Preface

Many changes are in store for the systems community in coming years, if it is to meet the challenges imposed by the many problematic situations extant in the world today. This community must rise to these challenges or it will deservedly pass away. I seek to provide the basis for stopping some of the bad practices, including the following:

- **Underscoping the Systems Domain**. Various devices are used that implicitly underscope the systems domain. Among these are representing this domain as coincident with particular methods, such as "systems dynamics" or coincident with the work of particular individuals, such as L. von Bertalanffy; or coincident with a particular academic program; or what is represented in the language of a particular marketplace such as information technology. This is particularly troublesome in education, since people are placed in public positions with weak understanding of the possibilities, and with tendencies to mis-formulate problematic situations and mis-apply both public and private resources.

- **Unimaginative Workspaces.** Workspaces tailored to the complexity of problematic situations are far too unimaginative. Workspaces that are not tailored to match the complexity of the problematic situations, and which do not provide opportunity to scan the extensive products of description and design work, and to keep such work constantly updated and available for inspection, updating, and learning by project personnel, virtually assure that errors will be

introduced into systems designs that will engender failures, some of which will cause loss of life, and all of which will cause major expense; sometimes extending into many billions of dollars.

- **Mismatched Media.** Habitual usage of small-scale media in small-scale problem-solving is carried over into systems domains. Typical mismatched media include, e.g., small computer screens, conventional textbook sizes, conventional blackboards and overhead projections; when present-day problematic situations require very large wall displays and wide-scanning capabilities with physical movement along the wall displays to allow for back-and-forth discussions among groups.

- **Linguistic Pollution.** The systems language is heavily polluted. It is necessary to dispense with outmoded and ambiguous language like "systems approach" and "problem-solving", which are not serviceable and replace them with well-defined terms like "systems science" and "resolution of complexity"[1]. Worst of all, the desecration of such terms as "science", and the willingness of universities to succumb to and sponsor such desecration in order to enable the coffers to be enlarged, is unforgivable, and must eventually be corrected.

- **Premature Quantification.** An entirely unjustifiable false sense of security arises out of premature quantification. Put an end to the practice of leaping prematurely into application of numerically-based methods that are well-known to the user, long before a problematic situation has been adequately defined and its attributes organized in a way that is responsive to, e.g., Ashby's Law of Requisite Variety.

- **Insensitivity to Discovered Behavioral Pathologies.** Human fallibility can now be explicitly recognized in methodology.

[1] The systems community is not alone in its linguistic barbarism. In governmental circles one constantly hears such phrases as "address the whole question" and deal with "both sides of the equation", so that presumably all will be well "at the end of the day". One might describe such practices as "government by metaphor".

Recognize, pay tribute to, and factor into systems science the discoveries of behavioral pathologies that have been made in the last half of the twentieth century; and which have now been demonstrated to be the basis for serious errors in systems made by human beings; errors that could have been avoided by responsible design practices.

- **Inadequacy of Comparisons of Alternatives.** For those who feel an earnest need for numbers, alternatives can now be assessed in terms of complexity metrics. Alternative designs are almost never compared on the basis of relative complexity, and quantitative measures of complexity based on known human behavioral pathologies are almost never taken into account in system design; which explains much of the difficulty faced by consumers in using systems designed with such inadequacy.

- **Blindness to History.** Some people thought about systems long ago. There seems to be a strongly entrenched belief that systems thinking originated in the last half of the twentieth century. Virtually every important concept that backs up the key ideas emergent in systems literature are found in ancient literature and in the centuries to follow. It is time to recognize the contributions of these elder scholars and factor them into systems science where their presence is absolutely essential to a mature science.

- **Monotonous Bifurcation.** Systems literature cannot be valued properly by weight. Too much of the systems literature is bifurcated. It offers either theory with no empirical evidence or (less commonly) empirical evidence with no supporting theory or, now and then, sheer fantasy with neither theory nor evidence; thereby at least giving some relief from the monotonous bifurcation.

