Chapter 8
Evaluating the Impact of Systems Research

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Abstract A central challenge of systems research is expressing implicit understanding of change and making it explicit. The goal of this guide is to address, "What distinguishes systems research from other forms of research?" Defining what constitutes good systemic research requires explanation about what is missing from the current practices of research, as driven by the assumptions of science. This requires revisiting assumptions about what we know (ontology), how we learn (epistemology), and how those have shaped our approaches to research thus far. In the seven chapters of this guide, concepts of systems research—philosophy, frameworks, problem structuring and research design, taking action, reporting results, and competencies—have been presented in systematic ways that instill rigor in systemic inquiry. These concepts correspond to the precision expected of science viewed through systemic lenses. Each chapter, and the portion of the research study it represents, needs to be its own coherent "whole," while also acting as part of a comprehensive study design. Good systems research puts science in context; its evaluation requires more than traditional scientific approaches and critical thinking. The need for systemic evaluation prompts several questions concerning the philosophical principles guiding research, the rationale for the chosen framework, the basis for problem analysis and research question development, and the resulting model. Research must be evaluated for systemic coherence as demonstrated in reporting findings, drawing conclusions, and making recommendations. Have the system and the systems researcher been changed by the inquiry? Essentially asking the question: What is systemic about the research and why does it matter?

Keywords Ontology • Epistemology • Systems research • Systematic • Systemic • Systems model • Rigor • Coherence • Context • Critical thinking • Credibility • Evaluation • Change

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What Is Needed and What Is Good Enough?

This book and its organizational model (Fig. 8.1) attempt to span a difficult chasm, with an intention of beginning a process of bringing multiple worldviews into a new coherence. For consideration of our readers, the authors suggest this chasm may be bridged through systems philosophy, processes, and practice. The previous seven chapters have presented different perspectives of the research cycle, viewing it systemically. The intention of this book is to offer diverse approaches to competent and comprehensive inquiry. Like most systems, our attention has been limited to this domain. As a result, these approaches are neither all-encompassing nor conclusive. The focus is on what is needed and what may be good enough to advance our understanding of how and why things work the way they do and possibly what could be changed.

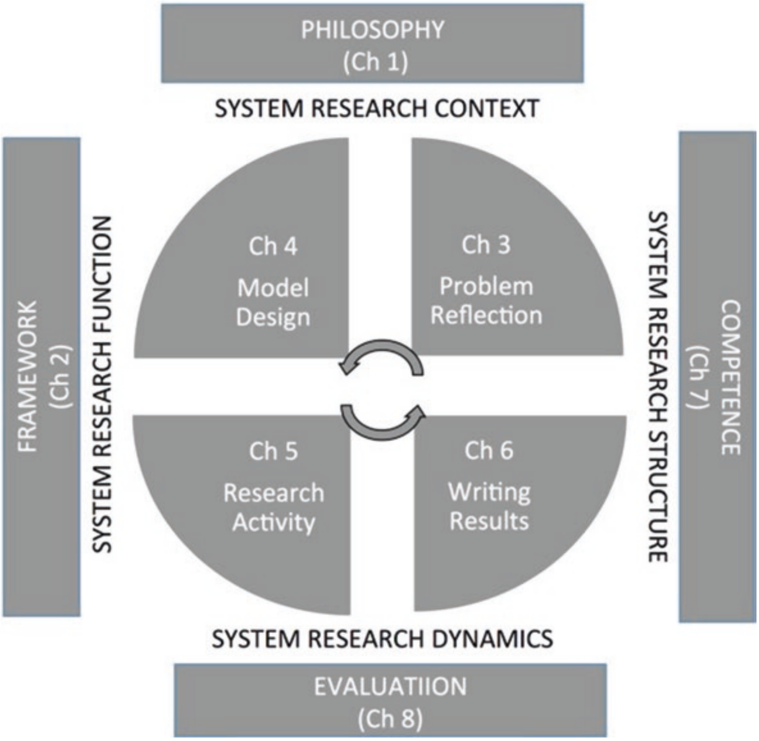

Fig. 8.1 PAR Holon organization of the book chapters

Rigorous scientific research has long been dominated by an emphasis on measurement and verification. Even though science, and most particularly physics, had moved beyond the Newtonian universe over a century ago, the scientific assumptions of that universe have continued to dominate research practices in many ways. This is evident in the standard application of the scientific method in many disciplines with far reaching implications and impact on fields beyond science. The standards of research have included validity, reliability, and generalizability. Representative samples, control groups, double-blind experiments, and rigorous statistical analysis have been the guarantors of the significance of findings. Observation and measurement were the hallmarks of empiricism, the foundation of verifiable knowledge. For the most part, to be "good enough" in science requires the application of the scientific method through testing a hypothesis in a controlled environment. This research strategy closes the system. In reality, the world is an open system. It is an outlier beyond controlled environments.

From the perspective of the social sciences (not to mention the humanities) this approach to research was challenging, at best. The need to force-fit the study of humans into laboratories, or literature and art into measureable variables, created conflicts from philosophical to practical levels. Many disciplines felt pressure to conform in order to "appear scientific," establishing quantitative studies as the only truly acceptable approaches, including management, psychology, economics, and others. There is value in the studies that have been produced, but they often provide a limited view of the subjects in question because the subjects are viewed in isolation equating to a vacuum outside their actual environments.

In addressing complex issues, these approaches remain insufficient. The premise of this book puts forth the proposition that systemic research approaches offer means to develop robust strategies to address complexity. The conundrum of sufficiency is among the issues the authors of this book explored as a collaborative team. An early discussion led to the development of the organizational framework for the book, developed by the authors and first presented by Kineman in Chapter 2.

This version of the framework as the model shown in Fig. 8.1, the PAR Holon organization of the book chapters, puts the eight chapters of the book into the same organizational and structural relationship with each other, as has been proposed that parts of a study be configured. In other words, using the framework, the book chapters reflect how systems research studies may be conceived, conducted, and completed. A critical point to consider is, "What is necessary in order to present an acceptable 'whole phenomenon' in research?" In a self-reflexive manner, this model will be used to talk about the evaluation of systems research. It is a way to consider this book, and the process of research more generally, as a system and broadly as a learning system.

What Is Needed?

In the previous seven chapters, concepts of systems research—philosophy, frameworks, problem structuring and research design, taking action, reporting results, and competencies—have been presented in systematic ways that invoke rigor. These concepts correspond to the precision expected of scientific inquiry. Yet the goal of this book seeks to address, "What distinguishes systems research from other forms of research?" In addition we ask, "What is needed that makes an inquiry systemic?" To answer those intertwined questions, researchers must go beyond systematic criteria (competence) to view inquiry through systemic frames (comprehensive worldview or *Weltanschauung*, defined in Chapter 3). This need for additional systemic evaluation of research prompts key questions based upon the content of each of the previous seven chapters. Here is a summary:

- What philosophical and ethical principles are guiding the research and do they sufficiently reflect a systemic basis for the research? Is the foundation used for the research systemically sound?
- What is the rationale for choosing the framework that will be used for the study, and what attributes have been selected that will represent the system in question?
- How have the problems been defined or research questions been developed? In what ways have these choices defined a whole system to be studied? What rationale was used and what aspects were purposefully included and excluded by virtue of the choices made?
- What is the research design for the study? Does the methodology fit the inquiry? Is it clear that the data selected to be gathered and analyzed will match not only the research design, but also the formal model that is being constructed?
- Is there systemic coherence between the philosophical and ethical principles with the framework, the way the problem has been structured, the research design, and the resulting model developed?
- How will the study be conducted (where, by whom, using what processes, etc.)?
- How will the findings be reported? In what form or format? How does the reporting reflect the dynamics of the system in question?
- What research competencies are required in order for this study to be conducted? Once completed, how have those competencies changed for the researcher?
- What is systemic about this research? Does it reflect properties of a whole system and of the nested "holons" (Koestler, 1967, p. 48; Simon, 1969; Wilber, 2007); that is, the system, environment, and subsystems involved?
- Does the research reflect integrated analysis with integrity in the process?

Remember, each chapter, and the portion of the research study it represents, needs to be its own coherent "whole" (i.e., holon), while also acting as part of a total (e.g., fractal), coherent study design. Like the systems we study, systems research is not merely a sum of parts. It is a system of learning itself. There are multiple scales and potential for self-similarity embedded within the learning system. The implications of these interrelationships will be addressed for each chapter in the following sections using the organizational framework (Fig. 8.1).

Where Do We Begin?

The study of a system could begin from any part of the model. While systems researchers can start at any part of the model, for the purposes of clarity, we will start with the outcomes of reporting (Chapter 6) and work around the model, much like the project management approach suggested in Chapter 3 (e.g., beginning with the end in mind; yet, in systems there is no end, just more learning). Inquiry arises from experience, so ask, “Where am I in the cycle with respect to my experience that compels me to seek out greater understanding?”

With respect to evaluation, which is frequently done in retrospect of an inquiry, it is easiest to begin with the outcome, represented in Fig. 8.1 in the lower right quadrant, labeled Writing Results, referring to Chapter 6. Written results or reporting is equivalent to the observable, measurable variables in a typical study. How would we determine the quality of that outcome? Using this model we could begin by asking, “How were these results produced?” And, “What caused them to come about?” These questions take us back to Chapter 5, the research activity. Note that in this particular model (Fig. 8.1), Chapter 8, evaluation, represents the connection between the outcome and the process (Chapters 6 and 5, respectively), which then makes the sequence logical in that the evaluative question is, “Are the outcomes reported coherent with the research activity?”

These first steps, however, are only the beginning. Remember that we are trying to understand a whole system, not just remove and analyze any isolated part of it. Continuing to move clock-wise through the inner quadrants, Chapter 4, in the upper left quadrant, represents the design of the model used in the research study. The connection between Chapters 4 (the model design) and 5 (the research activity) is done through Chapter 2, the overarching framework of the study. The evaluative question here is, “Does the structure of both the design of the model and study match the research activity?”

