



Physical Sciences

Complexity

Call for research proposals

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1 Introduction

The NWO Physical Sciences Board invites researchers to submit applications to the 2009 round of the Complexity research programme.

The Complexity research programme is a joint initiative of the NWO Physical Sciences, Chemical Sciences, Earth and Life Sciences and Social Sciences divisions, along with the STW Technology Foundation and the Netherlands ICT Research and Innovation Authority, supported by NWO's Governing Board. It is part of the NWO Theme Dynamics of Complex Systems, and addresses the challenges set out in the thematic programme document (which can be downloaded at www.nwo.nl/complexity).

A maximum of € 7 million has been made available to foster research in this area.

2 Objective

The Complexity programme aims to strengthen research in the Netherlands into the dynamics of complex systems, to create centres of expertise and to establish a community of complex systems researchers and users. The programme focuses on multidisciplinary research at the interface between scientific disciplines. As such, it aims to foster new collaborations between research groups from different disciplines. The development of a community will be enhanced by the establishment of a joint educational programme. PhD students working on the programme are expected to complete this programme. One strategy used in the Complexity programme is to involve potential users of research results in the research itself. There is therefore a special focus on the potential for results to be used in practice. Contact between researchers and users will be fostered with annual workshops and conferences.

Scope of the call

The research area is described in the Complexity programme document. The research themes are:

- Micro-Macro
- Complex Networks
- Predictability

Appendix 1 contains details of the research questions and challenges associated with these themes.

The programme document calls for the ideas, insights and knowledge of researchers from various disciplines working on complexity research in the Netherlands to be pooled to allow cross-pollination of traditionally independent research areas in order to give rise to new inspiration and insights. Researchers are accordingly invited to indicate how their proposal would help develop this theme.

Compartments

Researchers may submit proposals in three different 'compartments':

1. Question-driven research
2. Applied research
3. Curiosity-driven research

Compartment 1, Question-driven research

Proposals submitted in compartment 1 should concern research focusing on the questions set out by the programme's industry sponsors. These research questions are described in appendix 2. Representatives of these sponsors sit on an industry board specially set up for this programme. € 1 million has been reserved to fund question-driven research.

Compartment 2, Applied research

Proposals submitted in this compartment should be demonstrably geared towards the application of complexity research in industry or society. Applicants may submit detailed applications in accordance with the format set out in appendix 4. Alternatively, they may submit proposals in compliance with the terms and conditions of the STW Open Technology Programme (OTP) (<http://www.stw.nl/Programmas/>). In this case, too, pre-proposals must be submitted in accordance with appendix 3.

Compartment 3, Curiosity-driven research

Proposals submitted within this compartment, prompted by theoretical scientific questions, may focus on any aspects of the three research areas described above: Micro-Macro, Complex networks and Predictability.

Different procedures and criteria apply to the assessment of proposals in these three compartments, as described in section 4.

Complexity educational programme

This programme, designed to link the other elements of the research programme, will involve a number of activities, including workshops and courses. Some of the programme budget will be reserved for this purpose. Researchers implementing projects will be expected to participate in the programme, which will involve approximately 100 hours of study a year.

3 Guidelines for applicants

3.1 Who can apply

Applications may be submitted by researchers affiliated to Dutch universities and to NWO and Royal Netherlands Academy of Arts and Sciences institutes. The application should be submitted by one researcher (the main applicant) who is affiliated to one of these research institutions, on behalf of a team of researchers.

You should send a copy of your application to the director or dean of your institution. NWO will assume that you have informed your institution of your application, and that your university or institute accepts the grant terms and conditions of this competitive round. You should also:

- have at least a doctoraal, ingenieur or equivalent qualification;
- have sufficient research experience;
- be in a position to remain effectively involved in the research to which the grant application refers for the duration of the period for which the grant is being requested.

Simultaneous submission of identical or highly similar proposals is not permitted..

Applications from female candidates would be particularly welcome.

3.2 What can be applied for

The maximum amount available in this round is € 7 million. The programme will mainly subsidise research positions, up to a maximum of € 500,000 per project. The grant can be used to fund:

- Full-time trainee research assistants (AIOs) and/or two-year post-docs. An individual bench fee will be awarded to each research assistant or post-doc to (fully or partially) cover costs such as travel expenses and the printing of their thesis;
- Activities and equipment to support the research, provided their total costs fall between € 5,000 and € 30,000. The equipment must be intended exclusively for the project described in the proposal. The need for the equipment and its relationship to the project must be well substantiated;
- Travel expenses associated with the research, in so far as they are not covered by the bench fee;
- Travel and accommodation costs for guest researchers from other countries whose input is relevant to the research;
- Applications submitted in compartment 2a are subject to the OTP guidelines.

3.3 When can applications be submitted

The round consists of two phases:

- A mandatory pre-proposal phase in which you may submit abridged research questions (pre-proposals). The guidelines for this phase are set out in appendix 3. The abridged applications must be submitted by noon on 1 December 2009.
- The detailed application phase. The assessment committee will invite applicants to submit a full application. The guidelines applying to those selected to submit a full application are set out in appendix 4. Full applications must be submitted by noon on 1 March 2010.