It would be of no use merely to rail against bad practices if nothing were offered to replace the practices. I offer to replace these practices with systems science and what the application of systems science yields. The name "science" has been misused often in recent decades. I strive

constantly to honor it, and I do my best to use it in the way it was used by those noble souls so often treated badly in previous centuries. In this quest, we can draw some solace from such things as the words of C. S. Peirce that "truth, crushed to earth, shall rise again", and from noting that even though it took 400 years for the Church to acknowledge that Galileo had been correct, it did eventually acknowledge it. Perhaps even the university, as a generic institutional type, can find the strength ultimately to look to its integrity now and then and restore some of the linguistic integrity associated with the terminology describing its offerings.

Before I explain the organization of the book, I will describe first my perspective on what constitutes systems science and how I have presented this subject. The reader who is familiar with a significant part of the systems literature will soon realize that this presentation is relatively novel, although it does not ignore prevailing concepts. That is because this perspective has only arisen in my mind in the past year or so as I have been working to integrate over three decades of research and publications on systems, and it is only as a result of that effort that I have finally been able to arrive at a concept of what constitutes systems science. I have explained thoroughly the odyssey that produced this concept in **Appendix 3** of this book titled "Discovering Systems Science".

Systems science is best seen as a science that consists of nested sub-sciences. It is presented most compactly using the notation of set theory.

Let **A** represent a science of description. Let **B** represent a science of design. Let **C** represent a science of complexity. Let **D** represent a science of action (praxiology). Let **E** represent systems science. Then

$$\mathbf{A} \subset \mathbf{B} \subset \mathbf{C} \subset \mathbf{D} \subset \mathbf{E} \qquad \textbf{(1)}$$

Eq. (1) illustrates the concept that we can learn something of systems science by first learning a science of description. Then we can learn a science of design which includes a science of description. Next we can learn a science of complexity which includes a science of description and a science of design, and so on.

I have published books on **A**, **B**, **C**, and **D**, having only recently becoming clearly aware that what I was doing at the time was

constructing portions of Eq. (1). The present book is **E**. It cannot include **A**, **B**, **C**, and **D**, but it can incorporate them by reference, and it can provide necessary links.

Table 1 offers some of the linkages. Others will be made clear in the ensuing chapters and appendixes. The tables and figures in the last book cited in Table 1 are duplicates of identical tables and figures in the first book in the table and their numbers are subtracted from the totals to give a more accurate picture of the totals.

In light of what is shown in Table 1, the reader may begin to understand that the main purpose of the present book is to provide the glue that links together the work presented in these other books. In order to do this, the foundations that link these other works must be tightly constructed, and the empirical evidence that supports the use of the foundations and the linkages that form systems science are to be made evident here.

Table 1. Books That Describe Sub-Sciences of Systems Science

Science	Citation	Pages	Tables	Figures
Description	J. N. Warfield (1976) ***Societal Systems: Planning, Policy, and Complexity***, New York: Wiley Interscience.	490	46	115
Design	J. N. Warfield ***A Science of Generic Design: Managing Complexity Through Systems Design***, 1st Ed (1990) Seaside, CA; Intersystems. 2nd Ed. (1994) Ames, IA: Iowa State University Press.	635	46	132
Complexity	J. N. Warfield (2002): ***Understanding Complexity: Thought and Behavior***, Palm Harbor, FL: Ajar.	278	16	52
Action	J. N. Warfield and A. Roxana Cárdenas (1994): ***A Handbook of Interactive Management***, 2nd Edition, Ames, IA: Iowa State University Press.	353	18	8
Description	J. N. Warfield (2003) ***The Mathematics of Structure***, Palm Harbor, FL: Ajar.	164	21	24
Totals		1,920	147 - 21 = 126	331 - 24 = 307

What is Needed to Present Systems Science? To a first approximation, taking into account the 1920 pages in the books listed in Table 1, and the 400 or so pages in the present book, one could say that about 2,300 pages are required to present systems science. This would be misleading, because text alone is insufficient. **Appendix 2** of the present book describes the "Warfield Special Collection" in the George Mason University Fenwick Library in Fairfax, Virginia. This collection occupies over 90 linear feet (a measure used by librarians to indicate the size of such a collection). A computer link to the collection appears in **Appendix 2**. Following this link one can find on the Internet the contents of the collection. Included there are titles of more than 100 VHS videotapes, more than 20 DVDs, lots of audio cassettes, and hundreds of overhead transparencies. All of these audio-visuals have been used at one time or another to help convey the material that is described using text in this book. The behavioral aspects are among the materials most difficult to convey using text alone, and most readily perceived when one is cued as to what to look for on the videotapes or DVDs.

