human or not - operating in the same environment)? How can such system detect important event in their environment and respond adequately to it? How can a system exploit context and recognise not only the object but its affordances?*
- **Object and scene representation / recognition / interpretation:** *How can we represent / specify any instance of a 3-dimensional physical object or scene irrespective of variety, partial occlusion, view angle, lighting conditions, and possibly, motion? What can various modes of perception (visual, aural, haptic …) contribute to interpreting complex real-world situations?*
- **Rich sensory-motor skills**: *How can a complex system acquire the sensory-motor skills needed to move and operate safely and robustly in difficult outdoor terrains or domestic and other indoor environments? How should it handle simultaneous streams coming from multiple sensors and translate them into motor commands? What can be learned from solutions implemented in animals?*

More information can also be found in the survey organised by the EUCognition network 2011 of topics for research in the field of artificial cognitive systems. The results can be found at - http://www.eucognition.org/index.php?page=applications&apptype=questionnaire_fp8_survey_results

[7] The term "architecture" also refers to frameworks that allow for adaptation and self-modification.

5. Annex II – Extract from the ICT Workprogramme 2011-2012.

Challenge 2: Cognitive Systems and Robotics

Challenge 2 focuses on artificial cognitive systems and robots that operate in dynamic, non-deterministic, real-life environments. Such systems must be capable of responding in a timely and sensible manner and with a suitable degree of autonomy to gaps in their knowledge, and to situations not anticipated at design time. Actions under this Challenge support research on engineering robotic systems and on endowing artificial systems with cognitive capabilities. Both research strands are intricately intertwined: many functionalities and desirable properties of robotic systems rely on cognitive capabilities. Conversely, robotic systems are suitable platforms for motivating, guiding and validating more basic cognitive systems work.

Hard scientific and technological research issues still need to be tackled in order to make robots fit for rendering high-quality services, or for flexible manufacturing scenarios. Sound theories are requisite to underpinning the development of robotic systems and providing pertinent design paradigms, also informed by studies of natural cognitive systems (as in the neuro- and behavioural sciences).

Research under Challenge 2 will fuel progress for instance from robots that are largely pre-programmed, to robots that are programmable through teaching and learning; from robots that are largely tele-operated, to robots that autonomously plan complex tasks; from robots with rigid components and structures, to those with dexterity and manipulation skills going beyond human level; from robots that operate in tightly controlled environments, to robots that can properly interact and cooperate with people in real-world environments. Future robots will also come in various shapes and sizes (including miniature) and will increasingly incorporate intelligent materials, as well as advanced sensor, actuator and effector, (distributed, brain-inspired) memory and control technologies, and where needed, they will exhibit physical compliance.

Cognitive systems research extends beyond robotics. Hence, this Challenge will also address issues related to monitoring, assessing, and controlling heterogeneous multi-component and multi-degree-of-freedom systems, where this hinges on implementing cognitive capabilities. At an elementary level, such capabilities include establishing and recognising patterns in sensor-generated data. This is a prerequisite to higher-level operations such as scene interpretation, reasoning, planning, intelligent control, and complex goal-oriented behaviour. Learning, in appropriate modes, is essential at all levels.

It is equally important to be able to measure and compare progress towards the ambitious goals set under this Challenge. Developing suitable benchmarks, conducting benchmarking exercises and supporting scenario-based competitions are therefore firmly placed on the agenda.

Although Challenge 2 does not target any specific application area, research will be motivated, guided and validated by realistic, demanding and scalable real-world scenarios, where appropriate, backed by industrial stakeholders. Gearing up cross-fertilisation between relevant industry and research communities is a key issue in this respect and industrial participation is therefore greatly encouraged.

Work under Challenge 2 will improve competitiveness in existing and future markets (e.g., manufacturing, professional and domestic services), and provide innovative solutions in areas that include (but are not limited to) assistance and co-working, production, logistics and transport, construction, maintenance and repair, search and rescue, exploration and inspection, systems monitoring and control, consumer robotics, education and entertainment.

<u>Participation in the Open Access Pilot in FP7</u>

Open Access, defined as free access over the internet, aims to improve and promote the dissemination of knowledge, thereby improving the efficiency of scientific discovery and maximising return on investment in R&D by public research funding bodies. Since August 2008, the European Commission has been conducting a pilot initiative on Open Access to peer reviewed research articles in its Seventh Framework Programme (FP7). This pilot covers seven FP7 areas. Beneficiaries funded partially or entirely through this Challenge will be required to deposit peer-reviewed articles resulting from projects into an institutional or subject-based repository, and to make their best efforts to ensure open access to these articles within six months[8].