3.4 Drawing up an application

All proposals (both pre-proposals and full applications) should be written in English so that foreign reviewers can be consulted. You are invited to use the application form, which you can download from the programme website. The proposal should be a discrete document, and reference to any internal documents should therefore be avoided. Only references to the 'open literature' are permitted. Should reference to a preprint prove unavoidable, applicants are requested to enclose a copy (in electronic form) so that the assessors can refer to it. Further information on how proposals should be structured is enclosed (see appendices).

Researchers submitting application-oriented proposals (compartment 2) should decide in their pre-proposal whether they wish to submit their detailed proposal for assessment via NWO or the STW Open Technology Programme (OTP, www.stw.nl/Programmas), using the OTP Application guidelines). Detailed OTP proposals will be processed according to the usual STW procedure. Successful applicants who apply to STW will become participants in the Complexity programme network, and will have access to the educational programme and workshop activities planned under the Complexity research programme.

3.5 Specific conditions

Successful applicants must begin their research within six months of the date of the grant award. Applicants who fail to do so will have their grant offer withdrawn.

3.6 Submitting an application

Applicants should use Iris, NWO's online grant application system. Please see <https://www.iris.nwo.nl> for instructions on how to use the system. The same procedure applies for the submission of the preproposals and full proposals.

An application consists of two parts: a factsheet listing key data on both the applicant and the proposal, and the research proposal itself. The factsheet should be completed and submitted online using Iris in three steps. In the first step, you are asked to give a summary of no more than 250 words identical to the English summary in the research proposal. In the second step, you should verify your details. The third step allows you to add any co-applicants. This factsheet will be sent to the assessment committee. The fourth step required by the Iris application system is submission of the research proposal. The research proposal should be sent as a PDF attachment.

The **factsheet** must be completed using only ASCII symbols (plain text). It will not therefore be possible to use formulae, italics etc. They may, however, be used in the **research proposal**.

Reviewers

You are requested to suggest three potential foreign reviewers for your application. Please give their full name and their website and email address. Only reviewers who have no involvement with the research team and application are eligible. The assessment committee will also be asked to suggest reviewers. Letters will be sent

to a number of reviewers from this pool of names asking them to review the application.¹

¹ It is also possible (but not required) to submit the names of the (maximal three) persons who are not allowed to review. To guarantee the confidentiality you are required to submit your suggestions for the referees and non-referees per email to the programme office and **not** embedded in your application.

4 Assessment procedure

4.1 Procedure

4.1.1 Procedure for assessing pre-proposals

The scientific assessment of pre-proposals is carried out by an assessment committee based on the applications. That committee, consisting of an international group of scientists, will determine whether the pre-proposal is in scope (appendix 1) and select and prioritise proposals for a full application.

An extra step applies to applications in compartment 1, which will be pre-selected by the assessment committee and undergo a selection process by the industry board.

Within four weeks of submission of the pre-proposal applicants will receive the recommendations of the steering committee, based on the advice of the assessment committee, stating whether or not they should proceed with a full application. The steering committee may suggest that applicants intending to work on the same subject submit a joint application. The committee may also advise applicants to submit an application in another compartment in the next phase.

4.1.2 Procedure for assessing detailed proposals

Different procedures apply to detailed proposals submitted to the three compartments:

- Compartment 2a: Assessment will occur in compliance with the OTP procedure (i.e. including STW jury reports).
- Compartment 1: The assessment committee will rank the detailed proposals, taking into account the views of international reviewers and any rebuttal received from the applicants. The industry board will select proposals to be awarded grants in accordance with the available industry budget, and taking account of their ranking.
- Compartments 2b and 3: The assessment committee will rank the detailed proposals, taking into account the views of international reviewers and any rebuttal received from the applicants. Besides the usual peer-review procedure (the assessment of the reviewers), a parallel experimental peer review procedure will be conducted. Involvement in this procedure is entirely voluntary, and will be confidentially treated by the programme office. The main applicants will be asked to rank a number of proposals (approx. five) from other applicants in this compartment on the basis of the criteria set out in this document. When submitting a proposal each main applicant should indicate whether he or she would be prepared to engage in this exercise, and whether he or she agrees to his or her proposal being read and assessed by approximately five other applicants. The main applicant will therefore read the other applications in connection with this experiment in complete confidentiality, and with the approval of the other main applicants. The views of the main applicants will be used in an experiment being conducted by the Physical Sciences Board and will not be made available to the assessment committee. Any conclusions from the experiment will be announced once grants have been awarded.

4.1.3 Decision-making

Representatives of the participating NWO divisions, as well as the Netherlands ICT Research and Innovation Authority and STW will make up the programme's steering

committee, which will propose candidates for grants to the divisions concerned on the basis of the recommendations of the assessment committee and the industry board.

4.2 Criteria

4.2.1 Official admissibility of applications

The programme office will not process any pre-proposal or full application to which one or more of the following applies:

- the application form has not been correctly or fully completed and the applicant has failed to respond to a request to rectify the situation;
- the application has not been submitted by a researcher at a recognised scientific institution;
- the application is not consistent with the objective of the programme;
- the application was not submitted online via Iris;
- the application was submitted after the deadline;
- the application does not meet the requirements of this call for proposals.

