The ECCO research group

The following provides an overview of the aims, activities, members and organization of the *Evolution, Complexity and Cognition* group at the Vrije Universiteit Brussel. Most of this material can also be found on the group's website, http://pcp.vub.ac.be/ECCO/, which moreover contains a bibliography, related websites, extensive advice for beginning researchers, and downloadable versions of most of the software and papers listed here.

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Overview

ECCO, the *Evolution, Complexity and COgnition* group, is a transdisciplinary research group, situated at the Vrije Universiteit Brussel (VUB), and directed by Francis Heylighen. While founded under the present name only in 2004, our unofficial history goes back many years. Our members come from a wide variety of backgrounds, from physical science and technology via the biomedical sciences to the social sciences and humanities. Presently we have about 8 full members and as many affiliated ones. The group is expanding quickly, as wet get about a dozen new applications to join every year, from all around the world.

Our research focuses on the *evolution of organization*:

- how does a collection of initially autonomous, but interacting, agents self-organize?
- how does it evolve to an increasingly cooperative, adaptive and intelligent system, able to tackle problems too complex for individual agents?

Examples include the emergence of life from molecules, of multicellular organisms from cells, of the mind from neurons, and of languages, culture, markets and institutions from individuals.

We tackle this general issue through a number of more concrete research projects, addressing various theoretical aspects and practical applications, including computer simulations. ECCO members have published many papers and books on these subjects, and are regularly adding new working papers to the website. We further provide a bibliography of recommended reading by other authors on the domain, and a list of related organizations on our website.

ECCO regularly organizes international conferences, as well as weekly seminars at the VUB, to which everyone is welcome. We also provide teaching and consultancy about complexity and emerging technologies to cope with it. Since 2005, we moreover publish the open-access, electronic Journal of Memetics - Evolutionary Models of Information Transmission, available through our website.

If you are interested to collaborate with us, or apply for a PhD or PostDoc here, on our website we have gathered an extensive collection of practical information on doing research in ECCO.

Organization

The following lists the present members with their focus of research. "Core" members are those whose main research activities fall under ECCO; most of them make a PhD under the guidance of F. Heylighen. The others participate in ECCO projects, but have their main activity in other departments.

The mailing list EVOLCOMP@listserv.vub.ac.be is used by ECCO members to discuss research ideas and practical organization of the center. Members can moreover use their ECCO login to directly edit the ECCO website, and to access and edit the private ECCO-site (or "intranet"), which is used for internal information and as a "collaboratory" for developing new ideas and draft documents.

Director

- Prof. Dr. Francis Heylighen: evolutionary cybernetics

Core members

- Carlos Gershenson: design and control of self-organizing systems
- Klaas Chielens: quantitative, linguistic study of memetic selection
- Mixel Kiemen: framing the rational information handling process of active externalism to investigate the primacy of context.
- Laetitia De Jaegher: systems approaches to law and governance in a complex, dynamic society, with applications to risk management
- Marko Rodriguez: particle-flow networks to support collective problem-solving in science and society
- Dirk Bollen: situated and embodied cognition and the emergence of intelligent organization from local interactions
- Erden Goktepe: complexity and self-organization theories applied to the emergence of international institutions

Affiliated members

- Nathalie Gontier: an evolutionary reconstruction of the dynamics of language activity
- Andreas Loengarov: multi-agent simulations of the multilevel evolution of social structures and networks.
- Nick Deschacht: complex dynamics models of long-term socio-economic evolution
- John Stewart: evolution of greater cooperativeness and evolvability in organisms, society and individual consciousness
- Dr. Bertin Martens: the cognitive mechanics of economic development and institutional change
- Prof. Dr. Frank Van Overwalle: connectionist models of social and distributed cognition
- Prof. Dr. Jan Bernheim: evolutionary, progressive world views, and measurement of well-being
- Prof. Dr. Gustaaf Geeraerts:applications of complex systems models to international relations

- Geert Vancronenburg: systems dynamics and changing a world view
- Dr. Karl Tuyls: reinforcement learning and evolutionary game theory in multi-agent systems
- Kurt Laforce: evolutionary processes applied to regimes and international institutions
- Dr. Julien Libbrecht: cybernetic principles applied to the organization of health care

Former core members

- Johan Bollen
- Leor Gruendlinger

Affiliated Organizations

ECCO members are centrally involved in the following organizations:

- Principia Cybernetica Project: a well-known and extensive website summarizing the concepts and principles of the evolutionary-systemic worldview
- Journal of Memetics-Evolutionary Models of Information Transmission: free, peer-refereed electronic journal published by ECCO
- Global Brain Group: an international forum on the emergence of an intelligent, worlwide network
- Brussels Complexity: a forum for exchanging information for complexity researchers within the Brussels academic community (mostly VUB and ULB)
- Complexity Digest: free weekly newsletter providing a very extensive review of all complexity-related research in the world

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Short biographies of ECCO members

Francis **Heylighen** is a research professor affiliated with the *Department of Philosophy* and the interdisciplinary *Center Leo Apostel*, and director of the *Evolution, Complexity and Cognition* group at the *Vrije Universiteit Brussel*. He has worked during most of his career for the *Fund for Scientific Research-Flanders* (FWO), first as research assistant ("aspirant"), then PostDoc, and finally tenured Senior Research Associate ("onderzoeksleider"). He received his MSc in mathematical physics in 1982, and defended his PhD in 1987, on the cognitive processes and structures underlying physical theories [Heylighen, 1990]. He then shifted his research to the self-organization and evolution of complex, cognitive systems, which he approaches from a cybernetic perspective.

Francis Heylighen has authored over 90 scientific publications in a variety of disciplines, including a monograph and four edited books. Since 1990 he is an editor of the *Principia Cybernetica Project*, an international organization devoted to the computer-supported, collaborative development of an interdisciplinary knowledge network. He created (and still administers) the project's website [Heylighen, Joslyn & Turchin, 2004] in 1993, as one of the first complex, interactive webs in the world. Since 1996 he chairs the *Global Brain Group*, an international discussion forum reflecting on the emerging information society. He is the present editor-in-chief of the *Journal of Memetics: Evolutionary models of information transmission*, which he co-founded in 1996, and member of the editorial boards of the *Journal of Happiness Studies*, and the journals *Informatica* and *Entropy*.

His work has received a wide and growing international recognition from peers, students and the general public. This is shown by such indicators as the number of references to his work in the *Web of Science Citation Index* (more than 200), on the world-wide web (about 16000 according to www.google.com), in the national and international media (articles about his work have appeared among others in *New Scientist*, *Frankfurter Algemeine Zeitung*, *Die Zeit*, *Le Monde*, the *Washington Post*, and *Knack*). This recognition is confirmed by the number of people that have applied to do PhD or PostDoc research under his supervision (several dozen from all around the world), and the invitations he regularly gets to lecture in different countries or to write review articles for leading reference works [e.g. Heylighen, 2002; Heylighen & Joslyn, 1995, 2001]. He is a Fellow of the *World Academy of Art and Science*, and his biography is listed in *Who's Who in the World* and other international directories.

Carlos **Gershenson** is a computer scientist with a BEng (2001) from the *Fundación A. Rosenblueth* in México, and a MSc (2002) from the *School of Cognitive and Computer Sciences* at the *University of Sussex*. He is making a PhD on the design and control of self-organizing systems under the supervision of Heylighen. His research interests include distributed cognition, philosophy of mind, complex systems, artificial societies and computer simulation. At the age of 26, he already had published over 25 scientific papers in international proceedings and journals. He is a contributing editor to *Complexity Digest* and Book Review Editor of the high-ranking journal *Artificial Life*. His research has been covered in the national and international media, including *Nature News*, *Trends*, and *Technology Research News*.

