Chapter 1
Introduction

> . . . action and counteraction, which in the natural and in
> the political world, from the reciprocal struggle of discordant
> powers draw out the harmony of the universe.
>
> Edmund Burke, *Reflections on the Revolution in France*

1.1 Problem, Purpose, and Rationale

Within the last forty years, the engineer's concept of feedback has
entered the social sciences. The essence of the concept, defined more
precisely in section 1.2, is a circle of interactions, a closed loop of action
and information. The patterns of behavior of any two variables in such
a closed loop are linked, each influencing, and in turn responding to,
the behavior of the other. Thus the concept of the feedback loop is
intimately linked with the concepts of interdependence and mutual or
circular causality, ideas with a rich history in the social sciences. This
book is an investigation of the use of the loop concept in social science
that lies at the heart of feedback and circular causality.

In some areas of the social and policy sciences the feedback loop, by
whatever name it is known, has become a fundamental center of atten-
tion, a vital concept in the analysis of societal problems and the con-
struction of theory. In other areas, however, the concept is noted but its
applicability and explanatory power are seen to be very limited. In still
other corners, the concept is largely unrecognized.

This book investigates how people in the social sciences became
aware of the feedback loop concept, what they have accomplished with
it, and what they perceive its significance and limitations to be. I will
argue that the answers to these questions are linked—that what indi-
viduals accomplish with the concept of feedback and what they per-
ceive its strengths and limitations to be depend on the sources of their
understandings of it. I will show that ideas from five or six intellectual
traditions weave over time into two main lines of development of the
feedback idea in the social sciences, which I will refer to as the servo-
mechanisms thread and the cybernetics thread. Practitioners in these

two threads have significantly different perspectives on the proper use, problems, and potential of the feedback concept in the social sciences.

I have five reasons for undertaking an investigation of the evolution of feedback thought in the social sciences. Listing them will both lay out some initial presumptions and preview some of what we will find in the following chapters. Together they foreshadow a central claim of this book—that the loop concept underlying feedback and circular causality is one of the most penetrating fundamentals in all social science. The work demonstrates that great social scientists are feedback thinkers, and great social theories are feedback thoughts.

First, loop concepts are central to an emerging view of social reality. For some time the unidirectional view of cause-and-effect has been giving way to the circular, looping perspective of mutual causality. For decades we have applied variations of a research paradigm that strives to derive the causal connection between a "dependent" variable Y and "independent" variables X_1, X_2, . . . , X_n. What characteristics of a teacher correlate with teaching effectiveness? What will consumer demand for a company's product be next year? How does a manager's leadership style affect worker productivity? How do parents socialize children? Increasingly, social scientists are taking the point of view that the dependent-independent variable view is inadequate for some such questions. Teaching effectiveness is apparently the result of an interaction of characteristics of teacher and student. The demand for a company's product is not simply the result of consumer behavior but is partly determined by the company's own behavior in setting price, maintaining quality, being early to market and ship, and setting a balance among such goals. A manager's behavior is not independent of worker characteristics: worker productivity can turn around and affect a manager's leadership style. And children socialize parents. In each of these examples, and in a vast range of others, causality appears to be circular. Social scientists, public policy makers, business people, and ordinary folk have to learn to deal with the emerging fact of circular causality in social systems.

Second, the concept has already played an important role in the social and policy sciences. We shall see how in more detail in the chapters that follow, but a brief name-dropping excursion is appropriate here to make the point. The loop concept lies just under the surface of some of the most significant contributions in the social sciences. It is hidden but discernible in the writings of Malthus, Adam Smith, Marx, Mill, Keynes, and many others. It is almost explicit in Merton's concept of the self-fulfilling prophecy, Festinger's cognitive dissonance, the vicious circles in American race relations illuminated by Myrdal, and all the macroeconometric models descended from Tinbergen's analysis of

business cycles and Samuelson's multiplier/accelerator model. It was discovered before its time as "schismogenesis" by the anthropologist Gregory Bateson.