With this background, I am now ready to describe the organization of the present book. As the contents indicate, the book has five "Parts" which include 20 Chapters, and seven "Appendixes". I will explain briefly the purpose(s) of each Chapter and make some comments about their relationship to systems science, as I have defined it in Eq. (1). The comments will then be summarized in Table 2.

Foundations. Part 1, consists of a discussion of the foundations of systems science. It is argued here that all science, including systems science shares three common foundations, and that a distinguishing feature of systems science is that it must be neutral; i.e., not be attached to any particular arena, in order that it can be applicable to any problematic situation. This means further that it can be quite frugal in terms of methodology, having as its principal purpose to provide a service to local practitioners to describe their problematic situation in a viable language. For this to occur the systems science itself must have a high-quality discursivity founded in the theory of relations, since any system model will be comprised of relational descriptors. The history of the development of such a viable language is recounted here in terms of

thought explorers; and the evolution of the process that enables the local group to describe its situation and, ultimately to design a system for resolving it, is suggested.

Key concepts of quality control in modeling are described, and the authors of these concepts are identified. The importance of the work space and its layout as a factor in getting good work done is stated.

The discussion in Part 1 aims to strike a complementary balance between the removal of the negatives and the achievement of the positives as the essential foundational aspects of systems science, bypassing conventional ways of approaching systems issues by starting with well-known methods.

The Work Program of Complexity. The Work Program of Complexity has two main parts: Discovery and Resolution. Part 2 of the book deals with the Discovery portion. The Discovery contains two parts, Description and Diagnosis. Incorporated here are considerations of metrics of complexity which can be computed from the work of Description. The local group does the Description, and a person highly experienced with the action component of systems science called Interactive Management does the Diagnosis (without introducing new concepts, but merely feeding back to the group what their work has produced). What is described in Part 2 in a relatively few pages is detailed in books with many pages, hence the purpose of Part 2 is to provide overview to the Discovery portion of the Work Program of Complexity; not to generate expertise in carrying out the first part of the Program.

The second part of the Work Program of Complexity is Resolution. Part 3 of the book deals with Resolution. The Resolution contains two parts: Design and Implementation. Once again, books are available that deal with these parts, so again only a relatively few pages are required to provide overview, not to generate expertise in carrying out the second part of the Program.

Empirical Evidence of Effectiveness. One of the unique features of this book is a collection of contributions by authors from various countries who have experiences to relate that connect to systems science as presented here. It was my intention in inviting these authors to try to obtain a sufficient variety both in locale and in subject matter to help

show that the idea of systems science as a neutral science was a valid concept, and that what was being presented was also society-neutral in that the processes would work as well in one society as in another society, because the processes involved sensitivity to deeply-felt, universal human aspects. I feel that the authors have satisfied this intention, and I hope that you do too.

As I explain in my introduction to Part 4, I chose to place the contributions of the authors in four categories: the private sector, the government sector, the education sector, and the social arena. There is overlap among these, and the authors contribute to more than one sector, but I think their contributions shown here relate mainly to the topic of the Chapter in which I have placed them. Several of the authors could have made contributions to more than one Chapter, but I didn't feel that I could ask them to do more. I thank them very much for what they have done to help make this book more valuable. I have included the contributions of Carmen Moreno and Graciela Caffarel in both Spanish and English.

Part 5 on Systems Science. The discussion of systems science really occupies more than Part 5, although I have titled Part 5 "Systems Science". The subject is also the topic of the Appendices, so I am able only to deal with the subject in an overview way in Part 5. In Chapter 19 I give a quick overview of the subject, and in Chapter 20 I offer a few thoughts on a possible future for this subject.