Klaas **Chielens** is a linguist with a MA (2003) in Germanic philology from the Vrije Universiteit Brussel. His Master's thesis [Chielens, 2002] made an empirical investigation of selection criteria for the spread of memes. He is working towards a PhD under the supervision of Heylighen on the same subject, funded by the Vrije Universiteit Brussel He has practical experience with setting up websites, and managing student organizations. He is the new managing editor of the *Journal of Memetics*, assisting the editor, F. **Heylighen**, with the publishing and refereeing process.

Mixel **Kiemen** is a computer scientist with a MSc in Theoretical Informatics (2003) from the *Vrije Universiteit Brussel*. For his Master's thesis, he built a software agent simulation to investigate the creative process of tool-making. In 2004 he focused on "new media" and participated in the CONVIVIO summer course. Since the end of 2004, he is responsible for the Cartography of Research Actors project of *DISC*, the Brussels center for the knowledge society. His present research focuses on context-aware information technology to support virtual communities.

Marko **Rodriguez** is computer scientist with a BSc in Cognitive Science from the *University of California at San Diego* (2001), and a MSc in Computer Science from the *University of California at Santa Cruz* (2004). He was awarded a GAANN fellowship by the US Department of Education, which allows him to work as a researcher at ECCO. Together with D. Steinbock (Stanford University), he has developed the "particle-flow network" as a general methodology and software environment to model self-organization and distributed cognition. He has applied this to support collective intelligence in decision-making and scientific collaboration, and has written several papers on these topics. Marko is on track to receive his Ph.D in Computer Science from the *University of California at Santa Cruz.* In 2005, he will be working as a visiting researcher on distributed knowledge systems and digital libraries at the *Los Alamos National Laboratory* with J. **Bollen**.

Laetitia **De Jaegher** is a legal advisor who studied law at the *Université Catholique de Louvain-la-Neuve, Katholieke Universiteit Leuven, Rijksuniversiteit Leiden*, and *Moscow State University* (1998). She is specialized in environmental and energy law and risk management. She has made several conference presentations and written a few papers on these issues, and has practical experience with project and knowledge management. Her research interests focus on developing a new framework for governance in a complex and changeful society, based on principles of self-organization and collective intelligence.

Erden **Göktepe** studied Political Science in *Ankara University* (1996) and the *Université Robert Schuman* (1999), and has an M.A. in International Relations from *Galatasaray University* (2004). He worked as research and teaching assistant at the *International Relations Department, Galatasaray University* in Istanbul, Turkey before joining ECCO in 2005. In his Master's thesis he approached international relations from the point of view of complexity theory and self-organising systems. He is preparing a PhD thesis on the emergence of cognitive actors as a part of complex social evolution in international politics, with F. Heylighen and G. Geeraerts as supervisors.

Dirk **Bollen** has a Master's degree in psychology (2003) from the *University of Maastricht*, with specialization in artificial intelligence and cognitive science. He worked as a teaching assistant at the faculty of psychology and guided some robotic workshops for students at the computer science department, University of Maastricht. He is interested in dynamical systems models of situated and embodied cognition, and their applications to the self-organization of multi-agent systems. His current research focus is on how high level cognition emerges from low level information integration and interaction between simple components.

Nick **Deschacht** has a MSc in applied economics (2001) from the Vrije Universiteit Brussel. His Master's thesis, on the long-wave theory of economic development applied to the emerging information society, got an award as the best one of its year within the social science faculty. He works presently as an assistant, teaching mathematics and statistics to social science students. He is interested in complex systems models of long-term socio-economic evolution, the information society, and the evolution of preferences.

Nathalie **Gontier** studied Philosophy at the VUB (2001), and Comparative Science of Culture (Anthropology) at the University of Ghent (2002). Currently she is a research assistant for the Fund for Scientific Research-Flanders, connected to the Centre for Logic and Philosophy of Science. She is preparing a PhD in Philosophy about the origin and evolution of language. Her main research interests are philosophy of biology and evolutionary epistemology as implemented in the origin of life and language. Together with Katrien Mondt she founded DITO, a think-tank on inter- and transdisciplinary language research, and she is an affiliated member of the Language Origin Society. She also organized and chaired the conference on Evolutionary Epistemology, Language and Culture (EELC) (VUB, 2004). For a selection of recent publications on these topics, click here.

John **Stewart** is a senior labor relations policy adviser with the Australian Government. He has worked previously as a trade union organizer and arbitration advocate, and a fisheries manager. His main interest is in using an evolutionary perspective to answer the 'big' existential questions that confront all of us. He has published a number of papers on evolutionary theory in international journals, and authored the book "Evolution's Arrow:

the direction of evolution and the future of humanity", in which he analyses the mechanisms through which evolution produces ever more synergetic and adaptive systems, from cells to global society. Presently he is exploring techniques to enable humans to become self-evolving organisms, that can transcend the motivations and goals of their biological and cultural past.

Bertin **Martens** is an economist with a MSc (1979) from the *Katholieke Universiteit Leuven*. Since 1989 he works at the *European Commission* in Brussels on project design and evaluation, macro-economic modelling and implementation of structural reform programmes. He has combined his professional career with academic research by working part-time and taking sabbaticals to visit research institutes around the world. As such, he held Visiting Fellow positions at the *University of New South Wales*, the *Max Planck Institute for Research into Economic Systems*, *George Mason University*, and *Stanford University*—where he worked for six months with the Nobel Prize winner Douglas North. He focuses on cognitive science approaches to economic development and institutional change. In May 2004, he defended his PhD thesis [Martens, 2005] on the role of distributed knowledge in social and economic evolution, with F. Heylighen and M. Despontin as promotors. It will be published as a book by Cambridge University Press.

Frank **Van Overwalle** is a full professor affiliated with the *Department of Psychology* at the *Vrije Universiteit Brussel*. He has worked first as research assistant in the VUB department for new media and computer technology in education, then as PostDoc at the *University of California at Los Angeles* (1988-1989), and finally as PostDoc and tenured professor at the VUB psychology department.

He got his MSc in psychology in 1980, and defended his PhD in 1987 on “Causes of success and failure of freshmen at university: An attributional approach”, for which he received the *Tobie Jonckheere Award* of the *Belgian Royal Academy of Sciences, Letters and Arts*. He continued to work on attribution and social cognition, and then applied his and others’ research to the development of artificial neural network models of social cognition. He has received several grants from his university and the *Fund for Scientific Research-Flanders* in order to test some unique predictions derived from these theoretical proposals. This enabled him to employ several PhD students in his social cognition lab, who generate scientific output either as a PhD or in empirically oriented articles.

Frank Van Overwalle has authored some 40 peer-refereed scientific publications, in the domain of social cognition. His recent research focuses on artificial neural network models of various phenomena in the domain of social cognition at large, to demonstrate the common cognitive processes underlying many social findings. The aim is to abolish ad-hoc hypothesis building which is currently very flourishing in social psychology, and to attempt to develop a general cognitive theory encompassing the whole of social psychology, in line with general theories of psychological information processing. This has resulted in a number of publications in top-ranking journals such as *Psychological Review* and *Personality and Social Psychology Review* with an impact score (SSCI) between 3 and 7.

His work is receiving a broad and growing international recognition from peers, as evidenced by some 200 references to his work in the *Web of Science Citation Index*. He is a member of the *Royal Flemish Academy of Art and Science’s* committee of Psychology, the *American Psychological Association*, and the executive board of the *Belgian Federation of Psychologists* (BFP). He is a past secretary-general and president of the *Belgian Society of Psychology* (BVP), and is in the editorial board of the *European Journal of Social Psychology* and *Psychologica Belgica*.

