Description of Work (Annex I)

Part A: Contract details and objectives

1. **Full Title**: CONFORMAL STRUCTURES AND DYNAMICS
   Short Title: CODY
2. **Proposal number: 035651-2-CODY**
   Contract number:
3. **Duration of the project**: [48] Months

4. Contractors and places of implementation of project

The co-ordinator and other contractors listed below shall be collectively responsible for the execution of work defined in the annex:

The coordinator

1. University of Warwick [Warwick] established in United Kingdom

Other contractors:

2. Institute of Mathematics of the Polish Academy of Sciences [IMPAN] established in Poland
3. Helsingin yliopisto [UH] established in Finland
4. Centre National de la Recherche Scientifique Délégation Paris A [CNRS] established in France[1]
5. Universitat de Barcelona [UB] established in Spain
6. Christian-Albrechts-Universitat zu Kiel [CAU] established in Germany
7. Roskilde University [RUC] established in Denmark
8. Technoligical Educational Institute of West Macedonia [TEI of West Macedonia] established in Greece
9. Université de Génève [UNIGE] established in Switzerland

The coordinator and the other contractors are referred to jointly as "the consortium"

[1] The laboratoire de Mathematiques, Applications et Physique Mathematque d'Orléans (UNMR6628) which is carrying out the work is a joint research unit formed by Centre National de la Recherche Scientifique (Délégation Paris A) and Université d'Orléans

5 Project Overview

The overall aims are to understand **local self-similar structure of fractal spaces, objects or processes, by methods of space-time conformal rescaling.** The investigations and the subject of the training programme of the proposed network will therefore be contained in three closely related fields of mathematics and mathematical physics whose common denominator is the notion of conformal or quasiconformal structure: mathematical (conformal) analysis and geometric measure theory, conformal and low-dimensional dynamics, continuum scaling limits of physical processes.

5.1 Objectives

The following are objectives for the network:

A. Conformal Analysis and Geometric Measure Theory

A1. Conformal structures, analytic and geometric background and view, Objective: *A systematic study of mappings with finite distortion. quasiconformal mappings in metric spaces, applications to limit sets in dynamics and ideal boundaries.*

A2**.** Potential theory, analytic tools. Objective: *Description of analytically and quasiconformally removable sets, convergence of singular integrals and rectifiability. Applications to Julia sets and rigidity in holomorphic dynamics. Investigations towards the Brennan conjecture.*

A3. Topics in Fractals and Multifractal Analysis (see also A2, P1-2 and themes D). Objectives: *Construct a general theory, involving projection and intersection schemes. Derive a comprehensive multifractal description of new classes of measures emerging from deterministic processes.*

D. Conformal Dynamical Systems

D1. Iteration of interval and circle maps, and their complexification, weak hyperbolicity and physical measures. Objective: *The real Fatou conjecture and the Thom-Smale-Palis objective.*

D2. Geometry of dynamical and parameter space. Objective: *Improve the understanding of the rich geometry of both dynamical and parameter spaces, including the interplay between the two, for various families of rational or holomorphic maps in one complex variable.*

D3. Hausdorff measure and dimensions. Objectives: *Determine the conformal measures for various classes of Julia sets. Understand the periodic orbits and dynamical Zeta-function, compare P2.*

D4. Limit sets for Kleinian groups and relations. Objectives: *Understanding conformal measures supported on "deep" points. Find restrictions on rational maps via equivalence relations, more subtle than affine laminations, being a counterpart for the extension of the action of a Kleinian group to the bal.*

D5. Beyond dimension 1. Objectives: *Prove a "no wandering domain" theorem for Hénon mappings; Find a decomposition of the dynamical space analogous to the Yoccoz puzzle. Explore the parameter space for the famous Hénon maps corresponding to non-uniformly hyperbolic analogues of solenoids.*
D6. Iterated Function Systems (IFS). Objectives: *Improve the understanding of IFS with overlap and the Hausdorff and packing measures of limit sets (see A3). Determine the dimension of sets of parameters with defected dimension of the limit set or singular probability distribution in the "fat" case. Study infinte IFS's (*arising *in renormalization techniques D1,D2).*

P.Topics in Mathematical Physics (see also A3)

P1. Scaling limits in physical processes. Objectives: *Build a bridge between the probabilistic approach to random growth processes and conformal field theory in fixed and in fluctuating geometry. We expect progress in rigorous foundations for renormalization and universality for 2D critical lattice models. Extend research in other random models, where complex analysis plays an important role: Diffusion Limited Aggregation (a generic model of fractal growth), random matrices (of major importance in studying disordered media), etc. Make progress in the study of Schramm-Loewner Evolution and various lattice models (Ising, dimer models, SARW).*