Once the concepts of feedback and homeostasis became known to social scientists, they became central, organizing concepts for a number of important thinkers. Wiener's *Cybernetics* and the cybernetics movement that went with it influenced the thinking of Bateson, Kurt Lewin, Margaret Mead, Karl Deutsch, and hosts of others directly through their own work and indirectly through others' writings. As an alternative to "rationality" and optimization, Herbert Simon suggested the feedback concept as a basis for models for human behavior. Tustin identified servomechanisms as *The Mechanism of Economic Systems* and proposed the mathematical methods of control engineers for the analysis of economic dynamics. The TOTE unit of Miller, Galanter, and Pribram's *Plans and the Structure of Behavior* was explicitly based on a feedback view of psychological mechanisms. Deutsch's *The Nerves of Government* urged the scholarly exploitation of the analogy between communication and feedback in neural networks and their counterparts in governmental networks. Forrester's *Industrial Dynamics* initiated a modeling approach for management science that is explicitly centered on the feedback concept. In James Grier Miller's monumental *Living Systems,* the most complete statement of the general systems theorist's view of the world, the concept appears repeatedly at all levels, from the kidney to the "supranational" system. More recently, the feedback loop concept has played an important role in Weick's *The Social Psychology of Organizing* and provides the foundation for a form of psychological counseling called reality therapy, as described in William Glasser's *Stations of the Mind.* Currently, in works like Gleick's *Chaos* and Prigogine and Stengers' *Order out of Chaos,* feedback loops are emerging at the heart of the phenomena of complex nonlinear dynamics and unpredictable deterministic systems. Thus psychotherapy, psychology, sociology, anthropology, social psychology, economics, political science, and management have all been touched and changed by the discovery of the potential significance of the feedback loop in human affairs. We shall investigate these appearances of feedback and circular causality much more thoroughly in the chapters that follow.

Third, in spite of these developments the concepts of feedback and circular causality are not well understood. Some see several very distinct concepts here—interdependence, mutual causality, circular causality, recursion, self-reference, feedback, knowledge of results, causal loops—while others lump various ones of these together. Some limit the concept of feedback to homeostasis and control, implicitly or explicitly restricting it to refer to negative feedback.[1] Some derive the

dynamic behavior of a system from its feedback structure, while others fail to connect feedback to dynamics. Still others try to draw dynamic inferences from feedback structure but produce demonstrably false conclusions. In formulating or critiquing quantitative models involving feedback, some use data in inappropriate ways. Few take adequate account of compensating feedback effects in making policy decisions.[2] And some see problems that others ignore or bypass with the application of the feedback concept. This investigation is a step toward improved understandings.

Fourth, an emerging conclusion from some applications of the feedback perspective holds that the concepts of feedback and circular causality are essential to reliable policy analysis. Experience with dynamic, nonlinear models of feedback systems repeatedly shows that failure to take account of existing feedback effects in the analysis of a policy initiative can cause exactly the wrong conclusions to be reached. More subtly, information feedback can be used to explain the observed tendency of social systems to be "policy resistant," to react more weakly and more perversely to policy shifts than some experts predict. A promising key to understanding and anticipating such behavior is the notion of compensating feedback.

I have a fifth, more personal, set of reasons for investigating the evolution of the feedback perspective in social science. The concept of feedback lies at the core of my field, system dynamics. It is a relatively new field, originating just thirty years ago, using computer simulation to help understand complex social systems. But it reflects traditions and patterns of thinking that are far older and far more widespread than is generally recognized. Exposing the evolution of the feedback concept and its uses in the social sciences will help to map the intellectual context of my field.

