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HUMAN RESOURCES AND MOBILITY (HRM)
ACTIVITY

MARIE CURIE ACTIONS
Marie Curie Research Training Networks
(RTN)

Call: FP6-2005-Mobility-1

PART B

STAGE 1 - OUTLINE PROPOSAL

"TASMAN"

Contents

Theory and Applications of Stochastic Modeling and ANalysis (TASMAN)

1 Introduction

The proposed research and training network (RTN) "TASMAN" will focus its effort on stochastic models and brings together statisticians, probabilists and system theorists.

Motivation. One striking feature of mathematics is its capability to provide the right model for largely unpredicted applications. Famous examples are quantum mechanics in the '30s, control engineering in the '60s, finance in the '90s and biology nowadays. It is also remarkable that *stochastic modeling* has played a key role in all these applications, and it has thus been a *success story* in the past; it is a widespread belief that it has the assets to remain on this path in the future.

Objectives. The main *scientific goal* of this network is to build new theory to fill the gaps which are present today in the modeling of dynamical stochastic systems. The need for new theory stems essentially from the fast technological advances, which have resulted in increased data availability and (through increased computational power) the possibility to use complex stochastic modeling.

Computationally intensive methods (like MCMC, exotic option pricing, high frequency data analysis, protein folding analysis), were impossible ten years ago. Also a range of new areas (microarrays, genome sequencing, mobile telecommunication networks, climatology) called for development of new models. But the pace of this development has been so fast that a comprehensive theory for complex models has been lagging behind: central issues, like identifiability, stability and robustness, have to be addressed anew to make the use of these models reliable. It is therefore the right time to push for a *major theoretical effort* in the development of stochastic modeling. In addition, this project has the *ambition* to be aimed not only at answering today's questions, but also to provide a theoretical framework and analytic tools for issues which will be raised in the future.

The *training objective* is to organise a unique interdisciplinary training programme for young European researchers, both in the theoretical and applied fields of the scientific programme. This training will be promoted through exchange visits between the partner teams, presentations at network meetings and ample room for the development of complementary skills. The final goal is to provide Europe with a new generation of well-trained scientists that will be able to advance the European research in this area and that are well-equipped to put Europe at the forefront of new developments.

The network. The program will require an *interdisciplinary* research effort with strong competences in stochastic analysis and time series, stochastic modeling and identification, and statistical inference. This is the reason why this network brings together probabilists, system theorists and statisticians.

The proposed network comprises 15 teams from 12 countries, in which most of the prominent European experts of the field are present. It stems partly from the previous IHP funded research training network DYNSTOCH, but the inclusion of six new teams has increased its research potential. Experience from previous RTN projects (essentially DYNSTOCH, but also ERNSI), will provide valuable knowledge in the network management and in organizing the training program.

An example of the strategic importance of having well trained professionals in this area is provided by the financial industry in the last ten years: suddenly (and almost frantically, especially after the collapse of the Barings bank had shown the importance of having a back-office with good mathematical competences), all financial institutions started to hire probabilists, statisticians and systems theorists. At the time the EU area was able to cope with this demand precisely because it had a strong tradition of basic research in these areas. In fact some of these people came from the previous RTN projects DYNSTOCH and ERNSI.

There are strong signs that a similar situation might occur very soon in microbiology and later, as data collection improves, in environmental sciences.

2 Scientific Quality of the Collaborative Project

The principal aims of the proposed network are

- **to make a major contribution to the theory of modelling of and statistical inference from stochastic processes and**
- **to apply new theoretical results to a set of well chosen applications.**

Experience shows that these objectives can best be met in *a combined effort where purely theoretical research and more applied work on a few well-chosen topics stimulate each other.* Moreover, novel high level applications will prosper better when they are the result of or are complimented by new advances in theoretical research. The theoretical work will apply the methods of modern probability theory, including stochastic calculus. Computational and numerical methods will play an important role in the work of the proposed network. Because of the complexity of the models to be considered, the statistical methods will in most cases necessarily be highly computer-intensive, especially in view of huge amounts of data in specific fields of application. The main fields of applications of this theoretical work will be in *finance, biology, environmental studies and in telecommunications.* Particular emphasis will be put on the development of new models whose dynamics better reflect those of the physical data. The results of this research will be *applicable in the financial industry, in the software and telecommunication industries, and in companies that use advanced biological technology.*