P2. Infinite dimensional systems. Objective: *Study coupled map lattices and more general infinite dimensional systems*

P3. Turbulent transport. Objective: *Explore IFS approximations not only for modelling passive transport in synthetic turbulence but also for other transport phenomena of practical importance: high Reynolds number flow and porous medium flow in multiscale materials.*

5.2 Overall approach and methodology

The above objectives will be studied in terms of the following 'transversal' connections:

Quasiconformal surgery, Parabolic implosion, Renormalization techniques, Thermodynamic formalism, Harmonic analysis and Probabilistic methods.

Tasks will be allocated according to the particular strength and expertise of each consortium member, with secondments between teams ensuring transfer of knowledge.

Part B: Implementation

1. Research.

The research is split into the following workpackages and tasks to address the above objectives.

Work Package I: ***Conformal structures, analytic and geometric background and view; Potential theory, analytic tools (A1-A2)***   This workpackage is one of the 'engines' of the proposal and includes for example the aim to generalize classical theory about quasiconformal mappings to more general settings, applications of holomorphic motions, removability of sets.
Leader: Coordinator for this workpackage is partner 3 [UH].
Task I.1. To study mappings with unbounded but controlled quasiconformal dilatation.
• Partner 3 [UH]: Prove results which are relevant for quasiconformal surgery of complex dynamical systems; for example in relation to boundaries of hyperbolic components where one needs results about mappings with unbounded but controlled distortion.   • Collaboration through secondments will be necessary.
Milestones: M I.1.
Addresses: Research Objective A1-A2.
Task I.2. To study mappings of finite distortion with random coefficients.
• Partner 3 [UH]: Optimal regularity and removability results for mappings with exponentially decreasing dilatation; rigidity estimates for mappings of finite distortion.   • Collaboration through secondments will be necessary.
Milestones: M I.2
Addresses: Research Objective A1-A2.
Task I.3. Singular integrals on general settings including metric measure spaces.
• Partner 3 [UH]: Establish conditions under which boundedness or convergence imply rectifiability (geometric regularity) of the underlying measure.   • Collaboration through secondments will be necessary.
Milestones: M I.2
Addresses: Research Objective A1-A2.

Work Package II : ***Topics in Fractals and Multifractal Analysis (A3, see also A2, P1-2 and themes D)***

This workpackage includes to work on a general theory for computing fractal dimensions and multifractal description of various measures associated to dynamical systems.

Leader: Coordinators for this workpackage are partners 2 [IMPAN] and 8 [TEI].

Task II.1. Hausdorff dimension and multi-fractal analysis of singular measures.

- Partner 8 [TEI]: Calculate the Hausdorff dimension of several sets characterized by their digits in some base. Study the Salem sets and more generally the relation of the Hausdorff dimension of a measure with respect to its Fourier transform and several asymptotic relations.
- The maximal benefit from the expertise in the network will be reached by appointing a number of ER and ESR's and by secondments with other teams.

Milestones: M II.1

Addresses: Research Objective A3.

Task II.2. Building multiscale transforms based on wavelet–type techniques on fractal spaces generated by anomalous scaling laws.

- Partner 8 [TEI]: Detect data emerging from IFS approximation, with a view to explore the scaling limits of the cascade approximations and the rate of approximation spaces
- The maximal benefit from the expertise in the network will be reached by appointing a number of ER and ESR's and by secondments with other teams.

Milestones: M II.1

Addresses: Research Objective A3.

Task II.3. Strange attractors and thermodynamical formalism.

Partner 2 [IMPAN]: The aim is to make progress in constructing a general theory, involving projection and intersection schemes in relation with geometric measure theory (in relation with A1, A2) based on recent breakthroughs, in dimension 1 and higher (conformal and non-conformal). Applications in geophysical fluid dynamics, on porous medium flow, biological systems (and – if possible - also on multifractal analysis of electrocardiograms) will be made.

Milestones: M II.1

Addresses: Research Objective A3.

