# Mathematical and Computational Organization Theory Workshop
## April 22 and 23, 1995
## Los Angeles, California

Mathematical and Computational Organization Theory
Workshop

April 22 and 22, 1995

Los Angeles, California

Organized by

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Abstracts
Mathematical and Computational Organization Theory

## LEARNING CONTROL IN DYNAMIC DECISION MAKING TASKS

FAISON "BUD" GIBSON

forthcoming

## SIMULATING THE IMPACT OF TECHNOLOGY ON INDIVIDUAL AND COOPERATIVE WORK

**DAVID KAPLAN**
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Through the use of the ARTORG (Artificial Organization) simulation the impact of technology on both individuals and cooperative work can be predicted. Existing technology such as two-way audio communicating device's as well as new technology for video and shared manuals are incorporated into the ARTORG. Flexibility of the simulation includes both the varied combinations of technology and the ability to accomodate a wide variety of tasks.

Maurice Rojer
Models of Collective Bargaining Processes Tested

Maurice Rojer
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Collective bargaining between organizations is a widely spread phenom- enon. Bargaining takes place at different levels and in different contexts, such as international multi-lateral disputes, mergers between organiz- ations, between employers and unions, between political parties in parlia- mentary decision making, etcetera. Several theories and models have been developed to understand, explain or predict outcomes of these inter- organizational bargaining processes. Until recently, however, formal bargaining models were lacking any systematic account of the dynamics caused by interactions between bargaining organizations, or actors. The process is an important aspect of bargaining, though. Outcomes, whether optimal or sub-optimal, are the direct result of

(inter)actions of bargain- ing actors, and are not the result of ex ante solution concepts. Solutions of, for instance, game theoretic bargaining models do not account for interactive dynamics. As far as theories do account for the process they do not pretend to be able to explain or even to predict outcomes of that process.

Since 1985, two models have been developed in which the bargaining process is formalized and the bargaining outcome is predicted from the process. The first model, the so-called Expected Utility model by Bueno de Mesquita, treats collective decision making, or bargaining, as a conflictual activity. The second model, the Exchange or Logrolling model by Stokman and Van Oosten, emphasizes the cooperative nature of bargain- ing processes. Although both models approach the bargaining process in fundamentally different ways, they are directly comparable in their predictive and explanatory value. Both models are based on the same variables: the potential control of actors over outcomes, the salience of the issues for the actors, and the outcomes preferred by the actors. Thus, besides the fact that the bargaining process is now modelled, another benefit of these models is that they can be, and have been, empiri- cally tested, even in different bargaining settings: the Expected Utility model has yet been tested on several international disputes, like the future of Hong Kong and the Israel-Arab conflict. Both models were also tested at the same occasion, in the context of a number of policy issues in the European Community. The latter test resulted for both models in correlations between predicted and actual outcomes of .70. Although they seem to perform equally well, they make different predictive errors. The question remains which model performs the best in general.

At the moment I test the models in a quite different institutional context: bargaining between organizations of workers and employers, resulting in collective agreements on labour relations and working conditions. The Dutch context, in which the models are tested, features plural representa- tion (more than one union and/or employers' organization) and multi-issue bargaining. Thirteen collective agreements are analyzed which amount to 200 bargaining issues. A preliminary test of the Exchange model shows correlations between predicted and actual outcomes of .74.

Gabor Peli & Bart Nooteboom
(University of Groningen, Faculty of Management and Organization, The Netherlands)

Learning to Cooperate: the Simulation of Transaction Costs in Supplier-User Relations

The present simulation model addresses issues of subcontracting: if producers do not possess all the necessary skills for production, then they may seek to employ suppliers who offer the desired complementary competences. The focus is on the dynamic issues of cooperation: suppliers adapt their competences to users' products, and users learn to absorb contributions from their suppliers. Transaction

Cost Economics (TCE) is taken as a departure point, and it is extended with processes of learning and mutual adjustment between partners.