The proposed network brings together specialists and prominent researchers, often of world class level, from various fields in mathematics and engineering, notably statisticians, probabilists and systems theorists. It is the combination of a vast and wide body of theoretical knowledge available in the team as well as its experience with the selected applications, often obtained by collaboration with researchers in other scientific disciplines, that makes it pre-eminently qualified to carry out the proposed research. It also creates the stimulating scientific environment that is indispensable for a successful training programme.

2.1 Research objectives

A main theme in the research of the proposed network is *the interaction between theoretical developments and advanced applications.* Practical questions will stimulate new theoretical research and new achievements on the theoretical side will almost immediately find their way to the applications that we will consider. Next to theoretical advancements, we will pursue *significant progress in the mathematical aspects of applied fields stimulated by a further development of the accompanying mathematical theories.* Besides, translating a practical problem into a well-defined mathematical one has the additional and not to be underestimated virtue that a methodology to solve it may result in methods that are not only applicable to the original problem, but also to a much wider range of applications that may be completely different from the original one. The true power of applied mathematics is the potential to solve problems at a general level by isolating the essential mathematical features and solving problems that have been abstracted from their origin. This is exactly the case for the methods to be developed by the network, which are based on the mathematical technology of stochastic calculus, time series techniques and deep statistical methods. These methods will extract the essentials from arbitrary data sets that are believed to be generated by a rather general random mechanism. The division of the project objectives into a number of smaller research programmes as outlined below should not be interpreted as list of isolated themes. On the contrary, *the interaction between these subprogrammes, usually based on their common mathematical features, and the expected cross fertilization, is a central issue*, especially between the theoretical and applied subprogrammes.

2.1.1 Theoretical research themes

The main expertise of the proposed network lies in the fields of stochastic processes, both in discrete and in continuous time, and in statistics. In this section we describe the theoretical research we want to pursue by topic.

T1. **General theory of and inference from stochastic processes.** In many applied fields statistical models based on stochastic processes in continuous time are becoming more and more prominent. The rapid development of stochastic analysis, stochastic integration theory and the theory of stochastic differential equations (SDEs) in the past decades has made these applications possible. But recently new fields of research have emerged. In the theory for SDEs fractional Brownian motion or Lévy processes as driving forces open a new and vigorous field of research as well as SDEs with delay and branching diffusions. Although important progress has been made, many unsolved problems remain. Within the network special attention will be devoted to fractional processes, random time changes and change of measure problems, stochastic differential algebraic equations and Markov additive processes. Besides, also in the theory of discrete time processes and time series analysis, new interesting classes of processes will be studied. Of particular relevance for this project are locally stationary processes and the processes that are used to model Dynamic Bayesian networks.
Theory of statistical inference from stochastic processes can be developed at a high abstract and general level. But, obviously, by specializing to particular classes of processes, as mentioned above, the general theory can be further developed and refined, often leading to more concrete results. Both parametric and nonparametric approaches will be pursued. Numerical methods and simulation will play an important role, because of the complexity of the models to be considered and in view of huge amounts of data in specific fields of application.

T2. **Partially observed processes.** It is often the case that models for specific phenomena are multidimensional, where only few components of the models are observed or where observations are corrupted by noise. Another instance is where models use continuous time processes, whereas observations are in discrete time. In these cases traditional methods like maximum likelihood estimation are useless, since the likelihood of the observations will rarely be available explicitly, except in a few special cases. New methods for statistical inference have to be developed. However, we will not only explore new techniques for estimation, but also new systematic approaches, in particular those that are based on stochastic systems theory, like new directions in stochastic realization theory. Closely related to these topics are stochastic filtering theory and Bayesian methods. In the project there will be special attention to asymptotic theory for optimal filters and for posterior distributions. Applications include stochastic volatility models and models for gene regulatory networks.

