Relational Methodologies and Epistemology in Economics and Management Sciences

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A volume in the Advances in Finance, Accounting, and Economics (AFAE) Book Series

Information Science REFERENCE
An Imprint of IGI Global

Published in the United States of America by
Information Science Reference (an imprint of IGI Global)
701 E. Chocolate Avenue
Hershey PA, USA 17033
Tel: 717-533-8845
Fax: 717-533-8661
E-mail: cust@igi-global.com
Web site: http://www.igi-global.com

Library of Congress Cataloging-in-Publication Data

Names: Biggiero, Lucio, 1955- editor.
Title: Relational methodologies and epistemology in economics and management sciences / Lucio Biggiero, Pier Paolo Angelini, Mario Basevi, Nunzia Carbonara, Antonio Matrogiorgio, Eliano Pessa, Enrico Sevi and Marco Valente, editors.
Description: Hershey, PA : Information Science Reference, [2016] | Includes bibliographical references and index.
Identifiers: LCCN 2015041972| ISBN 9781466697706 (hardcover) | ISBN 9781466697713 (ebook)
Subjects: LCSH: Social sciences--Methodology. | Science--Methodology. | Social epistemology. | Knowledge, Theory of.
Classification: LCC H61 .R45 2016 | DDC 300--dc23 LC record available at http://lccn.loc.gov/2015041972

This book is published in the IGI Global book series Advances in Finance, Accounting, and Economics (AFAE) (ISSN: 2327-5677; eISSN: 2327-5685)

British Cataloguing in Publication Data
A Cataloguing in Publication record for this book is available from the British Library.

Chapter 13
On the Relationships between Connection Modes and Workgroup Performance:
The Moderating Role of Group Size and Task Complexity

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ABSTRACT

Notwithstanding the central place covered inside organization science and the economic theory of the firm, organization design theory still lacks sound building blocks concerning the effects that some fundamental variables have on workgroup performance. In this chapter a contribution to fill in this gap is given with reference to the relationships between connection modes and performance. In particular, through an agent-based simulation model a number of experiments have been done respect to the moderating role played by group size and task complexity. Results confirm current (but not really scientific) knowledge, and bring forth our understanding of these fundamental (and mostly nonlinear) relationships. Among the main results, it can be underlined that the best combinations between connection modes, task complexity, and workgroup size occur when complex tasks are connected by mutual adaptation and run by a small number of agents, or when less complex tasks are connected by parallel or sequential interdependence and performed by a large number of agents. Moreover, when a modules volume to be worked out is heterogeneous in terms of connection modes between module's tasks, and thus, a multi-mode group should be issued, respect to the corresponding choice of issuing specialized groups there is a general decrease in efficacy.

DOI: 10.4018/978-1-4666-9770-6.ch013

INTRODUCTION

The objective of this paper is to contribute to build an organization design theory by studying tasks interdependence within a workgroup, and to understand how its performance (in terms of efficiency and effectiveness) depends on different aspects of technological interdependence and contingent variables, namely workgroup size and task complexity. We are therefore focusing on a very micro-organizational level, because the whole organization or inter-group relations are not investigated, as well as leadership styles and workers' skills, and other behavioral aspects[1]. As regards the role played and effects produced by connection modes, here we exploit definitions and results of an earlier work (Biggiero & Sevi, 2009), which uses the same COD Model applied here, and that describes it in more detail.

As it will be seen, it is just a contribution for building a consistent, complete, and satisfactory organization design theory (Miller *et al.*, 2009), but nevertheless it is a fundamental piece, because any such theory cannot avoid to face with the basic problems of a theory of interdependence and coordination (Burton, 2013), explaining which connection mode is more complex, and how different combinations between connection modes and coordination mechanisms, group size and task complexity can affect performance. It is not a coincidence that these are the key questions faced by almost every micro-organizational approach to design theory (Baligh, 1986; Baligh & Burton, 1981; Burton, 2013; Burton & Obel, 1998). Even if in a simplified context, our model provides significant and reliable answers to some of these problems. Finally, without much additional effort, it could serve as a basis for testing the validity of theoretical approaches appeared so far.

The next section presents the key concepts and theoretical architecture, introducing precise definitions of technological interdependence, and discussing their implications for the assessment of their degree of complexity. In Section three model structure, methodology, and agents behavior are described, while the following section examines workgroup performance when it is characterized by only one connection mode. Performance is measured by the number of completed tasks after 1000 working days (1000 iterations of the program). This way the effects of connection modes, group size and task complexity on performance can be analytically examined. However, since in reality a same workgroup should face more often with a mixture of connection modes, in Section five the performance of groups with mixed interdependence is analyzed, while again taking into account and distinguishing the effects of group size and task complexity.

A Brief Theoretical Background

A central theme in management and organization sciences – and more recently in organizational economics (Williamson, 1981, 1985, 1996) and organizational engineering too (Babic, 1999; Eppinger *et al.*, 1994; Suh, 1990, 2001) - is undoubtedly that of organization design (among the many, Baligh, 1986, 2006; Baligh & Burton, 1981; Burton, 2013; Burton & Obel, 1998; Burton *et al.*, 2006; Galbraith, 2012; Grandori, 2001; Van de Ven & Joyce, 1981), i.e. that is finding rational criteria, key variables, and decision-making processes to design an effective and efficient organizational structure or to change (re-design) an already existing one[2]. This (re)design theme is, in its essence, also common to economics, because it concerns how to divide and coordinate work within (intra) and between (inter) organizations, which was one of classical economists (Smith, Ricardo and Marx) central problems. However, during what could be called "the neoclassical economics era", approximately lasting one century from Jevon's and Walras' foundational contributions, economists' attention to strict organizational or technological issues – and even to a theory of the firm – has been episodic and fragmentary (at best). There has been a sort of tacit (and often explicit) division of disciplinary territory: management and organization sciences on one side (Donaldson, 1985, 2001; Pfeffer, 1997), and industrial and organizational economics on the other (Barney & Ouchi, 1986; Dietrich & Kraft, 2012; Roberts, 2004). The former were dealing almost exclusively with single organizations, neglecting markets and industries, while the latter were mainly focusing just on them, and considering single organizations as black boxes.

Over the past 30 years, however, there has been a kind of mutual "disciplinary invasion": on one side economists have proposed a number of theories, such as (but not limited to) agency costs theory (Bo & Driver, 2012; Fama & Jensen, 1983; Holmström & Milgrom, 1991; Holmström & Tirole, 1989; Jensen and Meckling, 1995; Milgrom and Roberts, 1992), transaction costs theory (Williamson, 1975, 1981, 1985, 1994, 1996) - which concerns organization structures and strategies, and even human resource management through incentive systems (Holmström & Milgrom, 1994; Milgrom & Roberts, 1992) – and economics of mechanisms design (Hurwicz, 1973; Hurwicz & Reiter, 2006), which investigates on various aspects of hierarchy and organizational structures, and on the efficiency of decision making processes (Li, 1999; Sah & Stiglitz, 1986; Van Zandt, 1995). On the other side management and organization scholars have developed a number of theories on the relationship between companies, such as the resource dependence theory (Pfeffer & Salancik, 1978), the theory of competitive advantage (Porter, 1985), industrial demography and population ecology (Freeman & Hannan, 1975; Hannan & Freeman, 1977), and others. All this to say that organization design theory is a very interesting theme at the crossroads of industrial and organizational economics on one side, and management and organizational sciences on the other side.

