European Commission

6th Framework Programme
Anticipating scientific and technological needs

NEST

New and Emerging Science and Technology

PATHFINDER Initiatives

http://www.cordis.lu/nest

Call for proposals to be launched in late 2003:

- ***Tackling complexity in science***
- ***Synthetic biology***
- ***What it means to be human***

Interim Document

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This is a working document of DG Research for consultation. It should not be taken as a definitive basis on which to prepare proposals for the NEST activity. Guidance to proposers will be provided for each NEST call for proposals.

1. Foreword

This document gives a brief overview of NEST, and information on the scope and objectives of the three PATHFINDER initiatives which are envisaged for publication at the end of 2003.

The information presented in this working document may evolve by the time the call itself is published. Only the Call and the Work Programme, as actually published, can be considered as legally binding information.

A set of supporting documentation in order to clarify these PATHFINDER initiatives and to guide proposers when drafting proposals is also under preparation and will be posted on the NEST web site (*http://www.cordis.lu/nest/home.html*) at the time of publication of the call.

2. NEST: Introduction, objectives and overall approach

Under the sixth framework programme, Community research is organised mainly around a small number of highly concentrated "thematic priorities", which focus a high level of funding on areas where research is expected to have the greatest potential to benefit Europe's society and economy in the medium term. By necessity, the research fields associated with the thematic priorities are sufficiently well established to enable the future directions of scientific and technological progress to be sketched out with some confidence.

But if Europe is to maintain a truly dynamic research capability, it needs not only to support the critical research areas for tomorrow, but also to seek out the most promising opportunities for the day after. Advances in scientific understanding are punctuated by unexpected developments – new theoretical insights, unforeseen experimental findings, the availability of higher-resolution instrumentation - that create new avenues for science and technology, for example by providing ways to resolve long-standing problems or by opening up productive new directions for research.

At the same time, Europe needs to be aware of potential problems and risks that are signalled by new developments in the science base, and take appropriate steps to address them.

NEST provides a means to anticipate scientific and technological opportunities and needs in new and emerging areas. It supports research that falls within the legitimate scope of Community research and which cuts across or lies outside the thematic priority areas, in particular because it is highly interdisciplinary and/or multidisciplinary. The research will also respond to unexpected major developments.

NEST supports three main types of research actions, each with a distinctive profile.

- ***ADVENTURE***: Research projects, in emerging areas of knowledge and on future technologies, in particular in multidisciplinary fields, which are highly innovative and involve high (technical) risks.

- ***INSIGHT***: Research projects aimed at assessing new discoveries and newly-observed phenomena, where the latter may indicate important potential problems or risks to society.

- ***PATHFINDER***. Larger-scale actions, focusing on emerging areas of science and technology that are identified, in conjunction with the scientific community, as having particular promise and/or urgency.

In addition ***NEST SUPPORT*** actions will be carried out, focused on the conceptual and practical questions associated specifically with NEST implementation. They will run in parallel with the three above-mentioned research actions.

Because NEST is a new initiative for Community research, the specific features of these actions, their means of implementation and the balance between them may be adapted in the light of progress achieved during the course of the programme.

It is envisaged that participants from any third country may, in appropriate cases, participate.

3. PATHFINDER initiatives

These are targeted actions, focusing on emerging areas of science and technology which have significant potential for Europe in the long term. They are intended to seed the early development and emergence of research in particular strategic areas, and generate a significant "leverage" effect on the early development and consolidation of European research capabilities. Where the potential of these fields is demonstrated, PATHFINDER actions could form a precursor to more conventional funding through the framework programme.

PATHFINDER initiatives are progressively introduced into the work programme and launched by means of specific calls for proposals on an annual basis. Each PATHFINDER initiative involves one or more calls for proposals (ie sometimes covering two consecutive years of the framework programme). Topics are identified during the course of implementation of the framework programme, in conjunction with the scientific community, on the basis of their particular future potential.

Each PATHFINDER initiative consists of a number of specific targeted research projects (STREPs)[1], as well as a Co-ordination Action (CA) (or where justified, more than one CA) to bring together the wider community of actors in Europe within a long term, strategic perspective. Expert groups may also be set up on each PATHFINDER topics, as well as on prospective PATHFINDER topics, to develop strategic orientations. Proposals for STREPS will be selected on an individual basis according to the relevant evaluation criteria in order to create an overall portfolio of projects corresponding to the topic in question. The associated Co-ordination Actions may include activities such as: drafting of roadmaps, identification of emerging opportunities, mapping of excellence within the EU, and organisation of specialised conferences or training activities.