As soon as the situation has been rectified and the application can be declared officially admissible, it will be processed.

4.2.2 Active input and involvement by society/industry

All proposals submitted in compartment 2 require that possible users of the research have active input and involvement. These users may be companies and/or social organisations. Users of the research are defined as persons, companies or institutions outside the research area itself with an interest in applying the results of the research. Active involvement should be reflected in the description of the research, the plan of work and the roles that all partners will take in the project. Active input should preferably also involve a financial commitment.

4.2.3 Scientific assessment

Both pre-proposals and full applications will be assessed by the assessment committee on the basis of their **scientific quality, innovative character** and **relevance**.

The **scientific quality** of the proposed research will be assessed on the basis of the following characteristics:

- the scientific significance of the proposal;
- the clarity of the objective;
- the competence of the research team, including in terms of cross-border research;
- the plan of work and its feasibility;
- the relationship between the research goal and the funding requested;
- the added value of the interdisciplinary collaboration;
- the urgency of the proposed research.

The **innovation** of the proposed research should lead to new concepts, deeper understanding or new methods. A proposal's innovative character might lie in new applications for existing methods and techniques, or in the development of new techniques.

The **relevance** of the proposed research will be assessed on the basis of whether it is relevant to parties outside the scientific community (this is more important in the

case of applications submitted in compartments 1 and 2) and whether it has a bearing on the challenges of the research theme. The potential impact of the research on science or society could be high. The level of funding contributed by industry may be considered in the assessment of a proposal's relevance.

In the event that several proposals occupy an equal position in the prioritisation, preference will be given to proposals in which one or more candidates for implementation are named, or where the main applicant is a woman.

4.3 Composition of committee

Both pre-proposals and full applications will be assessed by an international assessment committee made up of representatives of universities and industry. Membership of the committee will depend on the number and heterogeneity of the applications. The members of the committee will be listed on the website at a later stage.

5 Other information

5.1 Contact details

For further information please contact:

- Dr. Nataša Tošić-Golo, telefoon: +31 (0)70 344 09 15, n.golo@nwo.nl
- Dr. Lex Zandee, tel. +31 (0)70 344 06 60, l.zandee@nwo.nl

5.2 Documentation

You can download this call and other information from the Complexity website:

www.nwo.nl/complexity .

5.3 Timetable

<i>1 October 2009</i>	Launch of call
<i>1 December 2009</i>	Deadline for submission of pre-proposals to the office of the NWO Physical Sciences Division
<i>6 January 2010</i>	Announcement of results of pre-proposal round
<i>1 March 2010</i>	Deadline for submission of full applications
<i>23 April 2010</i>	Applicants receive reviewers' comments and are given the opportunity to respond ('rebuttal')
<i>3 May 2010</i>	Deadline for submission of rebuttal
<i>June 2010</i>	Letters of award and rejection sent out

6 Appendices

6.1 Scope of the Complexity programme

Introduction

This document serves as a guideline for the assessment committee and for applicants as to which proposals are in scope or out of scope of the call of the Complexity programme.

Considerations

The purpose of the programme is to strengthen the Dutch knowledge position in the field of Complexity. Thereupon the intention is to build an active multidisciplinary community of researchers in this field.

Scope

There are two aspects considered when determining whether the proposal is in scope or out of scope:

- Does the proposal fit into to call
- Relevance of the proposal for advancing the field of complexity research in The Netherlands.

Fit

Complexity is hard to define in general, but there are a number of characteristic features that are shared by almost all complex systems. Complex systems are, without exception nonlinear and have a strong multiple-scale or even scale-free character, in time as well as in space. A complex system can often be seen as a large collection of small elements that interact with each other at a microscopic level. Such elements may be atoms in physics, molecules or cells in biology, consumers in socio-economics or galaxies in a cosmological context. More is different in complex systems: phenomena observed at a global-macroscopic-level cannot be reduced to the properties of the constituent elements, but are emergent properties that arise through self-organizing of local interactions. The challenges formulated in the context of the three research themes show that the most promising opportunities for complexity research lie in combining approaches and ideas from different disciplines. This way, novel and potentially breakthrough insights can be obtained that go beyond the setting of specific systems. Moreover, there is an intimate interplay between developing these transdisciplinary insights and a specific disciplinary complex system: novel insights can both be inspired by and be applied to a given complex system in a wide range of scientific expertise. A research proposal submitted to the NWO Complexity call should be intrinsically transdisciplinary, extending beyond a straightforward combination of two or more disciplines. It's core consists of studying the underlying concepts or mechanisms, that can be distilled from complex phenomena exhibited by nature, society or a computer simulation, and that are characteristic for complex systems in general. For instance, emergent behaviour at the macroscopic level, such as the outbreak of panic in a crowd, the catastrophe in which a vegetated area collapses into a desert, the sudden electric storm of an epileptic seizure, the global starburst that occurs as a result of a major merger event, share essential characteristics with well-studied concepts such as phase transitions in physics and bifurcations in mathematics. Likewise, questions about the prediction and possible control of congestion in traffic flow or about the growth and dynamics of sandbanks in coastal areas, correspond directly to theories on pattern formation that have been developed in mathematics and physics. This complexity call invites research proposals crossing boundaries between different disciplines.