Gustaaf **Geeraerts** is Professor of International Relations at the Vrije Universiteit Brussel (VUB), and has been Director of the Centre for Peace and Security Studies at VUB since 1993. Professor Geeraerts is Honorary Professor at the University of Kent at Canterbury, and a Deputy Editor of Global Society: Journal of Interdisciplinary International Relations. From 1986 to 1990 he was located at the Department of International Relations at the State University of Utrecht where he was specialised in research on the dynamics of international political processes. During that period he was also a member of the Board of Lecturers of the Centre for Advanced Research in International Affairs in the Netherlands (CARIAN).

His research interests centre around international relations theory and security in Europe and East Asia. He is currently working on modelling of complex phenomena in international relations.

His publications in English include: Possibilities of a Civilian Defence in Western Europe (1977), and more recently, "Progress and its Problems in the Study of War: Theoretical Needs and Practical Relevance", Bulletin of Peace Proposals (Vol.22, 1991); "War, Hypercomplexity, and Computer Simulation", Systems Research (Vol.11, 1994); (with Anthony Antoine), "IT & IS: Identifying the Needs of International Organisations - The Ideal of a 'Virtual' Partnership", in Pericles Gasparini-Alves (ed.), Increasing Access to Information Technology for International Security (1997); (with Patrick Stouthuysen), Democratic Peace for Europe: Myth or Reality? (1999); (with Men Jing), “IR Theory in China”, in Global Society, (Vol.15, 2001).

Jan **Bernheim**, M.D., Ph.D., F.A.C.P., M.F.P.M., is a Professor of Medicine (part-time, tenured) affiliated with the Human Ecology Department, Faculty of Medicine and Pharmacy, and the Bioethics research group at the Free University of Brussels (VUB). He has also been working as a biomedical consultant specialized in the effects of cancer drugs, initially for the pharmaceutical multinational UCB, and now independently at Bernheim - Pro Scientia.

His research interests include: measurement of happiness, societal progress and its implications for the evolutionary worldview, bioethics with a special focus on euthanasia, oncology: interaction between exogenous and genetic factors in hormonal carcinogenesis, and drug-disease interactions. At the moment he is focusing on finding further empirical support for the ACSA (Anamnestic Comparative Self-Assessment) method, which he developed twenty years ago as a non-relativistic tool to measure subjective quality-of-life. He has authored many international publications on these topics, some of which were published in top-ranking journals, such as *Proceedings of the National Academy of Sciences* (USA), *Bioethics*, and *the Lancet*.

Recruitment and training of new researchers

Since several years, ECCO's research has been attracting a growing number of candidates, nationally and especially internationally, who would like to work with us for their PhD or PostDoc. Our program offering the possibility of interdisciplinary PhDs has to some degree become the victim of its own success, attracting more candidates than we can comfortably handle. Our research center is not yet large enough to provide much supervision, infrastructure or financial support. This means that we have to be very selective in accepting further PhD candidates. After strict guidelines for admission were formulated in 2003, the number of applications seems to have stabilized at about a dozen

per year, of which somewhat less than half effectively start working in ECCO. For example, in 2004 alone 5 new PhD students joined ECCO, and many more applied.

Presently, the following candidates have passed the first selection stage, and thus have a good chance to join ECCO for the next academic year:

- Lito Kyritsi is a Greek bio-informatics researcher who would like to work part-time in ECCO on a PhD about a systems/complexity model of cancer.
- Steve Edgerton is a Belgian-British health researcher who would like to make a PhD on an evolutionary theory of health and quality of life.
- Tom Erez is an Israeli mathematician/complexity scientist, who would like to make a PhD on his Postext system cognitively-apt knowledge management.
- Prabakaran Sudhakaran is a young Indian molecular biologist, who should finish his PhD on molecular psychiatry in Cambridge University in September. He would like to come for a PostDoc stay in ECCO to work on self-organization in the brain and society
- Edward Bandiouk is a Russian/American computer scientist, interested to make a PhD on cybernetics and global brain technologies.

Selection criteria

According to our general criteria, the right candidates should:

- show unusual intellectual capabilities, in particular creativity, capability for abstraction, analytical and synthetic thinking
- have a solid education in at least one academic discipline, whether in technology, natural sciences, social sciences, or humanities
- are very open-minded, willing to explore ideas and approaches very different from their original background (e.g. art for a physicist, mathematics for a philosopher, or biology for a sociologist)
- wish to focus on a research subject that fits in with on-going research at ECCO
- are able to work largely autonomously, with little direct supervision
- have enough maturity, self-discipline and emotional stability to successfully carry through the long and uncertain process of preparing a PhD
- can find their own financial support (possibly with our assistance)
- are willing to collaborate with, and give/receive mutual support to/from, other PhD students at our center

Application procedure

If applicants seem to recognize themselves in this profile, and moreover seem to fulfil the formal requirements for admission as a PhD student at the VUB, they should apply in the following way:

- send an email application to the ECCO director, Francis Heylighen, explaining in some detail why they would like to do research in ECCO, and what their initial research ideas or interests are
- indicate whether they think you can get financial support on your own
- attach their full curriculum vitae, with their educational (and possibly professional) experience
- attach if at all possible any representative texts they have written (e.g. papers, bachelor's or master's thesis, essays...) that can give us an impression of how they develop and explain their ideas.

If this written application seems acceptable, the candidate is invited for a 2-3 day visit of ECCO, where they typically present their initial research ideas in the form of a seminar, and take part in extensive discussions with ECCO members. If here too our impression is positive, the applicant is in principle accepted as an ECCO member, and we start discussing the practical procedures for joining the team, from arranging the formal requirements of registration, eventual visa, possibilities for funding, etc. to the research work that is expected of them.

Guidelines for beginning researchers

Most of this general advice is available on the website, in the form of extensive answers with weblinks and references to the set of "frequently asked questions" below. Our intention is to develop this set of guidelines into a detailed "handbook" for young researchers, giving them the concrete information they require and teaching them all the practical skills that they need to succeed in their PhD and further research career.

This handbook will be complemented by a textbook providing a broad and deep introduction to the ECCO research domain, reviewing and synthesizing the main results from complex systems theory, cybernetics, self-organization, evolutionary theory, etc. Most of the material is already available on the Principia Cybernetica website (in English), or in the lecture notes of F. Heylighen's course "Complexiteit en Evolutie" (in Dutch).

Doing research in ECCO FAQ

Joining the group

- Who can apply to join ECCO?
- I already work in a research group. How can I become an affilliate ECCO member?
- What are the formal requirements to get a PhD at the VUB?
- Can I be an ECCO researcher even without a research contract?
- Can I make a PhD in ECCO from a distance?
- What can I expect when moving to Brussels?
- In summary, which steps should I take before coming to work in ECCO?

Getting academic support

- Where can I find funding for a PhD scholarship or PostDoc?
- How can I get funding for congresses?
- What academic support is available for PhD students?
- What can I expect from my promotor?
- Why do PhD students often feel alone and self-doubting?

Developing research and communication skills

- How can use I an outline to better organize my ideas?
- How should I write a paper/thesis?
- How should I write for the web?
- How can I use email most effectively?
- How can I increase the scientific impact of my work?

Academic activities

- Which activities are expected from a PhD student/beginning researcher?
- How and why should I best participate in conferences?
- What should I include in my scientific activity report or curriculum vitae?

