European Cooperation in the field of Scientific and Technical Research - COST -

Secretariat

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COST 231/08

MEMORANDUM OF UNDERSTANDING

Subject :	Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action MP0801: Physics of Competition and Conflicts

Delegations will find attached the Memorandum of Understanding for COST Action MP0801 as approved by the COST Committee of Senior Officials (CSO) at its 171st meeting on 18-19 June 2008.

MEMORANDUM OF UNDERSTANDING

For the implementation of a European Concerted Research Action designated as

COST Action MP0801

PHYSICS OF COMPETITION AND CONFLICTS

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 270/07 "Rules and Procedures for Implementing COST Actions", or in any new document amending or replacing it, the contents of which the Parties are fully aware of.

2. The main objective of the Action is to develop and extend the application of modern statistical physics, mathematics and computational physics in relation to problems associated with competition and conflicts such as occur in social, political, economic, financial and historical contexts and other relevant areas, where these tools can enhance and improve upon current approaches to these issues.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 40 million in 2007 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Chapter V of the document referred to in Point 1 above.

A. ABSTRACT AND KEYWORDS

Recently physicists have extended ideas of atoms and lattices to more generalized concepts of agents and networks and are facilitating new understanding of systems traditionally the province of other disciplines. Applications include, for example, competition between firms, mergers and acquisitions, evolutionary dynamics, cultural change and transportation networks. Set to undergo a renaissance in the 21st century, the area of complexity, rooted in statistical physics and probability theory is at the core of these developments. Better understanding in these areas will provide routes to greater social stability and economic well-being across an increasingly networked world. The Action will promote discussion and research across the physical and sociological disciplinary divide by providing a platform from which the participating researchers can develop important, new and substantial research initiatives aimed at tackling these key trans-disciplinary issues. Overall, the Action will provide a unique forum for physicists and mathematical scientists to share leading-edge knowledge, experience and build up a common language with economists, social scientists, industry and government.

Keywords: Complexity, competition, cooperation & conflict, self organization, emergence, extreme events.

B. BACKGROUND

B.1 General background

The idea that matter could be constructed from discrete atoms dates back to ancient times, however it was not until the renaissance that these ideas were taken seriously by the scientific community. At this time, in fact such ideas were used to try and describe human interactions and the nature of human behaviour. Over the past 200-300 years it is clear that their application to material systems has been highly productive and the wheel has now turned full circle and there is scientists return to the challenge of applying the ideas once more to sociological and economic systems. These systems include competition between firms and individuals, mergers and acquisitions, income distributions, growth of cities and urban environments, house price dynamics, evolutionary dynamics of societies, ecologies, queuing, waiting times and crowd and traffic control. Mirroring this activity is increased awareness by society at large of the incidence of extreme or critical events such as floods, power failures, global warming, terrorism, social unrest, outbreak of war, panics, epidemics, extinction processes and economic volatility. Better scientific understanding of the factors governing these will provide routes to greater stability and economic well-being across an increasingly complex, networked world with its competitive and strongly interacting agents.

Principles of complexity rooted in modern statistical physics and probability theory are at the core of these developments, subjects that are set to undergo a renaissance in the 21st century. Indeed no less a figure than Stephen Hawking is on record as saying that the 21st century will be the century of complexity.

A quantitative characterization of the dynamics of complex networks and structures that drive critical events will help with planning of rational strategies to cope with these important societal issues. It should be emphasized that the role of physics is not to compete with disciplines such as engineering, economics or social science. These disciplines are vital to development of pragmatic innovations. Physics has plays a role at a more fundamental sometimes philosophical level, striving to understand the basic rules and laws that govern dynamics and structural characteristics of systems where the basic rules are unknown. For example, the laws of Keppler and Newton begot understanding of the motion of planets; Schrodingers equations facilitated understanding of the characteristics of atoms. Equally the work of Gibbs and Boltzmann gave rise to statistical physics which allowed us to predict the behaviour of assemblies of molecules. However application of these ideas to everyday systems is often not straightforward and relies on collaboration between the physics community with complementary disciplines such as chemistry, engineering and biology. In recent years, physics has been successful in its study of finance and some aspects of economics as a result of a pragmatic approach to the modelling of financial data. These efforts of physicists are slowly being recognized by the economics and finance community. The topic of this COST Action, which takes physics into the sociological arena, is harder. In part this is because it is less quantifiable although at the same time one can say that it is more important in the sense that the potential outcome has a much wider impact on society. Without question, it is a high risk project with pioneering characteristics that meets the criteria surrounding COST Actions. In making these points the Action steps very firmly fit into considering issues outside the financial arena that was the main thrust of COST P10 Physics of Risk which ended in June 2008.