Furthermore, the implications of the role of feedback and circular causality in the computer simulation methods of system dynamics are not well understood. The feedback loop is the fundamental building block of system dynamics models, and it is the basic unit of analysis and communication of system behavior. Moreover, it is the feedback notion pressed to an extreme that leads to the endogenous point of view that is perhaps the single most characteristic and significant feature of the field.[3] I believe that an essential step in understanding the potential of the system dynamics approach is the illumination of the deep meaning and significance of the feedback concept within the field and within the social sciences at large.

There are thus three questions which have guided this investigation.

1. How has the loop concept underlying feedback and circular causality evolved in social science?

2. How has it come to pass that different people interpret the feedback concept differently and see different potential in it?
3. Is it possible to evaluate different uses and interpretations of the concept, to identify its most fruitful future directions in social science theory and social policy?

1.2 Concepts and Definitions

A basic premise of this investigation is that there is a unifying loop concept underlying a number of superficially diverse ideas in the social sciences. Servomechanisms engineers, whose work came eventually to influence the social sciences, capture feedback systems in terms of differential equations. Econometricians express interdependencies in an economy using difference equations. Other social scientists use words to paint verbal pictures of circular causal processes: vicious circles, self-fulfilling prophecies, homeostatic processes, and invisible hands. Underlying all these representations, as we shall see, is the concept of a closed loop of causal influences.

Since the concept of a loop is fundamentally visual, we will use visual terms to give an intuitive definition of the loop concept underlying feedback and mutual causality. (See Figure 1.1.) An arrow drawn from A to B will be taken to mean A "causally influences" B. Thus if A influences B, and B in turn influences A, we would have a pair of arrows that form a loop of mutual or circular causality. To this elemental loop we attach an additional idea, which we shall refer to as the *polarity* of the loop. It is the concept of polarity that gives the causal loop its perceived analytic and explanatory power.

The polarity of a circular causal loop reflects the loop's tendency either to reinforce or to counteract a change in any one of its elements. Following the terminology that has become common since the emergence of the feedback concept from engineering into the social sciences, we shall characterize such loops as "positive" or "negative":

- A causal loop that characteristically tends to reinforce or amplify a change in any one of its elements is called a positive loop.

In a positive loop, an increase in an element A feeds around the loop and tends to cause A to increase still further; likewise a decrease in A tends to cause A to decrease still further. Similarly,

- A causal loop that characteristically tends to diminish or counteract a change in any one of its elements is called a negative loop.

In a negative loop, an increase in A feeds around the loop and tends to cause A to slow or reverse its increase; likewise a decrease in A tends to cause A to slow or reverse its decrease.

The motivation for the positive and negative labels comes from the

way loop polarities can be obtained from the polarities of the individual causal links that combine to form the loop. The "arithmetic" of causal links parallels the arithmetic of multiplying signed numbers. To establish the parallelism, define a causal influence from A to B to be positive if a change in A tends to produce a change in B in the same direction: an increase in A tends to produce an increase in B, a decrease in A tends to produce a decrease in B. Similarly, define a causal influence from A to B to be negative if a change in A tends to produce a change in B in the opposite direction: an increase in A tends to produce a decrease in B, a decrease in A tends to produce an increase in B. It is then easy to argue that the polarity of a causal loop is the product of the polarities of its causal links. We have the following unambiguous definition:

- A causal loop is positive if it contains an even number of negative links, and is negative if it contains an odd number of negative links.

An example best illustrates this arithmetic of link and loop polarities. Consider the circular causal loop shown in Figure 1.1, which happens to be abstracted from two classic works on the study of discrimination in the United States (Myrdal 1944, Merton 1948). It contains two positive links and two negative links. The causal link from Prejudice to Discrimination is labeled positive to capture the assumption, in this causal argument, that an increase in prejudice in a majority group tends to produce an increase in discrimination, or, in the more hopeful direction, a decrease in prejudice tends to produce a decrease in discrimination. A change in prejudice is thus assumed in this diagram to tend to cause a change in discrimination in the same direction. Hence, the link is positive.

