

Tom Allen, MIT, USA

'Factors to Consider in Structuring the Organization for Innovative Product Development'

There are a limited number of factors that determine the most effective structure for innovative product development. Basically, we have to insure good information flow from both the market and from technology sources. To do this, we must take into account the pace at which both markets and relevant technologies are changing. In addition, we must also account for the interdependencies inherent in the product architecture and in the nature of the tasks to be accomplished. This paper will develop a theory of product development based upon these considerations and show how the theory can be implemented organizationally.

Bjørn Asheim, CIRCL (Centre for Innovation, Research and Competence in the Learning Economy), Lund University, Sweden

'Innovation is small: SMEs as Knowledge Explorers and Exploiters'

Traditionally, the challenge of SMEs has been to exploit knowledge for innovative purposes. In order to achieve this a range of public policy instruments such as brokers, mobility schemes, technology centres, clusters and regional innovation systems (RIS) have been launched. This type of SMEs, typically found in traditional sectors in e.g. the industrial districts of the Third Italy, is characterized by a synthetic (engineering) knowledge base and applies a DUI (doing, using, interacting) mode of innovation. The challenge of a RIS is to upgrade these SMEs to higher value-added production through innovation.

SMEs as knowledge explorers are based on an analytical (science) knowledge base and apply a STI (science, technology, innovation) mode of innovation. This type of SMEs is typically found in e.g. science parks linked to (technical or research based) universities in 'sectors' such as biotech and nanotech. In these cases the existence of a RIS with a strong, research based university is a necessary condition for the development of clusters with emerging, science based SMEs. The presentation will use research carried out on Swedish DBF (dedicated biotech firms) in Medicon Valley in Øresund, where Lund University represents the strategic collaborative partner in the RIS, to illustrate SMEs as knowledge explorers. Depending on the type of SMEs in a region one may expect to find a regional differentiation of innovation policies towards SMEs.

Dimitris Assimakopoulos, Grenoble Ecole de Management & LINC Lab, France

'Are New Product Development (NPD) Teams in MNCs Regionally Embedded? Key individual roles in semiconductor network innovation and other findings from the non-globalisation of a NPD team in Grenoble'

This paper presents empirical findings from a new product development (NPD) team in the Analog and Mixed Signal business unit of a multi-national semiconductor company in France, and several additional sites in Europe and beyond. More specifically, we investigate three knowledge-intensive socio-technical networks: seeking technical and organisational / managerial advice; and, discussing new ideas / innovation; as well as the internal and external formal and informal structures underlying the NPD process in terms of lead-customer innovation in the largest semiconductor company in France, and four additional sites in Italy, Czech, Finland and India. The results highlight key roles, such as central connectors and knowledge brokers (Cross and Prusak 2002, Cross et al 2006), that team members play in such a NPD team, and identify key individuals in our case study. Moreover, our findings show that the team we studied is regionally dis-embedded and primarily taps into the knowledge and competences of key people in France and select business partners such as its lead customer abroad. Based on in-depth semi-structured interviews with key individuals in Grenoble we put forward a set of organisational capabilities for strengthening similar NPD teams in the semiconductor or other high velocity industries.

John Casti, IIASA Vienna, Austria

'Would-Be Worlds: Toward a Theory of Complex Systems'

By their very nature, complex systems resist analysis by decomposition. It is just not possible to study, say, the human immune system or a stock market, by breaking it up into individual parts---molecules or traders---and looking at what these parts do in isolation. The very essence of the system lies in the interaction among all its parts, with the overall behavior of the system emerging from these interactions. So by throwing away the interactions, one also throws away any hope of actually understanding the workings of the system. The problem is that until very recently, there was no way of studying these sorts of systems as complete entities, since to do experiments with stock markets, immune systems, rainforest ecosystems and the like was either too expensive, too dangerous or just plain too difficult. But the arrival of cheap, powerful, widespread computing capability over the past decade or so has changed the situation entirely.

This talk will examine the way in which the ability to create surrogate versions of real complex systems inside our computing machines changes the way we do science. In particular, emphasis will be laid upon the idea that these so-called "artificial worlds" play the role of laboratories for complex systems, laboratories that are completely analogous to the more familiar laboratories that have been used by physicists, biologists and chemists for centuries to understand the workings of matter. But now we have laboratories that allow us to explore information instead of matter. And since the ability to do controlled, repeatable experiments is a necessary precondition to the creation of a scientific theory of anything, the argument will be made that for perhaps the first time in history, we are now in a position to realistically think about the creation of a theory of complex systems.