Chapter 3 in this model is labeled “problem reflection.” This upper right, inner quadrant, is one of the more challenging parts of Aristotle’s four causes (material, formal, efficient, and final); the one associated with purpose. In a practical sense, it is often where a study begins. What is it that a researcher has chosen to study, and why is that important? It also contains questions about choices of boundaries and their ethical implications. Not surprisingly, the connection between Chapters 3 and 4 is Chapter 1, the philosophical basis on which a study is built. Philosophical belief systems drive both the purpose and design of a study, whether they are consciously known or not. From an evaluative standpoint, the question arises, “Is the philosophical and ethical foundation for the research systemically sound?”

The next movement around the model goes from purpose and meaning back to the specific data that were chosen. The connection between those, as represented by Chapter 7, is the competency of the researcher(s) in question. With respect to evaluating systems research, this is a difficult but essential question to ask. “Are the researchers in question able to see the connections?” “Do they understand the relationships between different but interrelated and embedded ‘wholes’?” “Do they see the connections between the specific data that they have chosen to study and the purpose and meaning of the study as a whole?”

Looking at parts of the model can also help us understand some of the challenges about research and the need for a larger perspective. The bottom two inner quadrants (Chapters 5 and 6 in Fig. 8.1), if isolated, represent mechanical systems. They explain observed behavior and immediate causality of that behavior, but that is all. This is typical of many quantitative studies that get published in academic journals. It is also typical of the way that research gets taught in far too many institutions. Students choose a topic and propose hypotheses based on assumptions about the relationships between variables. They select data from existing datasets of information, often with little or no real understanding about who produced the data or how, much less why. They run statistical analyses on the data using predetermined tests of significance, and then present the results. Assuming that statistical significance is shown, they report their hypotheses to be supported (or their null hypotheses not to be supported, more accurately).

In fairness, unspoken assumptions reside in the backgrounds of many such studies. If researchers are explicitly building on the work of closely related colleagues or fellow researchers, then stating every underlying assumption explicitly would simply be a waste of time and energy. The prevailing wisdom is that they are “adding to the body of knowledge” of a given domain. The incremental evolution is considered the researcher’s contribution. A generally accepted standard of practice in traditional research in many scientific fields is to present findings of statistical significance. Then, in the process of presenting results, researchers attempt to explain them through some levels of causality that are not necessarily supported by the studies themselves. This disparity would become apparent if the questions posed by this model were addressed.

On the other side of the chasm, research studies can be described using only the top two inner quadrants of Fig. 8.1. In isolation, these quadrants represent many qualitative studies where belief systems encompass most of the research, involving every manner of human connectedness, political and social correctness, respect for diversity, and concerns for emancipation. Unfortunately, many of these studies lack not only testable findings, but any significant amount of rigor, and often of defensibility beyond the immediate settings in which they were conducted.

As above, there are often missing arguments as to why research approaches have evolved as they have. Not only are there problems with trying to force phenomena into data-forms which do not fit, there are also legitimate questions about human objectivity when approached in terms of Newtonian science. As stated earlier, simply turning a variable into a number does not make it more accurate. In many cases, it can strip it of meaning and connection relative to what it was intended to represent.

What Is Missing?

Defining what constitutes good systemic research requires some explanation about what is missing from the current practices of research, as driven by the assumptions of science—primarily physics (Agassi, 1968). To do that requires examining assumptions about what we know (ontology), how we go about learning (epistemology), and how those have shaped our approaches to research thus far (Boorstin, 1983). Remember, too, that what we formally consider to be science only began around 1600 A.D. even though the roots of those ideas began at least 2000 years earlier. To a large extent, what we are calling "systemic" goes back equally far (or could be thousands of years older), but got lost along the way (Clagett, 1955; Golinski, 2005; Kuhn, 1962).

So what is a systemic approach to research? From a philosophical perspective, consider that formal research is just one of many ways in which people try to learn about or understand the worlds in which they live. Kineman laid a foundation in this book in Chapter 2 through references to Rosen's (1991) modeling relation, which can be seen as a general description of the practice of science, as well as his proposition that R-Theory[1] might represent a universal process of learning found in nature. Learning begins from the moment we are born and continues in various ways throughout our lives (Popper, 1972). It starts from our most immediate surroundings and sensations (sight, sound, touch, taste, and smell). It is initially guided through caregivers, and as we acquire language we gain the ability to learn, symbolically, what others know and believe. At some point, most people discover that there are multiple explanations for the same phenomena in the world, and they have to decide how to choose what they believe.

A default, for many millennia (and still true for many people today), was to trust authority figures for knowledge. This is evident in the evolution of centers of power with those who organized and had the biggest buildings—such as churches, then governments along with public institutions, and now corporations (Hall, 1959, 1966, 1976; Hall & Hall, 1995). Those figures came in the form of parents, teachers, spiritual and religious leaders, those in political power, and eventually in the form of written documents. Also for millennia, explanations about the universe appeared in forms that we would now call myths and mysticism. Those generally involved spiritual beings of some form who caused or controlled occurrences in nature, through super-human (but human-like) abilities.

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[1] R-theory describes a closed causal unit of nature, called the "holon," which is a Rosen modelling relation between category theoretic mappings (integrating both concepts). R-theory provides a new method of analysis that can relate whole and fractioned (mechanistic) aspects of nature (Kineman, 2012).

When people in ancient times viewed the stars at night, they saw gods and goddesses in the form of constellations. Rich and complicated mythologies developed about which gods controlled which aspects of nature and the relationships between them. Most every ancient civilization had its own version.

Ancient Greece had a particularly well developed body of myth, led by the god Zeus who ruled over Mount Olympus. Out of this tradition, though, evolved new ways of thinking which set the stage for the development of Western thought and modern science.

By the fifth century B.C., the theory of atomism had been developed, which proposed that "The world was composed exclusively of uncaused and immutable material atoms—a unity changeless substance" (Tarnas, 1991, p. 21). It was also the Greeks who brought a notion of mathematical order to the understanding of the universe.

Plato focused on the study of the cosmos as particularly important. No longer were the heavens ruled and populated by gods and goddesses. Stars and planets were material bodies following patterns of order, yet to be discovered. It was this connection to astronomy that would create the foundation for modern science.

> For the riddle of the planets, as formulated by Plato, and the long and arduous intellectual struggle to solve it, would culminate two thousand years later in the work of Copernicus and Kepler and their initiation of the Scientific Revolution. (Tarnas, 1991, p. 48)

According to Tarnas (1991), it was Galileo who established a new standard for science. Rather than following the ideas of Aristotle (a descriptive biologist), Galileo chose the work of Archimedes, a mathematical physicist.

> To combat the Aristotelians, Galileo developed both a new procedure for analyzing phenomena and a new basis for testing theories. He argued that to make accurate judgments concerning nature, scientists should consider only precisely measured "objective" qualities (size, shape, number, weight, motion) while merely perceptible qualities (color, sound, taste, touch, smell) should be ignored as subjective and ephemeral. Only by means of an exclusive quantitative analysis could science attain certain knowledge of the world (Tarnas, 1991, p. 263).

This brings us to the point where Whitehead (1925/1967) explained more directly many of the problems that we still face. As he stated these:

> Galileo keeps harping on how things happen, whereas his adversaries had a complete theory as to why things happen.…It was a great mistake to conceive this historical revolt as an appeal to reason. On the contrary, it was through and through an anti-intellectual movement. It was the return of brute fact; and it was based on a recoil from the inflexible rationality of medieval thought. (p. 8)

Whitehead (1925/1967) went on to explain the impacts that this turn in science created.

> Science has never shaken off the impress of its origin in the historical revolt of the later Renaissance. It has remained predominantly an anti-rationalistic movement, based upon a naïve faith. What reasoning it has wanted has been borrowed from mathematics which is a surviving relic of Greek rationalism, following the deductive method. Science repudiates philosophy. In other words, it has never cared to justify its faith or to explain its meanings. (p. 16)

Because this version of science has not endeavored to answer these larger questions, it leaves much open to interpretation. While providing insight into questions, in and of itself, traditional science is insufficient because it leaves questions of relevance to lived experience of the world unanswered. This gives cause to a search for fuller explanations for understanding the world around us. A systems approach, one that accounts for the context in which phenomena occur and operate, may inform these larger questions. Good systems research addresses complexity of these questions with comprehensive approaches that bridge the chasm scientific reduction leaves open. Systemic inquiry does not break down complex systems into parts with an expectation that doing so sufficiently explains how the world works. Adept systems research clearly describes the system and its complex relationships for understanding, using multiple perspectives and levels of analysis. Robust descriptions of systems enable insight and analysis revealing leverage points for choice or decision making depending on the desired outcome, for example stasis, intervention, and/or change. Good systems research values the process, progress, and products of the scientific method while providing additional insight gained through systemic approaches to inquiry. Systems researchers use scientific and systemic approaches in concert to bridge the gaps.

Toward a Systemic Perspective

A systemic approach to research seeks to understand whole entities and their relationships, in the context of relevant environments. Until we are able to comprehend the universe in its entirety, we are forced to make choices about distinctions. Where do we draw boundaries between a system and its environment? What is necessary to include as part of a system, and what is actually only a factor in the environment, or part of a related but different system? Even what we assume as being simplest and most obvious can change through different perspectives. There are some general principles, though, from which to begin.