The causal link from Discrimination to the Achievements of the minority is labeled negative to indicate an inverse sort of relationship. A change in discriminatory practices by the majority is assumed to lead to an opposite change in minority achievements in standard of living, education, health, and so on. An increase in discrimination tends to decrease potential achievement; a decrease in discrimination tends to increase potential achievement. Thus the link is negative by our definition. The other links in the diagram can be similarly explained.

The positive polarity of the closed causal loop that these influences form together can be obtained two ways. Blindly applying the "multiplication rule" for loop polarities, we see that the loop should be called a positive loop because it contains an even number of negative links, and the product of an even number of negatives is a positive. More insightfully, we see that the loop describes a self-reinforcing process in which prejudice feeds on the fruits of its own discriminatory tenden-

cies. An increase in prejudice, traced around the loop, tends to increase discrimination, which tends to lower minority achievements, which in turn increases the majority's perception of the inferiority, providing additional support for the majority's prejudice. More beneficially, a decrease in prejudice traced around the loop tends to lessen the majority's perception of the inferiority of the minority and leads in the direction of further reductions in prejudice.

The circular causal process described in Figure 1.1 thus fits our characterization of a positive loop as a self-reinforcing circular causal process. It does so precisely because the two negative causal links behave in effect like one positive link: the net effect of an increase in discrimination is an increase in majority prejudice. Thus the signs on the causal links operate together like the multiplication of signed numbers. The product of two negatives is positive; analogously, the polarity of a causal loop with an even number of negative causal links is positive. A similar development is easy to construct for negative loops, containing an odd number of negative links, as self-correcting or deviation-counteracting processes.

Thus our focus in this investigation is on signed causal loops— mutual or circular closed-loop causal processes characterized as either positive or negative. Throughout, we shall refer to a mutual or circular causal loop with its associated loop polarity as a feedback loop. This study is thus an investigation of the evolution of the implicit and explicit use of positive and negative feedback loops in social science.

I have deliberately glossed over a number of subtleties in the preceding development. First, there are a host of questions about *causality* in
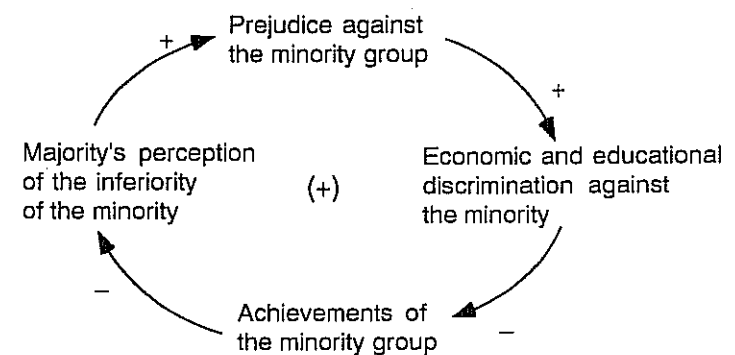

FIGURE 1.1: Causal loop used in the text to illustrate the determination of link and loop polarities (abstracted from Myrdal 1944 and Merton 1948).

social science, including whether the concept has any scientific meaning at all. The debate could be said to have been sparked by Aristotle, who asserted that men of art are wiser than men of experience, for men of art know the *why* of a phenomenon. "Clearly," he asserted, "wisdom is a science of certain causes and principles" (Apostle 1966, p. 14). In stark contrast, David Hume held that there is no basis for the concept of cause-and-effect because we only experience "one object following another" (Hume 1739; Book I, part I, section VII). Bertrand Russell concluded that "The word 'cause' is so inextricably bound up with misleading associations as to make its complete extrusion from the philosophical vocabulary desirable." He added that the only reason some philosophers persist in thinking in terms of causes rather than functional laws is that they do not know enough mathematics (Russell 1913). Still, John Stuart Mill built his *System of Logic* (1846) on a "law of universal causation" that "every consequent has an invariable antecedent." Closer to the present day, MacIver (1942) made a thorough attempt to defend and restore the place of causality in social science, identifying no fewer than eight kinds of *why*'s social scientists are concerned with.