Work Package III : ***Iteration of interval and circle maps, and the complexification, weak hyperbolicity and physical measures (D1) and Beyond Dimension One (D5)*** This workpackage includes also the applications of quasiconformal surgery, holomorphic motions and to deepen the understanding of holomorphic dynamical systems.
Leader: Coordinators for this workpackage are partners 1 [Warwick] and 4 [CNRS].
Task III.1. Physical measures.
• Partner 1 [Warwick]: The purpose of this project is to consider families of real polynomials, and prove that within such families for Lebesgue almost all parameters the systems have a physical measure. The main problem here is to transfer information in state space to information in parameter space. In the case when one has one critical point there are well-established techniques for doing this (based on the lambda-lemma), but in the case where one has several critical points new ideas will need to be developed. • Regular contact, and possibly a secondment are envisaged.
Milestones: M III.2
Addresses: Research Objective D1.
Task III.2. Size of tongues**.**
• Partner 4 [CNRS]: Given a family f_t of circle diffeomorphisms with rotation number rho(t). Determine the size of the tongues associated to rational values of rho(t). The purpose of this project is to generalize the results obtained by Cheritat concerning the asymptotic tail of the analytic parabolic germ through the small divisor approach. This task will be performed by a PhD student to be appointed as ESR. Regular contact with other scientists in France will be crucial for this project.
Milestones: M III.2
Addresses: Research Objective D1 and D2.
Task III.3. Higher dimension.
• Partner 1 [Warwick]: To make some progress on a no-wandering domain theorem in dimension two. This is an extremely challenging task. • Partner 4 [CNRS]: To make further progress in understanding Henon maps in C^2.
Milestones: M III.1
Addresses: Research Objective D1 and D5.

Work Package IV : ***Geometry of dynamical and parameter space (D2)***
Leader: Coordinators for this workpackage are partners 4 [CNRS] and 7 [RUC].
Task IV.1. Yoccoz puzzle and parapuzzles in the multicritical case.
• Partner 7 [RUC]: Obtain combinatorial and analytical/geometric descriptions of the cubic connectedness locus and corresponding dynamics. • Regular contact, and possibly a secondment are envisaged with other partners.
Milestones: M IV.2
Addresses: Research Objective D2.
Task IV.2. Newton's method for entire functions.
• Partner 6 [CAU]: To study Newton's method for general classes of entire functions. In particular, find "small" sets of starting values that find all roots and to show that the area (in the plane) of the attracting basins is infinite for functions of small order of growth. • There will be regular contact with other scientists in Germany and possibly secondment with partner 5 [UB].
Milestones: M IV.3.
Addresses: Research Objective D2.
Task IV.3. Bifurcation of parabolic points.
• Partner 4 [CNRS]: Describe bifurcations of parabolic points through approximations of holomorphic vector field • Close contact with various scientists in France and with partner 1 [Warwick].
Milestones: M IV.1
Addresses: Research Objective D2.
Task IV.4. Geometric limits.
• Partners 4 [CNRS] and 1 [Warwick]: Study geometric limits, parabolic renormalizations and iterations of transcendental functions.
Milestones: M IV.1
Addresses: Research Objective: D2.
Task IV.5. Study the geometry of dynamical and parameter spaces of families of entire (or meromorphic) transcendental functions.
• Partner 5 [UB]: The geometry of dynamical and parameter spaces of families of entire (or meromorphic) transcendental functions. • Regular contact with other teams, and possibly secondment, will be essential.
Milestones: M V.2
Addresses: Research Objective D2.

Work Package V : ***Hausdorff measure and dimension. Limit sets of Kleinian groups and relations. Iterated Function Systems. (D3,D4,D6)***

This workpackage includes questions about Lebesgue measure and conformal measures for Julia sets. In spite of recent progress, much remains unknown about the dimension, measure and conformal measures of Julia sets and Kleinian groups.

Leader: Coordinators for this workpackage are partners 6 [CAU] and 2 [IMPAN].

Task V.1. Hausdorff and Lebesgue measure of Julia sets.

- Partner 6 [CAU]: Obtain results about Hausdorff dimension and area of Julia sets for certain classes of functions with unbounded set of singularities. Other conditions that play a role here are suitable notions of hyperbolicity. Questions concerning the area of Julia sets are closely connected to ergodicity, and such problems are also part of the research task.
- There will be regular contact with other scientists in Germany and with other teams.

Milestones: M V.1

Addresses: Research Objective D3-D4.

Task V.2. Determine conformal measures for various classes of Julia sets.

- Partners 2 [IMPAN] and 4 [CNRS]: develop the method of inducing leading to infinite IFS and to investigate periodic orbits and the dynamical Zeta-function. Obtain deeper understanding of the hairy structure of Julia sets for entire/meromorphic functions in general; more comprehensive theory fat Julia set; results on the continuity of Hausdorff dimension of Julia sets and study of the problem of the continuity for Julia-Lavaurs sets.

Milestones: M V.2 and M V.3

Addresses: Research Objective D3-D4.