These philosophical points will be illustrated by on-going work with artificial road-traffic networks, as well as with systems for studying social and cultural phenomena.

David Cleary, Ericsson Labs, Athlone, Ireland

'Innovating change from research, to standards, to products, and back again.'

The telecommunication community has gone through many ups and downs in the past eight years, following on from the internet 'dot-bomb'. Many lessons have been learned with some being forgotten; however two key ingredients of innovation have become more important than ever---research and standards. In this talk I will discuss the changing environment of multinational research, its objectives and its approach with regard to innovating pragmatic standards and the intrinsic links back to research once complex problems are found.

In particular, I will draw reference from the problems of managing third generation mobile networks (3G) and the approach taken to address this in the Cooperative OSS Program (CO~OP). Specifically targeting the systems 'integration tax' pressure on operators and service providers, where five major mobile suppliers teamed up with the TeleManagement Forum to drive open management standards. Alcatel-Lucent, Ericsson, Huawei, Nokia Siemens Networks, Samsung and Wipro joined forces to drive implementation of a common architecture for mobile network management.

Tony Connolly, Visor Limited, Blackrock Co. Dublin, Ireland

'Challenges for SMEs in commercialising Innovation'

SMEs are responsible for considerable levels of innovation with many entrepreneurs setting up small companies to get their idea off the ground. This can be a very cost effective mechanism for carrying out research and development, which is often more difficult and costly with the overhead and procedural shackles of large organisations. However, commercialising these innovations has considerable challenges for an SME that has no brand recognition, no channels to market and is seen to be risky by potential customers who like the safety of recognised international brands. Tony is a Chartered Accountant with over 20 years in the Technology sector. He has been involved in a professional capacity in the design and implementation of new technologies as well as mergers, acquisitions, fund raising, due diligence reviews for tech SMEs. He is currently a non-executive director of 5 different SME technology companies and founder/CEO of a Software-as-a-Service company at the early stages of commercialisation. He will outline the key challenges facing SMEs and his views on how these can be addressed.

Phil Cooke, Cardiff (UK) & Aalborg (Denmark) Universities, UK

'Regional Innovation Systems: Development Opportunities from the Green Turn'

This presentation outlines the concept and theory of regional innovation systems (RIS). It demonstrates the importance for economic development of integration between the knowledge exploration or generation sub-system and the knowledge exploitation or commercialisation of innovation sub-system. Following an account of the evolution of RIS characteristics from a more institutional (IRIS; public) to a more private (ERIS; entrepreneurial) mode, configured in line with the distinctive characteristics of the region under investigation, attention is devoted to the way RIS are handling the 'green turn'. The green turn expresses the sudden rise in demand for eco-innovations in energy, transportation, agro-food and waste recycling or 'industrial ecology.' These are convergent technologies where clustering and inter-cluster cross-fertilization characterise 'green' regional innovation system capabilities. Some indications of job-generation effects of such green RIS emergence are provided.

Frank Cunningham, DG INFSO Evaluation, European Commission, Belgium

'Linkages between EU ICT Research and Deployment and Eco-systems of Innovation'

In the 'eco-system' of research and innovation the *links* between innovation actors are crucial if the systems as a whole are to function effectively and play a part in economic growth and social welfare. The new and emerging model of business R&D is a model of open innovation where firms can tap into world-wide talents pools and acquire external technologies through licensing, *collaborative research*, mergers and acquisitions¹.

Support to collaborative R&D and Deployment programmes is one significant way of strengthening the *linkages* between the actors within innovation systems – primarily those involved in conducting R&D, though increasingly many collaborative programmes have also involve potential users and other interested parties. Collaborative programmes such as the EU's 7th Framework Programme ICT research (FP7 ICT) and the ICT Policy Support Programme of Competitiveness and Innovation Framework Programme (CIP ICT-PSP) can strengthen the knowledge bases of research and innovation actors and enhance the prospects for subsequent exploitation and innovation via the creation of research networks and enhanced links between the actors.

Traditional approaches to evaluate research and deployment programmes have mainly focused on inputs, outputs and outcomes and have left relatively untouched the *dynamics*² of research, deployment and innovation. New methodologies and tools are needed to better understand the impacts of EU, National and Regional funding on collaboration networks within the 'eco-system' of research and innovation.