Objective 2.1: Cognitive Systems and Robotics

- <u>Target outcomes</u>

CALL 7 - CLOSED	*a) **Robotic systems operating in real-world environments**: Expanding and improving the functionalities of robotic systems and further developing relevant features, such as autonomy, safety, robustness, efficiency, and ease of use. As appropriate, work will include exploring ways of integrating, in robotic systems, new materials and advanced sensor, actuator, effector and leading edge memory and control technologies.*

CALL 9	b) **Cognition and control in complex systems**: Enabling technologies based on the acquisition and application of cognitive capabilities (e.g., establishing patterns in sensor data, classification, conceptualisation, reasoning, planning) for enhancing the performance and manageability of complex multi-component and multi-degree-of-freedom artificial systems, also building on synergies between cognitive systems and systems control engineering. This outcome complements Objective 3.3 / target outcome (d).

CALL7 and 9	[*For both Target (a) and (b)]:* Realistic, highly demanding, scalable real-world scenarios will motivate and guide research related to targets a) & b), and serve to validate its results. *Specific Targeted Research Projects* (STREP) are particularly suited to *high-risk endeavours*, breaking new grounds, with high potential rewards. They are also appropriate for component-level research for particular domains. *Integrated Projects* (IP) are preferred for *system-oriented efforts*; they are expected to encompass all stages of the research and development lifecycle and, where appropriate, cutting across research topics.

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[8] Further information: http://cordis.europa.eu/fp7/find-doc_en.html; http://ec.europa.eu/research/science-society/open_access; http://ec.europa.eu/research/science-society/scientific_information/

CALL9

c) **Gearing up and accelerating cross-fertilisation between academic and industrial robotics research** to strengthen synergies between their respective research agendas through joint industrially-relevant scenarios, shared research infrastructures; joint small- to medium-scale experimentation with industrial platforms and implementation of comparative performance evaluation methodologies and tools.

CALL7 – CLOSED

*d) **Fostering communication and co-operation between robotics and cognitive systems research communities** through: identification of common interests and areas of co-operation; knowledge sharing between EU, national, and international initiatives; supporting open-source hardware and software developments; updating R&D roadmaps taking account of work under relevant past and ongoing European programmes; addressing issues such as market potential, user acceptance, standardisation, continuing education, ethics, and socio-economic impacts; outreach to relevant professional and general audiences.*

CALL9

e) **Speeding up progress towards smarter robots through targeted competitions** based on suitably evolving reference scenarios focused on capabilities at issue under this Objective, and involving relevant stakeholders. This includes soliciting private sponsorships, organising and managing pertinent events as well as accompanying dissemination measures and public relations activities.

CALL7 and 9

Expected impact

For a), b) and c):

- Integrated and consolidated scientific foundations for engineering cognitive systems under a variety of physical instantiations.
- Significant increase in the quality of service of such systems and of their sustainability in terms of, for instance, energy consumption, usability and serviceability, through the integration of cognitive capabilities.
- Innovation capacity in a wide range of application domains through the integration of cognitive capabilities.
- Improved competitive position of the robotics industry in existing and emerging markets for instance in the following sectors: manufacturing; professional and domestic services; assistance and co-working, production, logistics and transport, construction, maintenance and repair, search and rescue, exploration and inspection, systems monitoring and control, consumer robotics, education and entertainment.

Consensus by industry on the need (or not) for particular standards. More widely accepted benchmarks. Strengthened links between industry and academia.

CALL7 - CLOSED

Expected impact

For d):

Stronger cohesion between relevant industrial and academic R&D communities; and a higher level of awareness among wider (including non-professional) audiences of the potential of the technologies at issue.

CALL9	For e): Greater innovation through competitions which allow to measure and compare progress towards the ambitious goals set under this Challenge.

Funding schemes:

a)-b): STReP or IP; c) IP; d-e) CSA (CA only)

Indicative budget distribution: EUR 155 million

Calls:

CALL7 - CLOSED	*FP7-ICT-2011-7: target outcomes (a), (d)* - *IP/STReP: EUR 70 million of which a minimum of 50% to IPs and a minimum of 30% to STRePs* *CA: EUR 3 million*
CALL9	FP7-ICT-2011-9: target outcomes (b), (c), (e) - IP/STReP: EUR 80 million of which a minimum of 50% to IPs and a minimum of 30% to STRePs - CA: EUR 2 million