The network of scientists involved in these areas is large and most importantly the contribution from statistical physicists is now becoming not only recognized but also endorsed by other disciplines, including the economics and business community and sociologists. However, all these links are at an early stage of development. Some have managed to develop activity with the award of new Framework projects under the NEST/FET schemes. There are also other initiatives such as

COMPLEXITY-NET being undertaken by scientific research councils of a number of Member States across Europe under the umbrella of the EC ERANET scheme. Complexity-Net seeks to identify common and shared priorities in the general area of complex systems with a view to funding new scientific initiatives towards the end of this decade. This COST Action will play a seminal role in facilitating links within this disparate community helping to position them such that they can benefit from new initiatives in due course.

The Action will address these issues by gathering experts from across the academic spectrum including physicists, engineers, economists, business and sociologists as well as some experts in the private sector to share state of the art knowledge and experience. In this way the Action will support the building of a world leading community versed in the understanding of complex systems and their application to sociological as well as economic issues. The network will bring new and innovative science to bear on the challenges outlined above, applying principles of complex systems to the construction of both new methodologies and building blocks for understanding development of models and strategies that deal with competition, cooperation and conflict. Many of these methods are currently under active discussion and require a flexible approach for further development. This involves networking and intensive discussion between the protagonists and parties involved.

One perhaps novel aspect that it can be believed could add not only to this Action but also have other wider ramifications is to include within the Action a proposal for at least one working group meeting that brings together the above mentioned community with those in the many other COST Actions concerned with sociology and economics in order to engage with and both offer and identify new challenges.

This COST Action is not only timely but with its instruments including working group meetings, short term missions and training schools is the most appropriate framework to facilitate progress and enable this new and emerging subject to truly develop and achieve maximum effectiveness

B.2 Current state of knowledge

In the past few years a number of scientists have proposed models based on physics for use in social sciences. Within COST Action P10 Physics of Risk, there has been a realization that the time is now ripe for a concerted attack on social issues as opposed to financial issues. An important factor limiting more widespread application is the lack of sufficiently accurate and comprehensive data. This limits detailed comparison and alignment of models and reality. Often, models are designed with some specific problem in mind but limited efforts have been made to validate their premises and, in particular, the behavioural rules of the agents. There are many reasons for this not least because the social scientists responsible for collecting data are concerned with answering different questions and not yet sufficiently engaged with the physics community. In a recent publication, Roehner has suggested a different point, namely a fundamental difference in beliefs between the physics and social science communities. Physicists take the view that the world may be described by simple rules, for example, Newton's laws, rules for the periodic table, Einstein's theory of relativity. These laws were deduced through the efforts of many scientists over many hundreds of years of careful observations of the natural world. The observations were painstaking and involved the development of many increasingly sophisticated technologies that allowed spurious outcomes and noise to be eliminated. This quest still continues simply because physicists believe that such simple laws exist. Roehner suggests that a similar quest has not been undertaken by social scientists simply because they do not believe simple rules exist in the social science domain. Yet even with the limited data available to him, Roehner offers compelling evidence in the case of one social phenomenon, namely the occurrence of suicides that such rules might indeed exist. Other physicists are showing that simple rules also exist in the case of traffic and pedestrian flow. Furthermore, most economists now recognize that herding, a statistical phenomena that can be described well by methods of statistical physics does indeed account for speculative bubbles in finance. A key issue is the signal to noise ratio that is very different in social systems than physical systems. If this really is so, then the task is to undertake more careful observation and use better tools of measurement tasks for which physics is ideally suited.

One key issue is that the outcome of models used so far in social science depends explicitly on the microscopic rules and universal properties that are found for material systems. However these have not yet been found for social systems. An example of this is evolutionary game theory on graphs, where it is being realized that the emergence of cooperation on social dilemmas depends on the strategy update rule of the model [Szabó, G and Fáth, G, Evolutionary games on graphs, *Phys. Rep.* 446 (2007) 97-216]. The only way to validate these results is by the traditional scientific method: designing and performing experiments that allow falsification of hypotheses and predictions of models. This is a domain in which a true cross-disciplinary approach is badly needed to go from the experiments with a few individuals carried out by experimental economists to the larger groups needed for reaching sociologically relevant conclusions. Teams including statistical physicists, sociologists, economists, psychologists and computer scientists should focus on verifying the key assumptions of currently used agent-based models, in order to assess their applicability as well as the relevance of the conclusions drawn from them.