DG Information Society and Media has been at the forefront in recent years in developing methodologies and tools to assess the 'behaviour additionality' of the EU RTD intervention in terms of *linkages* within the EU ICT RTD community, with the global ICT innovation processes and with regional innovation systems.

This presentation gives a synthesis of the evaluative work based mainly on social network analysis that was carried out between 2004 and 2008 in the area of ICT. It explains how the work can contribute towards better understanding the links between research, deployment and regional innovation systems, and thus improving the assessment of the impact of EU level interventions in research and deployment on regional eco-systems of innovation.

¹ Benchmarks of our innovation future: February 16, 2005; www.futureofinnovation.org

² i.e. the processes involved in generating innovation outcomes from a systems' point of view is non-linear, networked and with multiple feedback loops.

Bernd Ebersberger, Management Center Innsbruck, Austria

'Technological Competences and Variety in Regional Innovation Systems'

Innovation performance and eventually economic growth of a region is determined by the technological competences within this region. This presentation analyses the regional distribution of competences in Austria. Based on the Frenken et al. (2007) related and unrelated variety in Austrian regions are analyzed. The analysis illustrates how patent data can be utilized to assess growth potential in regional systems of innovation.

Henry Etzkowitz, Newcastle University Business School, UK

'Innovation is Academic: Universities as Entrepreneurs'

The entrepreneurial university, combining economic and social development with teaching and research, is the latest step in academic development. Following from the 1st Academic Revolution in the 19th century, making research an academic mission the 2nd Academic Revolution is based upon realization that knowledge is polyvalent, having simultaneous theoretical and practical consequences. Pursuit of the economic potential of research simultaneously with its dissemination and advancement is the basis of triple academic roles as teacher, researcher and entrepreneur, successively and simultaneously.

There are three levels to the development of the entrepreneurial university: Institutional, Organizational and Individual. The individual level is realized through entrepreneurial behaviour of students, teachers and administrators. For example, "Science Angels," a previous generation of academics, who have earned funds from firm formation, may invest in a colleagues project despite lack of revenues, based upon an understanding of the technology and its business potential given their academic and entrepreneurial experience.

The internalization of technology transfer and business development capabilities at the organizational level is complemented at the institutional level by a 'game of legitimation' aligning new purposes with old ones e.g. entrepreneurial activities with accepted functions such as research and service to show that they are in accord. A shift in regional and national systems towards knowledge-based firm formation has been the key to expansion of the entrepreneurial university model from an academic anomaly into a predominant objective. Each successive innovation in academic mission has given the university an enhanced ability to set its own strategic direction.

Francesca Giardini, Institute of Cognitive Sciences and Technologies - ISTC CNR, Italy

'INNOVATION DYNAMICS IN AN AGENT-BASED MODEL OF INDUSTRIAL CLUSTERS'

Industrial clusters are localized networks of firms, suppliers, and institutions widespread around the world. Clusters' actors are embedded in a complex network of relationships generally built upon informal contacts and personal assessments of their partners and competitors, either direct or indirect. This interplay between economic performance and social evaluation in industrial clusters is closer than it appears and gives rise to different networks' configurations. In a previous work (Giardini, Di Tosto, Conte 2008) we modeled an artificial cluster with firms exchanging products and information and we tested the effects of reputation spreading on firms' quality of production and profits. We developed an agent-based model in which agents can choose among several potential suppliers by relying either on their own evaluations, or on other agents' suggestions. Our results showed that reliable evaluations make the cluster's quality of production increase, as well as its profits, whereas false assessments negatively affected the cluster's performance. Moving on from these results, we want to apply our model to investigate how social evaluations may affect the dynamics of innovation in a network of firms. More specifically, we put forward that reputation, an evaluation coming from an undisclosed source, contributes to network enlargement because it permits to gather information about several potential partners without bearing the costs of direct interaction. In a reputation-based network we expect to see a higher number of interactions, although less stable and enduring, compared to an image-based network. In this latter case, firms rely exclusively on suggestions coming from known informers, without exploring the network for better partners. In our view, different types of social evaluations may affect the emergence of innovation and the network configuration of artificial firms working into an industrial cluster.

Nigel Gilbert, Professor of Sociology, University of Surrey, UK

'The SKIN model: modelling innovation networks'

In this presentation I shall begin by introducing the idea of agent-based modelling, locating it within social science traditions of modelling and showing how it is especially appropriate to modelling complex adaptive systems.