The model is set up on the basis of movements in an Eucledian space. The dimensions represent the skills that a user intends to obtain by cooperation ("complementary competences"). The supplier's position shows the competence configuration it possesses. The user's position reflects cooperative abilities: it indicates the competence configuration that the user can best absorb at a given time. The smaller the distance between a source and a user, the better they complement each other (cognitive distance). So, the partners have to "learn" to cooperate, making efforts to get closer to each other in the competence space. Moreover, the competences also has to be adjusted to the product the partners intend to produce. Products is represented by the competence configuration by which they can be optimally produced (ideal point). Multiple technologies may allow for multiple ideal points for the same product.

The simulation model assesses the advantages and drawbacks of having single/ multiple suppliers. The trade-off is evaluated in terms of characteristics like the speed of adaptation, accuracy of goal perception, consequences of defection, the frequency of product change. The results are demonstrated in a two dimensional space, in order to be able to plot movements visually. It is also shown that the "first mover vs. efficient production strategy" dilemma of traditional TCE can be obtained as a special case of the model.

## TRACKING AGENTS AND AGENT-GROUPS IN A DYNAMIC, MULTI-AGENT ENVIRONMENT

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31 January 1995

Interactive simulation (virtual reality) environments constitute one of today's promising emerging technologies, with applications in areas such as education, manufacturing, entertainment and training. Our current research effort is aimed at developing human-like, intelligent agents (virtual humans) that can interact with each other, as well as with humans in such virtual environments. Our current target is the development of intelligent pilot agents for real-world battlefield simulation environments. These pilot agents are based on a system called TacAir-Soar, constructed using the Soar integrated problem-solving and learning system. These pilots agents have already participated in simulated combat against human pilots -- most recently in November 1994, in a simulated military exercise involving about 2000 simulated military vehicles. (The pilot agents are being developed as a collaborative effort involving researchers from the Univ of Michigan and Univ of Southern California).

In air-combat simulation, as in most other multi-agent environments, agents have to interact with each other -- to coordinate with friends and compete with adversaries -- in order to achieve their goals. Air-combat simulation provides a concrete and "real-world" setting for investigating agent interaction. This paper reports on an investigation of one key requirement for intelligent agent interaction -- "agent tracking". Agent tracking involves continuous monitoring of the observable actions of other agents, and inferring their unobserved actions, higher levels goals, behaviors and plans. A pilot agent has to track the actions and behaviors of its single opponent or a group of opponents to be effective in air-combat engagements. Previous work in agent tracking has focused on static, single agent environments, and thus the dynamic, multi-agent air-combat simulation environment raises some novel challenges: First, agent tracking has to occur in real-time. Second, this is a dynamic environment where agents exhibit a complex combination of goal-driven and reactive behaviors, rather than rigid plan-based behaviors (as in static environments). Such complex behaviors have to be tracked appropriately. Third, a pilot agent often faces a coordinated attack by a group of opponents, and needs to track such group activities.

Our approach to address these challenges is based on previous work on model-tracing. To track an opponent's flexible/reactive actions and behaviors, a pilot agent executes a model of the opponent -- modeling the opponent's goals and high-level behaviors -- and matches the models' predictions with the opponent's actual actions for corroboration. While model tracing aids a pilot agent in tracking an opponent's complex behaviors, substantial modifications are necessary to address real-time constraints. One important concern is the high cost of backtracking during model tracing. We have devised a technique called "single-state backtracking" to alleviate this overhead cost.

In tracking the activities of a group of opponents, two main issues need to be addressed. First, tracking the activities of a large number of agents can be a substantial overhead -- problematical for real-time performance. To alleviate these computational overheads, "inter-model optimizations" have been devised. For instance, the model-sharing optimization attempts to reduce computational costs by sharing the execution of two models where possible. The second issue is tracking the coordinated maneuvers of a group of opponents. In one type of coordinated maneuvers, agents engage in identical activities. In another type of maneuvers, such as a post-hole, agents engage in very different activities in service of the maneuver -- the actions of an individual agent thus take on a completely different meaning in the context of the actions of the other group members. This last issue is not yet been resolved, and it tops our agenda for future work.

We expect that the techniques developed in this research -- given the concrete real-world basis of air-combat simulation -- will be applicable for agent tracking in other multi-agent domains such as virtual reality environments for entertainment and education.