The last few years have also seen a flourishing of graph theory now renamed theory of complex networks. Many studies have focused on topological properties of networks, in particular social and communications networks. Another well studied type of problems is that of dynamical systems on networks, in which the traditional support of the dynamical variables changes from a continuum or a lattice into a complex network. Many interesting results have been obtained through the combined effort of researchers from different fields. At this point, a step must be taken towards applications. Recently, it has been reported that in statistically similar networks, the dynamical behaviour may be different, the reason being traced back to the existence of largely different community (mesoscopic) structures on them [Lozano, S, Arenas, A, and Sahez, A, Mesoscopic structure conditions the emergence of cooperation on social networks, arXiv:physics/0612124v2 (2007)]. Not only the dynamics but the resilience to perturbations or attacks has also been linked to the community structure of networks, and it has been shown that there may be a trade-off between performance and resilience. This is a key issue for network design of networks and makes it clear that it is not enough to study global properties, such as degree distribution or clustering, but one must also look carefully at mesoscopic properties. Applications of complex networks to specific contexts need to take into account these aspects to ensure network structure is appropriate to its purpose. This needs contributions not only from statistical physics or mathematicians but also from sociologists and psychologists in view of the fact that in social networks communities must have a social counterpart in groups of people that relate in specific ways and through specific channels. Such a cross-disciplinary approach is most relevant when applying these ideas for instance to the design of organizations.

B.3 Reasons for the Action

From the above it should be clear that the topic is not only of considerable interest. It is extremely timely. Complexity is a topic with numerous applications in areas of importance (structure of social activity, crowds, epidemics, herding, traffic flow, formation and evolution of social groups and economic structures, behaviour of financial institutions, outbreak of war, suicide, evolution of cultures), where the basic character and understanding is at an early stage and progress will depend on debate across a number of disciplines that traditionally have not worked together. Thus the physics and mathematics community are required to cross a disciplinary divide that has ever since the industrial revolution separated their work from that of social scientists. COST Actions provide the perfect instrument for facilitating such activity.

B.4 Complementarity with other research programmes

There is the activity of Complexity Net and the EC NEST and FET initiatives. Many involved with this proposal are partners within these EC projects (for example, CREEN, MMCOMNET, DYSONET, IRRIIS GIACS and ONCE-CS.). Some of these initiatives emerged from partnerships formed within a previous COST Action P10 that sought to bring the physics and economics communities together.

New programmes will require wider multidisciplinary consortia spanning not just physics and economics but also sociology and psychology. This is one aim of this COST Action that will provide new opportunities for participants to bid for research funds in the coming years.

Unlike other Actions, COST offers a flexible mode of operation that optimizes the ability of participants to develop and share new ideas and evolve tailored partnerships that can then be the basis for more formal research applications to, for example, the EC Framework or Member State programmes covering both basic and strategic or applied aspects. A significant benefit offered by COST concerns the involvement of new groups and institutions. The ability to involve both young researchers and eminent experts in a flexible way is one of the most valuable aspects of the COST programme. This COST Action will act as a global umbrella for young researchers who seek to participate and benefit from being linked to these new and emerging projects.

C. OBJECTIVES AND BENEFITS

C.1 Main/primary objectives

Via greater understanding, to develop and extend the application of modern statistical physics, mathematics and computational physics in relation to problems associated with competition and conflicts such as occur in social, political, economic, financial and historical contexts and other relevant areas, where these tools can enhance and improve upon current approaches to these issues. Specifically the Action will demonstrate that the thinking behind application of methods of physics and statistical physics to social problems is not only appropriate but also can begin to demonstrate that basic principles underpinning social phenomena do exist and can be identified building, for example, upon recent work by Chen and colleagues (Phys. Rev. E 75, 046107 (2007)) where connectivity measures used in social sciences have been derived from the more general theory of percolation.

C.2 Secondary objectives

An additional objective is to increase understanding of the fundamental science underlying the above problems that can be modelled by network dynamics and microscopic models of interacting agents. Applied outcomes will be explored within a separate working group.

The area of competition and conflict is ubiquitous and a full understanding requires the undertaking of a multidisciplinary exercise. This Action is then deliberately broad in application and, with its trans-disciplinary approach, aims to offer participants the potential to contribute to the different inter-related components so keeping abreast of fundamental issues whilst continuing to focus on the core aspects identified in the title.

C.3 How will the objectives be achieved?

The key instruments offered by COST (working group meetings, short term missions and training schools) will provide the basis for achievement of the objectives. These will be used to stimulate the community which in turn will help with the identification of key problems and routes to their solution via collaborative research programmes supported by the EU, individual Member States and other means.

