TACIT & EXPLICIT KNOWLEDGE

HARRY COLLINS

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PREFACE

This book began as an attempt to put my earlier studies of tacit knowledge together in a coherent way. I thought it would be easy, but I soon found that rather than having my arms around the whole subject, my grip was precarious. I am not the only one who thinks the existing literature on tacit knowledge is less than clear. The confusions are found in all the disciplines that take tacit knowledge to be part of their concern, including philosophy, psychology, sociology, artificial intelligence, economics, and management. This book is, first, an attempt to resolve these confusions and, second, with the resolution in hand, an attempt to produce the coherent account of tacit knowledge. It can also be seen as a foundation for the tacit knowledge–based Periodic Table of Expertises Robert Evans and I set out in *Rethinking Expertise* (2007) and as a setting for the more detailed analysis of the notion of polimorphic and mimeomorphic actions found in my and Martin Kusch's *The Shape of Actions* (1998). Thus, this book amounts to the completion of a three-book project to analyze knowledge from "top to bottom"—from the nature of expertise to the nature of actions, with the nature of tacit knowledge in the conceptual middle.

Polimorphic actions are actions that can only be executed successfully by a person who understands the social context. Copying the visible behavior that is the counterpart of an observed action is unlikely to reproduce the action unless it is a mimeomorphic action, because in the case of polimorphic actions, the right behavioral instantiation will change with context. Here it will be concluded that, for now and the foreseeable future, polimorphic actions—and only polimorphic actions—remain outside the domain of the explicable, whichever of the four possible ways "explicable" is defined. This has significance for the success of different kinds of machine and for the way we teach. If we are ever to make the tacit knowledge associ-

ated with polimorphic actions explicit, such that we could build machines that can mimic polimorphic actions, then what I will call "the socialization problem" will have to be solved first.

The argument set out here begins with the claim that existing treatments of tacit knowledge are unclear about what is meant by the terms "tacit" and "explicit." It is also argued that while it is true that all explicit knowledge rests on tacit knowledge, we would have no concept of the tacit without the explicit. The second argument is that existing work fails to separate three phenomena, all known as tacit knowledge, which are quite different and which I refer to as weak, medium, and strong tacit knowledge. These have to do, respectively, with the contingencies of social life (relational tacit knowledge), the nature of the human body and brain (somatic tacit knowledge), and the nature of human society (collective tacit knowledge)—RTK, STK, and CTK.[1] It is CTK that requires a solution to the socialization problem if it is to be explicated. The experience of the individual who is learning something new usually involves elements of all three—though not necessarily in sequence—and the resulting "Three Phase Model," I suggest, is more fundamental and general in its reach than previous approaches. The experience of the individual, however, unless examined with analytic determination, is pretty much the same whichever of the three types of tacit knowledge is being encountered, and acquiring all of the types is often part of the same learning experience; that is why existing analyses work reasonably well when they address narrow problems and why it has not been noticed that very different things are being talked about. It is, nevertheless, vital to separate these different kinds of tacit knowledge if mistakes are to be avoided when the gaze is lifted and more ambitious problems and projects are addressed.

Some of the components of this book have been discussed before. The distinction developed in chapters 5 and 6—the difference between the body and the collectivity—were to some extent worked out in my contribution titled "What Is Tacit Knowledge?" that was included in *The Practice Turn in Contemporary Theory* (2001) and in an article published in *Organization Studies*, "Bicycling on the Moon" (2007). However, a complete classification of tacit knowledge emerged only with the idea of relational tacit knowledge, which is new to this book and arrived only with the most enormous

1. I originally called relational tacit knowledge "contingent tacit knowledge" but it later occurred that it might be useful to have distinct acronyms for the three types. "Relational" captures the idea that whether these pieces of knowledge are tacit or made explicit depends on the relation between the parties. The other two types of tacit knowledge do not become explicit when social arrangements change.

struggle. Sometimes, the simplest things are the hardest to see if one starts from the wrong position, and I now see that my *Artificial Experts* (1990) has relational tacit knowledge mixed up with other kinds of tacit knowledge. A good few of the examples used here have also been used before in *Artificial Experts*, *The Shape of Actions*, and other books and papers. The old examples remain well suited to make the points, and there are many new examples, too. It is only in this book that I have begun to understand exactly how they all fit together, and that is one of the main aims of the exercise.

