# DIFFERENT PARTS FOR DIFFERENT SMARTS: PARTONOMIES AND THE ORGANIZATION OF WORK

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## INTRODUCTION

This paper proposes an approach to analyzing the structure of common information spaces. The approach rests on three ideas. First, information spaces can usefully be described in terms of abstract relations used by participants to organize their work and interaction with one another. Here, I focus on part-whole relations as an example. Second, coordination mechanisms (in the sense of Schmidt and Simone 1996) are the devices and practices which realize connections among the different parts of information spaces. They thus form a natural focus for CSCW. Third, the relations among actors and their activities can be analyzed in terms of commitments and alliances among them.

## MULTIPLE PERSPECTIVES AND COMMON INFORMATION SPACES

The notion of common information space was developed by Bannon and Bodker (1997). The idea refers to a system of relations among actors who are participating in some activity together. In particular, a common information

space is the joint system of categories, descriptions, facts, knowledge, etc. which people and machines construct and use in the course of working together. The “space” is embodied in computer files, written documents, and many other physical arrangements used to store information. Access to the storage arrangements and knowledge of how to use them is part of the space. Such information (i.e., meta-data about the space itself) may or may not be embodied in the space.

What makes an information space common is joint use of (and access to) items of information, together with the interpretive arrangements which accompany and enable that use. The commonality of a common information space does not rest on agreement or consensus among users on either the content or structure of the space, nor does it rest on agreement of values and beliefs. Commonality means cooperation, not consensus.

An example will make the point clear. Every night when I sit down to dinner, my cat comes to me, puts her paw on my knee, and looks at me intensely. In doing so, she reminds me to take the various medicines which I am obliged to consume. In turn, I make a point of giving her a couple of treats, which are also little pills from a small plastic bottle. The common information space here is our joint knowledge that good things come as pills of a certain size, that these pills are stored in bottles of a certain size, that moving one of the bottles will cause the pills to rattle in a way that can be heard all over the house, that I keep some of the pills all to myself (despite clear instruction to the contrary), and many other facts about pills and their distribution.

Obviously, we need not attribute concern for my health or knowledge of pharmacy to the cat. She knows only that there are times when I will hand out tasty pills of a certain kind. Conversely, I know little or nothing about the cat’s problems in finding interesting treats. I know only that she will remind me to take my medicine. Each of us considers the other greedy and ignorant, but nonetheless serviceable, and we are content.

Of course, there is no guarantee that such a happy state of affairs will always be the case; cooperative work among humans is fraught with mis- and non-understandings which often result in inefficiencies, errors or damage. This has been a point of interest to data base specialists for many years. William Kent, for example, lists dozens of ways the relationship between a

few objects can be represented in a relational structure (Kent 1978, 1989). The tendency has been to view these non-matches as a problem to be overcome, presumably by superior design and more powerful technology. But one of the lessons which CSCW has driven home is that non- and mis-matches are inevitable and frequent, and that colleagues routinely develop ways and means of dealing with them and their consequences.

Each difficulty met by the people we study has its own history and character. It is like Tolstoy's unhappy families: each is unhappy in its own way. We need a more general apparatus for describing and analyzing cooperating actors' ways of framing things in common information spaces. One powerful way of doing this is to categorize information spaces in terms of the conceptual relations actors use to organize it. Here, I focus on the ways in which participants divide the objects of their concern into part-whole relations. I choose these relations because they appear in every sort of work, and yet they have received relatively little attention. For example, task structure (and the division of labor) can be viewed as part-structures; so can schedules.