It is easiest for most people to think in terms of physical objects, because that is how we first encounter the world. A bicycle has been used as an example (Ackoff & Emery, 1972, p. 32) because it takes on the properties of a functioning whole when the parts are assembled in certain relationships. There is no clear "origin" to the bicycle (no historical record of the first specimen) and different versions of history trace the original concepts to anywhere between the 15th and 19th centuries. By the early nineteenth century, though, bicycles were present and starting to flourish. For simplicity's sake, consider a bicycle as a machine with two wheels, used for human transportation, powered by a human using pedals. There are many variations of the structure of different bicycles, as well as of the materials used in their construction. Bicycles are ridden by animals in circuses, but that is an adaptation of the animal rather than the bicycle itself. In some general sense, we can distinguish bicycles from not-bicycles.

If we were to conduct research about bicycles, we could approach that simply by focusing on the bicycle itself. First, does it meet the definition of being a bicycle (e.g., human-powered transportation machine with two wheels)? If so, then how do we explain a bicycle? As a machine, it is relatively simple, but coming up with the concept was pretty ingenious (combining the efficiency of wheels with a human "engine"). There are many variations using high-tech, high-cost materials, making them very expensive. In several cities (e.g., Beijing, Shanghai, Amsterdam, Copenhagen, and soon possibly London) bicycles outnumber cars (O'Sullivan, 2016). All of these could be relevant variables about bicycles, but to what extent would they help to understand or explain a bicycle?

Another way to approach the question is to ask, "Why a bicycle?" Bicycles are machines, and they do not create themselves. Bicycles are created through a combination of humans and tools, using the materials selected. But bicycles are also created from some concept of a bicycle. As noted above, there does not appear to be a clear, historical origin of the bicycle, but every time that one is produced it follows some variation of a relatively stable pattern. And as means of transportation, bicycles are produced with some functional purpose in mind, whether for commuting to work, carrying loads of farm produce, or racing in the *Tour de France*.

These simple ways of explaining a bicycle can be mapped to Kineman's model from Chapters 2 and 4, in relation to Aristotle's four causes. The parts and materials that we see and can measure are the material causes of a bicycle. The crafts-people who make a bicycle are the efficient cause. The design concepts behind the configuration of a particular bicycle are the formal cause, and the purpose-in-use of that model of a bicycle is the final cause. As should become apparent, all of these causes are intimately interconnected and interdependent with each other.

As we consider a process of evaluation, then, we begin with Chapter 6 of the model in Fig. 8.1, in the lower right quadrant, which focuses on reporting results of the research. Beginning with the output from the study indicates whether a researcher's intention, design, and execution were brought to fruition and whether the outcomes were as anticipated or new information emerged.

Reporting What Happened

Chapter 6 takes us into the realm of conveying to others what we have learned from a research study. Varey (2016) describes the challenges this poses for systems research elegantly:

> If we take a moment to reflect on the question, "What is unique about systems research?" it is not surprising that doing system research generates questions about the forms and functions of research itself. There are three systemic features that become immediately apparent in a systems context. These relate directly to (a) the appropriateness of the research form, (b) the structure of the parts, and (c) the efficacy of the whole. These three considerations are central to a systems approach generally. The systemic elements of the research itself can be

> analyzed similarly. They highlight the *concept*, *composition*, and *concordance* of the research process being reported. Together these constitute a useful systems research aesthetic.
>
> An aesthetic test for reporting on systems research is to confirm the researcher has considered these features by identifying: the systemic boundary (of assumptions), the system of relations (in the composition), and the totality of effect (from their combinations). An elegant piece of systems research will potentially have each of these elements in harmony. For the systems thinker, elegant research has a balance in these elements intuitively. The skillful systems researcher may even embody *systemic beauty* in their research design consciously. (pp. 146–147)

The distinctions between systematic (systems as context), systems (as the content of a study), and systemic (as concept in a study) are also quite useful. And as Varey sums up one aspect of adequate research reporting:

> In writing-up systems research, the report of the research will ideally (even if briefly) situate the choices of: (a) system philosophy, (b) epistemological framework, (c) systems research methodology, (d) paradigm axiology, and (e) form of system depiction, as components within a totality. The researcher should justify each selection with reference to the other elements of composition. In this way, the research as a whole may be considered to include "informed, relevant, appropriate, significant, and representative" elements (Varey, 2013). (Varey, 2016, p. 154)

The goal is to report something that represents at least an aspect of wholeness; a description of dynamic entities as they exist and evolve in an ever-changing world of only relative stability. This requires that we capture not just an entity unto itself, but the patterns and processes that constitute that entity, or system, or subject of study.

Rosen's (1991) modeling relation has been proposed in this book as the foundation for systemic modeling (the representation of the research results). That is elaborated further through the R-Theory models presented in Chapters 2 and 4 (Kineman, 2012). Those specific models, and other variations offered in this book, are not intended as the only means of adequately describing research. They are meant, though, as examples of what might be adequate.

Within the model for this book, each aspect of a research study should be both whole and part; it should be complete unto itself, and it should be clearly connected and coherent.

Focusing on the reported results of a study, how clear, accurate, and complete is the model of what is presented (or represented)? In terms of the modeling relation, how closely does it replicate the phenomena that have been studied? If the model is "decoded" back into the natural world, how well does it fit? Does it explain the "thing unto itself" as well as the "thing" in relation to its environment, as both evolve in relation to each other through time?

In more practical terms, if you read the results of any given research study, what do they tell you? Do they explain both "what" and "why" about the system or subject in question (revisit the bicycle example)?

Self-referentially, does the research report (thesis, dissertation, etc.) explain the "what's and why's" about itself? Does the research report give you a clear understanding about how the study was conducted, including the concepts and design which produced it, as well as the bodies of knowledge and thinking from which it came?

It is unlikely that many existing studies fit all of the criteria that have been presented. In many ways, this is an idealized design (Ackoff, Magidson, & Addison,

2006) for modeling that will help to guide research into its next phases of development. In the future, it would seem probable that computer-driven models (or the next, further developments in technology) might provide more complete and dynamic representations of the systems that we attempt to understand. If so, creating those models will not be only a matter of more data. They will require different types of data, adequate to the wholeness of the systems in question, and new ways of displaying behaviors through means that we can comprehend.

Referring again to Fig. 8.1, evaluation connects research results with the research activities that produced them. That sets the stage for the next section of this chapter. It is also important to note, though, a connection which Varey (2016) emphasized several times, as captured in his words from Chapter 6:

> The way in which research choices form and shape a systematic research approach can be examined systemically. This "systems approach to systems research" is described as the testing of philosophical concordance (Varey, 2013). The proposition is that good systems research design should ostensibly contain an alignment between the philosophically critical elements adopted for good researching. (p. 153)

In this regard, writing up results of systems research is necessarily explicit and reflective about what happened in the system and what happened to the researcher.

Investigating the Subject System

Chapter 5, shown in the lower left quadrant of Fig. 8.1, takes us into the realm of research as an active process, that is, actually conducting the research study which was designed. Doing so inevitably revisits each of the previous chapters. How did we envision the study that we set out to do and ourselves in relation to it? How were the research questions created and what did those imply about the kind of model (in a general sense) that would result? How did those answers then shape the problem structuring and design of the study that was intended? How was the setting for the study, and the participants, chosen? And how did all of those factors begin to shape the elements that would create the model (the results) of the study? An overarching question that can be inferred from Chapter 5 is, "What actions occurred that brought about the results presented?"

Many researchers, especially as early students, begin studies assuming that most of the processes are relatively simple and often self-evident: Find a topic of interest, determine a place to gather data, then analyze the data, and report the findings. Many of those same students are frequently surprised at the number of unexpected occurrences that happen in the midst of conducting a study. Choosing a highly interesting topic does not necessarily make getting access to the right kind of data easy. There are protocols to be followed for most studies (e.g., legal and ethical standards to be met, such as dealing with endangered species, human subject protections, or sensitive cultural issues), some specified by Institutional Review Boards (IRBs). Beyond that, almost every study involves the cooperation of other people whose involvement is necessary, but who are not necessarily interested or invested in your study.

Not only does a research study need to be designed, it also needs to be managed. As Sankaran has described in Chapter 5, thinking of this in terms of project management can be helpful. It is useful to set timelines for each stage and activity, and to map out (more or less formally) the processes and people who need to be involved. In larger studies, researchers may consider using project management software to keep track of tasks, milestones, resources, personnel, and participants. Use of these tools can help document the activities of the study or latter analysis.

More generally, it is also useful to think of the interactive stages of participatory action research (PAR) as a path through which a researcher will walk many times during a research study. As described in Chapter 2 (Fig. 8.2), this is not a closed circle of steps, but a spiral which moves forward as you cycle through it. It is a process of engaged involvement between the researcher and the participants, as well as the subject in question. It is a process of learning through change, on all parts.

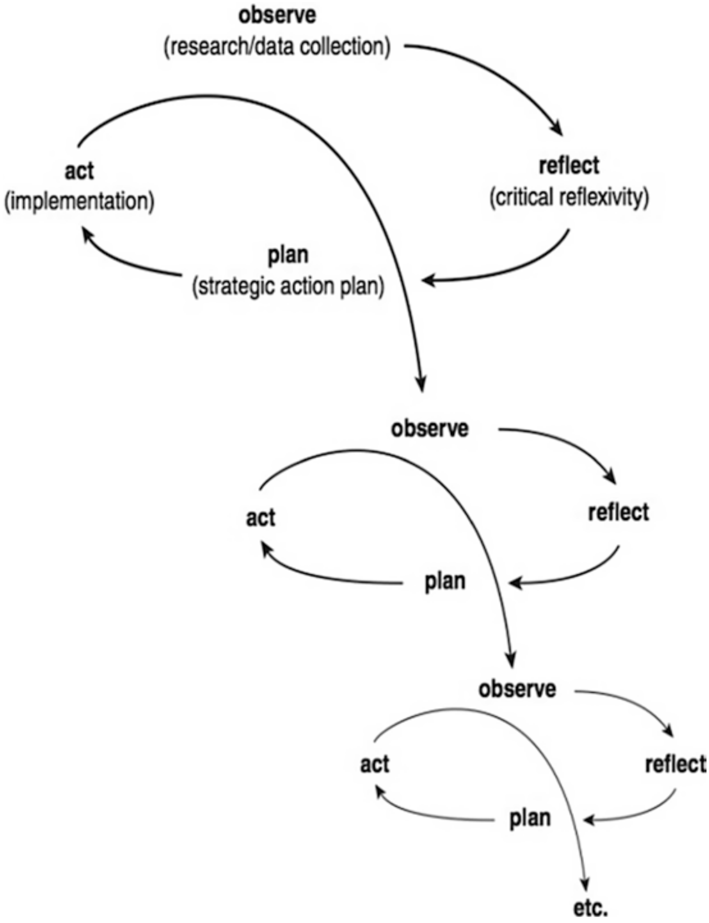

Fig. 8.2 Cycles in action research (O'Leary, 2004, p. 141)

An important question with respect to the implementation of a PAR study regards the "P" (i.e., participatory or participation). In social systems research, ideally, the participants act as co-researchers. They learn together along with the researcher, both from an ethical standpoint (most should have a right to be involved rather than "be studied") and from the practical perspective that they often already know much more about the system than anyone who might come in from the outside.