A summary of the arguments appears in Lessnoff (1974). The reader interested in the issues is invited to peruse these references, as well as Bunge (1963), Craik (1943/1952), Meehan (1968), Stinchcombe (1968), von Wright (1971), and particularly Lerner (1965). The latter contains an acclaimed paper by Herbert Simon, whose work figures prominently in this book, which argues, in essence, that even if we do not know what causality means in social reality we can be precise about what it means in models of reality. It is an interesting idea, one that absolves causal thinkers from any residual guilt, but we shall not address these issues. I choose simply to presume that the concept of cause in the social and policy sciences has meaning, from which we can derive a meaningful idea of closed loops of circular causality. Or perhaps more guardedly, I choose to begin, as MacIver did, concerned not with the validity of the causal concept but only with its universality—in particular, its widespread use underlying the notions of feedback and circular causality.

Second, the characterizations of positive and negative links in feedback loops given above are a bit too loose to cover without ambiguity causal links that represent additions and subtractions from accumulations in a feedback loop (see Richardson and Pugh 1981, pp. 25–28). Without going into detail, we note that some positive and negative signs in causal-loop diagrams may represent not proportional change but actual addition and subtraction. The presence of additive and subtractive links does not alter the characterization of positive and

negative loops given above, so further detail here is not really necessary for our purposes.

Third, there are a number of people in the evolution we are about to trace who would take offense at the use of the phrase "feedback loop" to stand for all signed circular causal processes. Some, for example, tend to use the term "feedback" for one link in a conversational or dialectical process, as in "giving feedback" to someone. Others who take a loop view of feedback prefer to reserve the concept for the explicit, deliberate "feeding back" of information in a control process. Some justifiably see useful distinctions among the ideas of interdependence, mutual causality, circular causality, and feedback. At this introductory point, we are not in a position to discuss the pros and cons, and we need a reasonably short name for the concept on which we are focusing. I will use the term "feedback loop" to represent the common loop concept that I perceive to underlie all signed circular or mutual causal processes. I will defend the choice at this point only by observing that in at least one line of thinking in the social sciences the notion of the "feedback loop" covers all closed-loop processes that can be represented in signed diagrams more or less similar to Figure 1.1. Starting anywhere in any such loop, something (presumably information) "feeds around" the loop and eventually "feeds back" to its point of origin. I should also note that there is probably a normative component to my use of a single term to cover these myriad ideas: I see a value to using a single label, so that what is in common to these ideas becomes the focus.

1.3 Perspective and Methods

Value Positions

Tracing the evolution of an idea in the social sciences is an investigation in intellectual history. This work is both something more and something less. The central characteristic that distinguishes it from pure intellectual history is that its author is not a dispassionate chronicler. As a practitioner in a field that emphasizes the feedback concept in formulating and analyzing simulation models for social policy analysis, I am part of the evolution I am tracing. A late comer, to be sure, but nonetheless I am a participant observer.

That fact forces caution on my part and the reader's. Throughout this work I have tried not to let my own perspective cloud or distort my presentations and interpretations of other perspectives. That effort has resulted in a number of cautions I have had to try to impose upon myself. There are, no doubt, places where I have not been successful.

Tracing the evolution of an idea soon convinces one that "priors" are very powerful.[4] My priors—my background and previous understandings of ideas related to feedback and circular causality—have no doubt colored my perceptions in ways I have not been able to detect. Part of the reader's caution therefore must be to exercise enough care to uncover my unjustified biases when they slip through. The obverse of this caution applies as well: the informed reader will also bring priors to this investigation. Perhaps we can hope that the misperceptions that come despite our mutual best efforts will balance out.

The effort to be unbiased, however, must not be allowed to prevent us from trying to perceive strengths and weaknesses in uses of the feedback concept that we shall encounter. The narrative contains a normative component, which is reflected periodically throughout and brought together in a discussion of issues and implications in Chapter 6.