I shall then consider how one might model innovation, considered as a process beginning with the invention or discovery of new ideas and ending with the successful marketing of new products, and emphasise the role of communication and networks in this process.

Finally, I shall outline the SKIN (Simulating Knowledge Dynamics in Innovation Networks) model and briefly review the use that has been made of it and the extensions that have been or could be made to simulate other knowledge-based networks.

**Martin Heidenreich, Jean Monnet Chair for European Studies in Social Sciences,
Department of Social Sciences, University of Oldenburg, Germany**

Authors:

Martin Heidenreich, Christoph Barmeyer and Knut Koschatzky

'Product development in multinational companies'

Multinational enterprises (MNEs) are an important channel for the international transfer of technological knowledge across national and cultural and institutional boundaries. Empirically, the increasing internationalization of research and development - particularly as a result of mergers and acquisitions - can be convincingly demonstrated. Usually, two internationalization strategies are distinguished, a home-base-exploiting and a home-base-augmenting strategy. Unclear, however, is whether and how multinational corporations actually succeed in managing the cross-border transfer of knowledge, as this requires the capability to dissolve cognitive schemata from their original context and use them in a new context. It is therefore necessary to analyze MNEs not only as knowledge-based networks, but also as a arena for cross-border power and exchange relations and as organizations of socio-institutionally embedded organizations, in which the different subsidiaries have only limited opportunities and interests in a decontextualisation of context-specific capabilities. Such a micro-political and cultural extension of knowledge-based views of the multinational firm has to start from the unlikelihood of a cross-border transfer of competence. On the basis of three case studies in the German and French automotive industry the explanatory power and the limitations of this thesis are discussed. Given the substantial costs and risks of the innovation projects analyzed, companies on the one hand collaborate within the group and with external partners. On the other hand, the associated loss of control, power and proximity advantages is limited by the encapsulation and spatial, organizational and social concentration of core activities. Companies try to limit cross-company cooperation on tasks which can be separated from the core innovation process. The internationalization and the distribution of the innovation process is therefore limited to strategically less crucial functions and tasks which can be decoupled from the core of a new project. Even global companies do not rely on a complete globalization of innovation processes, but on the spatial, organizational and social concentration of the participating researchers and developers - at least in the core of the innovation projects analyzed.

Harald F. O. von Kortzfleisch and Philipp Margin, University of Koblenz-Landau, Institute for Management, Germany

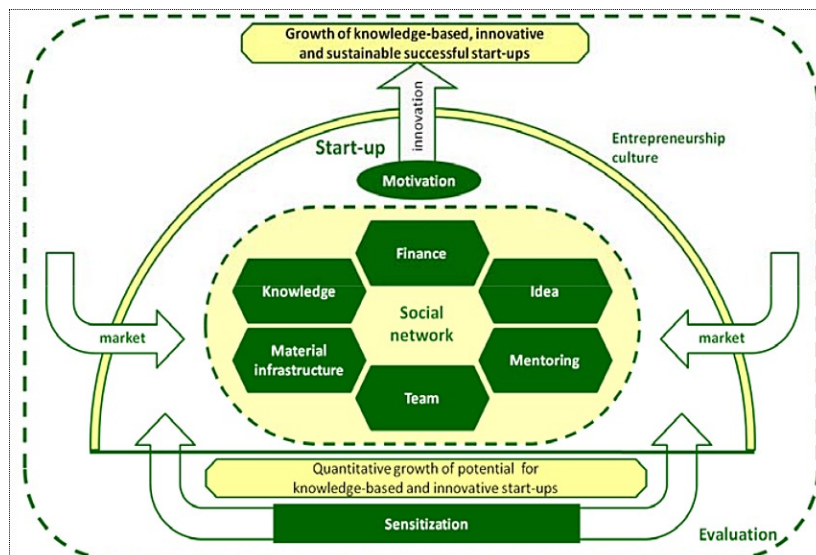
'Scientific Entrepreneurship Engineering – Exploratory Study and Conceptual Framework for Methods and Tools to Support Entrepreneurial Activities in Universities'

Scientific entrepreneurship can be defined as the dynamic process of transforming scientific knowledge into business-oriented innovations. Innovative, knowledge-based foundations are the main drivers for prosperity and wealth in today's knowledge societies. Therefore, the advancement of such start-ups needs particular attention to be paid by universities as major sources of scientific knowledge creation.