Among the many, an interesting example of this overlap is in the way in which organization design theory is addressed by some economists (Dosi & Marengo, 2013; Foss, 2001; Marengo & Dosi, 2005) and organization scholars (Grandori, 2001, 2013; Grandori & Furnari, 2008). Another example, still within organization design theory, is in the field of modularity (Baldwin & Clark, 2000; Brusoni & Prencipe, 2001; Langlois, 2002; Sanchez & Mahoney, 1996), task decomposition (Eppinger *et al.*, 1994; Marengo & Dosi, 2005; Simon, 1962; Suh, 1990, 2001), and optimal hierarchy (Hurwicz, 1973; Williamson, 1967 among the earlier, and then Marschak & Reichelstein, 1998; Radner, 1993, 1998)[3]. Each author is aware of (and to some extent uses) what is theorized in the other research tradition (Grandori, 2013).

Unfortunately, this great interest is still frustrated by an unsatisfactory level of current knowledge. Economics approaches are often too unrealistic and empirically meaningless, while those on the other side are poorly structured from a logical and theoretical standpoint, and often reciprocally incongruent. What is especially back is empirical verification, mainly due to the extreme organizational variety of real world, and to the consequent high costs and complexity of an empirical research that would provide statistically significant information. Excepted for some interesting and recent studies (Colombo & Delmastro, 1999; Delmastro, 2002), the well-known traditional benchmarks of empirical research on organization design are that of Woodward (1965), Aston Group (Hickson *et al.*, 1969; Pugh *et al.*, 1968), Blau & Schoenherr (1971), whose empirical base was often grounding on a few hundred (sometimes a few dozen) cases, investigated within a very limited range in terms of temporal, geographical and sectoral dimensions. Evidently a trifle, if compared to the sample size and stratification that would be needed. This not to mention the many methodological defects concerning both the way in which data were collected and conclusions were drawn, as discussed by various scholars (Child, 1972; Grandori, 2001; Grandori & Furnari, 2008; Van de Ven & Joyce, 1981).

As one can see, the situation is rather unsatisfactory, and thus, the construction and application of an agent-based simulation model can be very helpful, because it overcomes the problems of scarce logical consistency of current theories and facilitate empirical verification (at least into virtual reality). In fact, the need to express a theory in an algorithmic form to be viable for writing and running a computer program requires that you resolve any logical inconsistency. The model might be unrealistic (and eventually also incomplete) respect to the richness (complexity) of reality, but at least it would be certainly consistent. An agent-based simulation model is indeed simultaneously a theory and a virtual lab, with whom one can make virtual experiments, so as to very extensively explore all pertinent issues, and at significantly lower costs than those of an empirical research in the "real" reality[4]. Respect to other computational models into the field of organization design – recently reviewed by Burton & Obel (2013) and Fioretti (2012) – this one is more micro-analytic, and focused on the interplay between connection modes, task complexity, coordination mechanisms and workgroup size of an organizational unit, rather than on the (as well fundamental and much more visited) issue of fitness between organization structure and external environment.

KEY CONCEPTS

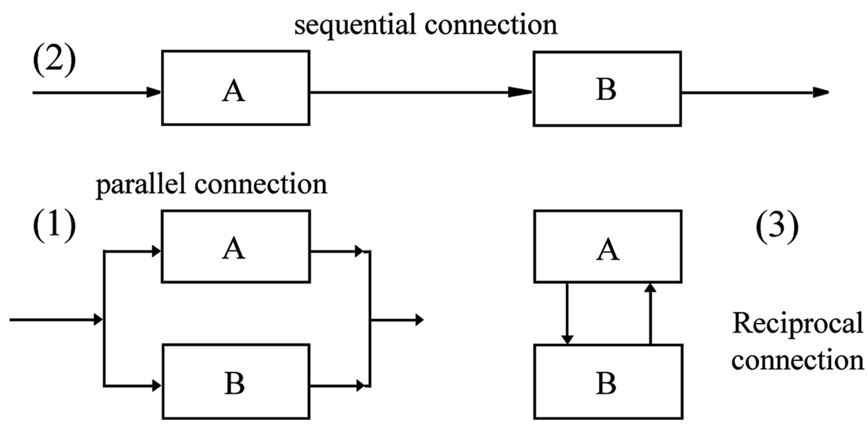
Connection Modes

An intentional and "rational" organization design process occurs through three groups of decisions, which indeed constitute three different theories: i) a theory of interdependencies, which studies types, modes, and degrees (strength) of connections between tasks (or activities, objects); ii) a theory of workers' grouping, which analyzes how these tasks can be grouped into organizational units; iii) a theory of coordination, which examines how coordinating people within organizational units, and between them. These theories are also connected each other, because, for example, a grouping choice depends even on the characteristics of interdependence and on coordination mechanisms. Grounding on the COD Model, in this contribution we explore how group size and task complexity affect group performance. Therefore, we involve issues related either to a theory of interdependence (Kiggundu, 1981) or to a theory of coordination (Crowstone, 1997). However, here the former is a key variable, while the latter is inserted through assumptions and fixed parameters. Indeed, the relationships between technological interdependence and coordination mechanisms has been investigated in a previous application of the COD Model (Biggiero & Sevi, 2009). The results of that analysis have been used here either to design experiments or to explain some of the new results.

If we focus only on technological interdependence[5], it comes that two or more tasks can be connected only by one (or a combination) of the following three fundamental modes[6] (fig. 1):

- Parallel, when tasks are linked just because they share the same input or contribute to the same output. In this type of interdependence activities can be, but not necessarily are carried out simultaneously;
- Sequential, when the output of one is the input of another, and so on in a sequence without feedback effects;
- Reciprocal, when the output of one is the input of another, and vice versa[7]. Also in this case the activities can be, but not necessarily are carried out simultaneously.

Figure 1. Fundamental connection modes



As known, all literature on this subject call these three types of connections as "interdependencies", but we prefer to call them connection modes, because at a closer look it appears evident that only in the third case there is a dependence one another. In fact, in the sequential connection the antecedent element does not depend on the consequent, and in the parallel connection both elements depend on a common third, thus they are neither inter-dependent nor even directly dependent, but only indirectly dependent – and hence, connected – through a third element. Given this heterogeneity, we consider more appropriate to call them connection modes instead of types of interdependence.

A close investigation of the fundamentals of cybernetics and systems theory would reveal that, overlooking the time dimension, all possible real cases can be only these three or one of its combinations. Besides its identification and definition, another issue concerns the evaluation of its degree of complexity. In fact, apart from quantitative aspects related to the number of tasks, the crucial question concerns whether the three fundamental modes have different degrees of complexity because of inner qualitative characteristics.

Regarding the complexity of connection modes, organization literature (Thompson 1967; Mintzberg 1979) has suggested that "all organizations have pooled interdependence; more complicated organizations have sequential as well pooled; and the most complex organizations have reciprocal, sequential and pooled interdependence" (Thompson 1967: 55). Following this approach, therefore, organizations that deal with parallel tasks aren't particularly complex and do not need special arrangements and coordination efforts to work properly. Sequentially working organizations are supposed to be more complicated, and still more those struggling with tasks connected by mutual adaptation, because these require accurate and fine-tuned management devices to allow work to be efficiently and effectively performed.