Task V.3. *Iterated Function Systems (IFS) (D6)*

- Partner 2 [IMPAN]: Improve the understanding of IFS with overlaps (Hausdorff and packing measures of limit sets). Determine the dimension of sets of parameters with defected dimension of the limit set and study probability distribution in the "fat" case (starting from recent breakthroughs by Avila, Tsujii, Gouezel and others). (Non)uniqueness of dimension equilibria will be related to work by Rams.

Milestones: M V.4

Addresses: Research Objective D6.

Work Package VI : ***Scaling limits, conformal invariance and universality. Infinite dimensional systems and Turbulent transport (P1-P3).***

Leader: This workpackage will be coordinated by partners 9 [UNIGE] and 4 [CNRS].

Task VI.1. Conformal invariance. It is widely believed that many 2D lattice models of physical phenomena (percolation, Ising model, self-avoiding polymers, ...) have conformally invariant and universal scaling limits, which enabled physicists to make striking predictions about exact values of dimensions and scaling exponents. Recently mathematicians greatly advanced in understanding these conjectures. Much of the progress was based on the new process introduced by Schramm, the Stochastic Loewner Evolution (SLE), which gives all conformally invariant curves which can arise as scaling limits. This leads to the following projects:

- Partner 9 [UNIGE]: Study the properties of SLEs:.dimensional properties of random sets, and properties of SLEs suggested by analogy with interfaces in lattice models.
- Partner 9 [UNIGE]: Construct scaling limits for lattice models. Investigate Ising interfaces on Riemann surfaces and understand universality (i.e. independence of the limit of the lattice).

Milestones: M VI.1

Addresses: Research Objective P1.

Task VI.2. Develop foundations for renormalisation.

- Partners 9 [UNIGE] and 3 [UH]: lay background for mathematical understanding of renormalization in the case of percolation, which might be easier, since no boundary conditions are involved.

Milestones: M VI.2

Addresses: Research Objective P1-P2.

Task VI.3. Percolation in physics.

- Partners 9 [UNIGE] and 4 [CNRS]: Elucidate some of physical questions (gradient percolation, self-avoiding walks, Brownian flights over polymers (typically DNA), to consider the widely open problem of DLA (diffusion limited aggregation) and some of its variants.

Milestones: M VI.2

Addresses: Research Objective P2-P3.

Task VI.4. Infinite dimensional systems.

- Partners 9 [UNIGE] and 3 [UH]: Investigate coupled lattice maps, and other more general infinite dimensional systems. Turbulent transport studied from the point of IFS approximations.
- Participation particular from the partner 4 [CNRS].

Milestones: M VI.2

Addresses: Research Objective P2-P3.

Scientific Milestones and Deliverables

Milestone	Month	Description	Comment
M C1	7	Opening Conference	
M IV.1	12	Deeper understanding of bifurcations of parabolic points.	Result of task IV.3 and IV.4
	12	First Activity and management Report	
M I.1	18	Advances in surgery in holomorphic dynamics.	Result of task I.1, towards WP IV
	24	Second Activity and Management Report	
	24	Audit Certificates and MidTerm Report	All partners
M II.1	24	Publication on geometry of measures and multi-fractal analysis (non-uniform or non-conformal scaling).	Result of task II.1-II.3
M I.2	30	Geometric regularity and removability results for certain mappings of controlled unbounded distortion.	Result of task I.1-I.3, towards WP IV
M C2	36	Conference	
M V.1	36	Conformal measures, exponents of Poincaré series and dimensions, for some weakly hyperbolic maps	Jointly tasks III.1 and V.1
M V.2	36	Results on differentiability (analyticity) of pressure in univalent or holomorphic dynamics setting, description of phase transitions, dynamical zeta-function.	Result of task V.1
M IV.2	36	Basic results on Yoccoz parapuzzles puzzles for families with several critical points and phase-parameter relationship through surgery	Result of task IV.1
M V.3	36	New estimates (computation) of Hausdorff, hyperbolic and box dimension of Julia (-Lavaurs) sets.	Result of task V.1 and V.2
M VI.1	36	Completion of study of conjecturally conformally invariant lattice models and some scaling limits. Results on multifractal properties of arising clusters	Result of tasks VI.1
	36	Third Activity and management Report	
M V.4	42	New results on IFS with overlap	Result of task V.3
M IV.3	42	Description of geometry and size of attracting basins for Newton's method for transcendental functions.	Result of task IV.2
M III.1	42	Results in higher dimension	Results of tasks III.3
M VI.2	48	Fixed point results for renormalization in dynamical systems and lattice models in statistical physics. Results on infinite dimensional systems.	Result of task VI.2-VI.4
M III.2	48	Completion of Palis programme in dimension 1.	Result of task III.1 and III.2
	48	Final Activity and management Report	
M C3	48	Final Conference	
	48	Audit Certificates and Report	All partners

The table below indicates the time scale and period for the execution of the tasks and milestones. Many tasks will require collaboration between several teams. One of the main aims of the network is tackle the fragmentation of the field by having young researchers stay at different nodes through secondments.