One challenge in this context is to support these start-up activities in universities in a systematic and holistic manner. In analogy to other research disciplines like software engineering or service engineering, also scientific entrepreneurship can be understood as an engineering discipline: Scientific entrepreneurship engineering stands for the usage of entrepreneurship-specific methods and tools in order to support entrepreneurial activities within universities in an integrated, systemic manner. Methods stand for theory-based measures in certain support areas for scientific entrepreneurship. Tools represent the operational level and help to reach the objectives of the respective support areas via concrete instruments.

From a theoretical point of view the body of knowledge concerning scientific entrepreneurship engineering is still in its infancy and needs to be further developed. Four different and separate types of approaches can be distinguished which need to be integrated because each of them illustrates just a small section of the relevant systemic context: Task- and role-centric approaches (e.g., European Foundation for Entrepreneurship Research (2007)), deficit-oriented approaches (e.g., Twaalfhoven (2004)), phases-oriented approaches (e.g., Consortium for Entrepreneurship Research (2005)), resources-oriented approaches (e.g., MIT Entrepreneurship Center (2007)).

The results of our exploratory empirical study investigating all the existing scientific entrepreneurship methods and tools at universities in Germany, Switzerland, and Austria point to the following important support areas for start-up activities in universities: Sensitization, idea, mentoring, team, social network, material infrastructure, knowledge infrastructure, financial infrastructure, motivation, entrepreneurship culture, innovation, and evaluation. These support areas for entrepreneurial activities in universities can be integrated into a holistic conceptual framework by integrating the theoretical approaches mentioned above with regard to their interfaces as shown in the following picture.



Tyll Krüger and Andreas Krüger, University of Bielefeld, Germany

'Time Sharing and Knowledge Transfer in Networks'

We study knowledge transfer and communication on networks in the spirit of epidemic processes, with special emphasis on time sharing and time ordering aspects. A new quantity - the communication index- is introduced which measures how good the time sharing/partitioning problem on a given network can be solved. Under the assumption that information transmission along an edge is related to the time available for communication on this edge we derive thresholds for various classes of random graphs and compare graphs with different degree-degree correlation. Applications and numerical results are given for some concrete collaboration graphs.

Austin Lacy, Institute of Higher Education, University of Georgia, USA

Authors:

Austin Lacy and James C. Hearn, Institute of Higher Education, University of Georgia, USA

'Entrepreneurialism and the Traditional Roles of the University: An Empirical Analysis of Emerging Product Shifts.'

Universities have long been regarded as multi-product firms in that they seek to produce multiple outputs simultaneously. The research literature has focused almost exclusively on the joint production of a familiar trio of outputs: teaching, research, and service. Arguably, however, U.S. universities have recently begun pursuing a fourth output: economic development, as facilitated by licenses, patents and start-up companies. As postsecondary institutions move in this direction, what factors influence their ability to continue pursuing their disparate educational missions efficiently? To address this question, this project is gathering data for a large sample of U.S. universities from the Integrated Postsecondary Education Data System (IPEDS, which contains extensive data for all U.S. research institutions), the National Science Foundation's Integrated Science and Engineering

David Lane, University of Modena and Reggio Emilia and the Santa Fe Institute, USA

'Artifacts and Organization: A Complexity Perspective on Innovation'

Over the past several years, my colleagues and I have been working out a complexity-based theory of innovation that is intended to explain how human beings have managed to generate the explosion of artifacts and the new functionalities they make possible. The theory starts from the premise that all artifacts have a history, as do the modes of interaction among people in which artifacts figure. The aim of the theory is to describe and analyze the processes through which artifact histories are realized:

- How do new artifact types come into being?
- How do their tokens proliferate and become incorporated into patterns of human interaction?
- And how are new patterns of interaction among human beings and artifacts generated?

As I will argue in the talk, we cannot begin to answer these questions without developing simultaneously a theory of sociocultural organizations: what they are, how they come into being, how they transform themselves.

The main conclusion of the talk is that our species has developed a new modality of innovation, in which artifacts and organization are inextricably linked: we generate new *artifacts* that are embedded in new *collective activities*, which are in turn supported by new *organizations* and sustained by new *values*. Over time, this new innovation modality gave rise to a positive feedback dynamic, which we call *exaptive bootstrapping*. Exaptive bootstrapping explains how we have generated so many transformations in our selves, our societies, our culture and our environment.