Biggiero & Sevi (2009) have logically and algorithmically demonstrated that the degree of complexity of these modes grows up moving from the parallel to the sequential to the reciprocal one. This result comes either from a logical analysis of the formal structure of the three modes or from the computational analysis of the coordination mechanisms complexity required to make them viable. In the logical analysis, complexity is defined in terms of the number of appropriate conditions (constraints) implied by the connection: the more conditions the more complexity. Differently, the algorithmic analysis is based on a key theoretical relationship between interdependence complexity and coordination complexity. According to Ashby's law of requisite variety (1956), these two levels of complexity should be equal to cope with interdependence and make coordination viable. In other words, a certain coordination mechanism is required to make a certain connection mode effective. Thus, the complexity of a certain coordination mechanism will be equal to that of the connection mode that is made effective by its introduction. Then, the complexity of a certain coordination mechanism is measured, on its own, in the same logical way that we applied to connection modes: counting concurring conditions (constraints).

Coordination Mechanisms through Norms of Behavior

As well known, drawing from Thompson and others (Donaldson, 1985; Grandori, 2001; Van de Ven & Joyce, 1981), Mintzberg (1979, 1983) proposes three types of coordination mechanisms: direct supervision, standardization, and mutual adjustment. The former is ruled by a boss, and it represents the typical hierarchical relationships, though it can be exerted in a variety of leadership styles. The second one is represented by the establishment of (repetitive) plans and the definition of standards: the typical expression is a routine or a fixed procedure to be followed more or less rigidly and invariably. The third is represented by direct reciprocal – and potentially multiple – interactions. This is a mechanism typical of teamwork, which occurs between a group of peers, possibly coordinated by a group leader. Later, other scholars proposed to add voting (Grandori, 2001) and incentives (Holmström & Milgrom, 1991, 1994) to the previous three, but indeed they are not really enlarging the spectrum: voting is a peculiar form of collective coordination, albeit not interactive, and thus, it could be grouped into the third type of coordination mechanism; incentives are instruments to enforce desired or unwanted routinized behavior, and thus, this tool belong to the second type of coordination mechanism. As well, (more or less computerized) parametric monitoring systems are tool belonging to second category of planning and programming coordination mechanisms. Hence, Mintzberg's theoretical framework is correct and exhaustive of the three fundamental types of coordination mechanisms.

Clearly, each one of them can (and should) be concretely implemented through a variety of norms (rules). In the COD Model six norms have been set up[8]: the first five belong to the second type of coordination mechanism, while the sixth to the third type. The first type has been neglected. Tab. 1 describes all of them, and indicates the corresponding coordination mechanism. As shown, from the third one on, each norm presupposes the enforcement of the previous ones. Therefore, from the third to the sixth norm described in tab. 2, due to the additional rule, to each norm it is associated a certain *coordination setting*, constituted by all norms holding at that point. Following the logical analysis discussed in the previous section, ascending from the first to the sixth, each norms is more complex of the antecedent, because it is more constraining of an agent's behavior. Moreover, besides its inner characteristics of increasing constraining power, each coordination setting is more complex respect to its antecedent because it presupposes the enforcement of previous norms.

Besides refining and categorizing interdependence types and coordination mechanisms, Mintzberg (1979, 1983) suggests also the appropriate combination between the two groups: for each interdependence type there should be an appropriate coordination mechanism. The well-known combinations are the following: parallel with direct supervision, sequential with routinization, reciprocal with mutual adaptation. Even for this suggestion Mintzberg basically refined and developed Thompson's ideas, though some of them were expressed in a slightly different (and sometimes wrong) way. The weak side of all this work was that it was based only on intuition and reasonability, without any logical, mathematical, algorithmic or computational proof. By means of the COD Model, Biggiero & Sevi filled in this gap. The crucial

Table 1. Norms and coordination mechanisms

Type of Norm	Description	Corresponding Group of Coordination Mechanisms
1. Cooperation Norm	Every agent does work (nobody defeats, free-rides, defects or loafs)	Planning agents' behavior (second type)
2. Finalizing Norm	Once started a component, agents must end it up moving from the current to next phase.	Planning agents' behavior (second type)
3. Anti-inactivity Norm (1 + 2 +3)	Agents forced to inactivity because engaged in a locked component leave it immediately and move to search another component.	Planning agents' behavior (second type)
4. Anti-trap Norm (1+2+3+4)	Agents avoid to be engaged in locked components. In sequential connection they avoid components following components not yet executed, while in reciprocal connection they avoid components that are waiting for feedback.	Planning agents' behavior (second type)
5. Focusing Norm (1+2+3+4+5)	Agents give priority to choose tasks in progress.	Planning agents' behavior (second type)
6. Collaboration Norm (1+2+3+4+5+6)	Agents give priority to choose tasks under working by other agents.	Reciprocal adaptation (third type)

Table 2. Coordination mechanisms ordered in terms of their complexity

	Connection modes effectiveness and efficiency		
	Parallel	**Sequential**	**Reciprocal**
Cooperation norm	Limitedly efficient, not effective	Not effective and not efficient	Not effective and not efficient
Finalizing norm	Fully efficient and limitedly effective	Not effective and not efficient	Not effective and not efficient
Anti-inactivity norm	Fully efficient and limitedly effective	Highly efficient and not effective	Weakly efficient and not effective
Anti-trap norm	Fully efficient and limitedly effective	Fully efficient and limitedly effective	Highly efficient and not effective
Focusing norm	Fully efficient and fully effective	Fully efficient and fully effective	Highly efficient and effective
Collaboration norm	Fully efficient and fully effective	Fully efficient and fully effective	Fully efficient and fully effective

point of their algorithmic demonstration lies on the consistency of the ordering of connection modes and coordination mechanisms, both measured in the same logical way (tab. 2).

Still with the COD Model, Biggiero & Sevi (2009) did a step forward: they demonstrated the previous correspondence algorithmically and computationally (tab. 3). Notice that coordination mechanisms are summed up from the former to the latter, because otherwise results would be different, meaning that more complex norms would be not so effective and efficient as they revealed to be in addition to the others. These previous results confirmed Thompson's growing scale of complexity ordering: parallel, sequential, and mutual connection. In particular, Biggiero & Sevi showed that, to get an efficient performance from a workgroup characterized by parallel mode, no coordination effort is required, while the group characterized by tasks connected in a sequential mode can work efficiently only by means of the introduction of rules that precisely define the sequence to be followed. Therefore, complexity increases because workers should adjust their activities according to the phase of advancement of each task. Finally, it was demonstrated that mutual adaptation presents more complexity because group members direct mutual coordination is required: every worker not only should know task state advancement, but she needs also direct collaboration of the other group members. While the group that works in parallel does not need any coordination, the one struggling with sequential tasks needs to share a rule which defines the sequence standard, and the one that works in mutual adaptation should lay down a rule obliging members to cooperate. Therefore, the growing scale of connection modes complexity is confirmed by the increasing need of coordination that they require.

In sum, a workgroup performance depends on the connection mode linking objects to be handled (manufactured), on the coordination mechanisms occurring between workers, and on group size and task complexity. We have discussed the former two, let's now address to the latter two. Group size is easy to understand, because it is measured by the number of its members (workers)[9].