The Appendices. Appendix 1 gives either photographs or drawings of people whose work helped me greatly in developing systems science. I describe briefly the relevant work of these individuals, and provide some information on the status of some of them.

Appendix 2 provides linkages to the "Warfield Special Collection" which is very large, and which offers a great deal of supporting research material for the scholar who wishes to spend some time in the library reviewing particular parts of the background, or watching videotapes of work as it progressed in particular applications.

Appendix 3 describes how the systems science was discovered, as a kind of odyssey through time, and Appendix 4 complements that by going into more detail on the linguistic aspects of systems science.

Appendix 5 discusses the two key neutral processes which I feel are sufficient to fill the needs of systems science. As I explain in several places, a well-carried out application of systems science will reveal what, if any, other methods may be needed to complete a project.

Appendix 6 offers three different ways to view this subject.

Appendix 7 is a short summary of the importance of structural graphics as a special kind of literacy requirement to help portray and understand complexity in particular problematic situations.

Table 2. Book Parts, Negatives–Positives Table

Part 1. **Foundations**–An overview of the severe negatives in the systems domain and ways of exorcising these negatives			
Division	Division Title	Negative(s) Attacked	Positive(s) Given
Chap 1	Unlimited Scope of Systems Science	Underscoping the systems domain	Constructing systems science as a neutral science, unconstrained by premature choices of methodology, while recognizing and accounting for those natural constraints which cannot be removed, but which can be taken into account in designing processes
Chap 2	The Human Being (Creative & Fallible)	Insensitivity to discovered behavioral pathologies	Designing processes to circumvent behavioral pathologies
Chap 3	Language (Overpromising, Underperforming)	Linguistic pollution	Founding discursivity for systems science, and applying the language of systems science locally to enable local language construction by local practitioners for local problematic situations
Chap 4	Second-Order Thought	Blindness to history, Premature quantification	Defining second-order thought as thought about thought itself, and what this means in terms of the development of science

Chap 5	The Thought Explorers	Blindness to history, Premature quantification	Identifying the key mathematics of systems science, explaining why that is the key mathematics, and revealing its historical development
Chap 6	Quality Control in Modeling Structure	Blindness to history, Premature quantification	Showing how to control quality in model development, and explaining why this method is appropriate
Chap 7	The Situation Room	Unimaginative workspace, Mismatched media	Showing how to tailor space for high-quality model development, and explaining why this type of space is required
Part 2. **Discovery**–how systems science itself is discovered, and how it provides the means of discovery in problematic situations			
Division	Division Title	Negative(s) Attacked	Positive(s) Given
Chap 8	Describing a Problematic Situation	Mismatched media	Explaining how a problematic situation is described, the process used, the products of the process, the nature of the description, and the use of the products as inputs to the design process
Chap 9	Metrics of Complexity	Insensitivity to behavioral pathologies, Inadequacy of comparisons of alternative designs	Describing a variety of numerical metrics of complexity, showing how the data are obtained, how they are computed, and mentioning links to sources of application of such metrics in making system design choices
Chap 10	Diagnosing	No clear picture in the systems literature of how diagnosis is done.	Diagnosis is carried out by a person who is highly experienced in "reading" the products of prior work; and who tests that reading against the perceptions of those who created the products. The diagnosis renders a verbal description to accompany the graphical products, thereby rendering a more complete description.