4. Proposed PATHFINDER Initiatives for the 2003 Call for proposals

The following topics for PATHFINDER initiatives are currently envisaged for the 2003 Call for proposals, to appear towards the end of 2003, with a deadline in April 2004. The total indicative budget for these three initiatives is expected to be about €35 million.

[1] For information on these project types see the Cordis web-site : http://www.cordis.lu/fp6/instruments.htm

1. Tackling complexity in science

Complexity is a critical challenge for many areas of science and technology. Emerging areas of science such as "systems biology" and "biocomplexity" are founded on the idea that phenomena need to be understood in the context of highly-interactive processes operating at different levels. Similarly, there is an increasingly urgent need to understand and predict the behaviour of highly-interacting man-made systems, in areas such as tele-communications, transport, and computer systems, which permeate the modern world. The same applies to human networks such as social, political and financial systems, where technology has tended to vastly increase both the complexity and speed of interaction, which is sometimes nearly instantaneous.

Better understanding, appreciation and prediction of the behaviour of such systems will require the development of tractable methods for addressing complexity. On one hand, this implies deep analysis of particular complex systems. On the other, there is clearly a need to develop general methods of analysis (using, for example, modern mathematical techniques of non-linear science) by investigating the similarities and commonalities between complex systems in diverse areas.

The objective of this PATHFINDER initiative is to give an impulse to complex systems research in Europe, by supporting cross disciplinary research on complexity as well as collaboration between the field of "Complex Systems Science" and particular disciplinary areas of science where complexity is a key issue, such as in biological systems, the environment, ecosystems, etc. It will promote the creation of new, interdisciplinary partnerships between researchers within the field of complex systems and researchers in a range of other fields, as well as the extension and generalisation of successful techniques for dealing with complexity from one area of research into others.

The research supported will have concrete and tangible objectives, addressing specific complex systems problems on the basis of potentially generalisable concepts, analytical methods and techniques. It will focus on a number of themes: common techniques or common problems for complex systems science, where research across different application areas may lead to generally applicable results, for example:

- **Representing complex systems as networks.** There is an emerging acceptance that the traditional ("reductionist") approach of the physical sciences has its limits and that complex systems have to be understood as networks of agents, evolving networks and even networks of networks. Bringing together what has been learned in various fields (social and economic systems, the earth system, network technologies, cognitive systems, etc.) could be very valuable for the development of unified approaches.

- **Emergence:** The appearance of totally new and radically different behaviour within a complex system as compared to the underlying (simpler) components, is one of the key aspects that make complex systems interesting and difficult to analyse. The use of common approaches across different problem areas would help to consolidate the field.

- **Predictability and extreme events in complex systems:** The question of how to understand and predict extreme events, in areas such as climate change, financial systems, traffic flows, social systems, etc, is of wide and urgent interest in complex systems science. Related issues are the "robustness" of such complex systems, their

ability to cope with failure and or breakdowns, and the qualities necessary to make such systems robust.

Partnerships should demonstrate deep knowledge of the complexity research field and of the disciplinary fields being addressed.

Proposals for the Co-ordination Action(s) associated with this PATHFINDER initiative should involve the extended EU complex systems science community and could, for example, involve providing access to the large amounts of relevant data available in the community at large, promoting short stays of senior scientists, and supporting advanced training activities such as Summer Schools to promote the use of the techniques of Complex Systems science in other areas of research.

Co-ordination with FET: This Pathfinder initiative will be executed in close co-ordination with the proactive initiative on Complex Systems of the Future and Emerging Technologies (FET) activity area under thematic priority 2. The FET activity covers IST related aspects of Complex Systems - care should be taken not to address issues which are already covered under FET

2. Synthetic biology

Over the past half century, molecular biology has developed as a vast and highly successful enterprise, unravelling the processes of life at sub-cellular scale and studying their various components. The tools for re-engineering biological processes have developed in parallel, providing both a medium for scientific investigation and the ability to create modified organisms.

Scientific and technological capabilities have now reached a point where "synthetic biology" - novel engineering systems making use of complex biological processes - can be envisaged. A new realm of possibilities for biology-based technologies is on the horizon, with the promise of an acceleration in both scientific discovery and innovation.

This development is of real strategic importance to the EU. As the "biology revolution" progresses, it must be expected that a true engineering approach to biology will emerge and be transferred to industry and the economy on a broad front. Europe needs to anticipate these developments, in order to develop the intellectual and physical infrastructures of the breadth and diversity necessary to foster them, and capture a share of the valuable intellectual property that is at stake. This will require engagement not only with the research challenges, but also the social, ethical and regulatory issues that will undoubtedly be raised.