Research themes

Three major themes within the field of Complexity have been selected: (i) micro-macro, (ii) complex networks, and (iii) predictability. These themes are by no means independent, they are often strongly overlapping and integrated, but they represent complementary approaches to the understanding and the study of complex systems. Complexity research and the three major themes have been described in more detail in the NWO-Brochure Complexity; Outline of the NWO strategic theme Dynamics of complex systems, available at <http://www.nwo.nl/complexity>. Here, we only give a brief outline of the three themes and list a number of examples and major challenges.

Micro-Macro

Perhaps the most important characteristic of complex systems is that properties observed at a global, macroscopic level cannot be reduced to the properties of the constituent elements. In a complex system, macroscopic level phenomena are often emergent properties that arise through, often nonlinear, local microscopic level interactions. The theme micro-macro focuses on the relationship between the microscopic components and the macroscopic behaviour of complex systems. Complex systems often have multiple scales in spatial structure (e.g., quarks-atoms-molecules-material-planet-galaxies) and in time (from nano-seconds to a Hubble time, from tic-by-tic trading to lifetime investment). These distinct scales reflect a hierarchical organization of nature. Both individual and collective emergent properties play a role as one moves from one scale to the next.

Challenges within the micro-macro theme

What are the key features of the dynamics of complex systems in particular the transition from interaction at the microscopic level to aggregate behaviour at the macroscopic level? How are emergent properties related to microscopic interactions? How does self organization in complex systems arise? Which features can be explained by a deterministic model and which need a stochastic explanation? What are the simplest complex systems or reduced form models which still explain the most important emergent properties and stylized facts observed in empirical or experimental data? How can we go beyond the paradigm where simple rules give rise to complex behaviour to where complex rules lead to complex behaviour? How do we deal with searching high-dimensional parameter spaces for identifying relevant behaviour in complex systems? Is it possible to reverse-engineer the mechanics of complex systems from studying a controlled set of external stimuli? How does feedback from macroscopic behaviour to microscopic behaviour affect the aggregate outcome and emergent properties of complex systems?

Examples of emergent micro-macro phenomena

- Phase transitions in physics; the discrete-continuum transition
- Interacting particle systems; these have been applied in the modelling of flocking birds, beating heart cells, and social interactions and herding in financial markets;
- Creation of an organism through interactions between genes through evolutionary processes;
- Psychological processes; they find their origin in the interactions between billions of neurons in the brain;
- In biological and socio-economics systems, properties at the population level are ultimately the result of interactions among individual elements within these systems. Ecosystems are shaped by evolutionary selection and mutation.
- Interactions among consumers, firms, and investors explain emergent properties at the macroscopic level, such as power-law distributions on firm size, wealth, and financial asset returns.

For these examples, following are some of the research questions:

- The discrete-continuum transition; how to establish links between spatial phenomena that are controlled by totally different time-scales. The spatial-temporal micro-macro interaction in materials is by far not resolved.
- How does adaptive behaviour in biological and social systems at the microscopic level affect aggregate behaviour at the macroscopic level? How does the degree of rationality/irrationality at the individual level shape aggregate behaviour?
- What are the emergent properties of different kind of neural network structures? Can we understand the properties and limitations of macroscopic processes, such as working memory, from the complex emergent properties of neural activity? How do emergent properties of neural activation such as awareness, influence this neural activity?
- The transition of non-living to living systems is a major transition in levels of complexity. How do self-organizing processes and genetic information accumulation co-determine this major transition?

Complex Networks

Another feature shared by many complex systems is the fact that they can be modelled as networks or graphs. The notion of a network or its more abstract representation as a graph, allows for dealing with the often inhomogeneous patterns of interactions within complex systems.

Many complex systems consist of large number of elementary components or modules that give rise to emergent behaviour through sparse, often nonlinear interactions. Such system can often be modelled mathematically as networks or graphs. With the introduction of small-world and scale-free networks models a modern network theory has developed, that has proved to be very successful in describing general properties of complex networks such as clustering, integration, hierarchical organization. It has also become clear that the topological properties of a complex network can predict how the dynamic behaviour on such networks such as synchronization will look like. Network evolution, self-organization and response to damage are important topics of research. Characteristic for this approach is that the details of the systems are less relevant than the topological structure of the networks that they form. This makes it possible to apply knowledge acquired within a field of research (for instance social networks) to completely other domains (regulation of gene networks; pathology of networks in the brain).

Challenges within the complex network theme

Applications within this major theme should be directed to the following main questions.

- How do complex networks develop? Are there general principles of self-organization that determine how a complex network arises from a more or less arbitrary disordered initial situation? Can this knowledge be used to steer network development in the direction of desired a new situation?
- How does the interaction of dynamics on networks (dynamic changes of network nodes) and dynamics of networks (slow evolution of network connections) take place? Which factors determine the efficiency of networks as transport systems of information, energy, entropy, traffic, money and so on.
- Which factors and properties determine the vulnerability of networks for different types of disturbances, and how can this knowledge be used to construct more efficient, robust networks? Can this knowledge be used to predict and prevent imminent disruption of networks?
- Is it possible to develop new models of complex networks that overcome some of the limitations of the existing models (Watts and Strogatz; Barabasi and Albert)? In particular, many complex systems display clustering, short path lengths, but also heavy tailed degree distributions and hierarchical structure: can these properties be caught in a single model? Can such a model explain and predict how these properties of complex systems arise?