## Niche Width Theory Formalized

Jeroen Bruggeman and Gabor Peli

Hannan and Freeman's Niche Width theory predicts for given environmental conditions whether specialist or generalist organizations will do better. Though it is generally accepted that conclusions (or, in this case, predictions) of theories must logically follow from assumptions, this is seldom rigorously checked in sociology. We formalize the Niche Width theory into logic, since formal logic has precise rules for inferencing. As a result, the underlying assumptions of our interpretation of the theory are explicitly specified. Furthermore, the meaning of basic concepts is more elucidated, and the domain of the theory more clearly delineated than in the natural language counterpart.

Niche Width theory compares a population of specialist organizations to a population of generalists, in nine different environmental settings, during a period of observation. Apart from the stable environment, eight of these environmental settings are characterized by three binary variabes: grain size (fine or coarse), variability (high or low) and similarity versus dissimilarity of resource configurations. The comparison of generalists to specialists is made under the so called "principle of allocation": the efforts of specialists are focused on being good at one thing (narrow niche), whereas generalists spread their capacity such that they are moderately good at several things (broad niche).

A major problem in the theory is the unclarity of the degree of dissimilarity of resource configurations w.r.t. niche widths of organizations. At this point, we developed two interpretations of their theory, hence two formalizations.

In the first interpretation, generalists can only cope with different resource configurations as long as they are not too dissimilar. Generalists can not stretch their niche widths beyond some degree. This line of thought resulted in a parsimonious and concise organization of the theory's explanatory structure: the notion of grain size could be left out altogether.

In the second interpretation there can always be a generalist population that matches different resource configurations, no matter how dissimilar they are. This approach gives account for the consequences of grain size and leaves room for further theory development into more complex patterns of environmental change.

Although both interpretations are conform to Hannan and Freeman's theory, the two formal representations differ in one of nine conclusion. The formalizations give explicit account for this difference, whereas the original theory is less explicit in its argument.

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---------------------Submission-----------------------------------------

IMITATION & INNOVATION: A ORGANIZATIONAL LEARNING PERSPECTIVE

by

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ABSTRACT

This study analyzes situations where the intensity of competition between firms is high, i.e. each additional firm producing a good or service has a large negative impact on the returns to all firms producing that good or service, and the capabilities of firms are easily imitated. The focus is on the effects of competition so defined on the propensity of firms to refine current technologies and develop new innovative technologies. To explore these effects we use a simulation model based on the integration of the organizational learning perspective and the evolutionary approach to economic change. This simulation examines directly the impact on innovation and refinement of imitation and competition. Implications of this framework and the simulation findings are discussed.

Innovations, whether radical or incremental improvements over existing offerings, can enable organizations to enhance and maintain their competitive advantage. The main source of this competitive advantage results from increased differentiation, which can be translated into increased market share and profit (Scherer & Ross, 1990). This paper develops a framework for an exploration of the effects of imitation and competition on the level of innovation in a group of firms producing services or products for the same markets. Both imitation and competition may have implications for the strategies firms choose to gain and maintain competitive advantages.

This paper uses the organizational learning perspective as the basis of the model of firms (March and Olsen, 1976; Levinthal and March, 1981; Levitt and March, 1988; Lant and Mezias, 1990; 1992). This is a particularly appropriate choice because the them es of organizational learning and innovation have been intertwined previously, both in conceptual work (e.g., Angle & Van de Ven, 1989; Brewer, 1980; Stata, 1989; Tushman & Nadler, 1986; Tushman & Nelson, 1990; Brown, 1991; Mezias & Glynn, 1993) and in empirical research (e.g., Henderson & Clark, 1990; Cohen & Levinthal 1990; 338; Sahal, 1981). The ability of the model to account for the effects of history is important. In particular, it may be essential to understand how the organization's past may affect its future capabilities for renewal and change (Lant & Mezias, 1990; 1992) in environments characterized by competition, imitation, innovation, and refinement.