ACKNOWLEDGMENTS

More in the way of a division of labor than usual went into this book. It would not have been written had it not been for the extended discussions of tacit knowledge I had with Rodrigo Ribeiro during my supervision of his PhD. Many of the early problems and tentative attempts at solutions arose as we talked things over and the results have frequently found their way into the book. Later this discussion spread to the weekly seminar of the Centre for the Study of Knowledge, Expertise, and Science, and exactly who contributed what to the earliest formulations would be hard to say. On the other hand, only as the manuscript's twenty-six drafts unfolded over a couple of years did the nagging logic of the page bring out the vital importance of starting with the explicit and finding a place for relational tacit knowledge, thus driving the argument to coherence while indicating the proper roles and meanings of the elements.

In the course of writing I frequently e-mailed authors and asked them to send this piece or that and they invariably responded with grace and more advice than I had any right to expect. I will make no attempt to list everyone who has helped in this way, because I would be bound to miss some. Nevertheless, I must thank Stephen Gourlay and Edgar Whitley for keeping me in touch with existing studies—each sending me a reading list. Being a terrible scholar myself, I contrived to get them to do some of my work for me, but the end result is my responsibility, as is the fact that there is no attempt in the book to do the kind of review of the literature that would give proper recognition to everyone who deserves it. I thank Terry Threadgold for convincing me, one way or another, that the apparatus of semiotics was not what I needed for the opening chapters and it would be better to start afresh from more elemental components. Rob Evans, Stephen Gourlay, Martin Kusch, Trevor Pinch, Rodrigo Ribeiro, Evan Selinger,

and Edgar Whitley read the manuscript and sent me really useful feedback. And Chicago's two anonymous readers did a wonderful job, perfectly understanding where the book was coming from, basing their criticisms on where it was trying to go, and doing their best to help it get there. Nevertheless, all mistakes and infelicities that remain are my responsibility. Finally, Christie Henry, my editor, has been brilliant—a full partner in the enterprise. So has Mary Gehl, my copy editor, and, on the basis of my past experience, so too will Stephanie Hlywak be, when it comes to putting the thing out into the wider world. If you are ever lucky enough to get University of Chicago Press interested in a project of yours, bite their arm off.

INTRODUCTION

The Idea of Tacit Knowledge depends on Explicit Knowledge!

We can know more than we can tell.

—Michael Polanyi, *The Tacit Dimension*

Now we see tacit knowledge opposed to explicit knowledge; but these two are not sharply divided. While tacit knowledge can be possessed by itself, explicit knowledge must rely on being tacitly understood and applied. Hence all knowledge is either tacit or rooted in tacit knowledge. A wholly explicit knowledge is unthinkable.

—Michael Polanyi, "The Logic of Tacit Inference"

The Territory of Tacit Knowledge

Tacit knowledge is knowledge that is not explicated. In this book, tacit knowledge will be analyzed and classified by reference to what stops it being explicated; there are three major reasons why tacit knowledge is not explicated; therefore, there are three major types of tacit knowledge. Of course, if we are going to say why things cannot be explicated, we first have to understand what is meant by "explicated." That gives rise to the structure of this book: explain "explicit," then classify tacit.

Tacit knowledge drives language, science, education, management, sport, bicycle riding, art, and our relationship to machines. That is to say, tacit knowledge makes speakers fluent, lets scientists understand each other, is the crucial part of what teachers teach, makes bureaucratic life seem ordered, comprises the skill in most sports and other physical activities, puts the smile on the face of the *Mona Lisa*, and, because we users bring the tacit knowledge to the interaction, turns computers from *idiots savants* into use-

ful assistants. The aim of the book is to reconstruct the idea of tacit knowledge from first principles so that the concept's disparate domains have a common conceptual language. To switch the metaphor, the idea is to generate a Google Earth–type view of the entire united domain that will make it possible to "zoom in" on any area with ease and understand its relationship with all the other areas. The case studies and analytic discussions of tacit knowledge that we already have in hand—the bike riding, the laser building, the sapphire quality–measuring, the car driving, the natural language speaking, the breadmaking, the transfer of knowledge between organizations, and so forth—will turn out to be aspects of the same territory seen from different vantage points. With the new map, we will see where those known bits of the territory are separated by mountains, where they are linked by passes, and where it was always just a matter of level ground.

Tacit knowledge currently lives a varied life in a range of academic disciplines, including philosophy, psychology, sociology, management, and economics; and by right, it ought to play a large part in the world of artificial intelligence. Those who first think of the term as associated with Michael Polanyi are likely to go straight to his famous example of bicycle riding: we can know how to ride a bicycle without being able to tell anyone the rules for riding, and we seem to learn to ride without being given any of the rules in an explicit way—our knowledge of the ability to ride a bike is tacit. This book will have a lot to say about the bicycle example, as it is one of the sources of confusion about the meaning of tacit knowledge, confounding knowledge embodied in the human body and brain—*somatic tacit knowledge*—with knowledge "embodied" in society—*collective tacit knowledge*.