Examples of complex networks

- The brain, with its billions of interconnected neurons in which bio-chemical processes at the micro-level give rise to consciousness and emotions at the macroscopic level, is perhaps the most challenging complex network of all. More often than not, these networks evolve. New connections may form, others may break: complex systems develop and adapt dynamically.
- Gene networks: Complex biological phenotypes of cells arise from gene regulatory networks in which transcription factors bind specific sites in the DNA to regulate target genes that may again be other transcription factors. This results in scale free networks of regulators and targets with specific local circuits. Why are some local circuits more common than others? What makes these networks robust and evolvable? Can we understand the cellular phenotype from its genotype?
- Materials: Patterning in materials and biological systems, where network formation becomes the order in the chaos. The creation, evolution, disintegration and transformation of such networks (microstructural patterns) is for most materials unresolved.
- Financial Networks: Panics in financial markets are manifestations of the behavior under stress of a complex, adaptive network. Complex because of a wide variety of financial and social interconnections. Adaptive, because behavior in these networks is driven by interactions between optimizing, but confused agents. Improved models of financial networks are crucial in understanding economic crises and preventing them.
- Supply Networks: Complex logistical and transport networks are increasingly interrelated between industries and transport organisations resulting in new patterns of goals and services movements.
- Social Networks: Society is composed of social networks between its members, where network ties can refer to friendships, marriages, professional ties, etc. The analysis of the structure and dynamics of social networks is important to understand the emergence of fads and fashion, the diffusion of information, ideas and new products, or the spreading of viruses.

Predictability

Predictability deals with the behaviour of complex systems and the extent to which this behaviour can be predicted or controlled on the basis of (partial) knowledge of its workings. The 'butterfly effect', associated with chaotic or non-linear systems has become a well-known metaphor for the inherent limitations of the predictability of nonlinear processes. Problems with predictability of complex systems are not restricted to chaotic phenomena, but also involve issues like path dependence, sudden bifurcations, irreversible phase transitions, stability with respect to stochastic fluctuations and the dependence of the process on the variation of parameters. Predictions of the behaviour of complex real-world processes are increasingly based on simulations of extended multi-scale nonlinear systems, with detection of early warning signals as an important goal. For instance, meteorologists wish to issue warnings for severe weather events on the basis of cloud-resolving simulations. Central questions are how to assess the predictability of these multi-scale systems and how to determine the reliability of a prediction. These questions go beyond the explicit context of the multi-scale model and thus lie at the core of complex-systems research.

Challenges with predictability

It is essential to assess the uncertainty in the model predictions rather than just making predictions. It is also of interest to estimate the predictability of the process itself, i.e. the reliability and the resolution of a prediction with the best possible model. A number of fundamental research challenges are of such nature that they combine theoretical, numerical and empirical aspects. Among these we can find the following specific questions:

- When does including more details induce better predictability? When is it possible to average small scales into large-scale effects without affecting the long-term predictability of a model? When does including new, large-scale, components affect the stability and the regimes of the system?
- What determines the predictive power of a model? This is a fundamental issue that is especially relevant in the context of long term predictions. A model may be accurate on a short time scale, but may exhibit unrealistic behaviour in the long run.
- Being predictive means that one is able to tackle both the deterministic and statistical problems in a quantitative manner. How can one consider simultaneously randomness, stability and deterministic fluctuations.
- Robustness for changes in control parameters. Is it possible to quantify the vulnerability of a system to a catastrophic event?
- Managing uncertainty in complex systems. How is the uncertainty in predictions related to uncertainties in the input data and model formulation? When should we measure more, and when should we model better?

Examples of predictability questions

There are plenty of examples of complex systems, and the ones listed here should only be seen as a very abbreviated list of possible research areas.

- Earth system models combining daily weather forecasting and climate forecasting and include other components such as the ocean, the biosphere and cryosphere. The predictability of climate change and the estimation of the uncertainty in these estimates are central issues.
- Financial markets can be modelled as complex systems, where the interaction of a large population of heterogeneous investors may leads to large swings in financial asset prices triggered by economics news, but strongly reinforced by herding behaviour and social interactions.
- The spatio-temporal dynamics of an infectious disease, such as HIV or the influenza virus is a complex process, driven by the spread of micro-organisms and resistance genes, and often fuelled by the very use of antibiotics, which can be modelled by a dynamically evolving network.
- Materials: How to predict the lifetime of a product on the basis of the full knowledge of the complex physics and history of the materials up to the atomic scale.
- Agent-based microscopic level traffic transport simulation models, with emerging, nonlinear aggregate traffic-flow patterns, can be used for traffic management. An interesting aspect is that travellers can actively decide what to do if traffic-flow predictions are available.

Relevance

Essential for the application oriented proposals is the serious involvement of (potential) users in the execution of the projects.