The next section will introduce the major ideas in a manner similar to this abstract. Then, we will discuss our theoretical framework by first establishing the basis for our definition of competition and discussing the effects. Then, we will develop predictions regarding the effects of imitation on the decisions of firms to adopt innovations or refinements to their current technology. Next, to further exploration of these predictions, we will suggest the applicability of a theoretical perspective that models firms as experiential learning systems. Based this perspective, we will develop a simulation analysis to address these issues, discussing in detail how we will operationalize firms, learning, innovation, refinement, competition, and imitation. We will close with a discussion of the results, indicating some of the limitations and directions for future work. We will focus on implications of our analysis for understanding the strategies firms choose to gain and maintain competitive advantage in environments characterized by both imitation and competition.

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Informal networks for cooperative problem solving
Kevin Crowston and Bernardo Huberman

In my presentation, I will discuss a simulation intended to model some aspects of informal networks of collaborators, sometimes called communities of practice (Lave and Wenger, 1991). The key feature modelled is that an agent's performance solving some problem can be improved by information received from some other agent (Huberman and Hogg, 1994).

An organization is modelled as a collection of agents trying to solve a common problem. Each agent has its own way to approach the problem. Agents exchange hints, such as decompositions of or partial solutions to the problem. Sometimes a hint will be useful (i.e., help the recipient solve its problem more quickly); in other cases, it may not help or may even be incomprehensible to the recipient. As well, part of the content of a hint may be encoded symbolically. Only agents that know the meaning of the symbol will be able to understand the hint.

Agents keep track of the utility of hints and adjust the probability of interaction accordingly: the probability of asking another agent for a hint will increase if that agent's hints have been useful in the past and decrease if not. Over the course of the simulation, therefore, a pattern of interaction between agents will develop. We hypothesize that having developed this pattern will allow the organization to solve new problems more quickly. The organization may also be better suited to solve similar problems (but perhaps unable to solve different problems).

The simulation to be presented consists of agents working on a traveling salesman problem (TSP). TSP was chosen for several reasons. First, TSP is a hard problem (NP-complete) which therefore requires considerable computation to solve. As well, there are several variations of the problem, such as different distance metrics or asymmetric TSP. Second, there are many ways of approaching the problem and information from one approach can be useful for others. For example, some methods take a collection of points and create a path, while others take a path and try to rearrange links to improve it. Some sample codes are available for these methods and many sample problems are available with known solutions. Finally, the nature of problem is such that computer agents can solve it.

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# COORDINATION: A MODEL AND EXPERIMENT

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2/10/95

## ABSTRACT

## INTRODUCTION

One general aim of our research is to work toward a computational theory of coordination that can be used to analyze both human and computational organizations, and that is consistent with other well-accepted conceputalizations and theories, such as Sociotechnical Systems (STS) theory. The specific goal of this paper is to describe a formalized theory of how characteristics of activities/tasks can be used to predict to context-specific coordination needs and management actions, and to illustrate, using real work organization data, how this theory can be automated for use as a design and decision support tool. There is a need for a theory of coordination that predicts to specific requirements for coordination strategies, because:

a) Most theories of coordination predict to static relationships between coordination mechanisms and org or job structure, ignoring the fact that people will have different coordination needs at various times, i.e., that people coordinate while performing specific tasks.

b) The effectiveness of coordination mechanisms is highly context-specific, yet most coordination theories are very general. Tying coordination needs to specific task characteristics makes the theory "mid-range", more general than "communication encounter specific" which becomes too hard to develop managerial strategic coordination strategies, yet more specific than the abstract theories available today.

The basic research questions addressed by this paper are:

1) What is a appropriate/useful/data-related conceptual model of coordination, that supports a deep predictive or explanatory theoretical model?

2) What is the deep model that can be used to explain:

2a) How specific predictor variables affect coordination outcomes, thus defining coordination needs?

2b) What are the effects of any particular change in a coordination configuration?

2c) Why should any particular configuration be better or worse (vis-a-vis outcome variables) in a given production or activity situation?

3) What are the implications of long-distance (time/space/other) coordination as in global virtual enterprises? Are any new aspects of the deep model/theory needed to account for long-distance coordination? Does the model change at all? The main aim here is to account for the goals of trying to find technology, coordination, or process configurations that reduce the added costs (e.g. via increased uncertainties) incurred by long-distance collaborative activity: how to break or reduce time/space barriers to "tele-coordination."

