Complexity-NET

European Network of Funding Agencies
Coordination of National Complexity Research and Training Activities

Instrument: Coordinated Action
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Report on National Complexity RTD landscapes

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Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

National Complexity Landscapes

This report documents major national complexity research and research training activities in Europe, partly supported by the participating funding organisations and the European Commisssion. The report is limited to cover the countries participating in the Complexity-NET, where the documentation has been established through the FP6-funded coordinated action.

The documentation contains information on number of researchers and Ph.D. students involved in complexity research, their research activities, funding obtained and results achieved. In addition, research groups have given their opinions on the strength and weaknesses and the opportunities and threats that they find characterise complexity research.

Below a summary of the obtained information is given, followed by the detailed information obtained from country to country.

Complexity research

What is complexity? What is a complex system? These questions have brought about a lively discussion among scientists, trying to give a definition that covers a vast number of remarkable complex phenomena observed in nature, in the laboratory, in mathematical modelling, in computer simulations, or as a result of social interactions. A number of contributions to this discussion can be found at the end of this report. To define complexity seems to be a challenge like defining life, intelligence or research excellence. Complexity seems to be a quality rather than a quantity. It is possible to list a number of common features describing a complex system, but a comprehensive definition of complexity does not exist.

Complex systems share a number of characteristic features:

- Complex systems are often far from equilibrium and cannot be described by linear relations; the behavior is non-linear and frequently stochastic in character.

- Complex systems have many strongly interacting components, and new patterns and behaviour may emerge through self-organising processes. Complex systems as a whole cannot be explained by the behaviour of their individual elements.

- Complex systems develop and adapt dynamically; they have often memory and can differ widely in character, over many space and time scales.

Research areas

The areas of complexity research are expressed in different subjects from country to country, emphasising complexity science as a widely ramified science across many disciplines, including mathematics, computer science, physics, chemistry, biology, medical science, engineering and social sciences, like economics and sociology.

Fields where scientists carry out complexity research include:

1. Non-linear mathematics and dynamical systems, chaos
2. Time series analysis, syncronization, prediction and control
3. Emergence, collective behaviour and pattern formation
4. Fluid dynamics, non-linear optics, plasmas, non-linear waves, solitons
5. Dynamics of interfaces and dislocations
6. Complex materials, catalysis, friction, granular matter
7. Atmosphere and climate modelling
8. Complex astrophysical and geophysical systems
9. Statistical mechanics, stochastic processes, and probability theory
10. Phase transitions, critical phenomena
11. Disordered systems, growth processes, fractals
12. Non-equilibrium thermodynamics
13. Soft matter
14. Biodynamics, systems biology
15. Biocomplexity, evolution, ecology, bioinformatics
16. Economic complexity, risk, game theory
17. Complex social systems
18. Environmental and energy transport processes
19. Optimisation, intelligent systems, pattern recognition, image processing
20. Organisational complexity, complex networks, distributed systems

From the list above, it becomes clear that complex behavior is ubiquitous. However, across the remarkable variety of complex systems, the phenomena observed exhibit surprisingly similar features. This observation has led to an extensive complexity research using mathematical modelling, computer simulations and advanced experimentation to provide new understanding of complex systems and new practical results, forming a foundation for the development of a multitude of new and exciting technologies and applications, including

a) effective methods and tools for analysis and optimisation of complex decision and production processes,
b) new mathematical models to analyse complex organisms and materials, and to analyse the dynamics and mixing of fluids and plasmas
c) robust control, regulation and surveillance systems,
d) more efficient signal and image processing techniques, and
e) functional models, strategies and tools for economic, financial and social analysis.

Status 2006

The documentation covers the activities by 793 researchers supported by a total funding of 136 MEuro. The researchers are identified as participants in one of 205 research groups, each group having approximately 4 staff members in average. From country to country the average varies between 2 (Belgium, Hungary and Ireland) and 7 (Denmark and Netherlands).

Each staff member has on the average associated one Ph.D. student and either a guest researcher or a postdoc. However, the numbers vary substantially from country to country. For U.K., Belgium and Ireland the averages are somewhat larger (app. a factor of two). For Denmark, Estonia, Italy, Portugal and Spain the averages are somewhat lower (app. a factor of two).