## PART-WHOLE RELATIONS: COMPOSITIONS AND AGGREGATIONS

There are two broad kinds of "part-of" relation (This way of framing the distinction is due to Wimsatt 1985). In the first kind, called *aggregates*, the parts have no particular relationship to one another, or vis-à-vis the whole. They can be moved around, interchanged, even added and deleted from the whole without significantly changing the character of the whole. Figure 1 lists some important aggregate relations.

| Relation | Part | Whole | Example |
|---|---|---|---|
| Member-of | Member | Collection | Tree \ forest |
| Portion-of | Portion | Material | Grain \ salt |
| Period-of | Period | Duration | Childhood \ lifetime |

**Figure 1. Some aggregate relations**

In the second kind of part-whole relation, called *compositions*, changing, adding, or deleting a part changes the whole in some significant way. Thus, what differentiates compositions from aggregates is that

compositions have at least one relationship between the parts and the whole. The relation is usually conceptualized as one of *function*-- that is, the existence or activity of the part is reflected in the properties or performance of the whole. Thus, for example, each stone in an arch acts to keep the arch erect; removal of any one stone will bring the arch down. By contrast, in an unorganized heap of stones, removing, adding or changing the relative positions of individual stones will still leave us with an unorganized heap of stones. Figure 2 lists some compositional relations.

| Relation | Part | Whole | Example |
|---|---|---|---|
| Place-of | Place | Region | City \ county |
| Made-of | Ingredient | Compound | Flour \ bread |
| Component-of | Component | System | Engine \ car |

**Figure 2. Some compositional relations**

Compositions have certain properties, depending upon the ways in which the parts are related to the whole. We can think of these as defining different kinds of composition. Among the most important are:

*Exclusivity*. Sometimes, a part may be shared among several different wholes. For example, a particular bibliographic citation may appear in several different published articles. None of the articles thus has exclusive possession of the part. By contrast, an automobile's engine may be a component of only one particular automobile at a time.

*Separability*. Parts sometimes can have an existence independently of their containing whole's existence, and sometimes they can't. For example, a room is not separable from the house of which it is a part, but the door to that room is.

Many additional complexities associated with classifying part-whole relations have gotten attention lately (cf. e.g. Artale et al. 1996; Casati and Varzi 1999; Gerstl and Pribbenow 1995, 1996; Kim et al. 1989; Motschnig-Pitrik and Storey 1995; Motschnig-Pitrik and Kaasbøll 1999; Simons 1987; Winston et al. 1987). Discussing them is not my purpose here. Rather, I want

to turn now to some of the implications of actors' classifications of part-whole relations.

## PARTONOMIES

In analyzing common information spaces, we naturally focus on the hierarchies of groups within groups formed by the taxonomies we use to classify things, processes and relations. In order to understand work relationships, we also need to consider part-whole relationships as well, together with the hierarchies we use to organize them. Hierarchies of parts are called *partonomies*, by analogy to the taxonomies used to organize relationships among kinds. But partonomies are not precisely analogous to taxonomies for several reasons.

First, partonomies are usually taken to describe individuals rather than classes. Even when we speak of part-whole relations in a class-oriented way, we are usually speaking elliptically. Thus, for example, when we say that an engine is part of a car, what we mean is that each particular engine is part of some particular car. This focus on individuals is even stronger when the part-whole relations involved are exclusive and inseparable.

This is not to say that it is impossible to have a partonomy of classes. It's entirely reasonable to talk about the part-structure of a class-- meaning, the part-structure of the members of the class. This treats exclusively of the extension of the class, not its intension. A car may have an engine, but the definition of a car does not have an engine; it has an engine-mention or engine-specification, which is not the same thing at all.

A second major difference between taxonomies and partonomies also arises from the focus of partonomies on individuals. Taxonomies don't classify individuals-- they identify or diagnose individuals as instances or members of a class. By contrast, we not only have partonomies of an individual; we routinely have multiple partonomies of the *same individual*, each rooted in the concerns of different participants. For example, consider the parts of a particular book, from the perspective of each of several audiences, as shown in Figure 3:

| Audience | Critic | Reader | Author |
|---|---|---|---|
| Part | Plot<br>Theme<br>Character | Good stuff<br>Boring stuff | Flow of scenes |

**Figure 3. Parts of a book, from the perspectives of different audiences**

These different partonomies cut across one another in complex ways, yet each is a legitimate way of viewing the structure of the book.