Philosophers of one kind will associate the idea with Wittgenstein's argument that rules of action do not contain the rules for their application—the rules "regress." Thus, to apply a rule like "do not walk too close to others in the street," one must know what "too close" means and how it varies from circumstance to circumstance, and one must know another set of rules to know how to recognize what kind of circumstance it is, and so forth. Given that we cannot produce an exhaustive list of such rules, this must mean that when we live our lives according to them we must be using tacit knowledge to know how they are to be applied. Philosophers of another kind will associate the idea of tacit knowledge much more with the human body and its relationship with the world of practices as discussed by, among others, Heidegger and Merleau-Ponty. In this book this conception will be discussed by examining Hubert Dreyfus's application of these ideas and will be shown to be just one conception of tacit knowledge—somatic tacit knowledge.

Developmental psychologists, insofar as they use the term "tacit knowledge," are also likely to think of it as having to do with the body. It is a fact that children nearly always learn the conceptual structure of the world through their body's interaction with the environment. Furthermore, our language turns on the makeup of our bodies—had we no knees we would have no notion of "chair"; had we no fingers we might have a different counting system; had we no eyes our conceptual world might be very different.

Sociologists of knowledge might have encountered the notion through my case studies of the way scientists learn to repeat laboratory manipulations, such as building working lasers or making delicate measurements. To accomplish these things requires enough personal contact between the scientists to enable things that are not spoken to be passed on in ways that may not be visible or apparent. Sociologists such as myself have highlighted what is here called collective tacit knowledge—which is located in society. In later chapters, my own early studies will be criticized for not paying enough attention to the different types of tacit knowledge and the different ways of passing them on that were ready to be examined if I had thought about it.

Those who come at the problem from the management literature might well take Nonaka and Takeuchi's discussion of the bread-making machine as their paradigm: Nonaka and Takeuchi describe the way the previously tacit knowledge associated with kneading dough for bread was elicited and formulated so that it could be reproduced in mechanical form in a bread-making machine. Again, the book will show that Nonaka and Takeuchi's conception is very narrow. They think the notion of tacit knowledge is exhausted by knowledge that just happens not to have been explicated but could be given a bit more effort. Nonaka and Takeuchi are dealing only with *relational tacit knowledge*. To understand the bread maker properly, a lot more is needed; a way of analyzing the bread maker more fully is offered in appendix 1.

Economists, or those whose concern is with "knowledge management" at the level of the organization, might think about tacit knowledge in terms of strategies for capturing elusive skills by recruiting people who already have needed tacit knowledge or by acquiring whole businesses that already have capacities embedded in their personnel that the existing firm lacks.

The three-way classification of tacit knowledge—relational, somatic, and collective—is the basis of the new map, but it will not be encountered until chapters 4, 5, and 6. Chapters 1, 2, and 3 are more of a philosophical ground-clearing exercise. The tacit cannot be understood without first un-

derstanding the explicit, and these chapters are an exploration of what "explicit" means. Readers who want to understand tacit knowledge in order to be able to use the idea effectively in their practice can skim the first three chapters—or at least jump over any parts that might seem overelaborated. For those readers who feel they won't understand the explicit or the tacit until they have worked through the relationship between digital and analogue strings and other such esoterica, the first three chapters might be worth a critical examination. A lot of it is a matter of stating the obvious—but stating the obvious is not always easy when one begins with a confused domain. Regardless, all readers will want at some stage to capture the sense of table 4 (p. 81) which offers four meanings of "explicable"; the later chapters refer back to these four meanings.

Problems with the Term "Tacit"

The problems of the existing discourse of tacit knowledge begin to show themselves as soon as one looks at the term itself. Thus, the *Chambers Dictionary* defines "tacit" as "unspoken" or "understood or implied without being expressed directly." But Polanyi talked of *can* and *cannot*: "we *can* know more than we *can* tell." In the dictionary definition, "tacit" is descriptive—tacit knowledge is knowledge that is not explicit—but in Polanyi's usage, "tacit" is knowledge that *cannot* be made explicit. The tension between "is not" and "cannot" permeates the entire discussion. Consider the antonyms: the opposite of the dictionary definition of tacit is "explicit"; the opposite of Polanyi's definition is "explicable." It is bound to be confusing if, to turn the thing on its head, two different parts of speech—"explicit" and "explicable"—have the same antonym—"tacit." And this is not to mention the fact that "explicable" generally means "can be explained," whereas the opposite of "tacit" means plain and clear and expressed directly; the first is about knowledge, the second is about style.