T3. **Time series analysis.** Much of the theory in this part of the research programme is inspired by questions arising in bioinformatics, like modelling of gene regulation, and in medical applications, like monitoring of critically ill patients. The key words in this part of the programme are locally stationary process, dynamical Bayesian networks, dynamical graphical models and semiparametric statistics. The statistical analysis will concentrate on recursive estimation procedures. For dynamic graphical models the principal aim is to find a suitable graphical representation of the dynamic dependence structure of the processes facilitating the understanding of the underlying structures. Similar ideas have been developed in time series based on a "Granger[1] causality" type of dependence concept. The application is however still quite restricted and more research is needed into parametrisations, estimation, model selection, computational aspects (using graphs to simplify computations where possible). Triggered by problems in econometrics there is a growing need for further development of optimal inference in semiparametric time series that for instance allows for estimators having smaller asymptotic variances than nonparametric estimators.

[1]Granger was awarded the Nobel Prize in Economics in 2003

2.1.2 Applied research themes

Although the *core business* of the proposed network lies in its contributions to the theory and statistical analysis of stochastic process, many of its researchers have acquired substantial experience with applications of their mathematically oriented research in other scientific disciplines. We expect to contribute significantly to the *mathematical aspects* of the topics that we have chosen. These are the following.

A1. **Mathematical finance.** There is a growing need for more sophisticated models both in discrete and in continuous time. Methods from stochastic analysis, control theory and numerical procedures play role of increasing importance in the study of complex market structures and financial instruments. In particular the pricing of derivatives, the treatment of large portfolio optimization problems and the modeling of the evolution of interest rates, have inspired the development of sophisticated stochastic dynamic tools. In discrete time research will be concentrated on finding new models that capture stylized facts of financial time series, like volatility clustering and fat-tailedness. To a certain extent these features are well described by GARCH and GARCH-like models, but in this context the use of semiparametric and time varying versions of GARCH models looks promising, as well as nonparametric principal component analysis applied to volatility surfaces. Stochastic volatility will also be a main issue in modeling with continuous time processes. Here we will apply in particular nonlinear filtering theory and stochastic calculus for jump-diffusion models. Another important issue is the pricing of security derivatives in incomplete markets or when insider information is present. Closely related are issues like finding optimal hedge strategies in incomplete markets or under partial information and the estimation of the market price of risk. Again stochastic calculus and methods from stochastic systems theory will be the main tools. The new models will often be based on the use of fractional Brownian motion and Lévy processes. A similar approach will be undertaken for new models for the term structure of interest rates. There are increasing demands (including new legislation like the Basle II accord) that banks and other financial institutions like insurance companies improve the management of their risk from holding positions in securities. This will require the use of more realistic and sophisticated mathematical models as well as improved statistical procedures to calibrate the models. Numerical methods that complement theoretical research will be important in most of the specific applications. The methods to be developed in Mathematical Finance will be used and modified to provide new insight into other fields of economics. In particular, utility maximization problems for macroeconomic stochastic growth processes and the modeling of new product diffusion in markets by stochastic processes will be treated in collaboration with economists.

A2. **Molecular biology and bioinformatics.** The data revolution is expected to have a tremendous impact on biology in the coming decade and it is expected that much of the theoretical research in the proposed network will find immediate application in biology. The recent development of a number of high-throughput technologies, including genome sequencing and microarrays , contributes to the generation of an unprecedented amount of data about biological or biochemical processes. Statistical analysis based on dynamical models will play a central role in modern biology; typical areas of application will be genetic networks, DNA sequence analysis, gene regulation, protein interaction and ion channel kinetics. Rich possibilities exist to develop statistical techniques that are useful for these applications. In the proposed network the emphasis will be on the use of dynamical Bayesian networks, hidden Markov models, statistical learning theory and graphical models. Markov Chain Monte Carlo methods will feature prominently in model fitting. We will also consider stochastic models in population biology and especially models for the transmission dynamics of (micro-and macro-parasite) infections. Such models present many theoretical challenges as well as having important public health implications for control of infections.