In average, one out of 4 research groups organises a Ph.D. school, while every research group in average organises an international conference. Per staff member UK, Denmark and Italy are organising more Ph.D. schools, while UK, Estonia, Hungary and Ireland are organising more international conferences.

The average of invited talks per staff member is 1.5, with a variation from 0.2 in Netherlands and Portugal to 3.8 in Hungary, probably dependent on the type of invited talks counted.

Funding also varies substantially with a total funding average of 172 kEuro. In Belgium, Denmark, Estonia, Greece, Italy and Spain, the total funding per staff member is between 16 kEuro (Greece) and 63 kEuro (Spain). The numbers are somewhat larger in the other countries Hungary (90 kEuro), Portugal (182 kEuro), Ireland (223 kEuro), Netherlands (248 kEuro) and UK (608 kEuro).

Also the distribution of funds in terms of where they come from varies, but generally 50 – 75 % comes from national grants.

The number of articles published per staff member is in average 3.9. It is app. 2 in UK, Estonia and Portugal, app. 3 in Denmark and Greece, app. 4 in Belgium and Ireland, app. 5 in Spain, app. 6 in Italy and Netherlands, and app. 8 in Hungary.

The number of patents filed is notably small everywhere.

Strength and weaknesses

Among the options given, there is general consensus that the strength of complexity research lies in the diversity of research area and in the scientific communication (articles, conferences etc.). Also the cooperation across the natural, technical and medical sciences and the international cooperation within EU are considered to be a notable strength.

The degree of exploitation of new technologies and the extent of cooperation in use of experimental equipment seem to be at a low level and are considered as weaknesses. Furthermore, there seems to be a great need for public dialogue, and the international cooperation outside EU and the cooperation with economic, social and humanistic sciences also need to be improved.

Opportunities and threats

Among the opportunities listed, the researchers clearly point at better mobility as the number one opportunity, and the decline in mobility as the number one threat.

The researchers expect that the effect pr. Euro in improving the exploitation of new technologies and the public dialogue is low in the present situation. Substantial investments are needed to improve these weaknesses.

RESPONDING UNIT:	EPSRC	FNRS	MSTI	EAS	GSRT	NKTH	IRCSET	CNR	NWO	FCT	MEC	TOTAL
Status 2006, complexity												
Groups	25	28	24	5	20	19	15	31	12	12	14	205
Scientific staff, person-years	120	56	156	30	52	30	30	95	89	55	80	793
% of women among scientific staff		25	16	20	15	13	19	14	16	45	10	18
Average age for scientific staff	35	35	45	41	46	50	44	43	45	35	40	41
Guest researchers, person-years	200	14	16	2	15	16	8	6		7	6	290
Postdocs, person-years	100	84	28	3	19	28	26	72	40	10	25	434
Ph.D.-students, person-years	200	112	96	19	55	44	68	43	43	10	35	724
Ph.D.-schools organised, number	10	1	14	1	1	2	0	8	6	0	1	44
International conferences organised, number	60	14	17	11	5	15	23	10	7	5	2	169
Invited talks, number	250	126	104	16	90	114	68	170	18	10	200	1166
National grants received in total, MEuro	55,5	2,1	3,8	0,5	0,4	1,3	4,1	3,2	16,2	10,0	3,5	101
European grants received in total, MEuro	10,0	1,1	1,1	0,3	0,4	1,2	2,5	2,5	5,9	0,0	1,5	26
Industrial grants received in total, MEuro	7,4	0,2	0,8	0,1	0,0	0,2	0,2	0,2		0,0	0,0	9
Articles published, number	250	224	433	55	153	236	113	570	557	100	400	3091
Patents obtained, number		10	5	0	0	3	1	5		0	0	24