Questions about the Use of "Tell"

Moving from the term "tacit knowledge" to Polanyi's phrase "we can know more than we can tell": what is "know," what is "tell," and what are "can" and "cannot?" Consider these questions:

If I encrypt the map reference for a U-boat rendezvous, do I know more than I can tell and is the encrypted message explicit or tacit knowledge? Before the Rosetta Stone was translated, could its contents be told? And how did I know that it contained knowledge of any kind and wasn't just a pretty

pattern? What if a mathematical ignoramus is told some rules for solving differential equations that he or she cannot use?—Is this telling or is it not telling? What if I overhear a few remarks exchanged between two people that I can't understand, but, noticing my puzzlement, they explain at length what they were talking about?—Is that tacit knowledge being converted to explicit knowledge? And what is meant by "understand" in this context? What if I give my love a single red rose? Is this telling her something? If I don't know what is on a computer CD, but I find out when I place it in the drive and the computer fires up, has something tacit been made explicit? Have the programmers told a pocket calculator how to do arithmetic? What if I use the record-and-playback method to train a machine to spray chairs with paint? Have I told the machine something explicit or does the machine now have the tacit knowledge of the trainer? Does a sieve have the knowledge to sort big items from small items, and, if "yes," did the designer "tell" the sieve how to do it? Does my cat have tacit knowledge of how to hunt? It doesn't have explicit knowledge! What if I have a special grip on my golf club that ensures that my hand assumes the right position? Is the special grip telling my hand what to do? What if I can write out the mechanical formula for balancing on a bike? Does that mean that bike riding is explicable? What if I tell a novice that he or she should look well ahead, not down at the ground, when trying to learn to ride a bike? Is that telling the novice how to ride explicitly? If I act for reasons that are subconscious, are they tacit and do they become explicit if the psychiatrist uncovers them?

In chapter 3 these questions will be answered and by the end of that chapter such questions should no longer seem puzzling. By the end of the book, questions about whether all or some tacit knowledge can ever be made explicit should no longer seem puzzling either, or, at least not so puzzling as they are now.

Coming to realize that something that initially seemed clear is confusing can be a perverse kind of progress. With the concept of tacit knowledge there are two important sources for this backhanded rejoicing. The first is the long-running attempt to build "intelligent" computers. Once upon a time, the only candidate for the meaning for "know" in Polanyi's "we can know more than we can tell" was human knowing. What was explicit was explicit to humans. Now we have to think about whether or not something should count as "explicit" if some set of instructions will enable a machine to carry out a task: should a successful computer program count as explicit knowledge even if a human could not execute it? When it was a matter of, say, print, it was easy: if a human could not use it in some direct

way then it was not explicit. But now machines can use or transform written symbols that humans can't and there is a new problem about what explicit means. It seems to me that some past discussions, not least my own, have involved a degree of sliding around this issue. The mistake is to believe that understanding human experience is the route to understanding knowledge. Rather, to understand human experience one must start by trying to understand all the things that might count as knowledge and then work out how humans might use them. The growth of automation has provided new problems and more demanding questions about what knowledge might be even though it remains the case that, in the last resort, humans are the only knowers.[1]

The second source of perverse progress has been the new understanding of the social setting of scientific knowledge that was first developed in the 1970s. This has advanced our understanding of human knowledge in general. In particular it has given us a much deeper understanding of the meaning and implications of Polanyi's claim that "all knowledge is *either tacit* or *rooted in tacit knowledge*."[2] The studies of science that began in the 1970s revealed that even the paradigm of explicit knowledge—scientific data or the algebraic expressions of theory—can be understood only against a background of tacit knowledge. This has revealed that the idea of the explicit is much more complicated than was once believed. In appendix 2, some specific new understandings that have come out of these two broad developments are listed and briefly described.

The claim that explicit knowledge depends on the tacit is, however, all too easy to overread. I have been earnestly assured by scholars that there is no such thing as explicit knowledge—it is all tacit. But if all knowledge is tacit, what is it that is "rooted in tacit knowledge"? Polanyi's very formulation shows that a distinction between tacit and explicit has to be preserved, though it doesn't show us exactly where the distinction lies or how it works.