C.4 Benefits of the Action

The overall benefit from this network is a promise to influence overall social and economic well-being of European society through better understanding of extreme events, conflicts and hazards. This will provide an improved basis for decision making and policy development. In addition the Action will:

- Widen understanding of and develop access to complex systems where a multidisciplinary approach is essential

- Assist the evolution of new cooperation and shared understanding between mathematical, social and economic disciplines

- Provide a new, unique forum at the European level for communication not only between researchers but also those interested in better understanding and exploitation of properties of complex systems;

- Help support the emergence of new research programme initiatives within both the EU and Member States;
- Facilitate the mobility of young researchers not only from Europe but in other countries beyond Europe into research teams across Europe;
- Open new employment opportunities for young researchers from physical and mathematical sciences:
- Provide a new route at the European level for communication between scientific researchers, companies and regulatory bodies;
- Facilitate improved competitiveness of European business in all its aspects (e.g. provision of public and consumer services);
- Help understand evolution of EU policy, especially with regard to design, conflict management and cooperation between different ethnic and cultural groups.

This initiative will facilitate the emergence of a new group of mathematical and physical researchers engaged in research of a highly novel nature with extensive multi-disciplinary relevance. In this way the Action will play a key role in broadening the training of young researchers within participating Institutes.

C.5 Target groups/end users

A number of different groups could benefit from the work of the Action. Social scientists and economists will benefit from the new tools developed by the physical science community; equally the physical science community, itself will benefit from being able to work across the disciplinary divide.

In the commercial sector, there are a number of companies engaged in providing policy advice in support of the core problems upon which this Action is based. The Action will seek to draw them into its activity and hopefully add to their efforts. Equally technological aspects will be considered and links with certain companies in the ICT sector fostered.

The Action also anticipates that this initiative will facilitate the emergence of a new group of physicists and associated researchers engaged in research of a highly novel nature with extensive multi-disciplinary relevance. In this way the Action will play a key role in broadening the training of physicists within the participating Institutes. The result will be that young researchers themselves who participate in the Action will find new opportunities for employment.

Via the involvement of researchers from East Europe, the Action aims to facilitate and support the development of new regional centres of research activity in these areas and enhance the integration of the European Research Area.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

The Scientific Programme rests on five mutually interlocking areas that address from different but complementary basic and applied viewpoints, the general topic of the Action i.e., Competition, Cooperation and Conflict. These areas will be the basis of the working group structure. In this way the Action will provide the means to give answers to the issues of interest.

1. Information and Knowledge

The availability of both information and knowledge as well as learning dynamics are key aspects for the understanding of relations of any kind within human groups and societies. Accordingly, this area will begin by considering the available information, for example, e-data bases and establish a forum for discussion between the social, economic, environmental and physics communities. Of importance will be the influence of competition, conflict and cooperation on various phenomena of importance and their long term memory. Non Markovian memory and aging effects are all important aspects that require extensive study. This will of necessity involve intense collaboration between disciplines. This research activity will seek to develop and focus studies in social areas not previously studied and encourage the collection of relevant data and social response functions for future studies in order to strive towards the quality of data currently available in the financial sector. Continuous feedback between physical models and the data collection process will allow validation of models, predictions and improvements. Furthermore, identification of aspects for which new data is needed will help guide the social scientists quest for information. In this way, cross links with other COST Actions in social science will be fostered. Information, knowledge and learning are also important for the microscopic descriptions of phenomena that will be developed in Area 2. In this way the Action will facilitate close interactions between the two areas.

2. Agents including Game Theory

In order to describe the atoms of the society, i.e. individuals, the appropriate paradigm is that of agents, and their interaction through behaviour and strategy choice is described by game theory. In this context, Area 2 encompasses efforts to develop descriptions at the microscopic level. The overall aim here might be said to extend atomic and molecular stochastic thinking together with computational methods to help solve problems linked to social, environmental, cognition and information technology issues. The main feature is to strive towards explanations for and control of complex collective phenomena characterized by relatively long space-time scales in terms of elementary elements that operate at finer scales. A key issue is not only the juxtaposition of various expertises and disciplines but also the intimate fusion of the complementary knowledge across these disciplines. In some instances this will require new languages that allow the formulation of novel questions as well as new grammar that allows novel interrogative forms. Possible applications include: Human interaction and coordination in space and time; pedestrian dynamics and panic; self-organized signal control and decision making; phase changes in society; social-cognitive risk; emergence and development of norms; technological change and forecasting; consumer choice and purchasing behaviour; opinion dynamics, evolution of language, law and religion distribution of income in society; immigration flows; competition between firms; dynamics of financial markets. A key challenge is to develop agents that can operate with low cognition both in their ability to gather information and in their ability to process such information. Such understanding and model development is crucial if the physics community is to contribute effectively to economic policy making.