A third major difference between taxonomies and partonomies is that different compositional relations generate different partonomies. Taxonomies typically are restricted to non-overlapping groups within groups. In contrast, we usually see no fundamental difficulty in the fact that different relations break something up into parts that don't necessarily coincide. The example of the book just given illustrates this as well. Sub-plots and characters cut across different scenes, for example. Alternatively, consider the task of planning and cooking a dish. Recipes routinely use two different partonomies: a list of ingredients, and a set of prepatory steps. The two partonomies are complementary.

In fact, even, even the *same* relationship can generate different partonomies. For example, the bones of my left fore-arm are part of my left arm, which is in turn part of my body. The same bones are also part of my skeleton, which is part of my body.

Analyzing partonomies is of course not the only way we may look at the structure of common information spaces. Virtually any relationship of interest, not just part-of or kind-of, can provide the basis for an analysis. These include, for example, version-of and depend-on. Moreover, many important and interesting connections are composed of mapping from the space created by one relation to that created by another. For example, comparative biology rests almost entirely on mappings among the classification of body parts (based on part-of), the classification of species (traditionally based on kind-of), and the classification of developmental sequences (based on phase-of) (Gerson 1998). So one topic for further research

in the study of common information spaces is analyzing patterns or systems of classification created by participants' use of relations.

By itself, analyzing the conceptual relations used by actors in negotiating their information spaces does not take us very far; we want to know how this way of looking at things ties to the organization of affairs. To do this we need two additional sets of ideas. One is knowledge of the ways in which actors and activities are organized; the other is a view of the ways in which social organization and information spaces come together.

## COMMITMENTS AND ALLIANCES

One useful way of analyzing organization is in terms of commitments of actors and alliances among lines of work. Here, I am making use of results in the sociology of work, and especially the Chicago school of symbolic interactionism. Philosophically, the approach is rooted in American Pragmatism, especially that of John Dewey and George Herbert Mead (e.g., Dewey 1938, Mead 1934). Sociologically, my approach is descended from the work of Anselm Strauss (e.g. 1991) and Howard S. Becker (e.g. 1970, 1986). In the last few years, the interactionist approach has converged with that of Bruno Latour, Michel Callon, and their associates at the Ecole de Mines in Paris (e.g. Latour 1987) and the two now form a commensurable, if not integrated, approach to the sociology of science. I've developed the ideas mentioned here in more detail elsewhere (Gerson 1998).

The most basic category I shall use is the notion of commitment introduced by H. S. Becker in 1960. A commitment is a bet that a certain course of action (and not others) will turn out to be the right thing to do– or at least, an adequate thing to do. For example, choosing one organism to study rather than another, or one experimental design rather than another, or one hypothesis rather than another, are all kinds of research commitments that scientists make routinely. Commitments are more than a verbal promise. They are an actual expenditure of resources. Commitments take an actor along a certain course of action; committing to one such course means that others are foregone, at least temporarily. If I spend my allowance on ice cream, then I can't buy comic books; if a scientist bets on a certain course of experiments, then she can't afford other kinds of data collection. Of course, it's often possible to back up and go in another direction. But not always;

some commitments are irrevocable– many kinds of surgery, for example. In any case, backing up and traveling down an alternative path always costs something: lost time, irritation, lost credibility, often money.

Commitments are not uniform in character. Some are more important than others. Every activity involves some tasks that must be done if the work is to be completed successfully. Latour (1987) calls these constraints of necessity "obligatory points of passage." Here, I shall call them "obligatory commitments" or simply "obligations." Of course, obligations can be negative– there are courses of action that actors should not or must not take. Misrepresenting the data of an experiment is an obvious example.

Work also involves options to which audiences are relatively indifferent: some commitments must be made, but exactly how they are made doesn't matter. Options may be specified in whatever way seems convenient, but some choice must be made. Actors choose among alternative options without seriously affecting the course of their work.