**Ricardo Leoncini, Dipartimento di Scienze Economiche (Dpt. of Economics),
University of Bologna, Italy**

Authors:

Tommaso Ciarli, Metropolitan Manchester University, UK

Riccardo Leoncini, University of Bologna, Italy

Sandro Montresor, University of Bologna, Italy

Marco Valente, University of L'Aquila, Italy

'Product architecture and the organisation of industry. The role of firm competitive behaviour'

The aim of this paper is to study how firms are able to change governance structure, product architecture, and production process to increase competitiveness, given technological interdependencies between products' components and their effects on production. Different firms (with different information and 'capabilities' sets) may face the changes occurring in the technological interdependencies by focusing on one strategy, or a combination of strategies. Indeed, the firms architecture allows for an endogenous contribution in the change of technological interdependencies. It is a dynamic adjustment of those strategies, we argue, that allow firms to increase their relative fitness.

The intertwining of decomposability, product and organizational modularity and technological search, is studied via a computational model representing one industrial sector, producing a final good. Heterogeneous firms compete for a final demand for which consumers have preferences on a number of characteristics. To produce the good, each firm uses a certain number of input components. Each input component contributes to each characteristic, according to the technological architecture of the good, and to the degree of modularity among components.

Improvements in the technological performance is achieved by exploiting a 'corrugated' technological landscape. The contribution of a single module is increased by looking for a maximum (either global or local) value of its fitness. However, the global fitness of the integrated good is determined by the correlation structure of the whole set of modules. Thus, firms may opt to change the product architecture. The landscape exploration is modeled with a continuous version of the NK model.

Firms seek to increase competitiveness through a number of strategies that impact on costs and quality of final goods. Short-term strategies address adaptive changes in process routines, acquisition of fitter components, or product innovation of in-house components. In the long term, firms seek to introduce changes in the architecture of the product to define a standard for components' characteristics, and re-frame the organizational structure. When successful, this second strategy, reshapes transaction costs and core competencies.

Rajneesh Narula, University of Reading, Business School, Department of Economics, UK

'The advantages and inefficiencies of R&D activities by large firms'

Formal R&D activities tend to be expensive, scarce-resource thirsty, risky, and have a fairly large minimum efficient scale. It is no wonder then, that large MNEs tend to account for a considerably large share of the formal R&D activity undertaken in many industries. I will first discuss the current trends in the organization and management of R&D by MNEs. I will then highlight some of the challenges large firms face in maintaining complex global networks at optimal level of efficiency.

Andreas Pyka, Economics Department, University of Bremen, Germany

'Comprehensive Neo-Schumpeterian Economics'

Within the last 25 years great progress has been made in Neo-Schumpeterian Economics, this branch of economic literature which deals with dynamic processes causing qualitative transformation of economies basically driven by the introduction of novelties in their various and multifaceted forms. By its very nature, innovation and, in particular, technological innovation is the most exponent and most visible form of novelty. However, Neo-Schumpeterian Economics should be concerned with all facets of open and uncertain developments in socio-economic systems. A comprehensive Neo-Schumpeterian (CNSE) approach therefore has to consider not only transformation processes going on, e.g., on the industry level of an economy, but also on the public and monetary side of an economic system. The presentation introduces those extensions and complements to a comprehensive Neo-Schumpeterian economic theory, and develops some signposts in the sense of a roadmap for necessary strands of analysis in the future. The CNSE approach then will be applied to an indicator-based approach detecting the varying patterns of future orientation present in European economies.

Andreas Pyka, Terhi Nokkala, Hannes Brauckmann

Title:

The Agent-Based NEMO-Model (SKEIN) - Simulating European Framework Programmes

The SKEIN model is supposed to investigate various aspects of politically induced innovation networks. It is an agent-based model of the network dynamics with decentralized agents doing research in collaborations and networks. Our presentation will introduce to the prototype simulation model as well as to the interfaces which allow a calibration to real world settings. In particular we are implementing two input interfaces dealing with the governance rules of the European Commission as programme designer, and behavioural rules of the universities and firms participating in the project consortia. The third interface is supposed to compare the results produced by the simulation model with empirical data on network evolution. For this purpose we calculate indicators from social network analysis for the artificial as well as for the real-world networks.