Measures of Complexity

Among the various ways to define and measure complexity (Biggiero, 2001; Casti, 1994), in our model task complexity is measured in terms of diachronic and synchronic variety, which is fully consistent with

Table 3. A computational appraisal of the effects of coordination mechanisms on workgroup performance in correspondence of each connection mode

	Connection Mode	Effectiveness	Efficiency
1. Cooperation Norm	P	0.16	0.53
	S	0.03	0.19
	R	0.01	0.23
2. Finalizing Norm (1 + 2)	P	0.66	1.00
	S	0	0.01
	R	0	0
3. Anti-inactivity Norm (1 + 2 +3)	P	0.66	1.00
	S	0.54	0.76
	R	0.16	0.58
4. Anti-trap Norm (1 + 2 +3+4)	P	0.66	1.00
	S	0.65	1.00
	R	0.29	0.74
5. Focusing Norm (1+2+3+4+5)	P	1.00	1.00
	S	1.00	1.00
	R	0.79	0.79
6. Collaboration Norm (1+2+3+4+5+6)	P	1.00	1.00
	S	1.00	1.00
	R	1.00	1.00

cybernetics and systems science. The former corresponds to the concept of variability, i.e. indicates how frequently a task changes over time, while the latter indicates how many different aspects characterize a task in a given moment. In this study, variability is expressed by the state of a module's specific execution during the 1000 steps of each virtual experiment. It can be still ready (untouched), completed, or at some stage of completion. In synchronic terms, modules differ according to two characteristics: the number of tasks and the number of task's components. Since we assume that a component is executed in a time interval, which may correspond to one hour work, the number of steps required to execute a certain component also defines its minimum duration.

In this contribution we still use the COD simulation model to see how the three different modes of connection are affected by variations of workgroup size and task complexity. This way, given a certain group size and task complexity, we can determine the connection mode that offers the best performance. Alternatively, given a certain connection mode, we can know at what level of task complexity and group size the best (relative) performance is achieved. Besides the specific characteristics of the results obtained in this work, what mostly matters is that what was argued by more or less intuitive and reasonable ideas has been algorithmically demonstrated in a definitely and incontrovertible way through an agent-based simulation modeling. That is, more or less authoritative or plausible opinions have been replaced by incontrovertible demonstrations. Here lays the extraordinary advantages of agent-based simulation modeling, especially in social sciences, where even long lasting debates have been carried on by discourses and not by incontrovertible proofs, and where, like in this case, empirical data are very difficult to be gathered, due to methodological obstacles and complexity of reality. Organization design theory is a field where the advantages of building agent-based simulation modeling are clear and concrete.

MODEL DESCRIPTION AND RESEARCH DESIGN

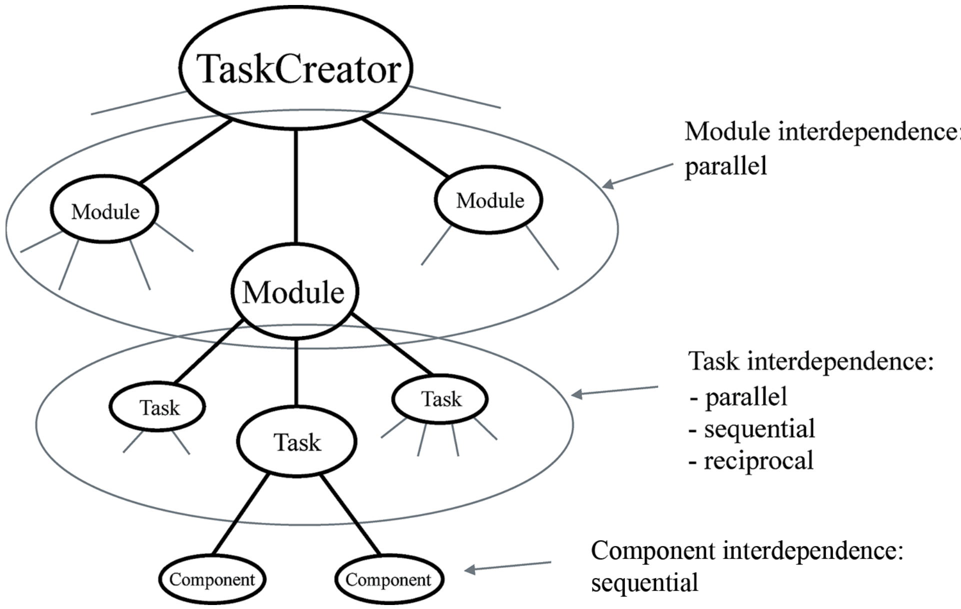
Model Structure

Our model[10] formalizes the three connection modes allowing the analysis of workgroup performance depending on various combinations of the following variables: single and mixed connection modes, growing module complexity and size. The model has a hierarchical structure ruled by two parent objects: TaskCreator and workgroups. While the former deals with modules creation, the latter manages the configuration of workgroups internal structures, and their governing rules.

TaskCreator (fig. 2) provides the volume (workload) and type of work to be performed. During the simulation, with a given frequency, it generates "objects" (modules) to be "manufactured". Let's figure out a library, whose personnel should code, catalog, index, and place on a shelf or in an electronic device a certain variety of objects, like books, journals, papers, CDs, etc. In this framework, TaskCreator may represent another organizational unit or the environment itself in a broad sense: anything that defines the amount of object that every day should be coded, cataloged, etc.

TaskCreator also regulates product complexity by fixing tasks number and the number of their components in each module, so defining the contributions required to each task completion. Each component corresponds to one simulation interval, so that the number of components defines the minimum duration and commitment in terms of processing time. TaskCreator then generates input modules to be processed, defines both the number of their tasks and the number of task components required to complete each module. Referring to the library example, TaskCreator defines both the number of object to work, and

Figure 2. COD Model structure



also the difficulty of each object, that is the amount of work requested to code, catalog, index, and place each task.

Each module is executed with one of the three different connection modes. However, it should be clear that modules (objects) arriving to the (librarian) workgroup come without connections among them, as indeed realistically happens. In this simulation model, technological interdependence, that is connection modes, holds only between tasks constituting each object to be treated alongside the library manipulation cycle (indexing, cataloguing, archiving, etc.). In this empirical representation, tasks are the elements of the manipulation cycle. Further, each task can have one or more components, which instead follow sequentially one another. In sum, input modules arrive to the workgroup unconnectedly, let say, lying and accumulating on what we can figure out as workgroup common tables. TaskCreator could represent just these tables.

It should be underlined that clerks (agents) are perfectly substitutes one another: they have no individual specialization that constraints a certain agent to handle a certain type of objects. Agents share a large common table where objects are deposited, among which there is no connection mode. Getting them from the common table, clerks take charge of these objects to start their manipulation cycle, according to the connection mode governing their tasks relationships. Workers are so interchangeable that in each interval – let say, each hour - they can work on others' incomplete tasks. Therefore, connection modes do not hold between workers (agents), but rather between module's tasks. Of course, through tasks' interdependence workers too enter into a specific connection mode, but while tasks interdependence remains fixed during the whole processing – because it is technologically defined and associated to each module – workers' connection mode depends on which task has been taken, and in principle it can change at any step.