Bibliographic Methods

The feedback-related works investigated in detail in Chapters 3, 4, and 5 represent only a fraction of what has been written employing the feedback concept, and only a part of what I have uncovered. They form a selected history. Although all histories are selective, it is fair to ask on what basis the selections were made.

The most reliable way to uncover feedback works that are considered significant by other scholars is to work backward in time—from recent works back toward books, articles, and authors cited. Feedback authors and works that repeatedly appear in such an investigation of citations clearly deserve to be analyzed for the nature and scope of their contributions to the evolution of the feedback concept. Part of the approach followed in this investigation involved working backward from known works to frequently cited authors and works. That process was particularly helpful in exposing lines of thinking that contributed to the origins of the cybernetics and servomechanisms threads. It was also somewhat helpful in tracing out the directions of the two threads.

A second way is to work the other way in time, from a given author's work forward to those citing or making use of it. This task is much more troublesome, particularly for frequently cited works. According to the Social Sciences Citation Index, a typical work discussed in Chapters 4 and 5, for example, appears in more than 800 citations from 1960 through 1982. It is clearly not possible to investigate all such citations, even for one work. And it is impossible to tell how many and which of such citations would be relevant to a study of the use of the feedback concept. A more promising approach is to look for inter-

sections: a set of works that cite two or more earlier works. The resulting lists are more manageable. This approach uncovered, among other things, the work of William Powers (see section 4.7).

In this investigation of the evolution of the feedback concept, however, the intersection approach tended to produce anthologies or review articles, particularly if one looked for sets of works that cite three or more significant feedback writers. Although initially a discouraging result that made it difficult to ferret out more recent important feedback works, that fact is significant. It contributes to the conclusion that there are distinct threads of feedback thinking in the social sciences. There are, for example, only nine authors that reference all three of Wiener, Ashby, and Forrester (see sections 3.2, 3.3, and 5.4). Only two of these involve actual applications, one to accounting information systems and the other to ecosystems. The others are survey discussions of the systems literature that do not, in themselves, make use of the feedback concept.

A third approach, distinct from citation searches, would be to search the titles of books and articles for occurrences of the word "feedback" or its various synonyms or associated concepts. This is a fruitless approach and one that is apt to be profoundly misleading. The most important social science works employing the concept of feedback and circular causality that I encountered had no reference to such terms in their titles. Furthermore, many of those that do contain the word "feedback" use it to refer to something akin to "constructive criticism," not the concept of circular causality with positive or negative polarity that is the subject of this investigation.

A number of these approaches could be facilitated by using computerized databases of social science literature. Garfield (1964) and Price (1965) have pioneered in such methods. Such techniques are particularly useful for finding titles containing given words or phrases, searching out intersection sets of citations common to two or more authors or works, and identifying networks of authors. I did not make use of computerized databases in this investigation, however. Investigations of the Social Sciences Citation Index by hand and eye, such as those described briefly above, did not yield enough new information to suggest that the results would be worth the expense. Furthermore, the fact that such databases are computerized only back to the early 1970s made them useless for much of the searching required in this investigation.

Of these feedback-related works in the social sciences that surfaced in the course of these various citation searches and readings, I have selected a subset to describe in detail and discuss. Many others are mentioned briefly in the course of the narrative, and still more are

contained in the bibliography. The selections were made with four aims in mind: first, to show the breadth of the significant uses of feedback and circular causality in the social sciences; second, to establish the presence of a split in the use of these concepts into two separate threads of feedback thinking; third, to show counterexamples to the split; and fourth, to display, through the authors' own words, issues and implications of this separation of feedback threads. It is interesting to contemplate that this work is itself a small part of the evolution of the feedback concept in the social sciences.