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Margherita Russo, Università degli Studi di Modena e Reggio Emilia, Dipartimento di Economia Politica, Modena, Italy

'Innovative policies for innovation networks. A complex system perspective'

The linear model of innovation has been superseded by a variety of theoretical models that view the innovation process as systemic, complex, multi-level, multi-temporal, involving a plurality of heterogeneous economic agents.

Accordingly, over time, the policy discourse has shifted its emphasis from the direct public funding of basic research as an engine of innovation, to the creation of markets for knowledge goods (through the enforcement of Intellectual Property Rights), to, eventually, the acknowledgement that knowledge transfer very often requires direct interactions among innovating actors. In most cases, the role of such policies is confined to the creation of a suitable interaction space for innovating actors - hence the emphasis on knowledge portals, information points for SMEs, technology transfer offices - in the belief that the role of policy is to favour the match between demand and supply of the knowledge needed to innovate. When innovation is conceptualized as complex phenomenon, however, the problem is not just how to match an existing demand and supply of knowledge but how to foster a process characterized by multiple agency levels, multiple temporal scales, ontological uncertainty and emergent outcomes.

If the complexity approach is to provide operative guidelines for innovation policies, then a robust complexity-based theory of innovation is needed, which, complemented with appropriate analytical and methodological tools, can serve as a guide for policy design and evaluation. The paper discusses an appropriate theoretical framework for studying innovation in a complexity perspective, and shows how such framework can be used in order to derive policy guidelines and tools for the monitoring and evaluation of policy interventions. The arguments presented are supported with examples drawn from several case studies involving regional innovation networks.

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Stefania Sardo, Università degli Studi di Modena e Reggio Emilia, Italy

Josh Whitford, Columbia University, USA

'Technology brokering, generative relationships and social capital. A social network analysis of "space and switch" functions'

The paper explores the economic and policy implications of technology brokering activities for innovating firms. The analysis builds upon a unique dataset recording the complete set of interactions enabled by a technology broker operating in the Italian region of Emilia-Romagna. The area is characterized by the presence of a decentralized production structure mainly composed of small and medium mechanical-engineering firms, often specialized in a few stages of the production chain and tightly integrated within formal and informal networks of relationships. Such networks are predominantly local but in some cases they involve international actors. Many final firms in this cluster – a subset of which use the services provided by the technology broker – are very successful exporters, and occupy world leadership positions in their respective markets. Our analysis introduces first of all the notion of brokering in a dynamic context characterized by generative relationships (Lane and Maxfield, 1997) and by the creation of social capital (Burt, 2003). By combining network analysis techniques and ethnographic research, we trace the network of relationships generated by the interactions among the users of the technology brokering service, we study the motivations that lead them to use these services, and we explore in detail the functions of the technology broker. The latter provides both a venue for interactions among its users ("space") and opportunities for contact among two or more agents ("switch"). Understanding the nature, functions and benefits of technology brokering is important both for the analysis of innovation processes and for the design of appropriate innovation policies targeted at decentralized SME production systems. The case study is also useful in order to develop a methodology to study the scope and effects of the activities of actors whose main objective is to foster social interactions and to promote innovation networks.

Pier Paolo Saviotti, INRA GAEL Grenoble, France

'The co-evolution of Technologies and Institutions and the Dynamics of Socio-Economic Systems'

The co-evolution of technologies and institutions is a very general phenomenon accompanying the evolution of socio-economic systems. New technologies can be created in an institutional vacuum but they can only diffuse largely in society if their further development is accompanied by that of appropriate (complementary) institutions. Such institutions define the rules according to which new technologies have to be used in order to provide citizens with benefits and to reduce the corresponding risks. The emergence of complementary institutions greatly amplifies the scope of new technologies, that is the size of the potential market they can attain and the contribution of the new technologies to economic growth. The initial emergence of a new technology induces the creation of complementary institutions, which in turn increase the output of the new technology and lead to a subsequent growth and transformation of the complementary institutions. In this sense the co-evolution of technologies and institutions constitutes an example of auto-catalysis and contribute to the rapid growth in market share of the new technologies considered. The co-evolution of technologies and institutions can then be considered a simplified example of a systemic approach in which different variables interact and create feedback loops. These non linear interactions shape in a fundamental way structural change and economic development and allow both the rapid rise in market share of new technologies and the rapid decline of mature sectors. In a generalized systemic approach many technologies and institutions can interact in the way described above and affect economic development.