Work Package	Task	Month	6	12	18	24	30	36	42	48
WP I	I.1				MI.1					
	I.2						MI.2			
	I.3									
WP II	II.1					MII.1				
	II.2									
	II.3									
WP III	III.1									
	III.2									MIII.2
	III.3									MIII.1
WP IV	IV.1							MIV.2		
	IV.2									MIV.3
	IV.3			MIV.1						
	IV.4									
	IV.5									
WP V	V.1							MV.1&2		
	V.2							MV.3		
	V.3								MV.4	
WP VI	VI.1							MVI.1		
	VI.2									
	VI.3									MV1.2
	VI.4									
			Opening Conference	**Year 1 Conference Year 1 Report**		**Mid Term Meeting, Mid Term Report and Audit Certificate**		**Year 3 Conference Year 3 Report**		**Final Conference, Final Report and Audit Certificate**

2. TRAINING AND TRANSFER OF KNOWLEDGE (ToK)

The network as a whole undertakes to provide a minimum of 260 person-months of Early Stage and 146 person-months Experienced Researchers whose appointment will be financed by the contract. The quantitative progress on this, with reference to the table contained in part C and in conformance with relevant contractual provisions, will be regularly monitored at the consortium level.

(i) General Training and ToK
Career developments plans will be drawn for each trainee so that the precise training package will be tailored to each individual's needs. The methodology to achieve the general and specific scientific objectives will be through

- Short visits of senior scientists from one node (or from outside the network) to another node, giving lectures or intensive courses and providing lecture notes.
- Short visits of recruited researchers, of up to a month.
- Joint mathematical weekends.
- Summer schools with courses for ESR's, accompanied by exercises and tutorials by the more experienced young researchers, in complementary themes (for example harmonic analysis, harmonic measure on Julia sets, conformal invariance of scaling limits of physical processes). These could take place as part of the planned workshops or conferences.
- Small theme workshops with invited expert speakers, providing an occasion for them to undertake joint work and to present their results.
- Two larger (interdisciplinary) workshops (after 1st and 3rd year)
- Organization of three international conferences (opening, midterm and final).
- Use the network web site as a bulletin board to advertise various openings, meetings schools and conferences, as well as to provide a directory for members of the network, to post questions to the scientific community on the network topics, and to find and deposit preprints.
- Publication of lecture notes from seminar schools, workshop talks and courses and preprints.
- ESR and ER's will be encouraged to publish their results in a time fashion. A network electronic preprint server will be set-up which will make this easier.

(ii) Training at local and network level:
We will have 8 schools, 6 workshops, 3 larger workshops and 3 conferences. During all of these, minicourses will be offered which will be aimed at both ESR and ER's. Each team will have a **network seminar** (typically meeting weekly) at its home institution, involving local PhD students and post docs. Also **Joint Weekend Meetings** (of groups which are geographically close enough) will be organised. The organisation of the school, workshops and conferences will be delegated to the partners. Some network activities will be placed within other scientific activities (which also are funded from elsewhere).
A. Schools. The schools will have a multidisciplinary character, with 3-5 complementary (5-10 lectures each) courses with exercises led by experienced researchers. However one topic will dominate (the given task(s) in parentheses below) to make them slightly focused to organize seminars helping in individual research. Some, activities will take place as part of other events. In addition, at least half of these schools will have attached to them a **one or two-day event** '*towards industrial applications*' (specific topics are already envisaged).
B. Workshops (6 small and 3 larger) and **C. Conferences.** (3 conferences with 80-100 participant, or larger if there is additional funding, taking place in Warwick, Warsaw and Paris.

Several proposals for workshops on 'towards industrial applications' will be discussed in the first steering committee meeting of the network, and at least one workshop will be focused on this theme whereas other workshops/conferences will have '*towards industrial applications*' events.