Conceptual Threads

Throughout the investigation I have found the metaphor of "conceptual threads" to be helpful. We shall see that since the emergence of the feedback concept in the social sciences in the 1940s there have been significant differences in the use of the concept among various feedback thinkers. The differences lump together initially into two lines of thinking in the social sciences, which I will refer to as "conceptual threads." The distinctions between the two feedback threads will be developed in sections 3.1 through 3.3. Here it is appropriate to motivate and define the general idea of a conceptual thread.

We are tracing the evolution of a concept in the social sciences. Its meaning and uses move through time, perhaps changing during one period and holding relatively constant during another. The concept is passed from individual to individual, usually in writings but also in direct conversation. The language can vary from words to mathematics or even pictures. Each individual to whom the concept is passed selects some of what is communicated, emphasizing some aspects and de-emphasizing or passing over other aspects. Furthermore, each individual brings to the concept notions and nuances from his or her own background. Thus as it moves through time the concept gathers together different ideas into one conceptual thread, much the way a wool thread is spun from diverse strands frequently contributed by different sheep.

In Chapter 2 I shall argue that modern interpretations of the concept of feedback in the social sciences are blends of ideas from a number of intellectual traditions: classical ideas in the social sciences about self-reinforcing and self-correcting phenomena; the notion of homeostasis from biology; loop concepts from formal logic; understanding derived from mathematical models of dynamic systems in biology, economics, and econometrics; and, of course, the term and concept of feedback itself from eingineering. The "thread" metaphor is thus quite appropriate: feedback thinking in the social sciences is the

result of the weaving together of ideas from five or six conceptual strands. I shall argue in Chapter 3 that subsets of these six strands weave together to form two rather distinct threads of feedback thinking in the social sciences.

The thread metaphor is also suggestive as a concept evolves over time. Threads can unravel into separate strands. A concept can move in different directions spawning somewhat different lines of thinking. Evidence that we shall encounter in Chapter 4 suggests that one of the two main feedback threads in the social sciences splits into two or three directions as it evolves through time, with one of its strands heading off in the direction of the other main thread of feedback thinking in the social sciences, the servomechanisms thread.

A conceptual thread, as I intend the phrase, is an interaction of people and ideas. People contribute to a line of thinking, and people select from it as they encounter it over time. People should appear in our pictures of the threads of feedback thinking in the social sciences. But a conceptual thread is a way of thinking, not a collection of people.

There are two ways people become connected with a conceptual thread. Usually, people are linked to a line of thinking by direct communication through the scholarly literature. People read about feedback, and what they carry away with them depends upon what they read and also what background they bring to the encounter. Thus one way that people become linked to a feedback thread is through the network of social scientists using the concept and writing about their work. One can find direct evidence of this sort of linking in the citations in published papers. One could call this being connected sociologically to a conceptual thread.

It is conceivable, however—and indeed it happens in this investigation—that some thinkers arrive at much the same patterns of thought, not by selecting from the same literature but by developing the same concepts and methods independently. People who are in completely different scholarly networks can be linked to the same feedback thread because they make use of the concept in the same ways. Thus the notion of a conceptual thread has a methodological dimension as well as a sociological dimension. We can objectively document sociological connections using citations evidence, but methodological similarities are more debatable and require detailed investigations of what people are actually doing with the feedback concept. For that reason, we shall make extensive use of analysis of direct quotations from feedback thinkers, in addition to citation evidence.

The purpose of pursuing the idea of different feedback threads in the social sciences is not simply to split hairs or threads. There is a serious significance to the existence of two separate lines of thinking

that share elements of a common concept. The significance derives from two simple propositions about the history and ecology of ideas.

1. People connected with the same conceptual thread will tend to think in similar ways, and their similarities can be predicted from knowledge of the characteristics of the thread.

2. People connected with a given conceptual thread perceive related ideas as if they were an established part of their own thread.

