COMPLEXiTY
research seminar

Friday 26 June 2009 @ LSE in room A316
14.00 – 17.00

Complex systems as "self-made puzzles" that can be programmed:
Lessons from biological morphogenesis

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Complex behaviour can result from simple agent-based rules, a fact often touted as the hallmark of complex systems. However, most well-known emerging patterns are either random or shaped by boundary conditions, and rarely exhibit an *intrinsic architecture*. Biological morphogenesis appears as a unique case of combined self-organisation and truly complex structures. Living multicellular organisms are made of parts arranged in specific ways that resemble engineered devices—yet, they also self-assemble in a completely decentralised fashion, under the guidance of genetic and epigenetic information spontaneously evolved over millions of years and stored in the zygote. Therefore, embryogeny is a prime example of *programmable complexity*. It demonstrates that complex systems can also include *diversity*, *modularity*, and *reproducibility*.

The seminar will focus on the often underappreciated abilities of complex systems to offer such *controllable* properties, at the same time (or despite the fact) that they are self-organising. There is a great demand for such precise self-formation properties in a variety of distributed engineering systems (e.g., self-forming swarm robots, self-architecturing software, self-connecting micro components) and is also an important challenge in complex techno-social networks made of myriads of human users and/or (mobile) computing devices (e.g., self-configuring manufacturing chains, self-deploying emergency taskforces, self-regulating energy grids or market economies).

At the core of this enterprise lie paradoxical challenges: Can autonomy be planned? Can decentralisation be controlled? Can evolution be designed? Can we expect specific characteristics from systems otherwise free to assemble, and possibly invent, themselves? It is suggested that the resolution of these apparently inconsistent objectives can reside in the change of scale at which design operates, to become "meta-design": instead of building the puzzle directly, shape the pieces in such a way that they will build it for you.

Dr. René Doursat is Director of the Complex Systems Institute, Paris Ile-de-France (ISC-PIF) and Full Member of CREA, the research centre in cognitive science and self-organisation at Ecole Polytechnique, Paris. Previously, he was a Visiting Assistant Professor in computer science at the University of Nevada, Reno. An alumnus of Ecole Normale Supérieure, Paris, he completed his Ph.D. at Université Paris VI in 1991, followed by a postdoctoral fellowship at the Institute of Neuroinformatics, Ruhr-Universität Bochum, Germany. After a segue through several startup companies of San Francisco Bay Area's software industry, Dr. Doursat came back to academia full-time in 2004, in Reno, then Paris. His research activities address the computational modelling and simulation of large multi-agent systems aimed at a new form of engineering inspired by biological, neural and social complexity. Dr. Doursat is the principal organiser of the French Complex Systems Summer School (Paris, 2008, 2009), the First International Workshop in Morphogenetic Engineering (Paris, June 2009), and other events in complex systems science and engineering. He is an Associate Editor of IEEE Transactions on Neural Networks, and an expert reviewer or advisor for several journals, grant agencies, award juries, and curriculum committees.

Please e-mail ComplexityGroup@lse.ac.uk *as soon as possible and by 22nd June at the latest to let us know you plan to attend. LSE students and LSE academics only, are invited free. Everyone else will need to contribute £20 to cover costs.*