3. Complex Networks

Building on the analogy with physics, social interaction between people can be understood in the same terms as physical interaction between atoms and, much in the same way as atoms interact with neighbors on lattices, individuals interact with contacts through networks albeit ones that are generally complex. Complex networks have become central to research in many disciplines, and most social science methodologies informally acknowledge the importance of networks in the spread of social phenomena. Complex networks can readily be observed in daily life, for instance, friendship networks, the www, bulletin boards, citation networks and the organizational structure of institutions and businesses. These networks exhibit many interesting features such as power law degree distributions, small diameter, a high clustering coefficient, assortativity or disassortativity amongst vertices and a community structure, and a remarkable robustness against random failures but, at the same time, they may exhibit a strong vulnerability to targeted attacks.

Although traditionally physicists studied systems on either completely connected mean-field networks, or regular finite dimensional graphs, it is now understood that many kinetic and dynamic processes behave quite differently on intermediate networks such as scale-free and small-world graphs. Area 3 aims to put this research into a coherent framework rooted in the nature of the underlying networks. Network structure and dynamics is fundamental to understanding many of these systems and the methods developed by statistical physicists and mathematicians, such as scaling approaches and percolation and graph theory used to analyze networks play a crucial role. Small world networks have proved fruitful in dealing with friendship and social networks together with power line networks used for high voltage transmission. Equally networks with degree distributions that decay as power laws have been used with success to characterize links across the World Wide Web, networks of scientific citations and bank networks that sustain payment flows and suffer bankruptcies.

A key challenge now is the development and understanding of the co-evolution of agents on complex networks taking account of, for example, heterogeneity. This offers the potential to explain behavioural patterns observed by economists, sociologists and psychologists as well as provide insight into marketing strategies, especially new viral marketing strategies that will be required as more advertising is embedded into the internet.

The objectives would be to develop a set of canonical theoretical and numerical models together with other approaches that capture the essential behaviour of a variety of competitive and competition models. These methodologies should help elucidate the necessary and sufficient ingredients required to observe particular behaviours, thereby allowing us to classify, understand and predict a variety of systems containing either competition or conflict.

Supporting this objective will be the aim of developing complex network models, static, growing and evolving, that are suitable for modelling the systems in which competition cooperation and conflict take place in the information age. This will require the integration of a wide range of techniques and methodologies to develop models that capture the essential behaviour of competition cooperation and conflicts.

4. Evolution and co-evolution

Dynamics is central to the understanding of competition and conflicts, which are generally not static situations but change (often very rapidly) exogenously or endogenously. While the dynamical aspect is necessarily addressed within the other Areas, identifying generic mechanisms governing a plethora of phenomena is an important goal, both to complete a common understanding of the different areas and to extend the applicability of the conclusions to other, more disparate contexts. It is only natural then that the Action includes to fourth work area with this generic view in mind.

Compared to the traditional approach of physicists in dealing with material systems where a global quantity such as energy is optimized, the dynamics of socio-economic systems are driven at an individual level and the quantities to improve are individual utility functions. Global considerations, while not absent, appear at a secondary level. Generically, the dynamics can be analyzed in terms of strategy learning. This connects to areas 1 and 2, through ideas of behaviour inherited in a biological style. Clearly the Action can extend the ideas to market dynamics when looked at from the viewpoint of companies. Strategies or behaviours that perform better, spread in the population. This could be compared ideas behind Darwinian evolution.

Importantly, it has been recently realized that the outcome of such evolutionary processes do depend on the details of the dynamical rules. This is a crucial point in so far as answers to questions such as the origin of cooperation are given on the grounds of specific dynamical rules, such as imitate-the-best or pairwise comparison, and any attempt to apply these conclusions to real situations needs a full understanding of delicate details of the interactions among the individuals of the system of interest.

On the other hand, in many cases there are more than one features undergoing evolution. This is often the case with the network describing the interactions within the society under consideration, where the behaviour of the individuals changes according to their interaction but it also induces changes in the network of contacts itself (i.e., new friends are made, friends become enemies, etc.). This co-evolution process clearly leads to intricate dynamics which is at present very poorly understood, not only from the physics viewpoint but even mathematically. The fact that co-evolution is the most generic form of evolution (evolution of hierarchies) and commonly arises e.g., in language-culture-political status, or in market strategies-company growth-economic opportunities makes it necessary to include a careful study of this kind of dynamical phenomena. In particular, contact with Area 3 is essential in order to provide a truly dynamical perspective on network formation processes.