## APPROACH

A work organization can be analyzed as a more or less coordinated structure of activites, with measurable and/or predictable performance outcomes. Consistent with STS theory, our focal organization performance outcome for this paper is outcome variance: control of variance is seen as a primary coordination goal. Within a work organization, some features are considered mutable, (thus strategic targets for improvement) and others are relatively stable (i.e. background structure). The work organization can be further analyzed into two types of substructure and activity: "primary work" (i.e., its rationalized basic process) "articulation work" (layered, adaptive activity that dynamically reorients or augments primary work in the face of contingency or variance). We recognize that one way to improve coordination is to restructure the primary work processes. However, for this paper, we consider these as background structure, and concern ourselves only with the design of layered, mutable articulation or coordination structures that effectively augment primary processes.

In this paper we propose a theory of coordination that links a model of an organization's primary process to the specification of an idealized coordination framework for that process. Specifying this theory is the first goal of the paper. Once we have the theory in place, we show how it can be operationalized and applied to specific organizational instances, for assessment and redesign. We do this in several steps.

First, we show how to model and capture the elements of an organization's work process using dimensions that are key for the predictive theoretical analysis. Next, we operationalize the theory in a computer program that performs the analysis, generating the characteristics of and idealized coordination framework for that organization. The idealized coordination framework models coordination using (5) two-valued dimensions, hence there are 32 different coordination configurations. Third, we analyze the collection of coordination support mechanism actually used in the target organization using the same 32-point space, placing the organization as one point in the space.

Finally, we suggest the secondary hypothesis of the paper, namely that when the coordination mechanisms actually employed match the theoretically-ideal coordination requirements, then the coordination will be effective. Mismatch can be along any one of the 5 dimensions, hence within two 5x2 configurations, there is a total of 994 possible mismatches. These can be arranged into a partial order, using contextual variables, so that some single mismatched dimensions or overall mismatched configurations can be judged less critical than others. We illustrate the analytical power of the model by applying it to data on four different configurations of actual procurement processes in a major aerospace manufacturer. The processes studied comprised some 122 process steps involving 10 suborganizations.

Overall, this approach:

1) Illustrates that the field of organizational and coordination theory is sufficiently robust and AI tools sufficiently flexible to be computationally formalized and that the formalization yields valid and usable results. In addition, computational formalization can be a contribution because it allows managers to quickly generate alternative scenarios of coordination mechanisms, and it allows theorists to test the internal validity of a theory whose semantics

are precisely specified and operatinalized, and to modify it in specific ways.

2) Presents a predictive theory of the relationship between task characteristics and effective dynamic (as vs. static) coordination strategies that integrates research from task, organization, and STS design and coordination theory, that is generalizable across situations, and that, when tested in the real world, yielded results with strong face validity. That is, what we have done is to develop a theory that predicts to effective strategies for managing coordination dynamically based on task needs.

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Claude Vogel
ORGANIZATIONAL SEMIOTICS: A METHODOLOGICAL ACCOUNT

Claude VOGEL, Ph.D.
CISI Ingenierie, Paris, France

Date: 11 November, 1993
Place: SSM-119, USC
Time: 10:30 AM

ABSTRACT:

This talk presents new research on methods and knowledge-based tools for organizational analysis and the design of organizational processes and information management in organizations. The objectives of the methods and analysis, called "Organizational Semiotics" are to:

* Study the dynamics of the exchanges of cultural objects (e.g. information, texts) inside social organizations,
* Map the structure of these exchanges over functional frameworks;
* Use this mapping as to reveal the internal logic underlying operation and reproduction of organizations.

The technical process of organizational semiotics involves the following tasks:
* organization sampling and identification of attractors
* cognitive analysis of clusters

* cultural regulation analysis

This talk will include a brief summary of the background and theoretical framework of organizational semiotics, a technical presentation of the three major steps (lexicographic, cognitive and cultural analysis) and a case-study application of the analysis in a real organization.

The information discussed in this presentation may of interest to academics, consultants, organizational analysts, and quality specialists concerned with human resources management, cultural information processing (infometrics, competitive intelligence, documentation), and cooperative work.