A3. **Physical and environmental sciences.** This area of application involves the development of theory and methods of inference for particular spatial-temporal processes arising in environmental contexts. One important example is that of precipitation fields, where the aim is to develop flexible and parsimonious stochastic models that capture many of the features of observed rainfall sequences and can be used to assist planners and decision makers in areas such as flood defence. Particular challenges include the incorporation of spatial and temporal nonstationarities (the latter due to global warming, for example), the stochastic simulation of nonstationary processes, and the propagation of uncertainty through chains of models. Applications in climatology will also be studied, including modeling climate variability and analysis of climate data. Fundamental research questions include the identification of relationships among different components of the climate system and the response of extreme weather events to changes in climate. A third focus will be the application of methods from stochastic analysis to develop models for physical processes, for example turbulence models driven by Lévy processes, and the application of inference for fractional processes to environmental statistics. Development of appropriate methods of model fitting and validation will be a particular concern.

A4. **Telecommunications.** The internet revolution has changed the stochastic modeling of telecommunication networks. The stochastic models of traffic, systems, services, and network structures have been under rapid development since early 1990's. In the statistical characterization of traffic, heavy-tailed distributions and long-range dependence have become more and more important areas of research and the new challenges this poses in mathematical statistics will be explored further. Performance analysis of various telecommunication systems is another topic that will be addressed, in particular for emerging mobile communication systems, where the spatial aspects play an essential role. The high performance standards motivate research on quality of service issues of communication networks. Optimization of caches is one of the issues here that will be studied. The global Internet is so huge and complex that its topology can be described only in statistical terms. Randomness is an essential future of peer-to-peer networks that connect millions of users and have several different organization principles and corresponding topologies. The theory of random graphs will be used to model growing networks, degree distributions with heavy tails will feature prominently. Another major area of research is code-division-multiplexing access (CDMA), where a single channel is used by many users without division of time or frequency.

2.1.3 Relations between research topics

In the next table we indicate how the research topics are interrelated and thereby demonstrate that the overall research programme has a high level of coherence.

	all research topics						
theoretical topics	T1	T2	T3	A1	A2	A3	A4
T1	•	•		•		•	•
T2	•	•	•	•	•		•
T3		•	•	•	•	•	•

The activities and areas of interest to the various teams are summarized in the following table.

	Amsterdam	Berlin	Budapest	Cartagena	Copenhagen	Freiburg	Gent	Heidelberg	Helsinki	Linköping	London	Padova	Paris	Rennes	Wroclaw
T1	•	•	•	•	•	•		•	•		•	•	•	•	•
T2	•	•	•	•	•	•						•	•	•	
T3		•	•		•	•		•		•	•	•			
A1	•	•	•		•	•	•	•	•			•	•	•	•
A2	•		•		•			•	•	•	•			•	
A3		•		•	•			•			•			•	
A4	•		•						•						•

2.2 European dimension

Europe is presently at the forefront of the developments of theory and application in the field of expertise of the proposed network. To maintain and strengthen this position combined research between different academic institutions and, wherever appropriate, industrial companies is indispensable. In short, main goals of the project from this perspective are

- **reinforcement of relationships among European research teams operating in the field of statistics for dynamical systems, both in a theoretical environment and in more applied areas, with the purpose of developing highly innovative interdisciplinary research. International mobility of researchers will be major tool in achieving this.**

The proposed research of this network fits well into the policy of the European Commission on scientific research. In the Communication[2] "Europe and Basic Research" one reads : *"Today, the general value of increasing knowledge and the importance of basic research for economic and social development, tend to be fully recognised again.*" The importance of basic research is emphasized as follows : "When one looks at what has happened to major discoveries, and considers the realities of our everyday environment, it can be seen that nearly all technologies, products and achievements which have led to economic and commercial success and/or concrete improvements to the quality of life are based on basic research". Concerning the way basic research finds it way to applications, the Commission writes "Often, the applications to which the work gives rise were totally unforeseen, and are in fields far removed from the field in which the work was carried out."