Month	Event	Obj	Responsible Partner	Participating WP
7	Opening conference: *Conformal Structures and Dynamics. The current state-of-art and perspectives.*	MC 1	1 [Warwick]	I-VI
7	School: *From holomorphic dynamics to symbolic dynamics.*		7 [RUC]	III-IV
9	School		5 [UB]	In particular III and IV
12	School		4 [CNRS]	Mainly I, III and IV
12	Workshop: *Topics in complex dynamics (D1-D3)*		5 [UB]	I-V
12	Workshop *Conformal structures and fractals, Paris*		4 [CNRS] and 9 [UNIGE]	I-VI
18	School		3 [UH]	I, VI
20	School: *Towards higher dimension*		6 [CAU]	III-IV
24	School *Fractals and multifractal structure, random growth models, topics in turbulence,* (A3, D3-4, D6, P1-3)		8 [TEI]	In particular II
24	Workshop		1 [Warwick]	III and IV
24	Mid Term Workshop		1 [Warwick]	
28	Large Workshop *Recent trends in conformal structures* (A1-3)		5 [UB]	I-VI
32	Large Workshop (D1-D2) *Aspects of transcendental dynamics*, 2008/2009		6 [CAU]	I-VI
34	Workshop		8 [TEI]	II
36	School (A2, D2) *Analysis on metric spaces and quasi conformal structures.*		2 [IMPAN] with support of 3 [UH]	I-IV
36	Conference	MC 2	2 [IMPAN]	I-VI
38	Workshop		3 [UH]	In particular I, VI
40	Large Workshop *Potential theory in dynamical setting and random growth models*	(A3-5, D3-4, P1)	7 [RUC]	III-IV
42	Workshop		6 [CAU]	III-IV
48	School (A1-3, P1-3*) Les Diablerets, mathematical physics*		9 [UNIGE]	VI
48	Final conference *Conformal Structures and Dynamics II. Reports on realization of all the tasks.*	MC 3	4 [CNRS]	I-VI

(iii) Multidisciplinary/intersectorial knowledge
Secondments shall be encouraged. We shall strongly encourage short, even 1 day, visits to the seminars within the country of the site or neighbouring countries. Teams will exchange information about seminars/courses and so on through their web pages, so that training and research in teams is coordinated. The teams can exchange experience, provide mutual help in overcoming difficulties etc. Some lectures will be videotaped and distributed and use shall be made of a website for the RTN, with some web-based training materials. Industrial connections will be encouraged through activities during workshops and conferences, supported by advise from the Industrial Advisors.

(iv) Integration of Young Researchers The best research training is to actually do the research.

- Each researcher will have both a **mentor** and a local **scientific supervisor** assigned.
- The organisation of the individual training at the site place is the responsibility of the local supervisor in collaboration with the Team Leader for that node.
- Upon appointment, the ER/ESR will, together with the personal mentor and scientific advisor, draw up a personal **Career Development Plan** (taking his/her career plans into account).
- The local mentor/scientific supervisor encourages young scientists to broaden their education and research by **collaborations.**

Training in contact with industry/commerce is planned through, in particular, activities are planned as part of workshops which discuss and encourage industrial applications. ESR/ER's will be encouraged to attend courses offered by participating universities, in **communication**, enterprise and project **management skills**, foreign and local **language courses** and also in other academic subjects. ESR and ER will be informed on their contractual rights/obligations and the possibilities to contribute to networking training, events, conferences.

3. MANAGEMENT

(i) Organisational structure. The network management structure will be divided into network-wide and local levels. The overall responsibility for the management rests with the network coordinator (CO), who chairs the Steering Committee (StC) consisting of the team leaders and 3-5 other leading scientists from the network. At the local level, the local steering committee will be formed consisting of the team leader and 2-4 members.

The Network Coordinator (CO) and Network Office. The coordinator is responsible for all management tasks according to the RTN rules, for the cooperation with the European Commission, for the scientific orientation and quality of the network and supervises training activities. The network coordinator will be in continuous contact with the members of the Steering Committee, calls meetings of the Steering Committee and chairs them. The CO is assisted by the Network Administrator, who will be appointed part-time and whose duties include:

- Running the network office and liaise with the accountant offices.
- To coordinate and initiate contact between teams.
- To facilitate training, recruitment, and advertisement of the programme.
- To create and maintain a webpage to distribute information and preprints.
- To register young researchers in the field of the network.
- Publication of a network bulletin, providing information about scientific events and new scientific results from the network to be distributed in particular to all registered applicants.
- To encourage and arrange dissemination of results, lecture notes and proceedings of workshops and conferences. This is done through reports of the team leaders, and provides the basis for a preprint series and subsequent publications (even lecture notes and surveys)

- To monitor that network activities are compliant with contractual obligations.
- To ensure that proper financial management and control is kept on the project, including local audit certification.