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## Local Sophistication and Organizational Performance

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ABSTRACT

In this paper, we show that the degree to which local sophistication of agents in an organization impacts the organizational performance depends on both task environmental factors and organizational factors. Our previous work concerned the modeling of tree organizations for multiagent addition task with respect to the response time performance metric. The task environmental factors modeled were the size of the task and the task environment granularity as the ratio between the unit task execution time and the unit message transmission time.

The organizational factor modeled was the structure of the organization determined by the number of levels and the branching factor. Here, we expand our task environment model by allowing nodes in the tree organization to fail, and we add the failure rate of nodes as an additional task environmental factor to be modeled. Since, the most natural way to add reliability to an organization under conditions of possible node failures is to provide task redundancy, we define a systemic way of providing such redundancy in our tree organization for multiagent addition task. Thus we add another organizational factor, which is the task assignment redundancy factor. Accordingly, we expand our performance model by adding the task completion probability metric to the previous response time metric. Since now, each node is assigned multiple tasks for redundancy, if we allow each node some autonomy as to the ordering of its local tasks, the organizational performance will vary depending on how well nodes coordinate their local task ordering behaviors. We define Organizational Performance Variance (OPV) as the difference between the worst and best organizational performance due to worst and best coordination efforts made by members of the organization concerning the ordering of local tasks. We present our preliminary experimental results, with explanations.

Mike Pich and Suzanne Stout

A Process Model of the Diffusion of Innovations:
An Examination of the Role of Limited Resources in Networks

Abstract

This paper presents a process model of the diffusion of innovations through networks. This process model offers a causal explanation for the time-varying adoption behavior of nodes in a network by taking explicit account of the effects of limited resources on a nodes ability to understand and implement innovations. We suggest that network nodes are constrained in their ability to adopt new innovations by limited resources. We examine the implications of this process model using discrete-event simulation.

"VDT-Enterprise": Ideas for Extending the Coverage of the Virtual Design Team (VDT) From Routine Projects to Non-routine Work Processes
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Raymond E.Levitt
Associate Director, Center for Integrated Facility Engineering
Stanford University
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The Virtual Design Team (VDT) system has been developed and validated as a computational anlysis tool to predict the impact of changes in task, team members, organization structure and communication technologies on the performance of project organizations engaged in complex but routine design tasks. Since enterprises are now increasingly re-engineering their work processes to resemble mini-projects, we believe that VDT can be extended to model less routine work processes in full scale enterprises engaged in knowledge work -- design firms, health care institutions, management consulting fims, etc. This talk will set out key limitations of the current VDT and discuss how we might implement some needed extensions to the framework, including contingent activities, goal conflicts and agency, and resource allocation.

Absract for MOT Workshop at INFORMS

Modeling Organizational Learning and Change in Response to Information Technology
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Gaye A. Oralkan
Graduate Student, Department of Civil Engineering
Stanford University
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This talk will describe a conceptual and computational framework for modeling organizational learning and change in response to information technology. Organizations generally introduce new information technologies into existing organizational structures with only first order effects in mind.

However, after the technology implementation, they discover several second order effects of the technology which were not initially taken into consideration. These second order effects interfere with the first order effects and result in a mismatch between desired and actual technological outcomes. Technology adopters need to consider the structural and cultural features of their organizations as they choose new technologies to implement and adjust these features to support the succesful implementation

of the technology. Such an adoption process requires a non-intuitive understanding of second-order effects. This research attempts to build a computational model to study the second-order effects of new technology. Thus, we view organizations as adaptive systems and study how individual preferences and competences as well as organizational structures (i.e., access and belief structures) adapt in response to a new technology. We merge ideas from the theories of structuration and organizational learning to describe how micro level actions are constrained or facilitated by meso-level structures and how micro-level actions in turn reshape meso-level structures.