The goal of this PATHFINDER initiative is to stimulate forward-looking cross-disciplinary research to demonstrate key principles and generate tools and building blocks, for synthetic biology. The research will focus on design and engineering of new biology-based systems and processes with substantially different characteristics from natural systems and with real applications in mind. This could involve, for example:

- Design, development and demonstration of key components of engineering systems based on biological processes (genetic circuits, metabolic pathways, signal transduction pathways) and their sub-components (functional proteins, metabolites, etc…).
- Applications in areas such as synthetic chemistry, production of new materials, energy production, communication and signalling systems and biological sentinels.

Projects should aim for tangible outputs which could include demonstration of engineering control over key biological processes, generic component technologies and "platform technologies" (which could include technologies not requiring a living organism for their operation) and generic tools for design and simulation of synthetic biology components. They should combine rigorous engineering methods and high quality science, and involve partnerships that combine expertise in cellular and molecular biology with other scientific and engineering disciplines. Work on human stem cells is excluded.

Proposals for the Co-ordination Action(s) supporting this PATHFINDER initiative should aim to network European activities in relevant fields, and also address, inter alia, the intellectual and material infrastructure requirements of synthetic biology, perspectives and strategies for innovation and industrial translation, including intellectual property, and analysis of the issues related to societal acceptance, including ethical, safety and regulatory aspects.

3. What it means to be human

Advances in molecular biology, neuroscience and genetics, have opened new perspectives for cognitive science, and associated fields like linguistics and anthropology. The question "what makes humans different?", once a matter of philosophical speculation, has now become central to science. It is at the core of current efforts to build an integrated understanding of the human mind.

The answers may have profound implications. Most obviously, they could provide scientific understanding and underpin technological development which in the long term will have big payoffs for society and the economy. For example, by understanding the specific nature and limits of human conceptual reasoning, it may be possible to devise more powerful artificial learning technologies. Improved education strategies should come from better knowledge of specifically human capabilities to perceive and encode information and experience in the process of development. Greater insight into the origins of human motivation, social behaviour and co-operation will assist the design of social and cultural institutions to accommodate human needs better.

But as our understanding of how and why we differ from our nearest primate relatives (and therefore how much we do not) improves, tensions should also be expected as society comes to terms with a new phase in our understanding of humanity in the broadest sense. And discomforting prospects are already emerging of future technologies that interfere with, or alter, the attributes we regard as fundamental to our humanity, and require serious consideration from ethical and regulatory standpoints.

With its common values, varied cultures, and strong research tradition in many of the relevant fields, Europe has a vital interest in this area and real potential for fostering scientific advance. *To exploit this potential, this PATHFINDER initiative will support cross-disciplinary research which brings to bear the latest insights from fields including genetics, biology, neuroscience, psychology, linguistics and anthropology to examine "how and why are human cognitive facilities unique?"*

The idea is to help build cross-national and cross-disciplinary links that will stimulate a broad European strategic agenda, exploiting the synergies between investigations in different fields. Projects should therefore bring different disciplines and levels of analysis to bear in novel

combinations, to address specific questions which have high scientific interest in the context of the quest for an *integrated* understanding of human cognition. Projects should address higher cognitive processes, within a comparative and evolutionary perspective, focusing on the question "How and why are humans different? In other words: what features make human cognitive abilities unique, and what are the origins of these features?" This question may be addressed from a variety of perspectives such as:

- **Individual cognitive development**: behavioural and cognitive development of the individual, considering the interplay between external and inherited factors.

- **Communication**, understanding the emergence/development of language and non-verbal communication (including its social and cultural aspects).

- **Executive functions, decision making**, and co-operative behaviour which might also take account of relationships between conscious and unconscious aspects of behaviour.
  Proposals for the Co-ordination Action(s) associated with this PATHFINDER initiative should assist in cross-disciplinary networking, and could also involve activities such as drawing up a strategic picture of European resources, analysing and assessing recent developments in the various fields, and developing roadmaps for future European research.

5. PATHFINDER - Means of implementation and practical aspects

The activities programmed will be carried out mainly by means of calls for proposals and will take the form of Specific Target Research Projects (STREPs) and Co-ordination actions. Proposals should be submitted as individual projects, not groups of projects, and should be single-stage, full proposals.

It is envisaged that a **pre-proposal check** service will be available for PATHFINDER proposals until three weeks before the deadline of submission. Proposers will be strongly encouraged to submit a pre-proposal to check that the proposal meets eligibility and scope requirements of the call.

The evaluation will be done with the help of external referees (independent experts working remotely at their premises) and/or panels of experts that convene to consolidate the referees' individual assessments.

Expert Groups will also be organised, in particular to analyse the need for future actions in specific research areas, as well as workshop and conferences, where these serve the strategic objectives of NEST.

For further information on NEST, see :

NEST web-site: http://www.cordis.lu/nest

6th Framework Programme: http://www.cordis.lu/FP6

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