Agents' Behavior

In every interval each agent has at its disposal three actions:

1. If she is not already engaged in a task component, then she can look for a new task to work out;
2. If she is already engaged in a task component, she proceeds to execute the following component (if any);
3. She forcedly remains inactive, because she cannot do any of the previous things.

Hence, the three actions are respectively: researching, executing, or waiting. In the former case an agent is looking for a new task to work out, because intentional defeating behaviors are not allowed in this version of the COD Model. Social loafing and its consequences on workgroup performance is implemented and studied in other versions of COD Model (Sevi, 2010). Tasks taking charge is chosen by members who are not currently engaged in some task, eventually because in the previous step they have just completed a task. To search a new task, she reviews all the components of all the tasks present in TaskCreator – that is, the objects place on the common table of library. Then, she chooses one randomly or by intentionally. This latter attitude is related to the enforcement of the following norms: avoiding locked components with norm 4, prioritizing tasks in progress with norm 5, or prioritizing tasks under working with norm 6. If an agent finds a task (module), she takes over the component and in the next interval she starts working. Indeed, especially for the workers' interchangeability assumption, in modern time it's enough to have a software showing the advancement state of each module, and specifying its inner connection mode. In case she does not find any component, she waits for the following period for a new search.

An already engaged agent proceeds executing that specific task moving from a component to the next until completing the task. Therefore, the possibility to leave the current execution of a task before its completion is excluded. The way in which an agent performs more or less effectively and efficiently depends on four factors: i) connection modes existing between tasks to be worked out and the stage of connected tasks; ii) task length (in terms of components); iii) group size; iv) workload charged on the whole group.

The third action available to an agent is inactivity, which is caused by the definitive or temporary impossibility to execute a task. This occurs in two particular situations: i) when an agent working on a sequential task has chosen – and thus, is engaged – in a component whose antecedent has not yet been performed; ii) analogously to the previous case, when an agent is engaged in a component whose task is connected to another in reciprocal adaptation, and this latter is trapped waiting for the necessary cooperation from other agents.

As already shown in tab. 3, in order to reach a given level of performance, each connection mode needs a specific norm or a specific combination of norms. Because the aim of this paper is to evaluate the effects of group size and task complexity on group performance, it was essential to neutralize the effect of connection mode. For this reason we set the model by applying to each connection mode the norms required to result in a fully efficient performance, as specified in tab. 3. Thus, in this work we designed groups that work on: parallel tasks by using the cooperation norm, according to which every agent does work, nobody defeats, free-rides, defects or loafs; sequential tasks by applying the anti-trap norm, according to which agents avoid to be engaged in locked tasks - that is, tasks following tasks not yet executed; reciprocal task following the collaboration norm, according to which agents give priority to choose tasks of modules under working by other agents.

Research Design

Our analysis takes place through various virtual experiments obtained by combining the three connection modes, workgroup size varying between 2 and 13 agents, module complexity varying between 2 and 4 tasks, and task complexity varying between 2 and 6 components. The range of variation of group size is consistent with indications coming from management and organization literature, according to which organizational units working on moderate levels of standardization and routinization, like an administrative office or a shop floor, have a size averaging between 5 and 12 people.

As concerning module and task complexity, lacking statistical data we hope that the chosen range correspond to a common situation. Certainly, as we previously referred to, this model has been built getting inspiration from the case of librarian jobs, at least in the old approach, when objects were exclusively or mostly papery materials. It could be the case of many other manual jobs, like apartment removal-transfer, or many other administrative office or shop floor jobs. Of course, there are also many much complex products, like car or aircraft components, which involve interdependence between much more tasks and components at the same time. The exploration of this combination space could be easily done in future experiments with COD Model, once that there were discovered good reasons to believe that some emergent phenomenon can occur due to scale effects phenomena related to module and task complexity. In fact, lacking such good reasons, the effects observed and analyzed in the range of variations examined here would be enough, because tendencies seem clearly depicted. Indeed, the augment of experiments and of their implementation at extreme conditions within the combination space would be very wishful to draw laws or quite general formal relationships. Hence, this task is charged on the future research agenda.

In order to measure group performance, we use as index the effectiveness, which is measured by the fraction of completed (fully executed) modules calculated at end of 1000 iterations of each virtual experiment. To eliminate any possible influence of initial conditions (and thus, of random seeds) on performance results, we used a series of 10 simulations, each with a different value of random number generators: average performance is calculated on each series of 10 simulations. Workload is not given at the beginning of work time[11], but supplied to the group step-by-step with a module creation frequency of 0.8. Therefore, in each simulation our librarian workgroup copes with 800 modules in average. The choice of a high frequency is justified by the need to show clear differences in performance between the various working groups, because in a series of pilot experiments – that we don't show here – we have seen that lower frequencies allow agents to easily complete all modules, and in such a situation the differences in effectiveness may due to random phenomena.

This remark is a sort of "anticipated result", which came from preliminary model tests. It offers already some interesting suggestion, because it states that, without time pressure and/or significant workload, the role played by connection modes sharply loses salience. In fact, under one or both of such circumstances, the performance of parallel, sequential or reciprocal connection modes tend to be, ceteris paribus, quite residual and largely dependent on initial conditions. However, it should be underlined that this conclusion holds not only under such conditions, but also (and likely remarkably) when dealing with only technological interdependencies, as we do in this model, that is, neglecting behavioral and

Table 4. Module complexity and size effects on workgroup effectiveness

		P2	S2	MA2			P3	S3	MA3			P4	S4	MA4
N. Tasks 2 N. Agents	2	14,4	18,2	25	N. Tasks 3 N. Agents		-	-	-	N. Tasks 4 N. Agents		-	-	-
	3	29	34,5	29		3	8,3	14,1	24,1			-	-	-
	4	47,6	52	50,4		4	16,8	23,7	27,2		4	5,7	11,8	23,8
	5	67,6	70,7	57		5	27	35,1	30,3		5	10,1	18,7	25,8
	6	90,1	91,2	76,3		6	40,5	48,1	49,6		6	17,3	27,1	27,9
	7	99,4	99,3	85		7	54,4	60,7	53,4		7	25	35,3	31,2
	8	99,7	99,4	98,9		8	70,1	76,1	59,2		8	34,8	45,9	48,4
	9	99,6	99,5	99,4		9	89	89,9	74,3		9	46,3	53,9	51,7
	10	99,6	99,3	99,5		10	99,2	98,6	80,9		10	57,8	66,3	55,2
	11	99,6	99,3	99,5		11	99,5	98,8	86		11	70,9	76,5	60,2
	12	99,6	99,3	99,5		12	99,6	98,9	98,2		12	87,3	89,8	73,2
	13	99,6	99,3	99,6		13	99,7	98,9	99,3		13	99,1	97,9	77,9

informational interdependencies, and many other characteristics of real agents' behavior, like defecting, cheating, etc., some of which have been analyzed in other models (Biggiero and Sevi, 2009; Sevi, 2010).

RESULTS ON SINGLE MODE SPECIALIZED GROUPS

Group Size Effects

In this section experiments will be implemented supposing that the production process occurs with only one connection mode, so to be able to make distinctions and comparisons among modes. To analyze size effects, we have created a series of simulations in which we let vary the number of agents between 2 and 13. Results are then grouped according to module's complexity - varying between 2 and 4 tasks – while keeping task complexity constant at 3 components: for example (tab. 4), P2, S2 and MA2 report the effectiveness of groups with tasks characterized by, respectively, parallel, sequential and reciprocal connection mode working with 2-tasks modules, and a number of actors that varies between 2 and 13. Notice that, for we have supposed that reciprocal adaptation should occur in a simultaneous way, to work out modules with 3 tasks, a group should have at least that size. Indeed, in principle it is possible to relax this condition, if dealing with a sequential feedback loop or even a free ordering, which are the two alternative applications of the reciprocal connection mode.