## Schemer-III: A Computational Framework for Modeling Organizational Dynamics

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Abstract
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This presentation examines the computational foundations of our research on organizational dynamics. We describe the intelligent-system architecture that provides the basic framework for our computational modeling and simulation-based experiments. This architecture, called Schemer-III, is the product of over ten years of research and development on distributed and single-agent systems that deliberate and act in real time. Schemer-III's ancestors (including the original Schemer system, Schemer-II, and the Heuristic Control Virtual Machine or HCVM) have served as the architecture for a wide variety of intelligent-system prototypes and fully fielded applications.

We have chosen Schemer-III as the architecture for a simulation testbed that we are developing to implement, explore, and test our theory of organizational dynamics. We refer to this simulation model as ACCORD, standing for Agency, Cognition, and Coordination in ORganizational Dynamics. We are using ACCORD to explore our own evolving theory of organizational dynamics. This theory depicts social and organizational dynamics in terms of situated patterns of resource-limited cognition and practice among social actors. We have chosen

Schemer-III as the architecture for ACCORD because its fundamental design provides a robust and precise computational basis for implementing our practice-oriented theory of social and organizational dynamics.

We begin by outlining the basic elements of the theory on which ACCORD is based. We outline our concept of intelligent action as deliberation and overt practice that is situated and adaptive. Social and organizational actors in ACCORD are modeled as coordinated systems of cognitive and practical dispositions. Actors' dispositions embody their resource- and capacity-limited skills for deliberations such as analysis, choice, or planning and the overt practices which they may carry out to perform tasks and otherwise interact with their physical and social environment. ACCORD represents actors' dispositions in a form that is very similar to Chris Argyris's notion of an ACTION PROPOSITION. We describe this representation and discuss how intentional constructs such as percepts, beliefs, desires, and intentions are embodied in and reified by practice in this dispositional theory. Next, we sketch ACCORD's equally dispositional account of social interaction and organizational structure. We outline how ACCORD models social interaction as relations among the skills of participating actors enabled and constrained by explicit resource and communication pathways and agency/authority relationships that are often tacit. In outlining our theory and its implementation in ACCORD, we place it in the context of work by such social theorists as Giddens, Bourdieu, Lewin, Argyris, and March whose ideas have stimulated our own approach.

We conclude by examining the Schemer-III architecture. We focus on its underlying computational model and examine that model's adequacy as a foundation for implementing our theory of social and organizational dynamics. We first describe Schemer-III's models of process and data abstraction and process execution. Schemer-III implements a more radically event-based concept of process management than any other intelligent-system architecture of which we are aware. We describe Schemer-III's basic modules, called HANDLERs, that encode related procedures and data. We then describe Schemer-III's event- and interrupt-directed model of process management. This model describes process execution and management both within and among handlers. We discuss how Schemer-III's handlers and its model of process execution support ACCORD's ability to model the dynamics of both individual actors and coordinated, multi-actor groups as cognitive systems of situated practices. Next, we discuss Schemer-III's constructs for modeling organizational structure. We review Schemer-III's concept of module interaction -- its interprocess communication model -- and discuss its ability

to implement our concept of social and organizational structure in ACCORD. We
focus particularly on Schemer-III's advantages for modeling organizations and
social systems with AMBIGOUS STRUCTURE. Throughout our discussion of
Schemer-III we compare and contrast it with other important intelligent-system
architectures for use in organizational modeling. We compare Schemer-III to
such production-system architectures as Newell's SOAR and Anderson's ACT* and
to so-called blackboard architectures such as Hayes-Roth's BB1 and Lesser and
Corkill's GBB.

Kent Sandoe
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Simulating the Software Cost Estimation Process

Although there have been many attempts to develop models to estimate software costs, most have failed to produce accurate forecasts of these costs. While developing new models may eventually prove fruitful, the focus of this work is on enhancing the understanding of the cost estimator and the cost estimation process as a way to improve estimate quality.

This research uses simulation to explore cost estimation using a three stage model of the cost estimation process that includes assessment, estimation, and adjustment phases. In the assessment phase, estimators analyze the software task to be estimated. In the estimation phase, an analogy based technique is modeled, where estimation is constrained by time pressure and organizational memory. In the adjustment phase estimator bias is modeled as padding and shrinking behaviors.