For research that does not involve human participants, a question is then whether there is a way to "engage with" the system in question. Are there safe and ethical ways to try to understand a system as it naturally functions—to capture the dynamics of the system as it behaves and evolves? For many types of studies, that question may seem out of place (e.g., research about animals in natural habitats, or climate studies, etc.). Ultimately, though, there is usually a desire to understand a system "as it is," in order to create the closest match possible between the formal and natural systems of the modeling relation.

Once completed, was the process itself coherent? As a systems researcher, it is important to be mindful of the drive to rationalize discrepancies and incongruities between what was anticipated during the design of a research study, despite accounting for context and boundaries, and actual behavior of a realized system. Ideally, these incommensurables should be acknowledged, duly explained, and documented for future research, which is the focus of Chapter 6.

Assessing the wholeness of the data gathering and analysis in a research project is dependent upon the connection with the design for the study, based upon the original intent for what was to be learned. That takes us back to the model design in Chapter 4, in the upper left quadrant of Fig. 8.1. Upon reflection of the actions taken during data gathering and subsequent analysis, did the methods implemented fulfill the vision proposed by the model? To assess this, researchers and their evaluators examine the cogence of the model.

Transforming a Description of the Subject System into a Model

In Chapter 4, Kineman (2012) builds upon the models from R-Theory as a way of capturing whole systems in research. While there are no absolute standards for the types of data or models used in PAR, the choices made should fit the intent of the study. The data selected should reflect the phenomena being studied, which will then be used to create a model most suited to the system in question; this is the process of encoding and decoding in the modeling relation.

An obvious question at this point might be, "Can you design a study specifically to be systemic?" More bluntly, "Can the design of a research study guarantee anything about the systemic quality of the processes or outcomes?" The simple answer is "no." None of the research methodologies described in this section is inherently systemic, in and of itself. A PAR study can be conducted focusing solely on mechanistic processes and material causes—and many have been. An approach to understanding systems in action, however, greatly increases the chance of researchers observing and experiencing the connections within systems and environments that could be of significance. It is then a matter of capturing those elements and relationships in ways which provide descriptions dynamic and evolving entities.

In order to achieve a level of mathematical rigor in systemic models, without forcing a reduction of the phenomena to numbers, Kineman suggests using symbols adapted from category theory (the varying lines and arrowheads described in Chapter 4). While this symbolic system may be challenging for many students and researchers who are not familiar with advanced mathematics, four-quadrant models may still prove to be useful and adequate.

The most familiar action research processes follow a 4-step model, often labeled as Plan, Act, Observe, and Reflect. For comparison, Fig. 8.3 shows four other variations of research approaches. All of these map to 7-step processes, which might also be correlated with the chapters in this book. Chapter 1 of the book, regarding philosophy, falls into the background of thinking about research, so Step 1 of the diagram correlates with Chapter 2 of the book, and so on—though not always in exact order.

The action research approaches shown include the Soft Systems Methodology (SSI; Checkland, 1999), Evolutionary Learning Labs (ELL; Bosch, Nguyen, Maeno, & Yasui, 2013), and a process used by the International Council on Systems Engineering (INCOSE, n.d.), referred to as SIMILAR (*S*tate, *I*nvestigate, *M*odel, *I*ntegrate, *L*aunch, *A*ssess, and *R*e-evaluate). Also included is a slight modification of the social research process described by Ackoff (1953).

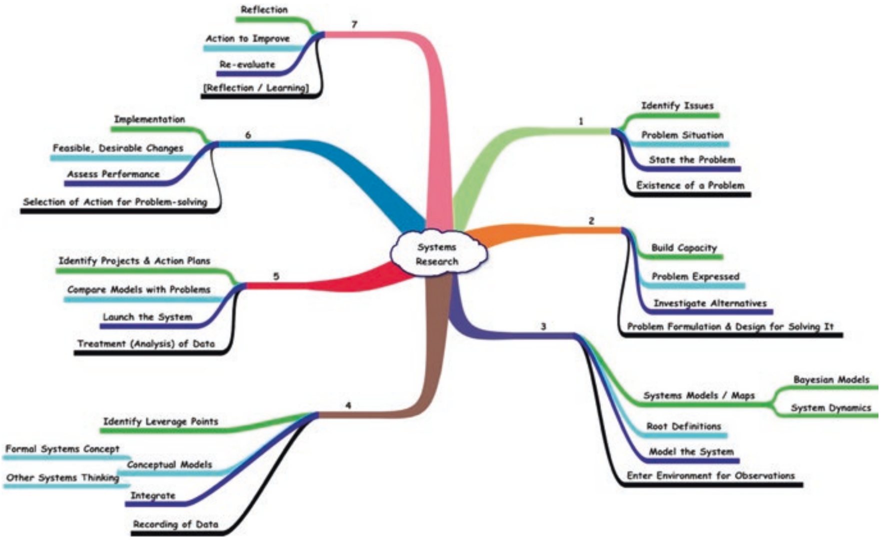

Fig. 8.3 Systems research model (Metcalf, 2016). Combining four versions of action research, in order from top to bottom of each branch (Incorporating Evolutionary Learning Labs, Soft Systems Methodology, SIMILAR, and Ackoff, 1953)

Step 1 of each process involves the choice of a system or a problem. That is also the drawing of a boundary between system and environment for the study. It indicates how the initial problem or system is framed, which then sets the stage for the kind of methodology appropriate to studying the problem, the kind of data needed to address or answer the research question, and so on. For the SIMILAR model, this is more like customer requirements or desired outcomes of a design.

Step 2 moves in slightly different directions according to the type of PAR used. ELL uses this step to identify the capacities of the participants and communities involved in the project. SSM continues from Step 1, in describing the situation in which the problem in question exists (Checkland, 1999). Ackoff (1953) explored potential solutions at this step, and SIMILAR evaluates possible design solutions.

In Step 3, both ELL and SIMILAR develop models. For ELL, these are typically System Dynamics models (Forrester, 1958, 1961) and Bayesian network diagrams (Pearl, 2000; Pearl & Russell, 1998), capturing the dynamic processes and alternative decision influences in a given situation. For SIMILAR, models may include: "physical analogs, analytic equations, state machines, block diagrams, functional flow diagrams, object-oriented models, computer simulations and mental models" (INCOSE, n.d., "Model the System," para. 1). At this stage, the general model for the entire process or project is also determined. SSM moves to root definitions, which are intended to describe the fundamental nature of the systems which are being studied. This is the stage at which Ackoff (1953) suggests to conduct observations and gather data.

Step 4 for ELL involves identifying leverage points, or those places where interventions will have the highest probabilities of impact. This comes from the use of the models in Step 3, in which situation is described and alternatives evaluated. For SSM, this is the stage at which models are constructed. Checkland (1999) described this stage:

> We now build the model which will accomplish what is defined in the root definition. The definition is an account of what the system *is*; the conceptual model is an account of the activities which the system must *do* in order to *be* the system named in the definition. (p. 169)

Checkland cautions against misinterpreting formal models as realities. Models are perceptions (cognitive constructs) of how things might be, not what they are in the real world. Instead, "it is simply the structured set of activities which logic requires in a notional system which is to be that defined in the root definition" (Checkland, 1999, p. 170). The model is built on verbs, describing the activities required by the system. Checkland further defines what he means by a model, in this way:

> S is a 'formal system' if, and only if: (i) S has an ongoing purpose or mission… (ii) S has a measure of performance… (iii) S contains a decision-taking process… (iv) S has components which are themselves systems having all the properties of S… (v) S has components which interact, which show a degree of connectivity… (vi) S exists in wider systems and/or environments with which it interacts… (vii) S has a boundary… (viii) S has resources… [and] (ix) S has some guarantee of continuity, is not ephemeral, has 'long-term stability', will recover stability after some degree of disturbance. (pp. 173–174)

Step 4 represents the integration phase of the SIMILAR approach, in which the parts of the developing model are brought together. Specifically, this requires identifying subsystems within the larger system, as well as the interfaces between subsystems and the feedback activities involved. For Ackoff's (1953) methodology, data from observations are recorded (and by interpretation, these become the elements of the formal system).

Step 5 for ELL involves planning for interventions into the system. All of the gathering and analysis of data, along with identification of stakeholders and resources available, and the leverage points to be targeted, culminate in plans to attempt to improve the situation in question. For SSM, the conceptual model which has been built is compared to the real-world situation being examined. This appears to be like the comparison between the formal and natural systems of Rosen's modeling relation. For SIMILAR, "launching the system means allowing the system do what it was intended to do" (INCOSE, n.d., "Launch the System," para. 1). The system chosen from the alternatives is designed in detail and produced. For Ackoff (1953), data from observations in the study is treated (analyzed) by the scientist or researcher.