Mathematics is basic research *par excellence* and in "The Unreasonable Effectiveness of Mathematics in the Natural Sciences", the famous 1960 essay of Eugene Wigner, the author makes clear that "the mathematical language has more to commend it than being the only language which we can speak; it shows that it is, in a very real sense, the correct language."

The foreseen activities of TASMAN, being mathematical, fall into the category of basic research, and are expected to have a spin off in various branches of modern technology.

2.3 Conclusions

Principal aims of the proposed research are the investigation of *new challenging problems in the area of statistics for random dynamical models, with a view towards applications* in some other fields of science. The network, being loyal to its mathematical background, will endeavor *to bridge gaps*

[2]Brussels, 14.1.2004

between these applied fields and the potential of mathematical knowledge offered by the participants of the network. Therefore a main spin off of the proposed research is an integration between different disciplines, based on the mathematical expertise available in the network. Contacts between members of the network with partners in for instance the financial industry will *promote and stimulate further industry-academia cooperation.*

Each network team has built up considerable expertise and experience in a sizeable number of the proposed research topics. However, split up into the involvement per topic, in most of the teams only a relatively small number of specialists are active, sometimes rather isolated in their country of origin and critical mass is lacking. An important goal of the proposed network is *to counter this kind of fragmentation.* Existing contacts and our past experience in previous networks will guarantee that the combined research effort will be highly successful.

Feasibility. The teams in the network host a number of world wide known specialists in the research fields, with an outstanding track record of scientific achievements. This will guarantee research of the highest quality. Moreover the intended contributions to each of the research topics are believed to be met within the time span of five years and therefore constitute a realistic research programme. The participants in the network, being reputed scientists, have proved to deliver innovative results and see ample room for new directions.

Breakthroughs are anticipated in the further investigation and application of fractional and Lévy processes, statistical inference based on these processes, the application of Bayesian methods and stochastic filtering theory, and dynamical graphical methods and semi-parametric statistics in time series. These anticipated new results will find their way to optimization problems and risk analysis in finance, to highly technological analysis in molecular biology, to better understanding of burning issues in the environmental sciences, like global warming and to performance analysis of telecommunication systems.

3 Training and Transfer of Knowledge Activities

The rapid development of technology, that makes complex stochastic modelling possible, and the opening of new (applied) research areas, has called for new theoretical advances. This results in a clear need to train a new generation of scientists. The pursued interdisciplinary approach to cope with the scientific challenges cannot be covered by a single organisation, but an only by a network such as TASMAN. There are four main assets which characterize this network:

- a broad research orientation in the many aspects of stochastic modelling
- the high scientific level of the teams, up-to-date knowledge of the research field
- well established training skills aimed at state-of-the-art training
- complementary training skills across the network.

By the combination of these assets, the network offers young researchers unique training opportunities that have no equivalent within a single research organisation or within one country. All training activities are aimed at supplying Europe with expertly trained and competitive researchers, who have the potential to become group leaders in their own right, either in academia or in industry.

3.1 Outline of the training program

Because of the rich availability of different research orientations across the network, both theoretical and applied, young researchers will have a wide choice to find a host team that has the right expertise that links up with their own research interests and scientific backgrounds. The majority of the teams involved in TASMAN already have a well-tested, partly in previous HCM and IHP programmes (like DYNSTOCH), and successful experience in training of young researchers. But also the new teams have an excellent training expertise of their own. Young researchers have in the past always had the opportunity to present their progress in research during annual workshops and special events and in fact, most presentations during the workshops have been given by young researchers. Based on these experiences the currently proposed network aims to continue the training of young researchers along these lines and wherever possible extend these.