Steering Committee

The Steering Committee (StC), consisting of all team leaders meets annually to decide on issues concerning the scientific and organisational plan of the network. During the first meeting it elects/nominates an Executive Committee, a Scientific Committee and approaches Academic and Industrial Advisers. It decides about financial issues within the contract with the EC. Yearly, the StC discusses and decides on:

- Progress towards the scientific objectives, in tasks, and progress in training.
- Precise topics of workshops and schools, programs and appointments of organizers of 3 large network conferences and 3 large workshops (1 year in advance).
- The annual financial report from the Network Administrator.

To assist the StC and the CO the following will be put in place:

- An **Executive Committee**, which assists the CO in all major decisions throughout the year, and is responsible for initiating and monitoring of network activities. It consists of the Deputy CO, the chairman of the Scientific Committee, the CO and the Network Administrator. It communicates mainly by e-mail and phone.
- A **Scientific Committee**, which will be set up as a subcommittee of the StC to monitor the network research programme, to draft annual scientific reports, and to advise the StC of actions which might need to be taken in the light of changing circumstances.
- **Outside Scientific Advisers** and **Industrial Advisers**.

Local level. At each site, a **local steering committee** will decide about all local network's activities. One of the elected members (the Local Manager) takes care of the network's practical organisation, such as the organisation of meetings, while the Scientist in Charge is responsible for the overall local training arrangements of the network. The ESR's and ER's will be asked to report at least annually (or at the time of their appointment). The tasks of the local StC are

- Decisions about spending of the local budget (but within network aims).
- Appointing early stage and experienced researchers in cooperation with the StC.
- Activities planned for the next months.
- Advertising vacant positions and providing information for the network web-pages to CO.

(ii) Coordination and decision making process. At the network-wide level the local needs will be represented by the local scientists in charge; their responsibility will consist in taking care of progress towards the tasks, which includes a report at each panel meeting of StC (or Scientific Committee), the scientific contribution at the Network Conferences (or Large Workshops) of annual talks for each task and, if necessary, the organization of smaller workshops.

(iii) Communication method. The Steering Committee (StC) meets once a year, discussing regularly by e-mail or by phone. The Executive committee communicates frequently, mainly by e-mail or by phone. The network will set-up a website and other facilities for the distribution of preprints

(iv) Task delegation policy. The network coordinator and network administrator monitor the way local budget is spent, how local training is performing, progress of ER/ESR's, planning of local events, and so on, and if necessary offers support to local teams. The Network Administrator also acts as first point of contact when there are difficulties setting things up.

(v) Vacancy Strategy. Vacant positions and research opportunities will be advertised by electronic media (web page, e-mail distributions), stating eligibility criteria, the mode of selection and a detailed description of the host institution, its infrastructure and measures to promote equal chance research opportunities for men and women. The network will create a **homepage**, which will have a special page for vacancies. The network plans to create **its own electronic bulletin**, in which the positions will be advertised. Applications for positions in the network will be made through the Network Office, who will work closely with local teams. The CV's and reference letters for applicants will be reviewed by the Executive Committee and the local Steering Committee (typically by email), and a pre-selection will be made on this basis. In many cases, applicants will be interviewed by a local committee, and based on all this information, the above committees jointly will decide who to appoint. Minutes of the process will be kept, while keeping gender and other issues into account.

(vi) Equal opportunity measures. Female applications and applicants will be encouraged. We shall invite female mathematicians to be on interview panels. We shall also give detailed practical information (about housing, shopping, schools etc.) to make it easier to convince young researchers to stay in another country.

(vii) Monitoring and reporting procedures. The Executive Committee and the Network Administrator will make sure that there are regular reports from ER/ESR's, local supervisors, mentors, training reports and budget statements. If there are short-comings, the Executive Committee, and in some cases the Scientific Committee will be asked for advise.

(viii) Dissemination of results policy. The policy will be to publish all results obtained through the network in international journals, and preliminary results should appear as preprints and so on. The network will set-up a website and other facilities for the distribution of preprints

(ix) Financial Management and control. The financial situation for the partners will be reviewed annually and if needed, readjustments will be decided in communication and agreement with the Commission services. The (CO) together with the administrator will ensure that proper financial management and control is kept. The partners will obtain Audit Certificates every 24 months and submit them to the European Commission along with the annual reporting deliverables.