6.2 Question-driven research, research questions (compartment 1)

6.2.1 De Nederlandsche Bank

General research questions:

How do information (dissemination), network topology and behaviour of market participants affect outcomes with regard to financial and/or interbanking markets during *extreme* circumstances? How are (negative) shocks propagated in such a complex system of markets, and how can they be absorbed?

Specific research questions:

- How could an 'early warning system' for crises in financial and/or interbanking markets be designed e.g. by means of agent-based modelling?
- How does collective destabilizing behaviour of agents ('panic') arise in financial and/or interbanking markets? What is the interaction with the regulatory framework; what underlying mechanisms can be identified? How could regulation/supervision or market design prevent destabilizing behaviour?

6.2.2 NS**Monitoring and Forecasting Passenger Flows in Public Transport**

A public transport operator can operate efficiently only with substantial passenger flows. The higher the utilization of the resources (vehicles and crews), the better it is from an efficiency point of view. A high utilization of the resources starts with accurate forecasts of mobility in general and of the *own* passenger flows in particular. It also requires a flexible operation, in which the allocated resources can be adapted quickly to changing demand forecasts. On the other hand, passenger flows in a public transport system consist of large numbers of individual passengers, each of whom made an own choice for using this public transport system. Thus also the behaviour of individual passengers plays an important role.

Besides relevant for planning purposes, having accurate forecasts of passenger flows enables a public transport operator to react effectively in case of a disruption of the system. In such cases, the effectiveness of recovery measures depends on the numbers and destinations of the passengers currently in the system. Thus it is important to have estimates of these as well.

Moreover, in the planning stage it is relevant to know how to influence the passenger flows in order to shift part of them in time and space, for example from peak periods to off-peak periods. This will enable a more efficient utilization of the operator's resources. It requires understanding passenger travel behaviour, involving the understanding of a series of choice decisions, such as activity choice, mode choice, route choice, and departure time choice.

Forecasting passenger flows starts with monitoring these flows. Currently, several rather low tech methods are used for that purpose, such as manual counts by conductors, 'Meten in de Trein', ticket sales, etc. However, modern ICT allows using more sophisticated methods, for example:

- Mobile telephones,
- Chip cards for public transport,
- Infra-red systems on vehicles.

Each of these methods has advantages and disadvantages. For example, infra-red systems do not provide links between the origins and destinations of the passengers. Translating such measurements into journeys of individual passengers is complicated therefore. Forecasting the passenger flows based on the earlier measurements requires taking into account several other external information sources, such as weather forecasts, information on special events, etc.

Summarizing, this research topic considers a problem that has a high level of 'Complexity' and addresses the questions of interest both from the micro-level and from the macro-level.

On the micro-level:

- How can public transport operators better forecast their passenger flows?
- How can public transport operators design strategies to shift passenger flows in time and space?

On the macro-level:

- Do public transport operators that have a higher informedness of their passenger flows also have a higher resource utilization and firm performance in general?
- How can public transport operators use the informedness of their passenger flows for passenger oriented disruption management?

From Micro to Macro:

- How to deduct decisions at macro level from data at micro level, from individual passenger preference to capacity network and stochastic flow models.
- How to balance micro and macro level in case of disruptions (combining data sets such as timetable and weather data, and studying passenger behaviour in response to stimuli like tariff differentiation)?

6.2.3 Cordys

Cordys is an innovative software company providing leading business process management (BPM) tools and services. The Cordys software suite enables process management across different, non-coordinated, enterprise systems:

The Cordys kernel enables any organization to define their process logic (the different process steps, their linking and business rules) and provide process execution capabilities with the benefit of rapidly executing business processes across different technical and organisational platforms.

Cordys recently announced a major cooperation with Google: This is exemplary for future information systems that will be network-centric, highly flexible, and user-defined and event-driven. It enables 'easy to join' and 'easy to leave' business networks, all using the same software and data. Such 'process networks' will be dynamic and very complex.

Some of the research questions are:

- To what extent should processes be de-composed and loosely coupled?
- How to define the essence of process 'event and state' and how to correlate distinct events/ states?
- How to assess and analyse process event patterns in multiple information networks?
- Can message flows in information networks be predicted or otherwise anticipated?
- How to link and manage correlations in information networks with different owners and how to maintain control, if and when necessary?

6.2.4 Chess

Chess is the ICT specialist in the field of innovative systems and critical solutions. Reliable prediction of the behaviour of complex systems is one of the goals that have to be validated. Appearances that no one can predict are of interest; for example in wireless networks. A number of properties of these networks are subject of research in the frame of the Complexity program. The research must be carried out by a multidisciplinary group. Their common goal will be to enable decisions that are reliable and lead to deeper understanding of the predictions.

- What is the most promising method, in the development of large scale wireless networks, to control the behaviour of the total network while programming the individual nodes.

6.2.5 Equens

Equens is a European leader in electronic payment, clearing and settlement services. Traditionally closely linked to today's financial institutions Equens foresees a future of transfer of financial, and other, value, via non-traditional payment systems and the development of 'near money'. Examples are mobile payment systems as well as

many new ways of Internet transactions. This development poses significant challenges for the core functions of its organisation. Some of the research questions are:

- Using advanced theories in complex systems, is it possible to assess network-based transactions patterns (mobile, Internet) and predict and control financial flows that result from such transactions? What tools and methods are applicable? Why should this be done?
- In which way will new payment models such as digital person-to-person money influence, or even threaten, (the stability of) our current financial systems?
- Will new payment models impact 'real money'? Why? How?
- How stable are the future, new payment models? Can fraud and other forms of misuse be predicted or pre-empted? How? Should this be done by way of analysing the transactional behaviour of clients? What (external, internal) sources of information should be used? How?