Step 6 of this cycle is about implementation and assessment, according to the different approaches. For ELL, this is putting plans into action. For SIMILAR, this step involves assessing the model as it was put into action in Step 5. For Ackoff (1953), results are given back to the customer of the research process. In SSM, feasible and desirable changes are implemented. According to Checkland (1999), changes can be of three kinds: in structure, in procedures, or in attitudes.

Step 7 is both reflective and preparatory. This is the step at which the entire cycle is evaluated for quality, effectiveness, and so on. Based upon the outcomes of the assessment, a new cycle of learning or intervention begins.

Note that the 7th step was added to Ackoff's (1953) approach in this model. As with most traditional research, there is no assumption of process evaluation or learning which is built upon. The assumption has been that scientific research would "add to the body of knowledge" in a given field of study, and therefore be a part of ongoing learning, presumably. In the practicality of most organizational research or consulting, as much of his work was applied, projects end when results are presented, and only occasionally carry forward into continuing projects. For SSM, this phase is just an extension of Step 6, as changes are implemented and evaluated. For SIMILAR, this is considered possibly the most important step, understanding what worked, what did not, and what improvements need to be made.

Most PAR studies value the creation of change in a system over the development or testing of theories. Outcomes of such studies are often just the documentation of the processes used and the changes noted. That can be valid in its own realm, where research itself is considered to be made meaningful through its improvement of human conditions. Historically, though, most qualitative studies are never brought together, or built upon each other, to create larger or more specific models of systems.

Based upon these four examples of PAR, there is no reason why the results could not be presented in more scientific terms, other than the typical processes and projects chosen. Each of the examples uses, or could use, very rigorous models as parts of the processes employed (for instance, the system dynamics and Bayesian models of ELL). The model derived from R-Theory, by Kineman, advocates for bringing concepts from traditional, physics-based science and the qualitative approaches typical of social science research together.

Other research methodologies, beyond PAR, are also amenable to being used in a systemic study. Case study, for example, "explores a real-life, contemporary bounded system…over time, through detailed, in-depth data collection involving multiple sources of information" (Creswell, 2013, p. 97). What are missing from a typical study are the connections with the context or environment, but those could be added without conflict with the methodology itself. Grounded theory also aligns easily with systems research, in that it provides an open process of investigation resulting in the presentation of a theory or model. Working towards a holistic framework as the template for the model would actually add a great deal of simplicity and value to most grounded theory studies. Mixed methods research appears to span the chasm referred to at the beginning of this chapter, by including both qualitative and quantitative forms of data. While that approach can certainly help create more complete descriptions of a subject of study, it does not necessarily create a model that maps (decodes) back to explain both the "whats and whys" of a system as it evolves through time.

In Chapter 4, Kineman explains that rigorous and defensible practice depends upon established rules and principles designed specifically for the subject system. He states: "Good system research depends on being aware of what kind of activity and aspect of the system the researcher is engaged in, and then applying appropriate methods and tests" (Kineman, 2016a, p. 103).

Chapter 4 of this book demonstrates a model while explaining the role of modeling in describing a subject system. Before moving into conducting the study, a systems researcher needs to evaluate the research strategy. Again, the framework introduced in Chapter 2 is useful in evaluation of the research plan, by providing the basis of questions that a researcher can ask, such as, "Is there systemic coherence in the approach to the research incorporating philosophy, frameworks, problem structuring, research design, and modeling?" Among the aspects of the subject system (contextual and realized), have epistemology and ontology been sufficiently addressed through structure and function? If so, does the research study have an explicit plan for tracking these elements through the next phases of the study? If so, a systems researcher can undertake the next steps with confidence that the approach is sound, even though the actual outcomes have yet to emerge. As noted in Fig. 8.1, Chapter 2 is the connection between the research design and the research activity.

Frameworks

Kineman uses Rosen's (1985) modeling relation as a foundation for Chapter 2. This explains the connections between *formal systems* (in his descriptions, mathematical models) and *natural systems* (the actual or real-world phenomenon). Formal systems become our explanatory models. They are created through the results of our research studies. What did we learn, and based upon that knowledge, what more can we explain about the things we set out to study?

Encoding is the process of choosing and entering variables that will be included in a formal system or model that attempts to describe a natural system to whatever degree of specificity chosen (contextual or formal/final). Decoding is the process of testing the model against reality, the natural system (actual, efficient/material). How closely does it match, or how completely does it explain the system, and can it predict the future behavior in question?

At the most general level, models are explanations. As Rosen (1991) stated,

> As we have seen, the modeling relation is intimately tied up with the notion of prediction. Natural Law, as embodied in modeling relations, thus equips us to look into the future of things; insofar as the future is entailed by the present, and insofar as the entailment structure itself is captured in a congruent model, we can actually, in a sense, pull the future of our natural system into the present. The benevolences of Natural Law lies in assuring us that such miracles are open to us, but it does not extend to telling us how to accomplish them; it is for us to discover the keys, the encodings and decodings, by which they can be brought to pass. (p. 64)

From that perspective, models can vary greatly with respect to how detailed, complete, or exact they may be—or need to be. Mental models, for instance, describe something like heuristics—*rules of thumb*—which act as frames of reference for how individuals see or interpret the world. Conceptual models can be early sketches of a process or product, intended to capture macro-level ideas with end users or nontechnical decision-makers. More exact and detailed models include blueprints and specifications in Computer Assisted Design programs. Scientific theories fall at the far end of this spectrum, attempting to describe the very essence of a phenomenon in a causal and predictive form. At present, the most exact scientific theories still tend to be expressed in mathematical equations.

Models, including scientific models, often begin with metaphor. According to Rosen (1991), proceeding from metaphor is "not an unreasonable thing to do" (p. 66). However, Natural Law exacts a cost for prediction and necessitates finding the right encodings (i.e., formal descriptions of variables in a study). If we presume otherwise, as in metaphor, we only have half of the modeling relation, which is essentially decoding without explicitly encoding. Rosen acknowledged the role of metaphor in science, especially biological science in its adoption of the machine metaphor introduced by Descartes. Again, Rosen explicates about another important metaphor often used in systems science, the open system, proposed by von Bertalanffy (1969). Rosen (1991) stated,

> Bertalanffy drew attention in particular to the metaphorical relation between what happens in the vicinity of stable point attractors (stable steady states) of open systems and the empirical facts of embryonic development: pattern generation or morphogenesis. In this metaphor, we seek to decode from the former into the details of the latter, again without the benefit of any specific encodings going the other way. It was this general metaphor, embodied in particular submetaphors by Rashevsky and Turing, that sent physicists like Prigogine scrambling to modify thermodynamics to accommodate them. (p. 65)

Experimentalists find metaphor problematic because verifiability is imprecise. As a result, they rely on specific encoding. The hostility of empiricists to theory expressed in metaphorical terms is a disparity between encoding and decoding. Since science currently relies on verification, metaphor is not considered science, even though it "can embody a great deal of truth" (Rosen, 1991, p. 66). Metaphor can be formalized, as in category theory, specifically in its concept of functor (Arzi-Gonczarowski, 1999; Kuhn & Frank, 1991). As metaphors illustrate similarities between two ideas or concepts, functors map between categories. Both infer similarity through relationship between entities, yet to differing degrees.

Social science research, especially when using qualitative approaches, tends to remain in the realm of metaphor. There are often good reasons for doing so. Simply representing a characteristic in research as a number does not make it a measurable variable. Assuming that those numbers can be calculated for statistical significance only compounds the problems.

Learning does not inherently require statistical or numerical calculations. The roots of PAR were founded in human collaboration, through learning about social systems with the people who created and perpetuated those systems. Typically, those participants were not scientists, and their language was not mathematics. Even so, tremendous value could be produced through the processes of learning together.

On the other hand, the weakness of much social science research is that it has remained content with staying at the level of generalities and metaphor. The problem is not necessarily in the language or representation (e.g., mathematics) but in the clarity and specificity of the phenomena being studied.

None of these approaches or models of research is necessarily right or wrong, or inherently "better" than the others. Each represents a different need or intent. The only caution is that the model should be coherent; it should represent "what it is" and not claim or attempt to be something else. (That is a frequent weakness of research studies, many of which claim to explain fundamental principles of a system or entity, when they actually have only described correlations limited to specific times and locations.)

In terms of the modeling relation, the question for evaluation is how closely the formal model (the one we create) replicates or explains the natural model (the one that is being studied). From Chapter 2, the Relational Holon, shown in Fig. 8.4, represents a general way of conceptualizing the aspects of a system that one would hope to capture in a model.

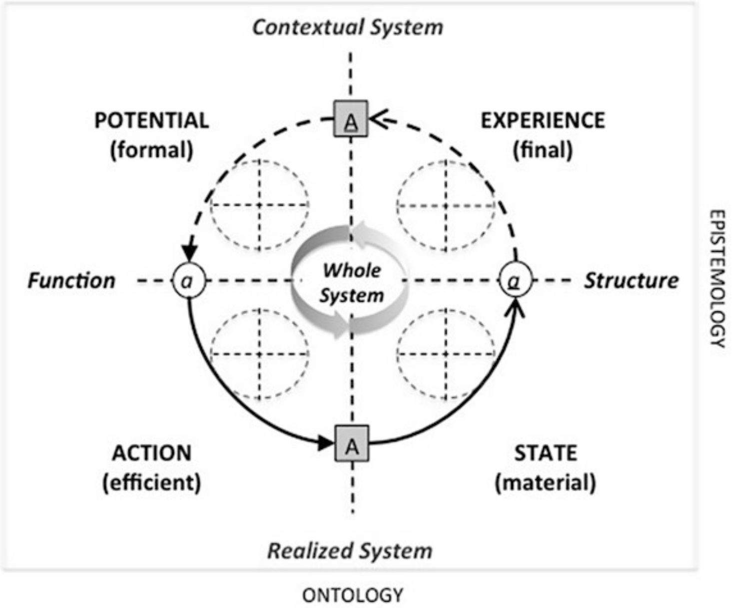

Fig. 8.4 Relational holon

Research that is limited to what Whitehead (1925/1967) called scientific materialism falls into the lower two quadrants of this model (dynamic processes and observable occurrences). Those address what is happening, but not why. The data and analyses in that kind of study may be highly accurate, but will still be restricted to the limitations of the questions and design of the research. Unfortunately, many published studies report strong correlations based on statistical analyses, and then offer conjectures about the reasons for the behavior without further support for them.