Sheila Slaughter, University of Georgia, USA

'UNIVERSITIES AND INNOVATION: NETWORKS AND STRATEGY'

Networks may be as important as organizations in shaping the success of innovation. This presentation examines three sets of networks critical to the US academic contribution to innovation. Networks link organizations, political and economic actors together but are independent of them. First, the contributions of the US competitiveness coalition, a bipartisan network of Democrat and Republican legislators, is examined, looking at the strength and durability of the network from 1980 to the present, and concluding with recent achievements such as the American Competitiveness Initiative (ACI) of 2006 and the America Competes Act (ACA) of 2007. Second, networks of the American Association of Universities' trustees are examined, again focusing on the strength and durability of the network, with special attention given to the connections of the trustees of universities to the broader economy through the many and linked corporate directorships held by trustees. Third, the correlation between trustees' economic interests, as represented by their corporate board directorships, and the types of research in which universities engage are explored.

Flaminio Squazzoni³, Dept. Social Sciences, University of Brescia, Italy

'The Modelling of Innovation Through Agent-Based Models'

In this talk I shall argue that the understanding of innovation in complex systems can benefit a lot from agent-based models. On one hand, I will emphasise the peculiarity of agent-based modelling in respect to more conventional theoretical and empirical approaches. A particular attention will be given to: (a) the relevance of unpacking innovation mechanisms through models that can guarantee a good balance of simplification/generalisation and complexification/description; (b) the possibility to model agents and processes that are involved in the emergence of innovation in an explicit way. On the other hand, I will introduce some recent examples from the literature on industrial clusters/districts, where innovation is studied with relation to interaction, proximity and informal coordination among localised firms. Finally, I will end with a discussion on how agent-based modelling can promote a better integration between empirical analyses and theoretical approaches to innovation.

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'Theory-based dynamical models of innovation processes'

A major problem in research on innovations is the understanding of invention, that is, the origin of innovations. A related problem is the diffusion of innovations through social networks. A common claim in the literature is that innovations are recombinations of current capabilities, as Schumpeter claimed, and that search is local, this perspective treating invention then as discovered in close proximity to current practice. A contrary perspective is to consider invention as sudden blind insight. In our opinion, the local recombination and search perspective fails to treat the many cases of significant invention that we observe, while the latter perspective yields little theoretical and conception gain. The key point seems to us that those approaches lack an appropriate ontology. In particular, the recombination centred perspective emphasises the role of artefacts, leaving the agents (whether humans or human organisations) a secondary role of pure recombinators. It becomes, therefore, possible to ignore the role of agents and to follow the pure technological trajectories of the artefacts. However, human agents - endowed with sophisticated cognitive and communication capabilities - can create and use artefacts in ways that are not just obvious at all. Indeed, they are embedded in a web of relationships among themselves, with their organisations and with their environment, which affect their ways of thinking and of using artefacts. Therefore, in our view, in order to understand innovation it is much more appropriate to take explicitly into account the presence of both artefacts and agents, rather than trying to 'project out' of the description one of these two terms. In this talk we discuss models where agents and artifacts interact in order to exploit their reciprocal characteristics, both at micro level (the interaction of few agents and artifacts) and at macro level (emergent structures in systems of many agents and artifacts).

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'Governing Research and Innovation Networks – the European framework programmes in perspective'

Innovation networks, understood as loosely knit and flexible constellations of actors, provide a coordination mechanism for the exchange, recombination and integration of knowledge. The governance of these networks concerns the explicit rules that determine the structure and the substance of collaboration at both the levels of individual projects and of broader communities.

The European framework programmes, which are at the heart of the NEMO project, represent an important policy instrument shaping the structure and substance of research collaborations in Europe. However, they determine only a fraction, be it an important one, of the actual research collaborations in what is commonly understood as the European Research Area.

In this paper, two questions in relation to the governance of the framework programmes will be addressed: First, what do we know about rules and determinants that facilitate the emergence of collaborative research and innovation at the level of projects and at the level of communities? And second, how can the European framework programmes be positioned in the context of the much broader research and innovation networks in the multi-level setting of the European research area?

Apart from some theoretical considerations on the determinants of the emergence and transformation of research and innovation networks, empirical insights on collaboration motives and the influence of governance rules will be presented, both on the collaborations induced by the framework programmes as such and on those that are induced in response to national and regional level initiatives.