Training of researchers

A core reason for the high failure rate among PhD students is the lack of supervision and interaction with other researchers. Since a promotor with several PhD students generally does not have the time to give them close, individual supervision, in ECCO we make the group as whole responsible for the stimulation, advice and feedback that beginning researchers most need. But this requires that the students actively participate in the research of the group. As a rule-of-thumb, in ECCO we expect a PhD student to every year perform at least the following activities:

- give a lecture or seminar about their latest ideas, in ECCO or elsewhere
- participate in 1-3 scientific conferences, locally or abroad, to interact with other specialists
- write one or more papers detailing their latest results, for our working papers series, or, preferably, for a journal or proceedings

Another reason for failure is that many PhD students spend their energy in unending side-activities, such as reading books, following courses, progamming simulations or organizing conferences, while postponing the essential stage of writing down their results, first as papers, eventually as a dissertation. To overcome this tendency towards procrastination, which typically results from lack of confidence in one's own researching/writing abilities, we propose the following simple series of steps, offering a smooth transition from the easy to the difficult:

- gather inspiration by reading, following lectures, talking to colleagues, thinking...
- write down your ideas immediately as you get them, creating a collection of notes
- organize your notes by using the method of outlining or idea processing
- develop your outline into a (PowerPoint) presentation
- present this outline as a seminar to the ECCO group (or at a conference), so as to get feedback from your colleagues
- taking into account the feedback, develop your outline into an ECCO working paper
- announce your working paper to colleagues/promotor, requesting more detailed feedback
- taking into account the feedback, improve your paper and submit it for publication

Once PhD students have become more experienced, they will be able to skip some of these stages, e.g. jumping directly from idea via outline to publication. If they manage to produce 3-5 peer-refereed, published papers in this way, they have in principle enough material to write a PhD dissertation. If the papers are well-structured and investigating different aspects of the same broad subject, it should cost them little effort to elaborate these into a coherent dissertation. They are then ready to defend and get their doctoral degree. Moreover, they can look forward to a further academic career, safe in the knowledge that in addition to their title they have already gathered an impressive curriculum vitae with several publications, lectures, ...

(Pre)history of ECCO

Although ECCO was founded under the present name only in 2004, it grew out of a series of formal and informal collaborations centered around Francis Heylighen, that go back 20 years. In 1984, as a young physics researcher, F. Heylighen came in contact with the psychologist Prof. De Waele and his then assistant Luc Van Langenhove. As they shared the ideal to promote interdisciplinarity at the VUB, they founded the informal "Transdisciplinary Research Group". Its primary activity was the organization of seminars and discussions involving many of the active researchers from the VUB and Ghent University, including E. Rosseel, J-P. Van Bendegem, and D. Aerts.

By 1987, the ambitions had expanded to the international level, resulting in the organization of the well-attended 3-day conference "Self-steering and cognition in complex systems"and a summer school on "Self-organization of cognitive systems" in 1988. The time seemed ripe to officialize the informal group, and a concrete proposal including an outline of the research philosophy which then already centred around the three themes of evolution, complexity (systems), and cognition, was presented to the VUB authorities.

However, at the same time, the late philosopher Leo Apostel independently submitted a similar proposal for a transdisciplinary research group focused on the construction of integrating worldviews. Given Apostel's fame, the VUB decided to honor only the latter proposal, so as not to divide resources over two transdisciplinary research groups. Out of this proposal was created the Center Leo Apostel (CLEA). However, the activities of this Center became increasingly infrequent, given that its members were mostly senior professors with a busy agenda and little time to invest in interdisciplinary research.

In the meantime, Francis Heylighen and collaborators independently continued their research, obtaining funding from the Fund for Scientific Research (FWO), while working to create an international network on complexity research. This eventually got realized as the Principia Cybernetica Project, for the computer-supported, collaborative development of an evolutionary-systemic philosophy.

In 1995, CLEA was drastically reorganized under the leadership of Dirk Aerts, taking in many younger researchers, including F. Heylighen and his then research assistant J. Bollen, and other members of the former Transdisciplinary Research Group. Thus, the kernel of what would become ECCO was now part of CLEA, being involved in CLEA's now very active program of research, projects, conferences (including the very successful "Einstein meets Magritte"), seminars and other activities. In addition, the ECCO group remained active on the international level, organizing conferences, developing the Principia Cybernetica website, and helping to found the Global Brain Group and the Journal of Memetics.

Thanks to the worldwide recognition of these activities, the ECCO-related research of Heylighen and his collaborators gradually began to attract more and more applications from students and outside researchers wanting to work with them, especially from abroad. On the other hand, the differences in research philosophy and interests between this group and the majority group in CLEA, which under the leadership of Dirk Aerts was focusing on interdisciplinary applications of quantum structures and cultural aspects of world-views, became increasingly clear. As the informal group was growing quickly, with most of the present core members joining in 2004, it was finally decided to establish it as an independent research group under the name ECCO.

The ECCO approach

Transdisciplinary perspective

ECCO aims at transdisciplinary integration, i.e. at the development of a unified conceptual framework that can be applied to problems in all the scientific disciplines, from the natural sciences to the humanities. As our name implies, we find the foundations for this framework at the point where the three approaches of *complexity*, *evolution*, and *cognition* meet.

The emerging science of complex systems extends the tradition of *general systems theory*, which sought to unify science by uncovering the principles common to the holistic organization of all systems, from atoms and molecules to mind and society. However, the classical systems approach failed because of two shortcomings: the systems it studied were considered as (1) well-defined static structures, (2) that are objectively given. To really understand systems, you need to know how they have *emerged* and *evolved*, i.e. how they came into being and gradually developed their organization.

This brings us to the second strand of our conceptual framework: evolution and self-organization. We see the self-organization of a system as the co-evolution and mutual adaptation of the system's components, driven by variation and selection internal to the system. The traditional view of evolution is then merely the adaptation of the system as a whole to its encompassing environment, driven by external, or "natural", selection. This holistic view of self-organization/evolution allows us to overcome the pitfalls of genetic or biological reductionism that are often associated with Darwinian approaches.

The other shortcoming of classical systems theory is overcome by noting that knowledge cannot be developed through passive, objective observation, but only through active construction by the subject. This brings us to the domain of *cognitive science*, which until recently was also stifled by a too reductionistic and static perspective. The newer approaches, however, emphasize the constant evolution and self-organization of knowledge, and the on-going interactions between subject and environment. This helps us to understand the intrinsic limitations, subjectivity and context-dependence of models, while still providing us with heuristics to improve our knowledge—however subjective or limited.

The integration of the three approaches—*cognition*, *systems or complexity*, and *evolution or self-organization*—points us to a wholly new philosophy of nature, mind and society. It sees the essential building blocks as *processes* and *relations*, rather than as bits of matter or energy. Their most important product is *intelligent organization*, which can be found at all levels, from molecules to global society. However, this deep metaphysical perspective is merely a starting point for concrete, scientific research with plenty of practical applications.

Research focus and methodologies

When studying the evolution of complexity, our emphasis is on the emergent *organization* or *system*: what is it precisely that the whole has more than the sum of its parts? In particular, our focus is on the *intelligence* of the system, i.e. its capacity to understand, adapt, solve problems, take adequate action, and learn from its experience. This is the perspective of collective intelligence, distributed cognition or the extended mind.

A complementary emphasis is on the dynamics or *evolution* of emergence: how do the interactions between components become gradually more coordinated? Which are the "forces" or selective pressures that push the system in the direction of increasing organization? Hoe does it self-organize and become cooperative, in spite of intrinsic obstacles such as uncertainty, conflict, competition and complexity?

This general problem is approached using a variety of ideas and methodologies from all the traditional disciplines:

- conceptual analysis and theory-building, e.g. using systems theory or thought experiments;
- computer simulation, e.g. with multi-agent systems or connectionist networks;
- mathematical modelling, e.g. using dynamical systems or multidimensional state spaces;
- case studies, e.g. of specific organizations or historical developments;
- empirical observation, e.g. of group processes, discussions and "games".
- practical applications, e.g. in collaborative technologies or knowledge management.