Additional objectives will include the development of analytical techniques that allow to make progress in the understanding of evolutionary and co-evolutionary processes in applied scenarios; the identification of specific mechanisms of evolution in socio-economic systems and their alignment with available and newly designed agent based models, and the acquisition of social data that allow for detailed comparisons with the dynamical observations of theoretical (analytical and simulation) frameworks.

It should be emphasize here that the thinking behind this work programme is of considerable importance. Some biologists have in fact argued that living creatures cannot be understood on the basis of their genes alone. Existence depends on certain selected or emergent patterns of molecular organization. It is effectively suggested that human behaviour in communities is also dependent on such emergent behaviour controlled by organizational patterns. In the future perhaps the Action will be able to share genetic information in the same way as IT experts currently share software in open source mode with new organisms emerging as a result. This area can be seen as exploring the underpinning technology that might provide new understanding of this.

5. Technology and Risk Management

The risk of faults in normal operations of complex infrastructures, in large and complex organizations can have serious impact on the well-being of citizens and a new generation of tools is needed to analyze and control risky scenarios. From the technological side, a major help can be provided by new tools which can be used to observe the world and acquire specific data under many diverse standpoints. From the methodological side, in turn, Complex Systems ideas and methods, coupled with Artificial Intelligence tools, can be developed and deployed to infer properties from acquired data, to compare observed properties with normal operating properties, to evaluate distances between observed and desired properties, to design specific Actions to reduce that distance, to perform these Actions through the command of some actuator enabling the Action to take place.

This area can be seen as an integration of Complex Systems analysis and Artificial Intelligence methods and tools, aimed at increasing safety and security in complex scenarios operations. All that will be linked with the latest developments of ICT to design new instruments for analysis and, eventually, control of complex scenarios such as those present in large urban environments, in complex infrastructures with large impact on citizens (airports and other critical transport infrastructures, congested vehicular traffic areas etc.).

Major test-beds to check deployability and usability of these ideas can be urban structured spaces, such as areas where large concentration of persons must co-exist and where complex tasks must be accomplished: examples of this class of spaces are airports, large underground networks or large open spaces where real-time analysis must be performed in order to issue specific decisions such as evacuation plans issued upon catastrophic events. In addition, classical critical infrastructures, for example, communication networks, electrical transmission networks and, in general, energy dispatching systems, logistic pathways, motorways etc. will be also object systems for this class of studies and simulations.

The integration of these ideas and methods will be performed by gathering scientific communities coming from different areas: urban planning and sociology, complex systems, transport and logistics, Artificial Intelligence and Robotics, telecommunication and electrical engineering, physics and applied mathematics. The purpose is to combining theoretical analysis and simulation of new models with the design of new technical instruments enabling the combination of world observation with fast and accurate data analysis. The goal is the understanding of physical and sociological processes and, ultimately, the increase of well-beings of people, via better control of technological systems and better understanding of physical and human-based processes.

D.2 Scientific work plan – methods and means

The principle activity will focus on around working group meetings that include senior researchers, postdoctoral fellows and graduate students to discuss issues related to the topic. A kick-off meeting will be used in the first instance to discuss and prioritize those issues which will form the basis for working group meetings in year one. Each working group will hold one, possibly two meetings during the first year. These will be supplemented with short term missions that enable participants to follow up in detail various aspects. The Action will provide an immediate outcome which will be publications arising from these missions. Annual meetings with linked Management Committee meetings will be used to repeat the process in further years. Separate Management Committee meetings will not be held in order to optimize the use of funds for scientific aspects.

Specific technical objectives in the first year will focus on building relationships between scientific and sociological disciplines; building and developing approaches to the analysis of data that allow interpretation by physical methods; exploring control of complex collective phenomena characterized by relatively long space-time scales in terms of elementary elements that operate at finer scales; the development of common vocabulary and fusion of complementary knowledge across disciplines; development and understanding of the co-evolution of agents on complex heterogeneous networks.

E. ORGANISATION

E.1 Coordination and organisation

The program will be divided into five working groups in line with the research areas outlined above. A Management Committee (MC) will oversee planning, implementation and coordination. Attention will be paid to developing trans-disciplinary links, extending the range of active members, encouraging mobility and training of young researchers, links with states beyond Europe and other strategic issues including gender, web site matters.

An open annual conference will permit sharing of experiences, assess advances and foster scientific directions and coincide with the MC meetings.