In the end, there are "best explanations" (most accurate, most reflective of the subject in question, most useful to a particular researcher, etc.) for a given phenomenon or system in question. This was a distinction made early on by many of the theoretical biologists who helped found the study of systems. Living organisms obviously required some material form by which they existed. There was, however, no material cause which explained them being alive.

The need to explore all four causes supports the four quadrants of the Relational Theory model. How any or all of the quadrants relate to, or explain, the phenomena being studied, is a question to be further investigated.

As to the criteria for good systems research, in Chapter 2, Kineman sets out a number of clear expectations.

> We can take it as a requirement for a book about "systems research" that if one proposes an exemplary framework it should be *rigorous*, if not in some viable sense *scientific*; that is, it should respect ontological and epistemological principles and follow a defensible logic that is justified at some foundational level in mathematical philosophy, arguably the common

> language of science.…We want to be able to analyze the *organization* of a system in terms of relations between context (e.g., dispositions) and actualizations (e.g., dynamics). (Kineman, 2016b, p. 25)

In considering Kineman’s explanation, the relations between context and actualizations create a *whole* or basis for the holon. The whole entails all four Aristotelian causal types in a natural relation; in doing so, it captures the essence of completeness through complementarity of potential existence and measurable behavior of a system. Kineman describes in great detail how the four-phase process of PAR corresponds to the four-quadrant model of R-Theory, incorporating Aristotle’s four causes. Each quadrant of the model represents a separate holon, while the complete model represents yet another level of wholeness. All of this is necessary to create the general framework for a research study.

Chapter 2 offers researchers an inherently systemic, relational framework to understand frameworks through the thought provoking question, “What is the rationale for choosing the framework that will be used for the study, and what attributes (encoding and decoding) have been selected for the model (referencing Rosen’s modeling relation) that will be constructed?” Each reseacher’s rationale for his or her choice of method, whether relational (Rosen, 1991; Kineman, 2012) or one of the other systemic frameworks (von Bertalanffy, 1969; Gunderson & Holling, 2002), must be explicitly articulated in the study. The articulation of the framework contributes to the foundation for the research, thus providing the direction for next steps in the research process, problem structuring, research design, and modeling. The time spent developing the rationale for choosing a particular framework sets the stage for every step that follows in the course of the study.

Connecting Function to Context

Returning to Chapter 4, and the connections which bring about modeling, takes us to the focus of Chapter 3, “problem reflection” shown in the upper right quadrant in Fig. 8.1. In the spirit of Louis Sullivan’s (1896) phrase, “form ever follows function,” problem structuring and research design explore how systemic research is developed starting with describing the subject system and determining the research question(s) compelling the inquiry. The summary questions posed for that chapter are as follows:

- What is the purpose of the inquiry?
- Why is it important?
- Who will use the research findings?
- What is the scope of the research?
- What are the limitations and delimitations of this research?
- What contribution does it make?
- What are the implications of research that is inconclusive?
- How will emergent phenomena be handled?

A more specific issue for systems research offered by Edson and Klein (2016) is this:

> Describing your subject system is not synonymous with "defining a system" in the context of systems engineering, which details system specifications for the purposes of analysis, design, and development. In the context of systems research, describing your subject system entails explicitly explaining the context and interrelationships in which the system operates and the relevant boundaries you will examine within the scope of your research. (pp. 60–61)

There are several critical points in this paragraph to note. Many research methodologies, including variations of some described in this chapter, approach research from an engineering perspective; they determine a model or product to be created, and then establish a process for doing so. In engineering and similar research methodologies, predominantly deductive methods are applied. Assumptions arise from assessment of customer needs and requirements. A prototype is developed and tested (e.g., beta-testing) to see whether it works as designed or if it "breaks." When a system fails, troubleshooting or another systematic process is used for identifying the cause and problem solving. In traditional scientific research, an equivalent begins with hypotheses and works to build a model from that basis, testing the hypotheses to determine whether they are true, false, or null. In these approaches, systematic methods are used in bounded and controlled environments.

Challenges in engineering and scientific research entail environmental or contextual variables. Frequently, these are human dynamics that pose latent and nascent variables, many of which may be implicit but never made explicit in the research. These variables are sometimes expressed as emergent properties. In science and engineering, they are largely viewed as intractable; hence the strategy of defining boundaries for the purposes of controlled experiments and system specification for clients. In both cases, the audience has a level of confidence in the results because the expectations have been clearly defined. They can be viewed as closed systems. However, the relevance of the research results or utility product developed falls short precisely because they have been developed in isolation. In both cases, the adage "the whole is greater than the sum of its parts" is profound. Both have blind spots that result in issues like:

- A design, product, or development works in theory not in practice;
- Customer needs are not met because neither the customer nor the designer were aware (e.g. latent demand) or articulated these needs (or wants/desires) until after the product was delivered;
- Specialization prompts myopia and disorganization;
- Errors due to lack of synchronization (e.g., medical errors).

In a systems research study, researchers cannot include everything that might be conceivably connected in a model. Choices have to be made about the factors that are most relevant to the system in question, at the level of functioning being investigated. Concurrently, there has to be an understanding that the system does not exist or function in isolation. There are also relevant factors in the environment which co-determine the system in question. Those factors can, in turn, be described as the relevant environment for the system, as opposed to the environment referring to the rest of the universe. These choices depend somewhat on the priorities of the system studied and its role in its environment.

The elements chosen represent the characteristics which will be encoded into the model of the system being studied (i.e., the formal system from Rosen's modeling relation). Together, those characteristics and their relationships, within both the system and its relevant environment, will display behaviors that should at least be informative about the natural system in question. Ideally, they will display behavior as it changes and adapts over time, as actual systems do.

If a research study is problem-focused, the problem might appear to be obvious. If multiple stakeholders are involved, however, that assumption might quickly be contradicted. People may believe that they see or experience the same problem, but how they understand or define the problem can vary greatly. Verifying and reconciling these different perspectives can be painstaking, yet necessary for the research to be coherent.

When research is more topic-focused, questions about how to choose a system may seem even more complicated. If the universe is intimately connected (as it appears to be) then how do you know what to choose to study, and how can you be sure that it is a system? All of these questions are important, and none of them are arbitrary. Learning how to identify and study systems is something of a skill set unto itself.

If we begin with a problem focus, for example, we could choose a general topic such as increasing rates of crime in a particular city or region. To some degree, the first choices are much like any other research process. You need to decide how to define what you mean by crime (violent and nonviolent; all breaches of the law, including crossing streets without obeying signs, or only violations beyond a certain threshold, etc.). Determining the system involved, though, can be a different issue. When we consider all of the factors that are relevant to the problem, how do we decide to draw that first boundary? That initial boundary determination may draw distinctions that possibly fall outside or be more inclusive than distinctions others would assume or make. Again, these choices are neither absolute nor arbitrary. In many cases, it may take some time and effort for a most useful way of framing a system to emerge.

One way to approach this is by looking at previous efforts and studies to see what has not worked in the past. Natural scientists often look for gaps in understanding, or incomplete theories. For many social issues, there is no shortage of possibilities. Political decision-makers tend to work from simple, targeted assumptions for which limited funding can be directed, and which can be explained to the public in equally simplistic ways. In cases of crime, for instance, stronger laws, increased enforcement, and longer jail sentences are all familiar conservative responses, assuming that there should be direct, causal relationships (much like action and reaction in physics). They tend to focus on the individual as the problem. Typical liberal responses include increased assistance with education and training, counseling or psychotherapy, and so on. This perspective sees the context or situation as the problem.

The most appropriate boundary for a given study might include all of these or begin with a unique choice which redefines the system in question.

Similar questions can be posed about medical studies and public health, about cities and infrastructure, about ecosystems, and so on. As systems evolve, often so do their structure, functions, and boundaries. One of the challenges in understanding systems is simply identifying them as they exist, rather than as we wish to see them.

Determining first what has been tried and not worked can provide clues as to patterns of behavior. Widening the scope of possibilities until it seems unreasonable, and then narrowing back until the behavior of a system makes some new, logical sense, is another approach.

Traditional research approaches often focus on the development and testing of hypotheses. Those can be valuable, but that assumes a great deal of knowledge about the system or situation in advance. Otherwise, each narrow hypothesis becomes something of a "shot in the dark," hoping that correlations appear.

Charles Sanders Peirce (1839–1914) described the process of investigation somewhat differently than traditional science. This involved both induction and deduction, but also what he termed *abduction*. As explained by Burch (2014):

> Peirce increasingly came to understand his three types of logical inference as being phases or stages of the scientific method. For example, as Peirce came to extend and generalize his notion of abduction, abduction became defined as inference to and provisional acceptance of an explanatory hypothesis for the purpose of testing it. Abduction is not always inference to the best explanation, but it is always inference to some explanation or at least to something that clarifies or makes routine some information that has previously been "surprising," in the sense that we would not have routinely expected it, given our then-current state of knowledge. Deduction came to mean for Peirce the drawing of conclusions as to what observable phenomena should be expected if the hypothesis is correct. Induction came for him to mean the entire process of experimentation and interpretation performed in the service of hypothesis testing. (section 3, para. 10)

Peirce described abduction as a natural, ongoing process of conjecture that humans use on a regular basis. He understood the combination of the three processes (abduction, induction, and deduction) as the parts of the scientific method, in a continuous loop of learning.