Referring on evidences of tab. 4, the results of the three groups of simulations with module's complexity varying between 2 and 4 tasks show that group performance sharply declines, even adding a single more task. This outcome is common to all the three connection modes. However, group size can compensate the reduction of effectiveness given by module complexity, but this compensation differs a lot between the three modes and it is very sensitive to the level of module complexity. In fact, when this level is at 3-task, a 10-members size is enough to reach almost max effectiveness with parallel and sequential connection, while with the reciprocal it would lack still 9%. Three more workers would be necessary to reach that same performance. With a 4-task level of module complexity, even 13 workers are not enough with reciprocal connection.

What is noteworthy is that such a relative disadvantage of the reciprocal respect to the other two connection modes intervenes only from the 9-members size on, because under that size the reciprocal mode is relatively advantageous. In other words, comparative effectiveness grows nonlinearly, likely because, notwithstanding the collaboration norm, when many workers approach the workload of modules characterized by reciprocal connection the effects of "reciprocal waiting", and thus, inactivity prevails, over time, on the capacity to complete modules and free workforce.

Another important result is that groups working on modules characterized by sequential connection always perform better than those working with parallel, regardless of module complexity and group size. Conversely, the advantage of sequential over reciprocal connection declines when module complexity increases and/or group size decreases. Finally, and interestingly, effectiveness gain obtained through size growth is always higher in the parallel and lower in the reciprocal connection, regardless of module complexity.

The explanation is that, holding the rule of forcing members to collaborate, small size groups with mutual adaptation perform better because they manage to concentrate available resources on specific incomplete modules' tasks. On the contrary, in parallel and sequential modules agents go to deal with incomplete (or new) tasks that will never be entirely concluded, because they are not forced to collaborate. On the other hand, let's remind that, without a collaboration rule, reciprocal adaptation performs very bad, because it is the most complex connection mode. In other words, its technical (inner, structural) complexity is so high that without that norm (and its accomplishment) mutual adaptation tasks are not viable (Biggiero & Sevi, 2009).

When size substantially increases, however, the need of collaboration required for mutual adaptation dramatically increases workers' waiting time, so losing effectiveness relatively to groups that deal with parallel and sequential tasks. This evidence confirms the common knowledge that the performance of a workgroup with mutual connection, which is well represented by a teamwork, dramatically decreases with group size. To this common knowledge our experiments add not only an algorithmic demonstration, but also that this effect occurs already at very small size, like 4-5 members.

Looking at the overall relationship between connection mode and group size we can conclude that groups with parallel or sequential tasks are directly and positively sensitive to size growth: it linearly increases their performance. Conversely, groups that deal with mutual adaptation turns out to be very effective in small size, but its growth improves performance in a less than proportional way.

Components Number (Tasks Length)

Besides the connection mode linking tasks, and besides tasks number, module's complexity is given also by tasks length. To study the effects of this factor – which is measured by the number of task components - we have developed a new series of simulations in which task components number varies between 2 and 6. In this group of simulations (tab. 5) size is held constant at 4, and the label of each workgroup refers to the tasks number to be performed. For example, MAc3 has size 4 (as all groups in this section), and deals with tasks in mutual adaptation with 3 tasks number and a number of components varying between 2 and 6. Looking at effectiveness, we can see that with many components mutual adaptation ensures better performance than the other two modes. Therefore, consistently with previous results, mutual adaptation performs better when tasks are more complex. This effect is even more evident when

Table 5. Task complexity and group size effects on effectiveness

		Pc2	Sc2	MAc2			Pc3	Sc3	MAc3			Pc4	Sc4	MAc4
N. Tasks 2 N. Compon.	2	75,5	77,4	62,6	N. Tasks 3 N. Compon.	2	31,7	38,9	34,4	N. Tasks 4 N. Compon.	2	12,4	21	29,9
	3	47,6	52	50,5		3	16,8	23,7	27,2		3	5,7	11,8	23,9
	4	33,4	37,8	41,8		4	10	15,8	22,2		4	3,2	7,1	20,1
	5	23,5	29,1	35,9		5	6,8	11,3	18,8		5	1,8	4,8	17,4
	6	18,7	22,7	31,1		6	4,2	8,7	16,4		6	1,2	3,5	15,4

tasks number reaches 4 (Pc4, Sc4 and MAc4), because they add up the two effects of complexity: tasks and components number.

To be more precise, lengthen tasks from 2 up to 6 components obviously decreases performance, because modules need more time to be completed. However, such a reduction is inversely related to the complexity of connection mode: modules characterized by parallel connections lose a little bit more effectiveness than those characterized by the sequential, and both they lose, in turn, *much more* than groups working on modules characterized by reciprocal connection.

Interestingly, the increase of task numbers makes reciprocal connection groups much more resilient to performance decline. And this resilience grows with the increase of task length: with 6 components, reciprocal connection groups lose 50% of performance, while parallel groups lose 76% and sequential 70%. Noteworthy, effectiveness loss follows a law of marginal diminishing returns.

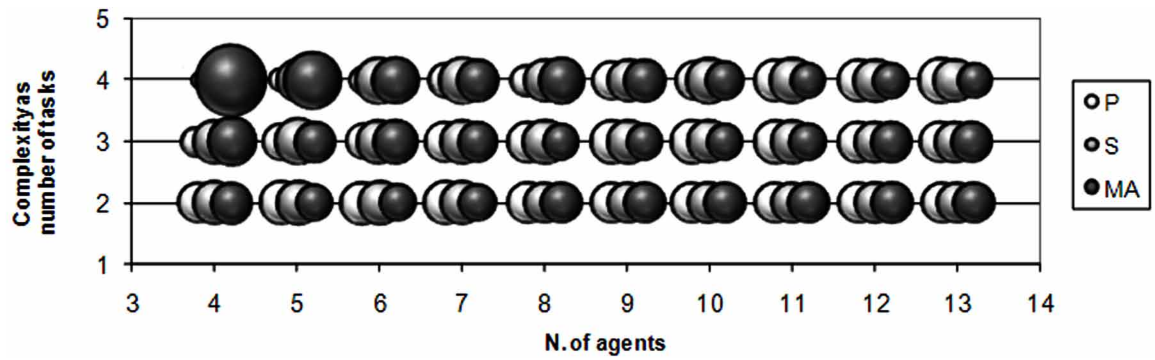
Apparently, in groups working in parallel or sequential modes the dispersion of resources grows with increasing tasks length (components number), because workers are longer engaged in tasks that will remain incomplete. From this follows that, given a limited number of human resources and complex modules, mutual adaptation would increase its performance. This confirms a fundamental principle of cybernetics, namely Ashby's law of requisite variety (1957), according to which, in order to be effective, a system's variety (complexity) should be at least at the same degree of that of its environment. In our model, environment complexity is given by modules' complexity generated by TaskCreator, that is lying on the common table of library.