Each working group will be coordinated by an expert member of the MC (names to be agreed at the first MC meeting). Working groups will hold at least one key meeting each year.

Short term scientific missions and meetings will be actively used to encourage information exchange and enhance opportunities for both young researchers and senior experts to participate in the inter-group programs.

A small sub-committee consisting of the Chair, Deputy Chair and the 5 working group coordinators will be set up to approve STSM applications. Any application will be required to show relevance to activity of one or more of the 5 working groups and be approved by the relevant working group coordinator. The Chair or Deputy Chair would then act as a further check on value prior to approval. This procedure will be completed quickly by email and formal meetings of this subcommittee outside the annual MC meeting are unlikely to be required. This sub-committee will also be empowered to respond to and agree other initiatives including working group meetings, training schools and other pertinent matters that may arise during the term of the Action. In this respect the sub-committee will act as an executive group for the Action. The Management Committee meetings then will act as a Board that, whilst suggesting and debating strategic developments of the Action will also be able to ensure sound financial and ethical and transparent operation.

The opportunity to organize training schools offered by COST will be discussed at an early stage with experts from the Action providing the teaching resource. Recognizing the budgetary limitations, attention will be paid to obtaining best value for money and choosing locations that maximize the numbers of early-stage researchers who can attend. This will be resolved by the MC and the organization delegated to a specific MC member. A small executive group from the MC will be tasked to help as necessary.

Coordination of national research in this area is at different stages in different Member States. There is the EU sponsored activity Complexity-Net within which research councils from across Europe are discussing possibilities for coordinated research programmes. Equally there is an interest from outside Europe in this area. Most if not all the states engaged in Complexity net are keen to participate in this Action and therefore the Action will be ideally placed to help overall coordination of key players within Europe, positioning them to take full advantage of new programme initiatives as well as facilitating the entry of new players into the field. Short term missions and training schools will help with this.

The Action will maintain a web site that will be open to all interested parties. This will contain notice of all meetings and training schools, details of participants including profiles and relevant publications. In addition links to and other sites will be included. Synthesis of all achievements will be made for promotion and publicity. :

Regular checks of the web site will be made by a nominated member of the MC to ensure that the site is up to date and reader friendly.

E.2 Working Groups

Each of the five working groups will have a coordinator who will take the initiative in driving working group activity. The coordinator will together with other members of the MC identify experts and young researchers to be invited. The locations will be varied to ensure that awareness of the activity is optimized and help enhance attendance.

E.3 Liaison and interaction with other research programmes

Some supporters of this proposal are already engaged with specific research projects sponsored by the EU as noted in section B4 above (e.g, CREEN, MMCOMNET, DYSONET, GIACS and ONCE-CS.); others have sponsorship from specific member states (E.g., CRESCO www.cresco.enea.it). These should form a core around which the Action can build new and additional links between the participants of the Action.

Where it seems appropriate the Action will also hold meetings within or alongside other key meetings organized, for example, by professional bodies or associations. In this way the Action will gear up the investment by COST.

E.4 Gender balance and involvement of early-stage researchers

This COST Action will respect an appropriate gender balance in all its activities and the Management Committee will place this as a standard item on all its MC agendas. The Action will also be committed to considerably involve early-stage researchers. This item will also be placed as a standard item on all MC agendas. The Management Committee itself will strive, in so far as it is possible, to have an equal balance of male and female members. Early-stage researchers from participating groups will be encouraged to take advantage of the short term mission instrument. Equally they will be encouraged to participate actively in the working group meetings. The training schools will be specifically targeted at young and new researchers seeking to enter this field of research.

F. TIMETABLE

The Action will run for four years and each working group will meet independently at least once each year. It is conceivable that two such meetings may be held subject to funds and the Action requirements. At least two training schools will be organised, the first in year two and the second in year three. Precise details will be subject to agreement by the Management Committee. A separate annual meeting will be held each year at which all working groups will come together to share and discuss common issues. Formal meetings of the Management Committee will be held during these annual meetings. A number of independent experts will be invited to these annual meetings and, in addition to contributing to the Action activity may also be invited to offer their views informally as to progress and the level of activity.

G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest:

AT,BE,BG,CZ,DK,EE,FI,MK,FR,DE,GR,HU,IE,IL,IT,LT,NL,NO,PL,PT,RO,RS,SI,SE,ES,CH, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at EUR 40 million for the total duration of the Action. This estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

The following non-COST countries have also participated in the preparation of the Action or otherwise indicated their interest: Argentina, Australia, Chile, India, USA.