The first proposition claims that ideas are something of a mixture of inertia and grease. Once a scholar sets an idea in motion, it tends to move in the same direction in the hands of others, and they find it easier to push. Newton used a far more elegant metaphor with similar meaning when he asserted that if he had seen further than others it was because he had "stood on the shoulders of giants." The second proposition suggests a dark side to the evolution of ideas, and it stems, I think, from the fact that everybody knows the first proposition. People looking outward from one line of thinking may be blinded to advances in another, closely related line of thinking, precisely because of the tendency to interpret new developments as old familiar ideas. Newton's image could be turned upside down—a scholar can fail to rise to new heights because of the weight of giants on his shoulders.[5]

If there are significant but subtle differences in the use of the feedback concept in the social sciences—if there are different conceptual threads that are unrecognized as such—there would be tendencies for people from those different conceptual threads to misperceive, in terms of their own understandings, work they encounter in the other threads. Strengths attributed to the feedback concept in one thread would be attributed to the other, perhaps without foundation.

Similarly, weaknesses or failures linked to the concept in one thread would be attributed to work in the other, again perhaps without foundation. To enable people to do the most with the feedback idea, we would first have to perceive the differences in usage and perceived potential, in order to move toward a more enlightened, presumably more powerful synthesis of feedback views.

Thus the real goal of illuminating different conceptual threads in the evolution of the feedback concept is the strengthening of the feedback perspective in the social sciences.

1.4 Overview

Chapter 2 lays out elements of six intellectual traditions, some of which can be traced to the ancient Greeks, which contribute ideas to modern understandings of the meaning and significance of the feedback concept in the social sciences. The content of this chapter is historical

background for the developments traced in Chapters 3, 4, and 5. It is brought together in section 3.1, and retrospectively interpreted in section 3.4 in light of modern understandings of the feedback concept, to show its links to the evolution of the feedback concept.

Chapter 3 describes in detail the beginnings of the two distinct threads of feedback thinking in the social sciences that emerge in the 1940s and 1950s. The characteristics that make these threads distinct are explored. The development makes considerable use of direct quotations and citation evidence to establish the existence and nature of the separation of feedback threads. In section 3.4 an effort is made to account for their differences by linking them to different aspects of the six intellectual traditions described in Chapter 2.

Chapters 4 and 5 explore developments in the two feedback threads in the social sciences, spanning roughly 1960 to 1980. Here the implications of the separation between the two threads begin to be felt. We shall find that the lack of recognition of the differences between these two feedback threads has muddled the concept of feedback and blended disparate ideas. Chapter 6 reflects on the preceding chapters and discusses a series of issues raised throughout the investigation. Of particular interest will be the following questions.

- For what purposes is the feedback concept employed in the social sciences? Where does it appear to be most promising?
- What explanatory functions does the concept of the feedback loop serve?
- What are other characteristics associated with a given feedback perspective? In particular, in what terms is behavior described? In what terms is behavior analyzed?
- What characterizes the causal views of different feedback perspectives?
- What problems is a feedback perspective particularly suited to address?
- In short, what are the elements of the "world views" of different feedback perspectives?

Notes

1. Negative feedback loops are circular causal processes that tend to counteract deviations from an equilibrium condition. See section 1.2 for definitions of terms and concepts.

2. Compensating feedback is a phenomenon in circular causal systems in which an external intervention produces natural feedback effects within the system that counteract the intended effect of the intervention. See section 5.4.

3. The endogenous point of view looks inside a complex system for the causes of its own significant behavior patterns. It can be contrasted to an

exogenous point of view, in which problems are seen to be caused by forces external to the system. See sections 3.3 and 5.4.

4. See Meadows (1980) for discussion of the significance of priors.

5. A famous social science principle akin to these ideas is Mannheim's paradox: All knowledge "is dependent upon the subjective standpoint and the social situation of the knower". Karl Mannheim, *Ideology and Utopia,* quoted in Landau (1972), pp. 34–42. The concept of a scientific paradigm may apply here (Kuhn 1962/1970).