Every commitment is both enriching and constraining in its effects, opening some options and foreclosing others. Every new commitment changes the relative importance of other commitments, making some less important, eliminating others as options, and making still others obligatory. The range of available options for addressing a specific problem narrows as a line of action proceeds. Making one commitment means that other, ancillary, commitments become obligatory. This is a very general process that can be seen everywhere: *options are converted into obligations as a side-effect of other commitments*. Commitments also potentiate one another and create novelties. For example, the development of a new instrument or technique may allow the discovery of a new kind of thing, as the invention of the microscope enabled the discovery of cells and micro-organisms. Every innovation thus opens new options and enables new lines of work, while making other options obligatory and closing off possibilities. That is, *new options are created as side-effects of other commitments*.

Often, two lines of work act as audiences for one another, supplying one another with both resources and constraints. When they do, we say they have formed an alliance. An alliance is formed when some of the commitments in one line of action are specified by another line of action. Each line of activity

is typically engaged in multiple alliances. Alliances thus form a complex system, tying many activities and their participants together in an intricate web. The web is like a mass of moving rubber bands, each of different (and changing) strength. In this metaphor, obligations are knots that tie two or more bands together. The bands are constantly knotting and unknotting, stretching and contracting as the bands knotted to them move, and occasionally snap under strain. Twanging any single band propagates a wave of movement throughout the system in complex ways. Where many bands lie parallel, their combined strengths resist change in that direction. Where the bands run across one another, they pull in many different directions simultaneously. In this latter situation, new forces of relatively small magnitude can have large effects.

When lines of work specify one another's commitments, each one's restrictions may fall on either the options or the obligations of its allies. Hence, there are three possible kinds of alliance. In the first kind, options are exchanged for options. An example is ordinary economic exchange in markets with many buyers and many sellers. This kind of alliance may be stable over long periods of time, but it is easily broken when an alternative supplier appears.

In the second kind of alliance, obligations are exchanged for obligations. An example is the traditional exchange of marriage vows, "forsaking all others." Where both parties take this commitment as obligatory, there is very little room for negotiation. It is brittle, collapsing rapidly if the obligations of both participants are not met.

In the third kind of alliance, options are exchanged for obligations. For example, consider the alliances between universities, foundations, and the scientists on their staffs. Universities provide space, libraries, salaries and other resources to scientists. Scientists provide teaching capacity, and attract students because of their reputations. Foundations provide funds, and receive gratitude and glory. Each participant can easily provide some things in the bargaining, but has great trouble in providing others. A university, for example, cannot move to another place very easily; its spatial location is obligatory. Alliances in which the obligations of each participant are met by the unconstrained options of other parties are easily formed and relatively

stable. Such alliances have a natural resilience that the other two kinds of alliance lack.

In sum, we wish to conceptualize work organizations as systems of commitments and alliances among complementary and competing lines of work. In particular, we want to show how patterns of alliance favor and retard certain kinds of conceptual arrangements, and conversely, how some conceptual relations are more or less well suited to specific alliances and commitment patterns. In order to do this, we need to focus on the specific ways in which alliances operate to affect the structure of information spaces and vice-versa. This requirement naturally encourages us to consider the ways in which coordination mechanisms operate.

## COORDINATION IN COMMON INFORMATION SPACES

Schmidt and Simone developed the notion of coordination mechanisms in their 1996 paper. A coordination mechanism consists of two parts: a protocol ( a set of conventions governing the interaction of activities), and an artifact (an object which embodies the protocol and perhaps information about its state). Coordination mechanisms (or just 'mechanisms') are used to organize activities– they support work devoted to organizing work.

Coordination mechanisms are exemplified very well by business forms and the rules which govern their use: bills of lading, purchase orders, pert charts, Gantt charts, checks, bills of materials, and so on. They also include many kinds of illustration as well: engineering drawings, for example, and the many different kinds of diagrams used by software engineers in designing and implementing programs (cf. e.g., Booch et al. 1999).

Mechanisms bring together the different perspectives created and used by participants. They align and reconcile the different views (hence commitments) which participants have, so that cooperation among actors with different perspectives is possible. Of course, sometimes a mechanism does not exist, and must be created. Sometimes, an existing mechanism needs reform as changing actors, technology and circumstances make established alliances obsolete. Reforms in turn can take the form of revisions to the established mechanisms. Alternatively, they might appear as new mechanisms or conventions (workarounds) which circumvent the restrictions

of the old way of doing things (e.g. Gasser 1986). The central problem for our analysis is this: what happens when alternative perspectives (e.g., different partonomies) apply in the same circumstances? There are several possibilities.