Problem structuring also revisits questions of philosophy and ethics from Chapter 1. Topics and subjects for research are not just chosen randomly, whatever the sense of detachment by the researcher might be. There are reasons for selecting a research topic, even if it is only due to the funding that was available for it. Likewise, a topic might be chosen for its currency or popularity, and therefore have anticipated future value to the researcher. These are still not just arbitrary choices, and their influences will become important in the research itself.

In theory, scientific research might be one of many processes taken over by artificial intelligence machines someday. At present, though, research is an inherently human activity. Research begins from some sense of need or curiosity (by the researcher, the funder, an employer, customer or client, or someone else). This is generally described within the rationale for a study.

The design for a research study is a much more creative act than most students initially understand. It truly is a process of design. Likewise, both research questions (including hypotheses) and findings from analyses of data involve a significant amount of intuition and generation of emergent concepts. These raise additional questions about the role of the researcher in relation to the subject(s) of study, and the design and eventual process of the research.

Referring again to Rosen's (1991) modeling relation, an essential aspect of problem structuring is the selection of the attributes that will constitute the formal system (i.e., the model) which the research study will produce. What will be observed or measured and how will that take place? Who will be involved and what kinds of language or symbols will be used to capture and record data? Without knowing yet what the outcome of the model will be, from what will it be constructed?

Chapter 3 suggests both systematic and systemic ways to formulate competent descriptions of the subject system through problem structuring by focusing on questions such as: How have the problems been defined or research questions been developed? In what ways have these choices defined a whole system to be studied? What rationale was used and what are the necessary losses for the choices made? What is the research design for the study? Is it clear that the data selected to be gathered and analyzed will match not only the research design, but also the model that is being constructed (i.e., has coherence been established between them)?

In addition, as the choices made through the previous steps of grasping philosophy and frameworks are integrated with the understanding of the subject system, researchers have developed a strategy for investigating the subject system as they have defined it in a well-articulated research design. From an evaluative perspective, systems researchers must reconcile whether the methodological design (methodology, research process) and the methods (techniques and tools) chosen sufficiently fit, both systemically and systematically, the problem they have described. The more explicit systems researchers are in the description of the subject system and the research design, the chances improve for evaluators to fully comprehend the nature of the study and can evaluate it equitably.

Thinking Systemically

The tie between Chapters 3 and 4 takes us back to Chapter 1, the overarching philosophy of a study, and in this case, of systems. Philosophy of systems provides context and rationale for choosing systemic research approaches as opposed to others. Thinking systemically requires an understanding of the world as ever-changing and evolving. Heraclitus, in Plato's *Cratylus,* is known for his thesis on flux, captured in the translation, "You could never step in the same river twice" (Sedley, 2003, p. 104). This begins with systems philosophy, as addressed in Chapter 1 of this book. Even the physical objects that we see as absolutely solid and stable only appear that way at certain levels of organization. Rather than assuming that the natural state of the world is order and stability, it is more prudent to ask, what factors or forces or phenomena create stable patterns of order out of a universe which is inherently malleable?

This is formally expressed through concepts such as process philosophy (e.g., Whitehead, 1925/1967) but the same ideas date back far beyond traditional science. Even the most static and enduring entities are, at some level, repeating patterns of organization; elements held or recreated in formation from moment to moment. As such, the systems that we choose to study are never absolutely separate from the rest of the universe.

Living systems, most particularly, are intimately interdependent with their environments (Miller, 1978; Parent, 1996; Simms, 1999). People tend to see themselves as unique individuals, with separate personalities and other traits, often described in terms of the *soul* (an eternal identity). Physiologically, though, we are only minutes from extinction without an oxygen-rich environment in which to live, or only days without adequate water. Like all living creatures, we are intimately connected with our biosphere and with many other types of environments. We continue to adjust and adapt, physically and socially, as our bodies recreate themselves, and we create and recreate our relationships in the world.

A traditional approach to science assumed a great deal of stability and consistency in the universe (Sheldrake, 2005, 2011). That belief underlies the use of sampling in research and the legitimacy of generalizing from a sample to a population as a whole. That approach worked well enough for periods of time in physics, where general principles could be found that were not directly dependent upon time or location. It is much more difficult in terms of human social systems, for instance, where populations are harder to define and research results harder to verify. In Chapter 1, Debora Hammond (2016) offers this summary:

> Beginning with an emphasis on the holistic nature of reality and the importance of considering relationships, both among the components of a system and with the larger environment, a systems-oriented ontology highlights organization, interaction and interdependence, shifting from the atomistic and individualistic orientation of the mechanistic worldview to a more organic conception of nature and an appreciation of the patterns and processes of relationship. (p. 13)

There are both practical and ethical considerations in research. Through the process of learning, we change, as does the system in question. Everything that we touch in the world may have some impact, and that includes the studies that we conduct. For example, an observer impacts the observed, as has been acknowledged by the Hawthorne effect, Observer effect in IT (e.g.,“Heisenbug”) and physics (related to, yet not to be confused with the Heisenberg Principle of Uncertainty), the Probe effect, and the Observer-expectancy effect (Weissenbacher, 2012.). One of the frameworks suggested by this book, PAR (Lewin, 1947; see also Argyris & Schön, 1978, 1989; Dewey, 1910, 1929; Freire, 1982; McIntyre, 2007), takes both practical and ethical issues into consideration. We enter into research understanding that we are studying dynamic processes in the midst of change. We can learn about them, and in some cases we can learn with them (with respect to human systems, at least). Ideally, we can learn many of the principles that cause their patterns of organization to remain stable at some levels over time. We also must consider our potential impact on the systems that we study, including the level of respect that we should observe for entities and phenomena that we did not create, and cannot re-create.

Werner Ulrich (2001) has written about boundary critique as a way of considering those choices. In Ulrich's (1999) tribute to C. West Churchman, he ponders Churchman's call for critical self-reflection in an essay about intellectual honesty as it relates to systems. Churchman's work was pivotal in Ulrich's (1988, 1999) understanding of systems. Churchman (1968) questioned his own work in saying, "How can we design improvement in large systems without understanding the whole system, and if the answer is that we cannot, how is it possible to understand the whole system" (p. 2)? Reflecting on this statement and considering the ethical implications of uncertainty in our decisions, Ulrich (1999) urges caution in his remark, "Uncertainty about the whole systems implications of our actions does not dispense us from moral responsibility" ("Intellectual Honesty," para. 4). To emphasize the importance of this responsibility, as a researcher may be influential and/or instrumental in effecting the subject system, Ulrich further quotes Churchman's statement, "the problem of systems improvement is the problem of the 'ethics of the whole system'" (as cited in Ulrich, 1999, "Intellectual Honesty," para. 4). In his reflection, Ulrich reveals a potential for benevolent bias in conducting ethical systems research—good intentions may not result in good systems outcomes. While uncertainty about understanding the whole system is an important consideration, it should not dissuade systems researchers from the work; however, the work should be ethically grounded. Systems researchers who check their assumptions develop an understanding that intending to do right (ethically) does not equate to being right (about the system).

Ulrich (1999) surmised that the message of systems,

> is not that in order to be rational we need to be omniscient, but rather, that we must learn to deal critically with the fact that we never are. What matters is not "knowing everything" about the system in question but understanding the reasons and possible implication of our inevitable lack of comprehensive knowledge. ("Intellectual Honesty," para. 4)

Bringing forward the questions outlined in Chapter 1, here are some of the first considerations for a researcher:

- What is my own relationship with the system I intend to study?
- What conceptual framework is guiding my choice of research topic?
- What assumptions, beliefs and values am I bringing to the research?
- What do I hope to learn?
- What impact will my research have on the system?
- What possible blind spots might I need to consider?

- How might I gain insights from the system itself?
- What might I learn from other disciplinary perspectives?
- What aspects of the system's environment might be relevant to my research?
- How will my research affect the larger environment (social or ecological) of the system?
- Whose interests does the research serve?
- Are there aspects of the system that might be negatively impacted by my research?
- What are my own motivations in doing the research?

As Debora Hammond (2016) summarizes her perspective in Chapter 1:

> Good systems research is broadly inclusive. It must be clear about the reasons for the boundaries it draws around the system under consideration, what is being left out, and possible consequences of those choices. Ultimately, good systems research supports the cultivation of wholesystems thinking. Good systems research seeks to nurture the health and integrity of the systems it serves and to manage the systemsthat structure our lives in ways that honor the needs and purposes of all participants in the system, as well as the larger environment within which that system functions. (p. 16)

Chapter 1 offers a path toward development of a systems perspective which is essential in creating a sound foundation for the research specifically by answering the question, "What philosophical and ethical principles are guiding the research and do they sufficiently reflect a systemic basis for the research?"

With Chapters 3 and 6 having already been discussed, the connection of competence of systems researchers closes the circle. The relationship between the description of the problem (even if theory development) and the expression of the research results depends largely on the competence of the researcher and the stance the researcher has taken relative to the researched. In evaluative terms, was the researcher able to adequately define the problem, design a research strategy, and report the outcomes in sufficiently systemic ways?

Role of the Researcher in Relation to the Researched

Chapter 7 returns us to the researcher as part of the research. As we think about designing and conducting research, what do we need to know? What skills or capacities are required for the kinds of research that have been described? Clearly, there are competencies beyond critical thinking skills that enable systems researchers to see and interpret systems in ways that are relevant to their stakeholders, whether they are scholars and/or practitioners.