Part 3. **Resolution**–how systems science provides the means of resolving problematic situations through systems design and implementation			
Division	Division Title	Negative(s) Attacked	Positive(s) Given
Chap 11	System Design	Insensitivity to behavioral pathologies, Inadequacy of comparisons of alternative designs	Processes for generating design options to match dimensions in the description of the problematic situation are given, using Ashby's Law of Requisite Variety as a disciplining agent.
Chap 12	Choosing from the Alternatives	Insensitivity to behavioral pathologies, Inadequacy of comparisons of alternative designs	Complexity metrics are computed using information produced to this point, and these metrics become part of the information used in choosing from the design alternatives that are developed.
Chap 13	Implementing the Design	Insensitivity to behavioral pathologies, Inadequacy of comparisons of alternative designs	A large amount of information is developed which culminates in developing a detailed plan for implementing a system design.
Chap 14	The Corporate Observatorium	Insensitivity to behavioral pathologies, Inadequacy of comparisons of alternative designs, Unimagina-tive workspace	A system design having been produced by a relatively small team, there is a significant educational task to enable a larger body of individuals who will be involved in implementation. This requires additional physical plant, called the corporate observatorium, where large graphical displays are laid out and maintained (NOT Pert Charts), showing the full development of the description, design, and work plan, which is kept up to date, and which precedes (NOT FOLLOWS) activities carried out in work programs.

Part 4. **The Practitioners**–offering empirical evidence of application of systems science in four major domains of humanity			
Division	Division Title	Negative(s) Attacked	Positive(s) Given
Chap 15	The Private Sector	Lack of empirical evidence from sector	Empirical evidence either as direct discussion of specific applications, or as opinions based on direct experience of the reporter; with various reporters from different parts of the world, having to do with different types of applications; coming from individuals who may be available to furnish additional evidence if required; some of whom have already made significant contributions to the "Warfield Special Collection" described in Appendix 2.
Chap 16	The Government Sector	Lack of empirical evidence from sector	Empirical evidence either as direct discussion of specific applications, or as opinions based on direct experience of the reporter; with various reporters from different parts of the world, having to do with different types of applications; coming from individuals who may be available to furnish additional evidence if required; some of whom have already made significant contributions to the "Warfield Special Collection" described in Appendix 2.
Chap 17	The Social Arena	Lack of empirical evidence from sector	Empirical evidence either as direct discussion of specific applications, or as opinions based on direct experience of the reporter; with various reporters from different parts of the world, having to do with different types of applications; coming from individuals who may be available to furnish additional evidence if required; some of whom have already made significant contributions to the "Warfield Special Collection" described in Appendix 2.

Chap 18	The Education Sector	Lack of empirical evidence from sector	Empirical evidence either as direct discussion of specific applications, or as opinions based on direct experience of the reporter; with various reporters from different parts of the world, having to do with different types of applications; coming from individuals who may be available to furnish additional evidence if required; some of whom have already made significant contributions to the "Warfield Special Collection" described in Appendix 2.
Part 5. **Systems Science**–expounding on the nature of systems science and speculating on a possible future for systems science			
Division	Division Title	Negative(s) Attacked	Positive(s) Given
Chap 19	Systems Science	Underscoping the systems domain	More detailed discussion of systems science.
Chap 20	Reflections and Speculations	No clear future picture for systems science	Personalized discussion of a possible future for the systems domain.
Appendixes–adding depth and perspective in selected areas, as well as links to extensive additional resources			
Division	Division Title	Negative(s) Attacked	Positive(s) Given
App 1	Gallery	Blindness to history	Pictures and descriptions of the older contributors and the living ones
App 2	The Warfield Special Collection	Blindness to history, Underscoping the systems domain	Showing the great variety inherent in the systems domain, and furnishing many examples of applications in great detail, including complete videos, DVDs, books, and reports.

App 3	Discovering Systems Science	Underscoping the systems domain; Monotonous bifurcation	Detailing the odyssey by means of which the systems science reported in this book was discovered.
App 4	Linguistic Adjustments	Linguistic Pollution	Explaining why the language that grew artificially in the systems domain is not serviceable, what some of the changes are that are required and why; and what terminology can replace the present language.
App 5	The Two Neutral Processes of Systems Science	Premature Quantification	Explains why only two processes are required for systems science, and why all the many other processes can be seen as possibly among those which would be shown to be required as an outcome of the application of systems science in specific problematic situations.
App 6	Statements, Themes Findings, Structure	Linguistic Pollution	Aggregative outlines of systems science portrayed in various ways, to show linkages.
App 7	Literacy in Structural Graphics	Linguistic Pollution	The importance of structural graphics in establishing discursivity in the domain of complexity.

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