Training by the partners in this network is especially attractive for young researchers, since altogether the network comprises the top of the world specialists in the fields of expertise. The network has outstanding facilities to offer for the training of young researchers and the dissemination and transfer of knowledge. Senior team members will serve as mentors to young researchers appointed by the network, who will become part of the staff of young researchers at the different universities and research institutes that are linked to the network. These young researchers will share their ideas and methods for solution with the other Ph.D. students at their host institute, permanent staff and visitors. They will be subject to alternative views on the problems they work on and are at the same time in the position to communicate their own vision to their immediate scientific environment. Of course, participation in international conferences will be part of the programme.

The training activities are mainly aimed at early stage researchers. There will be typically two kinds of situation: a) the funding to support students from outside the network in the Ph.D. programs of the network teams and b) visits of Ph.D. students within the network (supported by different fundings) to other teams. These visits usually vary between three and twelve months. Experienced researchers will be able to transfer knowledge to and from other teams with visits of the same kind (this cannot be achieved by senior staff’s visits, which are usually short). Shorter visits to other teams will be encouraged. The number of young researchers employed by the network will vary according to the sizes of the involved teams as well as the number of visits that a young researcher will make. This will depend on his/her personal training needs.

In total we request funding for 375 person months for early-stage researchers and 95 person months for experienced researchers. Split up into the amounts needed for the consecutive years of the training, these figures become 55, 110, 110, 100 and 15, 30, 30, 20 respectively. The ratio of early-stage researchers to experienced researchers in this proposal will then roughly be 4:1.

3.1.1 Team complementarity

The teams that form the network display a variety in training skills due to their different backgrounds, orientation in research and tradition. Whereas each team has a very good Ph.D. program, some teams, like Berlin, Freiburg, Heidelberg and Paris stand out for the very large number of students and of courses being offered; Amsterdam, Copenhagen and Padova, on the other hand, have built a strong record of successfully organised summer or winter schools on special research topics. Although most teams have contact with applied researchers in industries, these are more intense in Amsterdam, Berlin, Budapest, Freiburg, Padova and Rennes. All teams have a core interest which lies in probability and statistics, but it should be noted that four teams (Budapest, London, Padova, Rennes) have a component which is affiliated to engineering research institutions. For all teams the major advances are theoretical, but most of them display a know-how and expertise in areas of applied research that are of the highest international standards. This will provide young researchers both with new problems to work on and with perspectives on very interesting job opportunities.

3.1.2 Individual training

All eligible researchers will have a Personal Career Development Plan containing his/her specific training needs and scientific objectives. This plan will be composed jointly by the researcher and his/her mentor. We will follow existing procedures at the coordinating partner (Universiteit van Amsterdam), where already a PCDP according to the Marie Curie objectives is part of agreements between young researchers funded by a Marie Curie fellowship and the employer. Research training will be given by the team leaders or other senior researchers and intensive guidance will take place. The young researchers will have the opportunity to participate in a graduate programme with courses and summer or winter schools of interest to the project. Early stage researchers will have the opportunity to take courses in current Ph.D. programmes at research schools (when available) associated with the network and experienced researchers will be given the opportunity to lecture in these courses. In addition, research seminars or study groups are offered regularly in which new research topics are studied and discussed in light of recent literature. Young researchers will be actively involved in these activities and will give presentations themselves with the aim to increase their experience in lecturing and conveying their ideas to others. It has been experienced that young researchers learn more, when they visit different teams and this will therefore be encouraged. Where possible, young researchers will be stimulated to establish or to use contacts with research departments of companies, for instance in the financial industry or in telecommunications.

3.1.3 Workshops and Conferences

At the workshops we plan to organize tutorial lectures on specially selected topics of advanced research or on topics in which the background of research topics will be sketched. In this way the young researchers become more easily familiar with research topics other than their own. There will also be room for lectures by researchers from industry or government institutions where applied research on the topics of the network is carried out. The young researchers thus become acquainted with the possibilities of research outside the academia. Special events like summer schools or minicourses (in length varying from 2 days to a week) will also be organized by the network itself.