RESPONDING UNIT:	EPSRC	FNRS	MSTI	EAS	GSRT	NKTH	IRCSET	CNR	NWO	FCT	MEC	Average
Strengths and weaknesses, 1-5 scale												
1=Great weakness, 5=Great strength												
Diversity of areas of research	5,0	4,0	4,4	5,0	4,0	4,6	3,7	5,0	3,4	3,0	4,0	4,2
Cooperation in use of experimental facilities	4,0	3,0	3,0	2,0	2,5	2,8	3,4	3,0	3,0	2,0	3,0	2,9
Cooper. across natural/technical/medical sciences	4,0	3,0	3,4	5,0	3,5	4,1	3,6	3,0	3,8	4,0	3,0	3,7
Cooper. with economic/social/humanistic sciences	5,0	2,0	3,3	3,0	1,5	3,5	3,2	4,0	3,4	4,0	3,0	3,3
International cooperation within EU	4,0	3,0	3,0	4,0	3,0	3,9	4,0	5,0	4,6	3,0	3,0	3,7
International cooperation outside EU	4,0	3,0	2,9	2,0	2,0	3,9	3,5	4,0	4,2	4,0	2,0	3,2
Research training	5,0	3,0	3,9	3,0	3,0	3,5	3,6	5,0	2,8	2,0	3,0	3,4
Research mobility	5,0	3,0	3,0	3,0	4,0	3,4	3,5	3,0	3,2	2,0	4,0	3,4
Scientific communication (articles, conf., etc.)	4,0	4,0	4,0	4,0	3,5	4,1	4,1	5,0	3,8	4,0	4,0	4,0
Public dialog (events, press, positioning)	4,0	3,0	3,5	5,0	1,5	2,5	3,2	4,0	3,0	2,0	2,0	3,1
Exploitation of new technologies	4,0	3,0	2,8	3,0	3,0	3,5	3,4	3,0	2,8	1,0	2,0	2,9

RESPONDING UNIT:	EPSRC	FNRS	MSTI	EAS	GSRT	NKTH	IRCSET	CNR	NWO	FCT	MEC	Average
Opportunities (effect pr. Euro), 1-5 scale												
1=Smallest effect, 5=Largest effect												
Better research mobility, more guestresearchers	4,0	4,0	3,6	5,0	3,5	3,7	3,9	5,0	4,0	5,0	4,0	4,2
Better research mobility, more postdocs	4,0	4,0	4,5	5,0	4,5	3,8	4,6	5,0	4,2	5,0	5,0	4,5
Better research mobility, more Ph.D.-students	3,0	3,5	4,3	4,0	4,0	3,6	3,6	3,0	4,6	5,0	5,0	4,0
Better research training, more Ph.D.-schools	3,0	3,0	2,7	4,0	5,0	3,0	3,4	4,0	3,6	5,0	4,0	3,7
Better or additional equipment	3,0	3,0	3,4	4,0	4,2	3,0	3,4	5,0	2,4	3,0	3,0	3,4
Better scient. commun. (conferences, etc.)	4,0	3,0	4,2	5,0	3,2	4,0	3,5	4,0	3,6	4,0	3,0	3,8
Better public dialog (events, press, positioning)	3,0	3,0	3,5	4,0	1,5	3,3	2,6	3,0	3,0	3,0	3,0	3,0
Better exploitation of new technologies	3,0	3,0	3,5	3,0	2,5	3,7	3,0	3,0	2,6	4,0	3,0	3,1

RESPONDING UNIT:	EPSRC	FNRS	MSTI	EAS	GSRT	NKTH	IRCSET	CNR	NWO	FCT	MEC	Average
Threats (economic risks), 1-5 scale												
1=Lowest risk, 5=Highest risk												
Decline in research mobility, fewer guests	4,0	4,0	3,1	4,0	3,5	2,5	3,1	4,0	2,8	5,0	3,0	3,5
Decline in research mobility, fewer postdocs	4,0	4,0	3,8	4,0	4,2	2,8	3,8	4,0	3,8	5,0	4,0	3,9
Decline in research mobility, fewer Ph.D.-students	4,0	3,5	3,7	5,0	4,5	2,8	4,0	2,0	3,4	5,0	4,0	3,8
Decline in research training, fewer Ph.D.-schools	5,0	3,0	2,9	3,0	4,5	2,4	2,9	2,0	3,2	5,0	3,0	3,4
Decline in working equipment	3,0	3,0	2,7	4,0	4,5	3,1	3,1	4,0	2,2	3,0	2,0	3,1
Decline in scient. commun. (articles, conf., etc.)	4,0	3,0	2,7	5,0	4,2	2,7	3,2	3,0	2,6	3,0	2,0	3,2
Decline in public dialog (events, press, positioning	4,0	3,0	2,4	5,0	3,2	2,3	2,6	3,0	2,4	5,0	2,0	3,2
Decline in exploitation of new technologies	3,0	3,0	3,0	4,0	3,2	2,9	2,9	3,0	2,6	5,0	3,0	3,2