On-going Research Projects

The following provides an overview of the main topics currently being investigated in ECCO, including the names of the most directly involved researchers and some representative references.

Mediator Mechanisms in the Evolution of Organization

This project in a sense provides the theoretical framework for all other, more specific ECCO projects. It tries to understand how initially independent or competing agents can form a cooperative system, through the evolution of "mediators". These are concrete or abstract systems that regulate the interactions between the agents, so as to minimize conflict or "friction", and to maximize synergy. The mediator scenario integrates several more specific models of self-organization and the evolution of cooperation. It helps us to understand evolutionary progress towards higher organization, complexity and adaptability. It further suggests concrete applications, e.g. in economic development or the regulation of self-organizing systems.

Researchers: Heylighen, Gershenson, Stewart, Martens, Loengarov, Göktepe

Selected References:

- Heylighen F. (2004): "Mediator Evolution: a general scenario for the origin of dynamical hierarchies", [submitted]
- Stewart, J. E. (2000), Evolution's Arrow (Rivett: Chapman Press).
- Martens B. (2005): The cognitive mechanics of economic development and institutional change, (Cambridge University Press). (in press)

Evolutionary-Systemic Philosophy

Here we investigate the new philosophy, including ontology, epistemology and ethics, implied by the science of complex, evolving systems. The resulting integrated world-view

should allow us to address the age-old questions: What is? Who are we? Where do we come from? Where do we go to? What can we know? What is the meaning of life?...

Researchers: Heylighen, Gershenson, Gontier, Stewart, Bernheim

Selected References:

- Heylighen F. (2000): "Foundations and Methodology for an Evolutionary World View: a review of the Principia Cybernetica Project", Foundations of Science, 5, p. 457-490.
- Gershenson, C., F. Heylighen (2004a). How can we think the complex? in: Richardson, Kurt (ed.) Managing the Complex Vol. 1: Philosophy, Theory and Application. [in press]
- Heylighen F., Joslyn C. & Turchin V. (eds.) (1993-2005): Principia Cybernetica Web

Social Construction of Shared Categories

This is a four-year project funded by the FWO, in collaboration with the Social Cognition Lab (Psychology Department, VUB). It tries to determine how individually learned concepts or categories can become consensual through communication between the individuals, and in what ways the consensual concept is different or "better" than the individual ones. The issue is investigated in parallel through computer simulation and experiments with groups.

Researchers: Heylighen, Gershenson, Heath, Van Overwalle

Selected References:

- F. Heylighen & F. Van Overwalle: Research proposal to the FWO: The social construction of shared concepts: empirical study and computer simulation of a distributed cognitive process

Connectionist Modelling of Distributed Cognition

This collaboration builds on the previous one to examine more generally how cognitive processes can be distributed over different individuals connected by communication media. It assumes that these connections are variable, adapting to the task by reinforcing successful ones and weakening the others. Computer simulations of such processes help us to understand how knowledge and information propagate and self-organize within groups and organizations.

Researchers: Heylighen, Van Overwalle, Rodriguez

Selected References:

- Heylighen F., Heath M., F. Van Overwalle (2004): The Emergence of Distributed Cognition: a conceptual framework, Proceedings of Collective Intentionality IV, Siena (Italy)
- Van Overwalle, F., Heylighen F. & Heath M. : Talking Nets: A Multi-Agent Connectionist Approach to Communication and Trust between Individuals (ECCO Working Paper 2005-07)

From Information Society to Global Brain

This projects extends the connectionist perspective to better understand the future evolution of world society. The emerging knowledge-, network- or information society is conceptualized in analogy with the human brain, which is an immensely complex, self-organizing network of neurons and synapses, where information is processed in a

distributed way, and where knowledge is developed through connectionist learning mechanisms.

Researchers: Heylighen, Rodriguez

Selected References:

- Heylighen F. (2004): The Global Superorganism: an evolutionary-cybernetic model of the emerging network society Journal of Collective Intelligence[submitted]
- Heylighen F., Bollen J. (1996) The World-Wide Web as a Super-Brain: from metaphor to model, in: Cybernetics and Systems '[96 R. Trappl (ed.), (Austrian Society for Cybernetics).p. 917-922.
- Heylighen F. (2004): "Conceptions of a Global Brain: an historical review", Technological Forecasting and Social Change

Self-Organization of Intelligent Artefacts

This research applies general principes of self-organization and distributed cognition to design an "ambient intelligence" environment, in which several simple artefacts and/or sensors (e.g. traffic lights) communicate and coordinate to provide an integrated service.

Researchers: Gershenson, Bollen D.

Selected References:

- Gershenson C., Heylighen F. (2004): Protocol Requirements for Self-organizing Artifacts: Towards an Ambient Intelligence, in: Proc. Int. Conf. on Complex Systems (New England Institute of Complex Systems)
- Gershenson C. (2005): Self-Organizing Traffic Lights. (ECCO working paper)

Social Network Analysis for Research Collaboration

By using data about who authored which paper, we can generate a network of researchers and their documents, where the links represents associations such as co-authorship, co-citation, or similarity in paper content. This network can be used to recommend to a given researcher papers to read, people to collaborate with, or peers to referee articles, thus functioning as a mediator. Algorithms such as spreading activation or particle diffusion are explored to find which nodes in the network are most strongly related to an initial (set of) node(s).

Researchers: Rodriguez, Kiemen

Selected References:

- Rodriguez M. & Heylighen F. (2005): Research Proposal to the FWO:Analysis of network structures to support scientific collaboration
- Rodriguez, M.A., The Convergence of Digital Library Technology and the Peer-Review Process. (ECCO working paper 2005-04, to be published in Journal of Information Science)

Complex Systems Models of International Governance

Principles of systems, cybernetics, non-linearity and self-organization help us to better understand the interaction between actors in the international community, the emergence of new actors, and the possibility for creating a flexible system of governance that involves all stakeholders, while transcending the rigidities of the traditional legal framework.

Researchers: De Jaegher, Göktepe, Geeraerts, Rodriguez

Selected References:

- Geeraerts G.: War, Hypercomplexity, and Computer Simulation, Systems Research, Vol. 11, (1994), No. 4, pp. 53-66.

The Extended/Embodied Mind

From a cybernetic perspective, cognition is not limited to what happens inside the brain, but involves interaction with the environment via perception and action, and the use of tools to support thinking and memory. By redrawing the boundaries between mind and world, we hope to better understand fundamental cognitive processes (including consciousness). This will also help us to design external supports to augment individual and collective intelligence.

Researchers: Kiemen, Bollen D., Heylighen

Selected References:

- Bollen D., A dynamical systems analysis of an embodied and situated model of cognition, M. Sc. Thesis university of Maastrich(nl), 2004.

Mechanisms of Intelligence

Here we try to model the fundamental processes underlying intelligence (pattern-recognition, inference, problem-solving, understanding, anticipation, thinking, creativity, ...) as the propagation of information "particles" through a network of concepts and associations. A major hypothesis is that such propagation is more efficient in more intelligent brains. This hypothesis tested by developing a computer simulation to solve IQ-test-like problems, and comparing its performance with that of real people solving the same problems.

Researchers: Heylighen, Rodriguez, Bollen J.

Selected References:

- Rodriguez M. & Heylighen F. (2005). WordScore: a simulation of verbal IQ test performance (experimental: not always on-line!)
- Rodriguez, M.A.: The Hyper-Cortex of Human Collective-Intelligence Systems (ECCO Working Paper 2005-06)
- Heylighen F. Towards an anticipation control theory of mind (ECCO Working paper 2005-08, to be submitted to Behavioral and Brain Sciences)

Empirical Testing of Meme Selection Criteria

This 4 year project is funded by the VUB. It tries to operationalize the theory of memetics, which studies the propagation of memes or "idea viruses", by proposing concretely measurable criteria that distinguish fitter memes from less fit ones. Practically, the predictive value of these criteria is tested by measuring how well different "virus hoaxes" have spread over the Internet.