3.1.4 Complementary skills

Besides the obvious skills (writing in English, using LaTeX, lecturing at conferences and computer programming), participants will often learn how to organize workshops and other non-scientific skills, like webpage design. In the past several young researchers have learnt the local language. Making contacts within the network with other young and senior researchers will be encouraged as part of network building, since these are known to be of considerable importance in a further career. The coordinating partner has already set up an extensive programme for workshops and training courses for Ph.D. students in complementary skills. This programme includes orientation on subsidies and fellowships, grant writing, development of communication skills, project and time management, career orientation and planning. It will serve as an example for this training aspect of the network. Other partners have similar programmes or are in the phase of developing them.

3.2 Impact of the training and transfer of knowledge programme

Serious advances in applied research often strongly benefits from significant progress in an underlying abstract theory which "happens" to be the right one. In this sense, the statistics of random processes is a success story. Examples from real world practice of the past decade are the challenges posed by major breakthroughs in telecommunication (electronic exchange systems in the early nineties), mathematical finance (assessment of derivative securities and credit risk, late nineties) and in biotechnology (microarrays and protein folding models, now). In all these examples advanced application of probabilistic modelling has been indispensable and to that end applied mathematicians with a background in statistics of stochastic processes easily found their ways to highly qualified positions in industrial and governmental environments. Although the demand for qualified mathematicians from telecommunications companies and financial institutions is not as frantic as at its peak, it is remaining at a high level; it is expected to increase in biotechnology.

Mathematicians in industrial environments should also have the ability to communicate with colleagues from a different scientific origin. To that end they not only need to be excellent professionals in their own field but they should also have developed the skills to convey their results to others and to have an open mind and experience to listen to others when particular practical problems are explained. They should also have experience to translate such practical problems into mathematical ones by using the appropriate modelling techniques. The proposed network will enhance the possibilities of training at this point, because of its expertise in theory and experience with applied research.

Our experience in the past has shown that many young researchers that benefitted from a mobility programme had better chances to get interesting jobs requiring high qualifications. Of a total of 29 young researchers paid by the previous DYNSTOCH network who entered the job market, 20 found positions at universities (some at full professor level) and 9 in industry. Transfer of former Ph.D. students and post-docs from university research teams to industry and government institutions is a form of knowledge transfer that is long lasting.

The prime impact of the training at a national level will be stronger relations with other research teams in Europe, confrontation with alternative approaches and hence a better research environment and enhanced quality of research; at the European level better integrated research, a strengthened position of European research in our field of interest, not only by the time of the end of the contract but also for many more years in the future when the current young researchers will be involved in training of a next generation. The benefits for young researchers will be a better perspective for their career, a stronger position in the competition with other researchers, and better opportunities to find employment in many countries in the European Union. This will be caused by their experience in doing joint trans-national research at the highest level.

3.3 Conclusions

The proposed research programme has an important theoretical drive across the field and a strong applied component. Therefore, many of the training facilities will be aimed at stimulating interdisciplinary research. Shared research interests with for example banks and insurance companies or with telecommunication companies will promote industry-academia cooperation. Young researchers will be encouraged to participate in joint research projects and thus contribute to the embedded transfer-of-knowledge aims of the network. This will also prepare them for wider career prospects. The described complementarity of the involved teams will overcome a fragmented and isolated training practice.

All in all we believe that this proposal contributes to the objectives of Marie Curie Research Training Networks by offering a training programme within a well functioning international environment with diverse and interdisciplinary research in applied mathematics and in related fields of application.

In conclusion, the network offers an interesting blend of competences and skills which could be hardly replicated in a single Ph.D. program and therefore a quite unique training opportunity for young researchers which would be highly beneficial for their further career development. Thus the networks potential adds value to the training of the researchers well over and above that which could be provided within a single research organisation and national context.

ENDPAGE

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