4. Indicators of Progress and Success

4.1 Quantitative Indicators of progress and success to be used to monitor project

4.1.1 **Research activities** In reporting on progress with the implementation of its research plan the network will provide information and data on the following:

• organisation of or participation in and presentations to external specialist workshops and conferences (number; dates, places, title of event)
• specialist exchange among network teams (number, nature, when, where, who)
• individual and joint publications, directly related to the work undertaken within the contract (number, references)
• development of new scientific and/or industrial collaborations (number, references)
• scientific awards and prizes obtained from the work directly related to the contract (number, details)
• visit of Senior Researchers (number, name, place and time of visit)

4.1.2 **Training / Transfer of Knowledge (ToK) Activities** In reporting on progress with the implementation of its training and ToK Plan the network will provide information and data on the following:
• the rate of recruitment of ESR and ER for each participant and for the network as a whole (ratio person-months filled/offered)
• visits of Senior Researchers (number, name, place and time of visit)
• the nature and justification for adjustments, if any, to the original overall number of person-months of ESR and ER as well as to the breakdown of this overall number among the participants (see table contained in Part C)
• the time and duration of each individual appointment.
• the number, names and level of involvement of senior researchers directly associated with the tutoring/supervision of the recruited ESR or ER, at each participant
• the number of ESR that are expected to present their PhD thesis and when
• the number and place of the short visits and secondments, placement in company premises undertaken by each individual ESR or ER either within or outside of the network
• number of visits of the ESR and ER to their home scientific community
• attendance at network meetings by the ESR and ER (number, names, place, date)
• participation/presentations in workshops/conferences by ESR and ER (number, names, place, date)
• organisation of training events (e.g. schools, training workshop/seminar, hands-on training session on specialised instrument/techniques) at individual nodes (number, attendees' names, place, date)
• organisation of network-wide training events (number, attendees' names, place, date)
• participation in training events organised outside the network (number, attendees' names, place, date)
• number, place, purpose of any meeting (e.g. workshop) organised by the ESR or ER themselves
• employment for the ESRs and ERs following their appointment by the network.

4.2 Qualitative Indicators of progress and success to be used to monitor the project

4.2.1 Research Activities. In reporting on progress with the implementation of its research plan the network will provide information and data on the following:
• general progress with research activities programmed at individual, node and network level
• highlights on more particularly innovative developments
• citation index for publications directly related to the work undertaken within contract
• expected scientific / technological breakthroughs
• overall progress and possible problems encountered with individual work packages and/or network-wide research activities
• nature and justification for adjustments, if any, to the original research work plan and/or timetable
• progress on cross interaction among disciplines represented within the network
• progress on cross interaction between academic and industrial partners
• progress regarding interaction with industrial/commercial/economic interests outside the network
• access to / use of state-of-the-art infrastructure and facilities
• highlights on wider societal and/or ethical components of the project, such as outreach activities
• highlights on the scientific community recognition of the network research contribution (awards, invitation to conferences, …)

4.2.2 Training / Transfer of Knowledge Activities. In reporting on progress with the implementation of its training plan and ToK the network will provide information and data on the following:

• general progress with training and ToK activities programmed at individual, participant team and network level (type of guidance, supervision, coaching or mentoring in place to support ESR and ER)
• highlights on the development of more particularly innovative approaches to training and ToK (e.g. specific training packages of network-wide relevance)
• highlights on the exploitation of the "complementarities" between network participants with respect to training and ToK
• nature and justification for adjustments, if any, to the original training / ToK plan and/or timetable (e.g. opportunities for new collaborations regarding training activities)
• career development plans as elaborated by the ESR and ER involved in the project
• career development opportunities/prospects for ESR and ER involved in the project
• achievements regarding the acquisition of complementary skills such as communication, language skills, computer skills, project management, ethics, team building, etc.
• achievements regarding the training/ToK on specialised instruments/equipment's
• level of satisfaction of the trainees (e.g. as expressed in response to questionnaires)

4.2.3 Management. In reporting on progress with its management the network will provide information and data on the:
• effectiveness of the "internal" communication and decision making between the co-ordinator, team leaders, supervisors, down to the ESR and ER, including feedback processes
• effectiveness of the communication between the network and the Commission Services (frequency, efficiency, timely feedback's), particularly regarding the conformance with contractual provisions and the implementation of contingency plans where needed
• effectiveness of network communication with industrial and other stakeholders (anticipation of outcomes and possible end-users interests, contact preparation, follow-up and contractual agreement where appropriate)
• network self-assessment through benchmarking activities (exchange of best practices among participants and/or development of ad hoc performance indicators regarding cost management, staff selection, measurement of research/training/ToK outputs, young researchers' involvement, etc.)
• overall quality and efficiency of the "external" communication strategy of the network (Cordis; personal, team and network web sites updates; newsletters; etc.)
• effectiveness of the recruitment strategy of the network in terms of equal opportunities (including gender balance) and open competition at international level