Researchers: Chielens, Heylighen

Selected References:

- Chielens K. & Heylighen F. (2005): Operationalization of Meme Selection Criteria: Methodologies to Empirically Test Memetic Predictions, Proceedings METAS sumposium
- Heylighen F. (1998): "What makes a meme successful?", in: Proc. 16th Int. Congress on Cybernetics (Association Internat. de Cybernétique, Namur), p. 423-418.

Measurement and Development of Well-being

Happiness, quality-of-life, or well-being can be seen as the intrinsic value guiding personal and social development, providing the motivational equivalent of the evolutionary concept of "fitness". This projects tries to develop more accurate measures of this fundamentally subjective property, and to determine which basic factors promote the increase of social and individual well-being.

Researchers: Bernheim, Heylighen

Selected References:

- Heylighen F. & Bernheim J.(2000): "Global Progress I: empirical evidence for increasing quality of life", Journal of Happiness Studies 1(3)
- Heylighen F. & Bernheim J. (2000): "Global Progress II: evolutionary mechanisms and their side-effects", Journal of Happiness Studies 1(3)
- Heylighen F. (1992): "A Cognitive-Systemic Reconstruction of Maslow's Theory of Self-Actualization", Behavioral Science 37, p. 39-58.

Software and demos of computer simulations

ECCO's general research into self-organizing and cognitive systems is made more concrete by building computer models of such systems. This allows us to experiment with their behavior, and better understand how they function or solve problems. The following interactive demonstrations or software can be freely used or downloaded through our website.

Rodriguez M. & Heylighen F. (2005). WordScore: a simulation of verbal IQ test performance

This simulation uses propagation of "energy particles" through an associative network of words to find which word is most/least related to a set of given words. It solves IQ-test-like questions of the following form, where * designates the correct answer (at present it gets about 75 % right):

- Which word of the second list best fits in the first list? dog, cat, bird, fish : bush, pig*, house, car
- In the following list, which word is the odd one out? dog, cat, car*, pig, cow

You can invent new questions yourself and try them out in the web interface to the program (experimental -> not always online).

Rodriguez, M. (2005). Peerper: automatically discover referees for journal and proposal submissions

Peerper uses scientific coauthorship networks generated from arXiv and CiteSeer e-print servers to create a map of the scientific community. You can submit a manuscript and its references stimulate the network at the corresponding nodes. A spreading-activation algorithm distributes the energy throughout the network. The most energetic nodes are returned by the system as potential referees for the submitted manuscript.

You can try Peerper version beta online via the web interface to the program (experimental -> not always online).

Rodriguez, M. & Steinbock, D. (2003-2005). Confluence: Particle-Flow Network Simulation Package for Java

Confluence is a generic network package that has been used to model collective decision-making, artificial IQ-testing, and collaboration in coauthorship networks. It forms the foundation for many of the network software used by ECCO and is constantly being updated and expanded.

Gershenson C.(2001-2004) : RBNLab

A Software Laboratory for studying the properties of different types of random Boolean networks. It can calculate attractor statistics, graphic representation of dynamics, topology graph, etc.

Van Overwalle F. (2002-2005): Fit2 for Connectionist and Algebraic Modeling

This program allows you to simulate prominent connectionist and algebraic models of learning and induction. You can directly compare the simulation output with real observed data from actual psychological experiments (hence its name FIT). In addition, you can

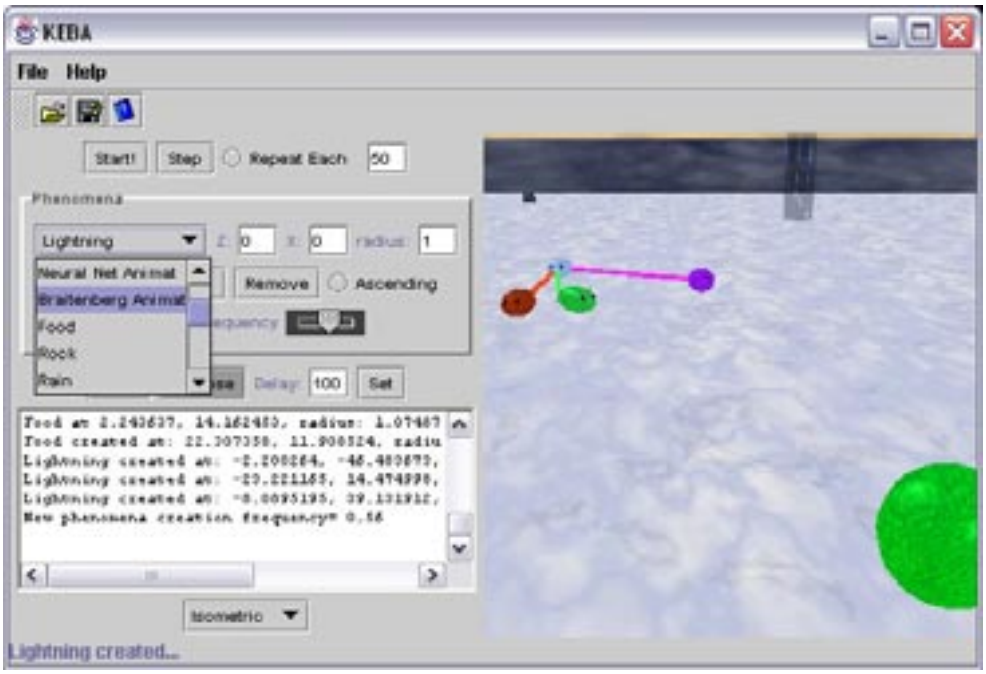

Fig.: a screenshot from the KEB simulation environment, showing some of the animats (right), and controls to manipulate their behavior, learning mode and environment (left).

automatically search for the parameter values of the simulated model that best fit with your actual data.

Gershenson, C. (2005). Self-Organizing Traffic Lights.

Using simple rules and no direct communication, traffic lights are able to self-organize and adapt to changing traffic conditions, reducing waiting times, number of stopped cars, and increasing average speeds. You can try the simulation with your Java-enabled browser.

Gershenson C. (2001-2002) : KEB: Knowledge Emerging from Behavior

A virtual laboratory for comparing different types of cognitive architectures, implemented in different animats. There are rule-based, behaviour-based, concept-based, neural network, and Braitenberg-style animats.

Gershenson C.(1999-2001) : ASIA: a Behaviours Virtual Laboratory used for studying Artificial Societies of Intelligent Agents.

This is a virtual laboratory where predator and prey animats try to survive in their environment. Useful for experimenting with virtual creatures, but also for teaching and learning animal behaviour. It includes the following features;

- Imitation and induction of behaviours.
- Reflex, reactive, and motivated behaviours.
- Adaptation of motivation degree, classical conditioning.

Courses and Consultancy

Teaching

Several ECCO members teach courses at university level, related to our domain of research. Of particular interest for the general ECCO subject is the course on "Complexiteit en Evolutie" ("Complexity and Evolution"), taught by F. Heylighen as a general introduction to the domain. This course has received the highest praise, both from colleague lecturers and the students who followed it, as being an exceptionally clear, yet broad and profound, overview of this complicated and confusing field. There exist extensive lecture notes (in Dutch), which are in principle sufficient for self-study, although active participation in the lectures is recommended.