Hence, if a workgroup were free to choose the most appropriate connection mode of its tasks, then it had to implement mutual adaptation when dealing with complex modules, but only under a strict rule of high levels of collaboration. Lacking that rule, it would become much better a sequential or parallel connection, if there exist a technology based on these two connection modes for the modules that should be manufactured. Alternatively (or in addition), the suggestion for managers would be that, if possible, of simplifying modules complexity reducing their tasks number and length.

A Summary View

The following figures (fig. 3 and 4) show group effectiveness by crossing size (agents number) and module's complexity (tasks and components number), while bubbles size depicts *relative effectiveness*, that is the percentage of effectiveness absorbed by each connection mode, expressed by the ratio on the whole performance in absolute values when summing up all the three modes. Overall, at low levels of complexity there are no substantial performance differences, but increasing complexity and with a limited group size mutual adaptation proves to be the most effective, followed by the sequential mode.

Figure 3. Module complexity and group size effects on relative performance



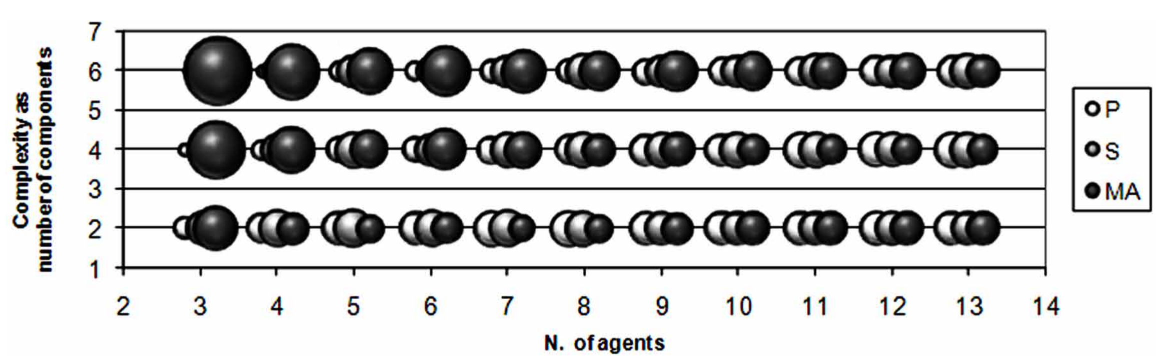
However, if size further increases positions change until sequential mode become the most effective, followed by the other two. We can conclude that with a limited number of human resources and high module complexity, reciprocal adaptation is more effective than sequential and this latter than parallel. This relative advantage of mutual adaptation gradually disappears increasing group size or decreasing module complexity. Relative advantages are reverted when tasks number grows, and neutralized when components number grows.

All these results indicate that the most appropriate combinations between connection mode, module complexity, and group size occur when:

- Complex tasks are connected by mutual adaptation and worked by a small number of agents;
- More or less complex tasks are connected by parallel or sequential modes, and performed by a large number of agents.

All the other combinations are not suitable. Clearly, these conclusions are crucial to organization design and group management, and especially if technology offers, for that specific products, viable alternatives in terms of connection modes. This would become even more significant if it were discovered that, as regards the module complexity and group size, a theory of coordination showed analogous results. But this is on the future research agenda.

Figure 4. Task complexity and group size effects on relative performance



Mixed Modes Groups

So far we have analyzed working groups specialized in the execution of only one connection mode, but this assumption is not fully reflected in real world since most workgroups are usually engaged in more than one. Although you can find a prevailing mode, it is reasonable to assume that most groups cope with multi-mode products. Thompson (1967) supposed too – but did not ever empirically verify - that modes are cumulative according to increasing levels of complexity. In particular, he claimed that a group coping with mutual adaptation will face also the other two, and that a group coping with sequential tasks should also face with the parallel, but that it won't be able to cope with work in mutual adaptation. Finally, a group struggling with parallel tasks can and should solve such tasks only. Though Thompson's focus is on agents' connection modes while we have built our model on modules-tasks, the idea that multiple modes intervene in most works is the same, and should be dealt with.

We then analyze workgroups copying with different modules, which imply different connection modes between their tasks[12]. We keep the condition that one mode prevails over the others, in the sense that there are more modules implying that connection mode. More precisely, each mix is made by 80% of tasks connected through the prevailing mode, and 10% of tasks for each of the other two modes. In this way we get three blocks of simulations with the following compositions:

- Pm: 80% parallel, 10% sequential, 10% reciprocal;
- Sm: 10% parallel, 80% sequential, 10% reciprocal;
- MAm: 10% parallel, 10% sequential, 80% reciprocal.

Group Size Effects

Looking at effects of group size[13] (tab. 6), we can immediately see that performance is essentially identical to that already seen in specialized working groups, because mutual adaptation proves to be the most effective in small groups. Likewise, groups that perform most tasks with sequential interdependence are consistently more effective than those that deal with parallel tasks. However, besides this qualitative similarity, a quantitative comparison between tab. 1 and tab. 5 shows a clear difference in the amplitude of returns, due to the cross-effects of mixed mode with an increasing number of agents: mixed groups performance results are smoother, and results seem to converge towards a common central value. For example, the group with a limited number of actors that poorly performs parallel tasks (P of tab. 1) seems to take advantage of the ability to perform tasks of other types (Pm's tab. 5). The opposite happens in other groups which, dealing now with a 10% share of parallel tasks too, decreases the level of their performance. By growing size, as we saw earlier, the low effectiveness of mutual adaptation flattens the performance of those groups that include a share of mutual adaptation tasks respect to those specialized in merely parallel and sequential tasks (P and S tab. 1). Specialized groups are more effective than those working on multi-modes, among which the only improvement occurs with prevailing parallel tasks (Pm) and with limited size. From these results we can infer that *having to perform a given amount of modules whose manufacturing is characterized by different connection modes, and assuming the possibility to choose the ways of forming groups and establishing their connections, the most effective choice is to assign modules to specialized groups*.

Table 6. Module complexity and size effects on workgroup effectiveness with mixed modes

		Pm2	Sm2	MAm2			Pm3	Sm3	MAm3			Pm4	Sm4	MAm4
N. Task 2 N. Agents	2	15,1	17,4	22,8	N. Task 3 N. Agents		-	-	-	N. Task 4 N. Agents		-	-	-
	3	29,7	32,6	29,2		3	10,2	13,5	22,1			-	-	-
	4	46,4	50	47,6		4	18,1	22,2	26,8		4	8,9	12,3	21,8
	5	66,1	68,1	58,4		5	27,6	32,4	29,9		5	13,3	17,7	25,6
	6	87,3	88,9	75,3		6	39,5	44,1	44,9		6	18,8	24,3	27,7
	7	99,3	99,1	88,4		7	52	56,3	52,9		7	25,3	32,7	30,6
	8	99,6	99,4	99,2		8	67,9	71,2	58,6		8	35,1	41,3	44,3
	9	99,5	99,3	99,5		9	83,9	87,3	70,7		9	45,1	51,3	50,3
	10	99,6	99,4	99,5		10	98	98,2	79,7		10	56,8	61,9	54,4
	11	99,5	99,3	99,5		11	99,4	99	90,4		11	67,7	73,5	58,5
	12	99,5	99,3	99,5		12	99,6	99	99		12	81,2	84,3	68
	13	99,6	99,3	99,5		13	99,5	99	99,4		13	95,2	96	76

Components Numbers (Task Length)

Here we can still see that (tab. 7), as task length grows, the best performance is obtained by groups who work mostly in mutual adaptation. However, by comparing these results with those of specialized groups, parallel and sequential modes perform better, and this accentuates by increasing complexity. In fact, the largest collaboration demanded by mutual adaptation allows mixed groups that run mostly parallel and sequential tasks to tackle more effectively complexity growth. However, this strategy reduces the effectiveness of the group which works mainly for mutual adaptation. In a certain sense, *the higher collaboration implied by reciprocal adaptation supports sequential- and parallel-dominated groups performance, while the lower collaboration of sequential and parallel modes "poison" the performance of groups with prevailing mutual adaptation*.