These essential researcher competencies return us to Chapter 1 and the philosophical foundations of research. For people who need or choose to live in a Newtonian universe, asystemic approach will not fit a reductionist paradigm. A researcher needs a different stance to accommodate the fluidity and ambiguity of systemic research. Absolute answers, while offering the comfort of prediction that is accompanied by limited variables and formulas, are adequate for understanding only a small part of the world. As useful as mechanistic approaches have been in understanding the world, they are limited in utility for addressing complexity and its inherent uncertainty. Despite recognition of their limitations, reductionist approaches have been relied upon to formulate what is considered knowledge and to guide decision-making with wide ranging implications. Much of this acquisition of knowledge and decision-making is accomplished through attempts to control uncertainty, assuming that phenomena can largely be predicted if we acquire sufficient quantitative data and employ the "right" models. These quantitative approaches forego the "messiness" and variability of qualitative data. This is evident in the current drive to simplify complexity. Yet, it is in the mess that we are likely to find some of the most compelling insight into our world. Our goal is not to simplify complexity, but to accept that complexity is inherent in many systems. Our objective is to develop parsimonious explanations that will inform us.

In many ways, systems research is like a feedback loop, with the drive for prediction and reduction of uncertainty as a reinforcing loop. Reinforcing loops that remain unchecked cause disequilibrium in systems over time. For example, like a runaway train without brakes, a push to quantify human experience dehumanizes the experience. In the case of the train, the balancing loop is represented by the brakes. In human systems, especially systems research, the balancing loop is the judicious use of both quantitative and qualitative data. Through experience, researchers learn to develop competence in the negotiation balancing loops to manage uncertainty with reinforcing loops that drive the satisfaction of requirements for certainty.

In systems research it is wise to develop a level of comfort with uncertainty (e.g., understanding the inherent value of requisite variety, diversity, mutation, and adaptation) to avoid a trap of misrepresenting systems in efforts to reduce or simplify complexity. Negotiation of uncertainty calls for the capacity to reconcile seemingly incommensurables and the capability to leverage both quantitative and qualitative data with reason. All of this is done in service of parsimony. It is simplicity of the explanation, not simplification of complexity that matters. As Rosen (1991) observed, multiple perspectives cannot be reduced to one model, otherwise the model itself becomes a mechanical model and does not aptly reflect complexity of a system.

Learning about a system through a process of research also tends to change how we see and understand systems more generally. As described in Fig. 8.2, completing one research cycle ideally sets up the next cycle of research and learning. At that point, new questions, new insights, and new possibilities should be present. Understanding this as a natural cycle of learning rather than necessarily as a formality simply increases the capacities of those involved. Whether it is an individual researcher or a group or community, learning simply continues. Ultimately, Chapter 7 asks, “How has the researcher and the researched been transformed through the process of the investigation?” In evaluating research, we have come full circle through the PAR Holon organization of the book chapters shown in Fig. 8.1. So it is natural to ask, “What comes next in the iterative learning cycle of systems research” (see Fig. 2.2 Cycles in Action Research, O’Leary, 2004)?

What Is Good Enough? Concluding Thoughts

Systems research is an attempt to understand and describe phenomena as they exist in the universe. That requires understanding both the contexts and the relationships in which they exist. It means knowing that even the most stable entities only exist in relative states of change. That understanding requires different questions, for instance, asking not only about the external forces that cause change to an apparently stable system, but also about the internal forces and relationships which cause the system in the first place.

Returning to the example of the bicycle, more than a few children have learned hard lessons about change. A bicycle put away for the winter, if not protected and maintained, encounters often unexpected changes. Tires go flat, metal parts rust, seats weather and crack, and so on. No one did anything terrible to the bicycle. It was simply a result of the relationships between the bicycle and its environment.

Learning to see and ask about new relationships is another aspect of systems research. If investigating space travel, few people are likely to find correlations with a bicycle. They are apparent, though, simply from remembering that the first successful airplane was designed by two brothers (Orville and Wilbur Wright) who ran a bicycle shop (Smithsonian National Air and Space Museum, n.d.). Ways of thinking about the control of motion on the ground led to learning about controlling motion through the air, and so on. Bicycles did not “cause” spacecraft. The interconnected and evolving parts—trying new ideas, changing designs, creating new ways of thinking about machines, working to create a human-powered air machine like there was a human-powered machine for the ground—all can be seen as causes for spacecraft.

The importance of systemic ways of learning and understanding is as relevant for problem-solving as it is for the discovery of new, scientific theories. It is equally important for processes of design, in which we create models of things that do not yet exist—the inverse process of creating scientific models of what already exists.

In the context of PAR, specifically, good systems research is a conscious process of learning and change. That requires awareness of the researchers about their own knowledge and learning, as well as their expertise in the systems being investigated. It requires skill in research design, knowing that choices have to be made, and boundaries have to be drawn. What gets encoded into the model both creates and limits it. All of this has bearing on how well the model replicates the natural system that it seeks to describe.

In the context of this book, good systems research would cross over the fragmented disparities that have long characterized different beliefs about research. Being clear and specific are critical factors in research. To the degree that mathematical descriptions enhance clarity and specificity, they should be considered. Measurements of material causes, though, are not sufficient explanations for systems, by themselves. Equally, metaphorical descriptions of beliefs about systems, even if based upon reports by participants, cannot be solely relied upon as rigorous data.

Evaluation of research is fraught with complexity, so it is no surprise that evaluation of systems research is just as, if not more, complex. Beyond questions of whether the research is sufficiently systemic, are questions about the quality of analysis and the process. In evaluation we ask, “Does the research reflect integrated analysis with integrity in the process? These questions bring us back to the beginning of the research process and this guide.

One of the goals of this book sought to answer the question, “What distinguishes systems research from other forms of research?” To answer that question, researchers must go beyond systematic criteria to view inquiry through systemic lenses. This chapter also asked the question, “What is needed and what is good enough?” The previous seven chapters, concepts of systems research—philosophy, frameworks, problem structuring and research design, taking action, reporting results, and competencies—outlined some of what is needed. Certainly, as with any research, a disciplined approach is fundamental. The concepts presented correspond to the rigor expected of most scientific inquiry. However, as we have seen, scientific approaches are not sufficient to address systemic inquiry. Scientific methods, while useful complements to other approaches are insufficient in the inquiry of complex systems. This requires researchers undertaking systems research to go beyond traditional approaches and necessitates discerning application of the concepts explained in this guide. A final word by Whitehead (1925/1967) might best conclude this chapter:

> There are two methods for the purification of ideas. One of them is dispassionate observation by means of the bodily senses. But observation is selection. Accordingly, it is difficult to transcend a scheme of abstraction whose success is sufficiently wide. The other method is by comparing the various schemes of abstraction which are well founded in our various types of experience.…Faith in reason is the trust that the ultimate nature of things lies together in a harmony which excludes mere arbitrary mystery. The faith in the order of nature which has made possible the growth of science is a particular example of a deeper faith. It springs from direct inspection of the nature of things as disclosed in our own immediate present experience. There is no parting from your own shadow. To experience this faith is to know that our experience, dim and fragmentary as it is, yet sounds the utmost depths of reality: to know that detached details merely in order to be themselves demand that they should find themselves in a system of things: to know that this system includes the harmony of logical rationality, and the harmony of aesthetic achievement: to know that, while the harmony of logic lies upon the universe as an iron necessity, the aesthetic harmony stands before it as a living ideal moulding the general flux in its broken progress towards finer, subtler issues. (p. 18)

Writing this book has been a long journey from IFSR conversations in Linz, where the authors explored the question, “What is good systems research?” That exploration led to this book. Our intent is to help newcomers, graduate students, and seasoned researchers develop confidence in designing, conducting, and reporting systems research that meets the standards of rigor required by academia and organizations commissioning research studies, many of which are major research projects. The journey does not end here, as we realize this is an early attempt to put forward a proposition of what will render good systems research. Indeed, this does not mean we believe it is perfect. As Jack Ring (personal communication, February 25, 2016) stated, "System projects fail not from lack of requirements but from lack of designer humility. System design is a discovery process and learning happens when arrogance yields to humility." As systems researchers, we adopt the spirit of Ring's words by acknowledging that we put forth these propositions with humility. As our readers are learning, we will continue to learn from those who use and evaluate our work. We remain open to suggestions and ideas that will build upon these propositions. There are many excellent books and resources to help readers with the nitty gritty of systems research practices. Our aim was not to replicate or mimic those works, but provide different perspectives that can be used with any of those resources while enhancing the work to stand out as good systems research.

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Appendix: Systems Engineering

Systems Engineering is an engineering discipline whose responsibility is creating and executing an interdisciplinary process to ensure that the customer and stakeholder's needs are satisfied in a high quality, trustworthy, cost efficient and schedule compliant manner throughout a system's entire life cycle. This process is usually comprised of the following seven tasks: **S**tate the problem, **I**nvestigate alternatives, **M**odel the system, **I**ntegrate, **L**aunch the system, **A**ssess performance, and **R**e-evaluate. These functions can be summarized with the acronym SIMILAR: **S**tate, **I**nvestigate, **M**odel, **I**ntegrate, **L**aunch, **A**ssess and **R**e-evaluate (INCOSE, n.d.). This Systems Engineering Process is shown in Fig. 8.5. It is important to note that the Systems Engineering Process is not sequential. The functions are performed in a parallel and iterative manner.

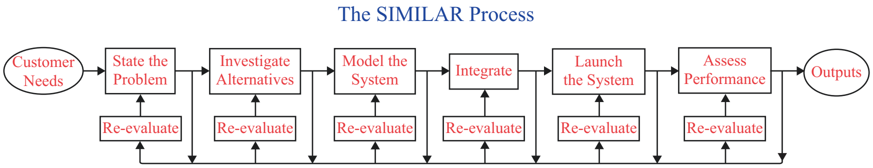

Fig. 8.5 The systems engineering process from Bahill and Gissing (1998)