We plan to develop these notes into a more detailed textbook in English, with the working title: "The origins of organization. An introduction to evolutionary cybernetics". Much of this material is available in a less structured format on the Principia Cybernetica Web. On demand, parts of this material can be presented elsewhere, in English or in Dutch, e.g. in the form of guest lectures, or seminars for business organizations. On request, we can also provide teaching and training in the use of basic and advanced information technologies (website development, multi-agent simulations, collaborative environments, programming...).

Consultancy

ECCO also makes its expertise available in the form of consultancy, for business, government or non-governmental organizations. We have been consulted among others by:

- PriceWaterhouseCoopers about the future of information technology
- the European Commission about :
  - new business paradigms for the e-economy
  - definition of a new research program on "Measuring the impossible"
  - mechanisms of self-organization in virtual networks
- Alcatel Bell Microlelectronics about coping with information overload
- Synthetron.com about collective intelligence software
- Cognitive Technologies, Inc. about learning web algorithms
- Foundation for the Future about long term evolution of humanity
- the Millennium Project about future social and technological developments
- the Irish Higher Education Authority to review a 5 million euro multidisciplinary research program centered around Media lab-Europe.

Costs

As a general rule, we provide consultancy and teaching for free to educational institutions, but ask about 600 euro for a day's work (preparation + presentation for one person) to others. The precise sum will depend on the type of activity and needs to be negotiated. This money is deposited on an internal university account of the WDOO type, used for income from so-called "Dienstbetoon" activities (services performed outside the academic community). We use this account to help pay for our general costs (infrastructure, travel, personnnel, etc.), thus supporting our research activities.

Conferences organized

The following meetings have been (co-)organized by ECCO people:

- Seminar and Lecture series: "Creative Processes"(VUB, 1986)
- International Symposium and Workshop on "Self-steering and Cognition in Complex Systems" (VUB, May 20-23, 1987).
- Summer School on "Self-organization of Cognitive Systems" (Rijksuniversiteit Groningen, Netherlands, August 1988)
- 1st Workshop of the Principia Cybernetica Project: computer-supported cooperative development of an evolutionary-systemic philosophy (VUB, Belgium, July 2-5, 1991)
- Symposium "the Principia Cybernetica Project", as part of the 13th Intern. Congress on Cybernetics (Namur, Belgium, August 1992)
- Symposium "Cybernetic Principles of Knowledge Development", as part of the 12th European Meeting on Cybernetics and Systems Research, (Vienna, Austria, April 1994)
- Symposium "The Evolution of Complexity," as part of the international congress "Einstein meets Magritte" (VUB, Belgium, June 1995).
- Symposium “Theories and Metaphors of Cyberspace”, as part of the 13th European Meeting on Cybernetics and Systems Research (Vienna, Austria, April 1996)
- 1st Symposium on "Memetics", as part of the 15th Intern. Congress on Cybernetics (Namur, Belgium, August 1998)
- International Workshop "From Intelligent Networks to the Global Brain" (VUB, Belgium, July 3-5, 2001) Proceedings: [Heylighen & Heath, 2004]
- One-day International Workshop on "Trends in Distributed Cognition: towards a formulation of a research agenda" (VUB, July 6, 2002)
- CLEA/Evolution of Complexity seminar series (2002-2003)
- ECCO Seminars (2004-...)
- Session on Philosophy and Complexity at the Complexity, Science & Society Conference (Liverpool, 11-14 Sep., 2005)

Seminar Programme 2004-2005

ECCO seminars normally take place each Friday at 17:30 in room 3C204 (Building C, 3rd floor), at the VUB Campus Etterbeek. Everyone interested is welcome, although the largest group of attendants are usually ECCO full researchers. The seminars are very interactive, with small groups (about 8 people). The intention is to discuss in depth the research being proposed, and to look for interdisciplinary connections with other ECCO-related themes.

09 Nov: Andreas Loengarov : Network Analysis of Food Webs

09 Dec: Klaas Chielens et al.: Developing an ECCO wiki

16 Dec: Mixel Kiemen: Implementation of the CRAB system

28 Jan: Carlos Gershenson: Self-organizing traffic lights

04 Feb: Marko Rodriguez: A Self-Organizing and Collective-Intelligence Approach to the Peer-Review Publication Process

11 Feb: Francis Heylighen: The role of mediators in the self-organization of biological, social and cognitive systems

18 Feb: Frank Van Overwalle: From Communication between Individuals to Collective Beliefs: a connectionist simulation of distributed cognition

04 Mar: Dirk Bollen: Applications of situated and embodied cognition

11 Mar: Erden Göktepe: Emergence of Social Organisations: From Stability to Dynamism

18 Mar: F. Heylighen & J. Bernheim: r-K Selection and Human Development: from quantity to quality of life

25 Mar: Klaas Chielens: Empirical measurement of memetic selection criteria

08 Apr: Tanguy Coenen: The influence of social software and knowledge sharing on creativity

15 Apr: Nick Deschacht: Complexity Theory and Marxism

22 Apr: M. Rodriguez & D. Steinbock & F. Heylighen: Particle-Flow Networks for Individual and Collective Intelligence Systems

29 Apr: Mixel Kiemen: The primacy of context: bootstrapping from intuitive ideas

06 May: Julien Libbrecht: Application of cybernetic principles to the organization of health care

13 May: Johan Bollen: Social network indicators of scientific impact

20 May: Gerard Jagers op Akkerhuis: Closure and the modular evolution of matter

27 May: Lito Kyritsi: Systems Modelling of Cancer

3 Jun: Laetitia De Jaegher: Towards sustainable development: the precautionary principle as a call for a new theory of law to support multi-dimensional governance

10 Jun: Francis Heylighen: Foundations for an anticipation-control theory of mind

17 Jun: Carlos Gershenson: A General Methodology for Designing Self-Organizing Systems

24 Jun: Tom Erez: Postext: a cognitively-apt formalism for knowledge management

Working Papers

The following lists recent ECCO working papers. These are as yet unpublished texts that are likely to still undergo elaboration or early versions of publications, and are available through our website.

2005

Chielens, K. & Heylighen, F. Operalization of Meme Selection Criteria. (ECCO working paper 2005-01, to be published in the Proceedings of the AISB Convention, 2005).

Gershenson C. Self-organizing Traffic Lights. (ECCO working paper 2005-02, submitted)

Van Overwalle, F., Heylighen F. & Heath M. Trust in Communication between Individuals: A Connectionist Approach. (ECCO working paper 2005-03)

Rodriguez, M.A., A Self-Organizing Collective-Intelligence approach to the Peer-Reviewed Publication Process, University of California, Santa Cruz Ph.D. Proposal, 2005.

Rodriguez, M.A., The Convergence of Digital Library Technology and the Peer-Review Process. (ECCO working paper 2005-04, to be published in Journal of Information Science)

Gershenson C. A General Methodology for Designing Self-Organizing Systems. (ECCO working paper 2005-05, submitted)

Rodriguez, M.A.: The Hyper-Cortex of Human Collective-Intelligence Systems (ECCO Working Paper 2005-06)

Van Overwalle, F., Heylighen F. & Heath M. : Talking Nets: A Multi-Agent Connectionist Approach to Communication and Trust between Individuals (ECCO Working Paper 2005-07, to be submitted to Psychological Review or Behavioral and Brain Sciences))

Heylighen F. Towards an anticipation control theory of mind (ECCO Working paper 2005-08, to be submitted to Behavioral and Brain Sciences)

2004

Bollen D., A dynamical systems analysis of an embodied and situated model of cognition, M. Sc. Thesis university of Maastrich(nl), 2004.