CONCLUSION

In this paper we analyzed the effects of group size and module complexity on the performance of groups specialized on a single connection mode or using mixed modes. The main results can be summarized as follows:

1. While holding module complexity constant, at small size mutual adaptation ensures better relative performance, but this advantage lowers with size increasing;
2. An increasing in module complexity makes mutual adaptation again advantageous;
3. The best combinations between connection modes, task complexity, and workgroup size occur when complex tasks are connected by mutual adaptation and run by a small number of agents, or when less complex tasks are connected by parallel or sequential interdependence and performed by a large number of agents;

Table 7. Task complexity and group size effects on effectiveness in mixed mode groups

		Pmc2	Scm2	MAmc2			Pmc3	Smc3	MmAc3			Pc4	Sc4	MAmc4
N. Task 2 N. Compon.	2	71,4	73,2	62,1	N. Task 3 N. Compon.	2	30	35,2	26,8	N. Task 4 N. Compon.	2	14,4	18,5	28,2
	3	46,4	50	47,4		3	18,1	22,2	26,8		3	8,9	12,3	21,8
	4	34	36,5	39,6		4	12,7	15,8	21,9		4	6,4	9,6	18,2
	5	25,6	28,1	34,4		5	9	11,9	18,6		5	5,4	7,9	15,8
	6	19,8	23	29,7		6	7,6	9,8	16,4		6	4,5	6,4	13,8

4. When a modules volume to be worked out is heterogeneous in terms of connection modes between module's tasks, and thus, a multi-mode group should be issued, respect to the corresponding choice of issuing specialized groups there is a general decrease in efficacy;
5. With small workload all differences tend to disappear.

Notwithstanding the copious literature on organization design briefly recalled in section two, it is almost impossible to compare our results with similar studies, because the complexity of the problems allows so many different research designs that it becomes hard to find comparable results. The variables lacking in this study but considered in others, and the variables considered here but lacking there prevent a correct comparison. For instance, here we did not consider economic and cognitive variables, neither product complementarity nor scale economies (even at technological level). Conversely, most economic and organizational literature deal with one or more of these variables, while lacking important technical or coordination aspects, like the modules and task structures. Moreover, many studies focus on the whole organization level of aggregation, and analyze the consequences of coordination mechanisms or task complexity in terms of the optimal level between centralization and decentralization of decisions. On the contrary, our analysis rests on workgroup level, and we doubt that results may be extended at organization level by simply increment group size, because too many other variables had to be taken into account.

Besides overlooking the coordination mechanism of direct supervision, the main limitations of this work are just related to the lack of some abovementioned variables, which would have substantially enriched the analysis and made results more comparable with other studies. Moreover, an explicit modeling of the connections between the workgroup performance with input and output environment would have made the efficiency and effectiveness analysis much more interesting and dynamic. However, dealing with basic questions in organization design and coordination theory that were still waiting for a clear and elementary treatment, we opted for a sort of KISS-style model, that is a research design extremely simplified with which running basic experiments. We hope that this effort could be appreciated and be useful for future developments, even though we know that when issues are so complex and hence analytical approaches so vary it becomes difficult to stratify and combine knowledge pieces obtained through very different models[14].

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ENDNOTES

[1] Indeed, this is a delicate and crucial issue, because structural aspects influence and are influenced by some behavioral aspects, but these interactions and its consequences are almost not investigated at all. Usually, who studies structural neglects the behavioral aspects, and vice versa.

[2] Here we speak generically of organizations and not specifically of firms, because what we say is at a such fundamental level that applies to both profit- and not-for-profit organizations.

[3] See also Lucio Biggiero & Antonio Mastrogiorgio in Chapter 7 of this book.

[4] For an introduction to agent-based simulation modeling in social sciences see Gilbert (2008), Gilbert & Terna (2000), Gilbert & Troitzsch (2005), Squazzoni (2012), Tesfatsion & Judd (2006). For the use of this methodology into the field of management and organization sciences see Burton and Obel (2013), Carley (2009), Carley & Prietula (1994), Davis *et al.* (2007), Dooley (202), Harrison *et al.* (2007), Ilgen & Hulin (2000), Lomi & Larsen (2001), Prietula *et al.*, (1998).

[5] In principle, other four types of interdependence can be well identified: behavioral, cognitive, economic, and informational. However, for a theory of the relationships among the five types is not yet even sketched in current literature, and for even each of these four latter is still ill investigated, we focus out analysis only on the technological type, which is indeed traditionally the most studied.

[6] When considering time, four other modes of connection add, because the parallel and the reciprocal can be divided into three basic cases. However, in this work we treat only three modes, which implies that we consider the parallel mode without time constraint in the execution order, and the reciprocal mode in the simultaneous mode. It means that in the former we assume the most simplex and in the latter the most complex case.

[7] Notice that reciprocity can take place also indirectly, "going through" one or more other tasks/agents. However, in this case of indirect reciprocity the property of reciprocity is not "pure", because it needs to be combined with a sequential mode.

[8] As can be seen, direct supervision has been overlooked.

[9] In our research design members are indistinguishable: same skills, same rules, same rationality, and no roles. They are a group of peer, and when they adopt the collaboration norm they constitute a team, because it implies that they communicate and cooperate each other.

[10] COD Model program can be found at www.knownetlab.it, where one can find attached guidelines for its concrete use. It's necessary to download LSD simulation platform (Laboratory for Simulation Development), available at http://www.labsimdev.org/Joomla_1-3/.

[11] It should be underlined that this choice strongly influence final results, as we understood from some piloting experiments and inferential reasoning. In fact, it directly reminds the crucial role played on organizational performance by the external environment. This issue, and the corresponding problem to find the appropriate environment/organization fit, has been deeply and extensively discussed in management and organization science. Here we do not deal with it, and thus, we made the choice of a stable environment, which supplies a constant quantity of a same type of product (or mix of products), depending on the specific experiment.

[12] Notice that the mixture occurs between and not within modules. In other words, modules remain internally homogeneous, and a mixed-mode workgroups deals with modules that differ in terms of the characterizing mode. The interesting case of modules characterized internally by hybrid modes has not been explored.

[13] As for the previous section, in this first group of analysis components number has been blocked on 3. Moreover, we use the same codification of specialized group: for example, MAm4 in tab. 5 indicates the effectiveness of the group that manufacture products with 4 tasks connected in the following proportion: 10% in parallel, 10% in sequential, and 80% in reciprocal.

[14] For a discussion of KISS and other perspectives on ABSM and its implications for knowledge growth in socio-economic sciences, see the Conclusion chapter at the end of this book.