H. DISSEMINATION PLAN

H.1 Who?

The output from this action will be of interest to a number of different communities. Specifically Government policy makers, advisers and similar groups concerned with the impact of large and relatively rapid socio-economic changes on society (for example, climate change, cultural change due to immigration, asset price changes such as energy, food and housing) and industry concerned with measurement, monitoring and controlling such effects. This Action will also target people concerned with training young scientists and facilitating knowledge transfer within the multidisciplinary area dealing with complex systems.

The dissemination plan for this COST Action will be guided by EU publication EU 20496 published in 2002 An Assessment of the IMPACT of the EU FAIR Agri-Food Research Programme 1994-1998 prepared by two senior scientists with substantial experience of industry, government and academia. Whilst the specific programme studied in this report was that of food and agriculture, the authors developed a new generic methodology that could be applied to any research programme regardless of the topic. In brief, the authors identified five domains against which impact of research projects could be judged. By using supplementary quantitative analysis, they further showed how the set of projects within the programme could be systematically ranked and success objectively measured. The five domains were:

Research: publications, conference presentations, awards. This aspect of a research project is usually the one that is most readily measured both during and also at the close of a project.

Commercial impact: new technology, patents, intellectual property, technology transfer. Indications of potential may be evident during a project; realized impact usually becomes evident after some years.

Training: training schools during a project are an important element; however the key measure identified by the authors was obtained directly from interviews with the trainees after the end of the project where details of career paths could be quantified.

Consumer impact: Does a project impact on the consumer. Whatever the topic, the potential for impact can be assessed by measuring direct links between project participants and consumer representatives on public bodies.

Regulatory impact: changes in regulations can take time but the interaction of project participants with policy makers and government officials is a key indicator or potential.

The dissemination plan has been developed against these domains. The entire plan will be optimized by placing particular emphasis during the term of the COST Action on the continued development of the network capacity and facilitation of the multidisciplinary links that will help the participants develop their research goals and tackle issues and problems of social relevance.

H.2 What?

Research is at the core of the activity of members of the Action. The Action will promote the publication of co-authored papers where COST is acknowledged in international peer reviewed journals. The Annual meeting of the Action and where appropriate the Working group meetings will be used as vehicles for the dissemination of Action activity and research results.

Exploitable technology can be expected to arise from the activity in working group five. Relevant commercial links will be fostered though the invitation of external international experts from industry and the regulatory sector to both working group meetings and the Annual meeting.

Training of young researchers that focuses on the new science, technology and its application across the multidisciplinary spectrum will be provided using the training instrument offered by COST. The schools will where possible be located in locations that are lowcost in order to attract as many young researchers as is possible within the available budget. Young postdoctoral fellows and researchers will be encouraged to attend working group meetings, present their work and encourage others to work in the area. Short-Term Scientific Missions will be used to facilitate this aspect and strengthen the network.

Regulatory links will be facilitated directly where possible and appropriate through invitation of relevant persons to the meeting. The Action will have the multidisciplinary links with economists and social scientists will help foster these kind of contacts.

H.3 How?

Publication of results will be a key route for dissemination of the key academic advances made within the Action. Presentation of work at key conferences is also important and the Action will where appropriate, align working group meetings alongside or within important conferences where relevant work can be presented. The nature of the Action will enable us to ensure contributions are delivered at conferences of a multidisciplinary nature involving not just physicists but also social scientists and economists and where industrialists and public officials, policy makers are present.

Cross disciplinary training of young researchers via the training schools and innovative graduate schools should help a new cadre of young researchers evolve and begin to contribute to the community. Wherever possible and whenever appropriate participation from experts and others in the commercial, government and non-governmental sector will be targeted and invited to attend the meetings.

The annual conference will be a forum for presentation and discussion of results, giving an overview to participants. However the Action will structure the audience to include external experts from both industry, government and if appropriate other bodies (e.g. technology transfer bodies, regulatory or consumer organizations). In this way the strong dissemination Action activity will be achieved. The Action will at the various meetings, especially the Annual Meeting, secure feedback that will help the Management Committee plan future meetings, schools and agree on priorities for short term missions and in this way take the activity forward.

A website will be developed that includes all relevant information and progress relating to the Action. This website which shall be maintained as an open site will also be linked to other sites concerned with this subject matter and act as a focus for the community seeking information about the subject.

Participants will be encouraged to publish their work in the press and take up invitations for media exposure where this is appropriate. Similarly non technical articles for the lay community will be encouraged.

During the term of the Action, various books and reviews will emerge and a final report will be prepared and published at the end of the Action.