1. When I say that one must start by thinking about all the things that might count as knowledge, I do not mean to claim that anything like classical epistemology is being pursued. First, for the sociologist of knowledge, or the Wittgensteinian philosopher, there is no classical epistemology—knowledge cannot be found in the absence of the activities of humans. The point is that we must *start* with an attempt to think about knowledge in a way that goes beyond human experience if we are to understand that experience properly. The starting point is to think of knowledge as "stuff" that might also be found in animals, trees, and sieves and then try to work out from this starting point what it is that humans have. Human experience alone is too blunt an instrument for the task.

2. Polanyi 1966, 195 (original emphasis).

The Tacit depends on the Explicit!

What the mistaken claim that all knowledge is tacit does indicate is that, mostly, explicit knowledge is harder to understand than tacit knowledge. Most writing on tacit knowledge takes it to be the other way around. Though the tension between tacit and explicit goes back at least as far as the Greeks, it was modernism in general and the computer revolution in particular that made the explicit seem easy and the tacit seem obscure. But nearly the entire history of the universe, and that includes the parts played by animals and the first humans, consists of things going along quite nicely without anyone *telling* anything to anything or anyone.[3] There is, then, nothing strange about things being done but not being told—it is normal life. What is strange is that anything *can* be told.

Once one sees how normal and natural it is to do things without being able to tell how they are done, one also sees that a good part of the notion that there is something strange about *tacit* knowledge is parasitical on the idea of explicit knowledge. If "all knowledge is *either tacit* or *rooted in tacit knowledge*," the explicit seems to be parasitical on the tacit—which it is to the extent that the explicit is without significance in the absence of the tacit. But the reverse is true when we consider not the knowledge itself but our *idea* of the tacit. The idea of the tacit is parasitical on the *idea* of the explicit. The idea that the tacit was special could not occur to anyone until explicability came to be taken to be the ordinary state of affairs and that moment was a recent one in human history, and one that is fast drawing to a close. Thus, in the traditional discussion—if something that has only been going on in full flow since the middle of the twentieth century can be called "traditional"—the idea of the tacit seems hard only because, mistakenly, the explicit has been taken to be easy. The pioneers of the idea of tacit knowledge, reacting to the enthusiasm for science and computing typical of the 1940s and '50s that made the explication of everything seem easy—no more than a technical problem on its way to being solved—had to fight to create space for the tacit, and, as a result, they made it into something mysterious.

It is time to redraw the map. I will argue that many of the classic treatments of tacit knowledge—those that have to do with bodily skills or the way the human brain works in harmony with the body—put the emphasis in the wrong place. What the individual human body and human brain do is not much different from what cats, dogs, and, for that matter, trees

3. Gourlay (2004) points out that the same applies to the socialization of children.

and clouds have always done. While humans encounter bodily abilities as strange and difficult because we continually fail in our attempts to explicate them, there is nothing mysterious about the knowledge itself. It is knowledge that, *in principle*, can be understood and explicated (in one sense of table 4) by the methods of scientific analysis. In practice it may be hard to describe the entire picture but it is hard to develop a complete scientific explanation of many things. In spite of the possibility of scientific explanation in principle, it remains true that for most individuals, if not all, that the body is central to the acquisition of knowledge. This, however, says less about the *nature of knowledge* than has been assumed; what it does indicate is something about the nature of human beings and how they acquire knowledge. More profoundly, it also remains true that the nature of the body does, to a good extent, provide the conceptual structure of our lives, but that conceptual structure is located at the collective level, not the individual. One of the main projects of this book is to demote the body and promote society in the understanding of the nature of knowledge.

There is a second reason the discussion of tacit knowledge is parasitic on explicit knowledge: the need to transmit knowledge from person to person. We want to know the most efficient ways to get people to be competent at doing new things. The cheapest and easiest way to enhance peoples' abilities is to tell them things. You can tell people things by giving them books to read or sending them messages over the Internet or, at worst, sitting them in classrooms and talking at them. But these methods will not work unless the thing that is to be transferred can be transferred via a medium such as print or talk. If it cannot be thus transferred, the process of raising the level of peoples' abilities is going to be the much harder, longer, and more expensive process of socialization, or apprenticeship, or coaching, or the equivalent—all of which require that everyone be physically shifted into the same geographical space and in fairly small numbers. Print or talk, if it works, can transfer abilities from one to many—it can be "broadcast"; apprenticeship cannot. Likewise, building machines that can do things for us is often said to depend on "making the tacit explicit." So more often than not, questions about the nature of tacit knowledge are tied up with questions about the transfer of tacit knowledge, and questions about the transfer of tacit knowledge are tied up with questions about converting the one type of knowledge into the other.