RESPONDING UNIT: **Status 2006, complexity, derived quantities**	**EPSRC**	**FNRS**	**MSTI**	**EAS**	**GSRT**	**NKTH**	**IRCSET**	**CNR**	**NWO**	**FCT**	**MEC**	**TOTAL**
Scientific staff per group	4,8	2,0	6,5	6,0	2,6	1,6	2,0	3,1	7,4	4,6	5,7	3,9
Guest researchers per staff member	1,7	0,3	0,1	0,1	0,3	0,5	0,3	0,1		0,1	0,1	0,4
Postdocs per staff member	0,8	1,5	0,2	0,1	0,4	0,9	0,9	0,8	0,4	0,2	0,3	0,5
Ph.D.-students per staff member	1,7	2,0	0,6	0,6	1,1	1,5	2,3	0,5	0,5	0,2	0,4	0,9
Ph.D.-schools organised per staff member	0,08	0,02	0,09	0,03	0,02	0,07	0,00	0,08	0,07	0,00	0,01	0,06
International conferences organised per staff mem	0,50	0,25	0,11	0,37	0,10	0,50	0,77	0,11	0,08	0,09	0,03	0,21
Invited talks per staff member	2,1	2,3	0,7	0,5	1,7	3,8	2,3	1,8	0,2	0,2	2,5	1,5
National grants received per staff member, kEuro	463	38	24	15	8	44	135	34	182	182	44	127
European grants received per staff member, kEuro	83	20	7	8	7	40	82	26	66	0	19	33
Industrial grants received per staff member, kEuro	62	4	5	4	1	6	6	2		0	0	12
National grants in % of total grants received	76	62	67	54	51	49	60	54	73	100	70	74
European grants in % of total grants received	14	32	19	30	45	44	37	42	27	0	30	19
Industrial grants in % of total grants received	10	6	14	16	4	7	3	3		0	0	7
Articles published per staff member	2,1	4,0	2,8	1,8	2,9	7,9	3,8	6,0	6,3	1,8	5,0	3,9
Patents obtained per staff member		0,2	0,0	0,0	0,0	0,1	0,0	0,1		0,0	0,0	0,0

Status 2006, definitions

Scientific staff, person-years
Number of members of the responding research units with permanent positions (typically in the positions of Professor, Associate Professor, Assistant Professor or Lecturer) and working in Complexity research

% of women among scientific staff
Percentage of female scientific staff members

Average age for scientific staff
Average age of scientific staff

Guest researchers, person-years
Number of researchers from other Universities or Research centres working in Complexity research, visiting the responding research units, weighted by the fraction of time they were visiting in 2006

Postdocs, person-years
Number of Postdoctoral fellows working in Complexity research at the responding research unit in 2006

Ph.D.-students, person-years
Number of PhD students working in Complexity research at the responding research unit in 2006

Ph.D.-schools organised, number
PhD schools organised by the responding research units within the subjects of Complexity Research in 2006

International conferences organised, number
International Conferences organised by the responding research units within the subjects of Complexity Research in 2006

Invited talks, number
Number of talks given by members of the responding research unit in 2006

National grants received in total, Euro
National grants received by the members of the responding research unit in 2006

European grants received in total, Euro
European grants received by the members of the responding research unit in 2006

Industrial grants received in total, Euro
Industrial grants received by the members of the responding research unit in 2006

Articles published, number
Scientific articles published in 2006 which were authored by the members of the responding research unit

Patents obtained, number
Patents obtained in 2006 which were filed by the members of the responding research unit