6.3 Guidelines for drafting an abridged proposal

Structure of pre-proposal

The pre-proposal should be written in English. It should be a discrete document, and reference to any external documents (other than literature references) should therefore be avoided as far as possible. De text in the section 4 should not exceed 1200 words.

1a Project Title

A short but specific title for the research for which funding is being requested. (Same as the title entered in the project information screen).

1b Project Acronym

If applicable. (Same as the acronym entered in the project information screen).

1c Principal investigator

Only enter the name of the main applicant (who is also the point of contact and intended project leader).

2 Classification

You are requested to indicate the compartment in which you believe your research belongs. Choose from the following:

Compartment 1, Question-driven research

Proposals submitted in compartment 1 should be for research targeted at questions set out by the programme's industry/social sponsors. These research questions are listed in appendix 2.

Compartments 2a and 2b, Applied research

Proposals submitted in compartment 2 should demonstrably be targeted at the **application** of complexity research in industry or society. Please indicate whether you wish to submit your full application in accordance with the STW OTP format (= compartment 2a, see www.stw.nl), or the NWO format (= compartment 2b, see appendix 3). Full proposals in compartment 2a will be assessed in accordance with STW procedure.

Compartment 3 is for all other research proposals.

Composition of the Research Team (maximum 1200 words)

Please indicate here which parties are likely to make up the research team:

- names of involved researchers, university/ies and/or institute(s)
- names of companies and/or social organisations that will be involved as partners.

In so far as possible, please give surnames and initials, titles, scientific background (including a brief CV) of the researchers. Please state who will act as academic sponsor to the trainee research assistant (PhD candidate).

4 Description of the proposed research (maximum 1200 words)

This section should consider the following aspects:

- research question and intended results
- research method
- significance of the proposed research
- specific applications on which the research will focus and their relevance to non-scientific parties, as well as systems and problems
- how the proposed research relates to research elsewhere
- describe the specific role of the 'demanding party' (industry and/or social organisation).

Structure this section as follows:

4a Scientific aspect

4b Innovation

4c Relevance

5 References

Brief summary of the references cited in the pre-proposal.

6 Budget

Give an indication of the type of implementing parties for whom you require funding and of the total project budget (= grant + university contribution(s) + contribution from industry and/or social organisations). The grant requested may not exceed € 500,000. The maximum duration of the project is four years.

6.4 Guidelines for drafting a detailed proposal (compartments 1, 2b and 3)

(For compartment 2a, see OTP guidelines at www.stw.nl)

Structure of research proposal

All proposals should be written in English. The proposal should be a discrete document, and reference to any internal documents should therefore be avoided. Only references to the 'open literature' are permitted. Should reference to a preprint prove unavoidable, applicants are requested to enclose a copy (in electronic form) so that the assessors can refer to it. Sections 6, 7 and 8 combined should not exceed 5000 words. This equates to approximately 10 pages.

Reviewers

You are asked to suggest up to three potential reviewers per email to complexity@nwo.nl. Please supply their full name, title(s), affiliations, gender and email address. *The reviewers may not have any conflict of interest with your proposal.*

You are also required to inform the programme office by means of an email whether or not you will be participating in the experimental peer review procedure.

1a Project Title

A short but specific title for the research for which funding is being requested. (Same as the title entered in the project information screen).

1b Project Acronym

If applicable. (Same as the acronym entered in the project information screen).

1c Principal investigator

Only enter the name of the main applicant (who is also the point of contact).

2 Summary of research proposal

Brief summary of the research proposal (maximal 250 words). This is the scientific summary that will be passed on to the reviewers.

3 Classification

You are requested to indicate the compartment in which you believe your research belongs, based on the same descriptions as in the pre-proposal round.

4 Composition of the Research Team

The research team has three parts:

- the individuals for whom the grant is being requested ('vacancies')
- the input from universities and/or institutes
- the input from the 'demanding parties'.

Please give surnames and initials, titles, scientific background and affiliation (university, institute, company, institution etc.) of all those involved. If the research is a PhD project, please state who will act as academic sponsor to the trainee research assistant (PhD candidate).

5 Research School

Specify the research school(s) at which the project staff will be conducting their research.

6 Description of the proposed research

This section should consider the following aspects:

- research question and intended results
- research method
- scientific significance of the proposed research
- specific applications on which the research will focus and their relevance to non-scientific parties, as well as systems and problems in the 'real world'
- how the proposed research relates to research elsewhere
- describe the specific role of the 'demanding party' (industry and/or social organisation).

Structure this section as follows:

6a Scientific aspect**6b Innovation****6c Relevance****7 Description of the proposed plan of work**

Please indicate roughly how the entire research project is to be phased, in periods. More specifically, you should indicate which activities are likely to be carried out in the first two years. Indicate roughly which tasks will be undertaken by which members of the research team. The project duration must not exceed four years.