The first case is the simplest: sometimes, there are no significant mismatches. Note that this does not mean there is agreement or happiness among the participants. A robber and his victim may both believe that the robber is willing to use his gun, but they will interpret and make use of this information in different ways, even as they cooperate.

Sometimes, participants are aware of differences, but are indifferent to them. For example, I may have strong opinions about which dishes I'm willing to eat at a meal (perhaps because of allergies), but have only a vague idea of most of the ingredients and prepatory steps that go into each dish. Thus, I might be willing to eat any dish, so long as it doesn't contain (say) cilantro.

There is a distinction to be drawn here between participants' indifference to known differences among themselves, on the one hand, and participants' ignorance of differences (which are presumed inconsequential) on the other. The distinction can become important when circumstances change, and the differences become significant in reformulated alliances.

The most interesting cases arise when partonomies conflict in some way. This can come about in many ways. For example, consider biologists maintaining a collection of specimens in a museum (e.g., Griesemer and Gerson, 1993). Traditionally, curators have used powerful insecticides to protect their collections from the attacks of insects. But in recent years, regulatory agencies such as the Occupational Safety and Health Administration have banned the use of the most effective pesticides, because they are as poisonous to humans as they are to insects. The pesticides, then, are an important aid in the curators' view, and a significant hazard in the view of safety regulators. The ban is enforced by university administrators, who have disallowed the purchase of the offending chemicals-- so a purchase order cannot be written. In short, an obligatory component of the chain of needed coordination mechanisms has been removed by one of the actors.

Here we have a conflict between two obligations: on the one hand, regulators and university officials must uphold the law; on the other hand,

curators must protect their collections; on the third hand (insects have six limbs, remember), the insects must eat. This is the most difficult and intractable form of mis-match: one which engages the irreconcilable obligations of participants. Here is a wonderful example, which appeared in the *New York Times* as I was drafting this paper:

> It could have been one of those minor triumphs that make a phone rep's day: Dawn Barbour, a customer service agent for Verizon– then Bell Atlantic– had just made an angry customer stop ranting, solved his problem and even elicited a kind word.
>
> 'I hate Bell Atlantic but you're the nicest rep I ever had' the caller said.
>
> A simple 'Thank you' seemed the right reply, but Ms. Barbour had to follow a script.
>
> 'Did I provide you with outstanding service today?' she inquired.
>
> 'Isn't that what I just said?' barked the customer, steaming right back up again.
>
> 'I felt like a total idiot,' Ms. Barbour said. But Verizon requires customer service agents to ask the 'outstanding service' question at the end of every call, she said, and if she had dropped it, a supervisor listening in could have deducted points from her performance score. Low points reduce the chance of a promotion, she said. (Walsh 2000: C1)

What is particularly interesting about this case is that the difficulty is imposed recursively; first, the script calls for a response inappropriate to the immediate circumstance; and then the local work arrangements make it effectively impossible to create a workaround. Where such mis-matches among obligations cannot be resolved somehow, the alliances will fall apart; it is telling to note that this story appears as background to the main story, which is about a protracted strike of workers against Verizon.

## CONCLUSION

The core point I want to make here is that we can best understand common information spaces in terms of commitments and re-commitments via coordination mechanisms in the systems of alliance which organize and sustain the information spaces. "Cooperation", I suggest, means building and repairing alliances which enable joint tasks to be accomplished successfully.

Alliances are built by engaging mutual commitments, and the most stable alliances involve trading off the options of one side for the obligations of the other. By construing their joint activities in ways that are commensurate, actors create a common information space.

To analyze this process, we must be able to analyze alliances, both the process of forming and reforming, them on the one hand, and the systems themselves on the other. We must also have some way of describing common information spaces systematically, and comparing the differences among them. Analyzing the relationships of coordination mechanisms to their containing systems of alliance on the one hand, and to their associated information spaces on the other, seems a good way to start.

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