At the risk of being accused of political incorrectness, I'll sum up everything that has been said so far with the punch line of an old joke about a lost visitor asking a passerby for directions to Dublin: "I wouldn't start

from here." As will become clear in chapter 1, we are going to take this advice and start from somewhere else.

What Will Be Found in the Chapters

Chapter 1 is an attempt to approach the notion of explicit knowledge anew from the most reduced set of elements. There are "strings" and there are "entities" (humans, animals, and inanimate objects). "Strings," as I define them here, are bits of stuff inscribed with patterns: they might be bits of air with patterns of sound waves, or bits of paper with writing, or bits of the seashore with marks made by waves, or irregular clouds, or patterns of mould, or almost anything.[4] Sometimes these strings have no effect on the things they impact, sometimes, being physical objects, they have a causal or mechanical effect, and sometimes they are "interpreted" and their effect comes from the meaning imputed to the patterns. "Explicit knowledge transfer" involves communication via strings of the ability to accomplish new tasks. Strings are the building blocks of what semiotics refers to as signs, symbols, and icons; strings, however, do not begin with the freight of inherent meaning that makes the notion of signs, symbols, and icons so complicated. On the one hand, the semiotic terms connote meaning; whereas on the other hand, whether they are actually read as having meaning or not is context dependent. The term "string" is more basic: a string is just a physical object and it is immediately clear that whether it has any effect and what kind of effect this might be is entirely a matter of what happens to it.

Consider this analogy: imagine I pick up a stone and throw it at a coconut, which then falls. I label the stone and similar stones "knocker downers." Then I need a whole philosophy to explain the puzzling behavior of knocker downers: it is inconsistent—sometimes they knock things down and sometimes they don't. It is the equivalent philosophical puzzle that can be avoided if one starts with strings, not signs.

There is a crucial distinction between "strings" and "languages." A language is a set of meanings located in a society, whereas, to repeat, strings

4. This has nothing to do with "string theory" as in physics. The metaphor in string theory is "lengths of string," whereas the metaphor used here is, as found in *Chambers Dictionary*, "a set of things threaded together or arranged as if threaded." In some ways, it is akin to the usage in computing—an ordered set of symbols in one dimension—but is more general still, including, as it does, the physical medium on which the information contained in the pattern is expressed.

are just physical objects. A condition for the existence of languages is some kind of approximate representation of meaning by strings; strings are the means by which languages are shared and there can be no language without sharing. Unfortunately, because language and strings are so intimately related, they are sometimes confused. But the strings are not the language. The difference between strings and languages is more sharply defined in chapter 1, which begins by looking at all the ways that strings can interact with other things.

If one is concerned with the transmission of knowledge between humans, one must be concerned, willy-nilly, with what is fixed. If the quintessential question is "How does A learn from B?" Whether B wants to build a laser, bake bread, speak sentences, live in society, or whatever, then the fact that what B learns is mostly not exactly what A intended, or the fact that the meanings of "bread" and "laser" are social constructs, perhaps with political significance, are not to the point. What is to the point is that something with a relatively fixed meaning that carries a degree of technical empowerment has to be transferred. Thus, in spite of the fact that translation can rarely be done without loss or transformation, this is not what is emphasized here. This book emphasizes that which is *not* lost in translation.[5]

This approach, then, is in *tension*, with most of what has gone on in the broad area of science and technology studies and semiotics over the last three decades or so, but it is not in *opposition* to it. Rather, a new kind of question is being asked of the same materials—instead of stressing the flexibility of interpretation, attention is turned to the fixedness. Everything that has been discovered during these decades about the degree of indeterminacy in the interpretation of a string remains true and a central, and a still unresolved puzzle, is how there can be any fixedness at all. In chapter 2 the puzzle is "papered over" with the term "affordance."

Chapter 2 also analyzes the nature of strings much more carefully, exploring the distinction between analogue and digital strings and showing how strings are continuous with cause and effect as it is ordinarily encountered in the world.

Chapter 3 reconstructs the everyday use of the notion of the explicit in terms of the basic elements. It takes up what has been worked out in chapters 1 and 2 and uses it to show how to resolve problems in the ordinary talk of explicable knowledge. Ordinary (academic talk) about these issues

5. For a treatment with the stress on the positive transformations associated with translation, see Latour 2005.