8 Expected Use of Instrumentation

What equipment or software will be needed? Present arguments. Please differentiate between existing equipment/software, and equipment/software that needs to be purchased.

9 Literature

Give a brief summary of the references cited in the proposal. You are also requested to list the five most important publications by all team members.

10 Budget

General

The project budget consists of two components:

- A. the researchers, activities/equipment/software and the additional travel budget for which you are requesting funding.
- B. the input from industry or social organisations (not eligible for funding); applicable only to proposals in compartments 1 and 2b.

Component A (grant requested)

(1) Staff

- Standard amounts are available to cover the salary costs of researchers. See tables 1 and 2.
- Funding for other staff may be requested only in conjunction with one or more researchers. They may not be appointed for longer than the subsidised researchers. Indicate whether you are employing staff with secondary vocational, professional (HBO) or university qualifications. See table 1.
- The standard amounts include provision for salary increases over the project period.

(2) Other

- An individual bench fee of € 5,000 will be made available for each trainee research assistant (AIO) or post-doc. The bench fee is intended mainly to cover their travel costs in the Netherlands and abroad, including attendance at conferences, as well as a contribution towards the costs of printing the AIO's PhD thesis.
- Funding may be requested for project-related equipment/software, provided their total costs fall between € 5,000 and € 30,000. Equipment/software costing less than € 5,000 will be regarded as part of the institution's infrastructure and will not therefore be eligible for this programme.
- An itemised budget must be submitted for both additional travel expenses and project-related equipment/software. Clear arguments for each item must be presented, and related to the research positions for which funding is being requested.

Component A total

Projects will be awarded a grant of no more than € 500,000. It is not possible to apply for extra resources during the course of the project.

Component B (input from industry and/or social organisations)

This component may cover (1) capitalisation of the hours worked, (2) the costs of material and aids used and (3) use of equipment and machinery.

(1) Capitalisation of hours worked

This refers to salary costs and social insurance contributions, plus an extra 50% in overheads. The participating parties are expected to make an active contribution to the project. This will be reflected in the plan of work, which will include an estimate of the number of hours to be worked by each staff member.

(2) Costs of materials and aids used

This must be based on historical purchase prices.

(3) Use of equipment and machinery

Take account of past depreciation and intensity of use.

Summary of project budget

Complete the table below.

Component A (to be funded from grant)

(1) Staff (see tables 1 and 2)	No FTE x amount	
a) appointment of PhD student(s) FTE x €	= €
b) appointment of post-doc(s) FTE x €	= €
f) appointment of other (new) staff FTE x €	= €
..... +		
Subtotal, staff		= €
(2) Other		
a) individual € 5,000 bench fee (only for AIOs and post-docs) FTE x €	= €
b) additional travel budget FTE x €	= €
c) project-related equipment/software FTE x €	= €
d) (foreign) visiting researchers FTE x €	= €
..... +		
Subtotal, other		= €
Total, Component A = subtotal (1) + (2)		= €

Component B (inbreng vanuit de bedrijfsleven of maatschappelijke partijen)

(1) Capitalisation of hours to be worked, plus 50% overheads	= €
(2) Cost of materials and aids used	= €
(3) Use of equipment and machinery	= €
..... +	= €
Total, Component B	= €
TOTAL PROJECT BUDGET (= Component A +B)	= €

6.5 Salary tables**Table 1**

For PhD students (AIOs), post-docs and other staff, please use the standard salaries agreed in NWO-VSNU (Association of Universities in the Netherlands) contracts effective from 1 April 2001. At 1 July 2009 these standard salaries (excluding individual bench fees) were as follows, in € and based on 1.0 FTE:

job title duration	PhD student	post-doc	other staff, qualification level		
			MBO	HBO	university
1 year	n.a.	not possible	47,514	57,140	68,345
2 years	n.a.	129,342	96,307	115,820	138,530
3 years	n.a.	196,635	146,413	176,078	210,605

4 years	200,013	not possible	197,868	237,959	284,620
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Table 2

For university lecturers and senior university lecturers, you may not exceed the maximum agreed in the Universities' Collective Agreement effective as of 1 July 2009, as indicated in the table below. The amounts are in € and based on 1.0 FTE, including social insurance contributions (incl. commutation of severance pay and extension due to illness). The amounts correspond to a starting salary scale of 11.10 for a university lecturer, 13.7 for a senior university lecturer and 17.7 for a professor.

duration	job title	university lecturer	senior university lecturer	Full professor
1 year		86,180	106,272	147,215
2 years		174,681	215,404	298,394
3 years		265,564	327,475	453,642
4 years		358,893	442,562	613,069

Table 3

The individual bench-fee applies for PhD student and post-docs. As agreed in the Universities' Collective Agreement effective as of 1 July 2009, the bench-fee in € on basis of 1,0 FTE:

duration	job title	aio	postdoc	other staff		
				MBO	HBO	university
1 year		n.a.	n.a.	n.a.		
2 years		n.a.	5,000	n.a.		
3 years		n.a.	5,000	n.a.		
4 years		5,000	n.a.	n.a.		