The results of the simulation indicate that teams of estimators perform significantly better than individual developers, cost engineers, or users. Time pressure had a negative impact on all types of estimators, estimating individually and in teams. At the same time, improved organizational memory had a positive impact on the quality of estimates produced by estimators of all types.

Robustness and Affordability in
Continually Available Telecomputing Services Infrastructure (CATSI)

Carl Hewitt & Carl Manning

Abstract

We characterize robustness robustness the ability to meet responsibilities, especially when challenged. From this characterization, it is evident that robustness is a fundamental systems issue.

Today, portable computers and wireless (cellular) networks are used intermittently through the day and mostly in an individual fashion. Commercial products are being introduced and marketed using combinations of terms such as ``agent'', ``assistant'' ``communicator'', ``companion'', ``digital'', ``mobile'', ``nomadic'', ``palm-top'', ``pen-top'', ``personal'', ``pervasive'', ``ubiquitous'', etc. However, none of these product visions adequately addresses the research issues which must be addressed to increased robustness.

At a basic level we can ask:

How is greater robustness to be achieved?
``Telecomputing Services''.

How can Telecomputing Services increase robustness?
``by becoming Continually Available''.

Continual availability means that telecomputing systems can be used effectively at times and places where they are not currently available. Hence, we will use the term Continually Available Telecomputing Services Infrastructure (henceforth known as CATSI). In this decade, the CATSI paradigm shift will have enormous far-reaching economic, political, and social effects. This shift presents both new opportunities and problems for individuals, organizations, communities, and the nation.

Dan O'Leary Identifying Conflicting Probabilistic Knowledge in Multiple Knowledge Base Systems

Multiple knowledge base systems often combine the judgements from their multiple knowledge bases into a single judgment. Unfortunately, if the judgments are disparate then the judgements generally should not be combined. Instead, the disparate nature of the judgments suggests that the rationale for the disparate judgment should be explored. For example, there may be errors in the judgments, or the judgments may be for different issues. As a result, it is important to be able to determine if the knowledge sources are disparate. Accordingly, the purpose of this paper is to explore approaches to determine if probability judgments of different experts are disparate.

Traditional statistics are used to investigate whether or not agent probability judgements are different. In addition, a new approach is developed to determine if the agent judgments are similar enough to combine or disparate enough to treat separately. A case study is used to illustrate the problems of combining multiple agent systems and to demonstrate the new approach.

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Gaye Oralkan
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Steve Mezias & Alan Eisner
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ANNOUNCEMENT: CALL FOR PAPERS

Journal of Mathematical Sociology
Special Issue on Computational Organization Theory

The Journal of Mathematical Sociology invites submissions for a special issue to be titled "Computational Organization Theory." Papers should be concerned with organizational issues of traditional interest to sociologist. Papers should employ either mathematical, logic, or simulation models of organizations, models of organizations as collections of intelligent agents, or models of individuals' actions within organizations.

Relevant issues include but are not limited to:
• The impact of organiztional processes
• Organizational learning
• Organizational design
• Organizational evolution
• Organizational performance under stress
• Formal bases for organizational theory
• Organizations as collections of complex, intelligent, adaptive agents
• Organizational transformation

Each paper should include the following:

• A clear statement of the organizational issue that is being addressed. This introduction should be grounded in the sociological and organizational literature.

• A discussion of the key building blocks in the model. What was important about including just these components. This discussion will be considered one of the critical aspects of the paper. Issues of robustness and sensitivity should be addressed.

• A brief discussion of why formal modeling techniques are needed for this particular problem (not general comments). This should include a discussion of the benefits of using these formal modeling techniques to work on this particular problem (again, not general comments about the benefits of formal modeling). Why was formal modeling needed to generate the observed result. Provide a look into the future work, based on the current effort(s).

• A discussion of earlier formal models in this area (mathematical, logical, or simulation). If alternate current models exist they should also be mentioned. This discussion should be brief, but should motivate the model(s) to follow. Prior literature can also be located in the context of the current modeling issues.

• A clear statement of the organizational finding(s) generated.  How does this advance our understanding of organizations.

Submit four copies of your paper, in JMS style, before February 1, 1995, to the special-issue editor: Kathleen M. Carley

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