Heylighen F. (2004): "Mediator Evolution: a general scenario for the origin of dynamical hierarchies", (ECCO working paper, 2004-01)

Heylighen F. & Bernheim J. (2004): "From Quantity to Quality of Life: r-K selection and human development" (ECCO working paper, 2004-02)

Loengarov A. Total Trophic Impacts: A simulation approach to measuring total trophic impacts in an ecological community (EASy MSc Dissertation, 2004)

Loengarov A. The evolution of kin-friendly behaviour in the absence of kin recognition: a basic simulation (EASy A-life paper, 2004)

Loengarov A. Some first steps in search of actors in simple, dynamic, transformational networks (EASy Adaptive Systems paper, 2004)

Loengarov A. Inferring Intentions from Motion Cues (EASy Visual Perception and Cognition term paper)

Rodriguez, M.A., Advances Towards a Societal-Scale Decision Support System, University of California, Santa Cruz Masters Thesis, 2004.

Selected ECCO publications

Below you will find a selection of representative publications by ECCO members. "*" signs indicate special relevance for ongoing ECCO research. This means that people wishing to get a deeper insight into our research are advised to start reading the publications with the most "*" signs.

*Bollen D. (2004): Representation in situated models of cognition (ECCO technical report).

*Bollen J. & Heylighen F. (1996) "Algorithms for the self-organisation of distributed, multi-user networks. Possible application to the future World Wide Web", in: Cybernetics and Systems '96 R. Trappl (ed.), (Austrian Society for Cybernetics), p. 911-916.

Bollen J. (2001) A Cognitive Model of Adaptive Web Design and Navigation - A Shared Knowledge Perspective, Free University of Brussels, Faculty of Psychology, PhD Dissertation.

Bollen J., Heylighen F. (1998): A system to restructure hypertext networks into valid user models, New Review of HyperMedia and Multimedia 4, p. 189-213.

*Chielens K. & Heylighen F. (2004): Operationalization of Meme Selection Criteria: Methodologies to Empirically Test Memetic Prediction, in: Proceedings of the Joint Symposium on Socially Inspired Computing, p. 14-20.

De Jaegher L. (2004): The Balance between Precaution and Innovation: Towards New Strategies for a Sustainable Risk Management, European Bio-science Law Review, January 2004.

Gershenson, C. (2002a). Philosophical Ideas on the Simulation of Social Behaviour. Journal of Artificial Societies and Social Simulation vol. 5, no. 3.

*Gershenson, C. (2002b). Behaviour-based Knowledge Systems: An Epigenetic Path from Behaviour to Knowledge. Proceedings of the 2nd Workshop on Epigenetic Robotics. Edinburgh.

Gershenson, C. (2002c). Classification of Random Boolean Networks, In Standish, R. K., M. A. Bedau, and H. A. Abbass (eds.) Artificial Life VIII: Proceedings of the Eight International Conference on Artificial Life. pp. 1-8. Sydney, Australia. MIT Press.

**Gershenson, C. (2004). Cognitive Paradigms: Which One is the Best? Cognitive Systems Research, 5(2):135-156, June 2004.

*Gershenson, C., P. P. Gonzalez and J. Negrete. (2000b) Thinking Adaptive: Towards a Behaviours Virtual Laboratory. In Meyer et. al. (eds.) Simulation of Adaptive Behavior 2000 Proceedings Supplement. Paris, France. ISAB press.

Gershenson, C., F. Heylighen (2003). When Can we Call a System Self-organizing?, In Banzhaf, W, T. Christaller, P. Dittrich, J. T. Kim and J. Ziegler (eds.), Advances in Artificial Life, 7th European Conference, ECAL 2003, (Springer, LNAI 2801.), p. 606-614.

*Gershenson, C., F. Heylighen (2004a). How can we think the complex? in: Richardson, Kurt (ed.) Managing the Complex Vol. 1: Philosophy, Theory and Application. [in press]

*Gershenson C., Heylighen F. (2004b): Protocol Requirements for Self-organizing Artifacts: Towards an Ambient Intelligence, in: Proc. Int. Conf. on Complex Systems (New England Institute of Complex Systems)

Gontier, Nathalie. 2004. De oorsprong en evolutie van leven – 15 van het standaardparadigma afwijkende thesen Brussel: VUBPRESS. [The origin and evolution of language – 15 non-Neodarwinian theses]

*Gontier, Nathalie, Van Bendegem, Jean Paul, & Aerts, Diederik (eds). 2005. Evolutionary Epistemology, Language and Culture - A nonadaptationist systems theoretical approach. [Theory and Decision Library]. Dordrecht: Springer.

Gontier, Nathalie & Mondt, Katrien. In press. Dynamisch Inter-en transdisciplinair Taal Onderzoek: De nieuwe Taalwetenschappen. Brussel: VUBPRESS.

Gontier, Nathalie. In press. “Language and pathologies – an epistemological reflection.” Cognitive Systems: Special issue on the Oxford-Language and pathologies conference of the Language Origin Society.

Heylighen F. (1989): Heylighen F. (1989): "Causality as Distinction Conservation: a theory of predictability, reversibility and time order", Cybernetics and Systems 20, p. 361-384.

Heylighen F. (1989): Heylighen F. (1989): "Self-Organization, Emergence and the Architecture of Complexity", in: Proceedings of the 1st European Conference on System Science, (AFCET, Paris), p. 23-32

Heylighen F. (1990a): Heylighen F. (1990): "Autonomy and Cognition as the Maintenance and Processing of Distinctions", in: Self-Steering and Cognition in Complex Systems, Heylighen F., Rosseel E. & Demeyere F. (ed.), (Gordon and Breach, New York), p. 89-106.

*Heylighen F. (1990): Representation and Change. A Metarepresentational Framework for the Foundations of Physical and Cognitive Science, (Communication & Cognition, Gent), 200 p.

Heylighen F. (1990c): A New Transdisciplinary Paradigm for the Study of Complex Systems?, in: Self-Steering and Cognition in Complex Systems, Heylighen F., Rosseel E. & Demeyere F. (ed.), (Gordon and Breach, New York), p. 1-16.

**Heylighen F. (1991): "Cognitive Levels of Evolution: pre-rational to meta-rational", in: The Cybernetics of Complex Systems - Self-organization, Evolution and Social Change, F. Geyer (ed.), (Intersystems, Salinas, California), p. 75-91.

Heylighen F. (1991): Design of a Hypermedia Interface Translating between Associative and Formal Representations", International Journal of Man-Machine Studies 35, p. 491-515.

**Heylighen F. (1991): "Modelling Emergence", World Futures: the Journal of General Evolution 31 (Special Issue on Emergence, edited by G. Kampis), p. 89-104.

*Heylighen F. (1992) : Selfish Memes and the Evolution of Cooperation, Journal of Ideas , Vol. 2, #4, pp 77-84.

Heylighen F. (1992) : "Evolution, Selfishness and Cooperation", Journal of Ideas, Vol 2, # 4, pp 70-76.

Heylighen F. (1992): "A Cognitive-Systemic Reconstruction of Maslow's Theory of Self-Actualization", Behavioral Science 37, p. 39-58.

*Heylighen F. (1992): "Principles of Systems and Cybernetics: an evolutionary perspective", in: Cybernetics and Systems '92, R. Trappl (ed.), (World Science, Singapore), p. 3-10.

Heylighen F. (1993): "Selection Criteria for the Evolution of Knowledge", in: Proc. 13th Int. Congress on Cybernetics (Association Internat. de Cybernétique, Namur), p. 524-528.

Heylighen F. (1994) "Fitness as Default: the evolutionary basis of cognitive complexity reduction", in: Cybernetics and Systems '94, R. Trappl (ed.), (World Science, Singapore), p.1595-1602.

**Heylighen F. (1995): "(Meta)systems as Constraints on Variation: a classification and natural history of metasystem transitions", World Futures: the Journal of General Evolution 45, p. 59-85. variation, World Futures: the Journal of General Evolution .45, p. 59-85.

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