THE ROAD LESS TRAVELED:
Constructing Systems Science
From the Basic Triad for All Science
THE 2002 BERTALANFFY LECTURE for the
International Society for Systems Sciences

(Notes on the PowerPoint Slides)

John N. Warfield

1. TITLE SLIDE. This title slide is intended to convey three ideas.

The first, "The Road Less Traveled" means that I have worked in complexity and systems science along directions that are not those most commonly seen in the complexity and systems literatures.

The second, "Constructing Systems Science" means that I propose to discuss the structure, content, and purpose of systems science from a new perspective.

The third, "the Basic Triad of All Science" refers to my belief that any science has to involve three entities;

- **The human being**
- **Thought**
- **Language**

To see this, we need only imagine that one of these is absent, and try to imagine how in the world a science could be constructed without involving that one.

I propose also to discuss "derivatives" from these three. Derivatives will be ideas that stem directly from one of these three or from relations among some combination of them. One of the key derivatives is a sense of purpose stemming from the human being that helps distinguish one science from another.

It is my view that systems science can be constructed solely from the Basic Triad and its Derivatives, including a sense of purpose. I hope to

convince you of this in this presentation.

SLIDE 2. Bertalanffy Photo. Having never met Bertalanffy, but knowing of the following that he has attained, I felt it appropriate to show a photograph of him taken from the Internet. While my presentation does not refer further to him, I do believe from his writings that he would fine the topic appropriate, and I certainly hope so.

I thank Mike Jackson and Siwei Cheng for extending to me the invitation to give this Lecture, and I hope it will meet with their approval.

SLIDE 3. Robert Frost Photo. The title "The Road Less Traveled" is taken from a poem by the late Robert Frost, a very popular American poet. It expresses well the feelings that I have toward this presentation, and I would like to read the poem to you, so you may perhaps see why I chose it.

SLIDE 4. "The Road Less Traveled". [Warfield reads the poem]

SLIDE 5. Three Who Took the Road Less Traveled. It has not always been a good idea to take "the road less traveled". I show here a triad of people who did that, and what happened to them. I sincerely hope that I will have a somewhat better fate.

SLIDE 6. The Organizing Triad for this Lecture. I make frequent use of triads, connecting three ideas together. In this slide, I show the three main linked ideas involved in this lecture:

- Summarizing Triads (a set of triads that collectively largely summarize the whole content of this lecture)
- The Domain of Science Model (which I use to force self-discipline on myself when developing and discussing science)
- The Derivative Hierarchy (which I shall present to use to show my proposed construction of systems science)

SLIDE 7. The Domain of Science Model. I introduced this idea, the

Domain of Science Model, to the Society for General Systems Research about 15 years ago. [check the number]. Please note that the science is defined to consist of a "corpus" (which includes foundations and theory) and "methodology". Outside the science, but attached to it is the "arena". The arena embodies the central purpose of the science, and is where the science is tested and from which proposed amendments are generated to improve the quality of the science. Please note that the model is circular, with each part constantly helping each other part, as appropriate

I will refer to this model frequently as I proceed.

SLIDE 8. THREE PURPOSES FOR THE DOMAIN OF SCIENCE MODEL.

Noting that the DOSM shows a science and its associated arena, these two collectively making up the "domain" of the science, this model is intended to serve 3 purposes:

- **To help in describing any science**
- **To discipline the development of any science**
- **To discuss how two or more sciences interrelate**

SLIDE 9. THE DERIVATIVE HIERARCHY AND THE BASIC TRIAD

I show here my construction of systems science in outline form. At the base of the hierarchy is the Basic Triad which I introduced previously. Please note that systems science lies at the top of this structure. The structure is an "inclusion structure" meaning that each component includes all of the components lying below it.

Please note that systems science incorporates four other sciences: a science of description, a science of generic design, a science of complexity, and a science of action. Each of these constituents has the same central purpose: to support the systems science.

It is my intent to work up this hierarchy, beginning with the Basic Triad, continuing with the science of description, and so on, and finally discussing systems science.

SLIDE 10. THE SUMMARIZING TRIADS. I list here a dozen "summarizing triads". As I move along, I will discuss each one in its own place.

SLIDE 11. THE TWO-DOMAIN THEORY OF ACTION. In this presentation, I assume that two essentially independent domains make up human action. One domain is the domain of "normality" where most of our actions take place. The other domain is the domain of "complexity". Most of which takes place in this second domain is ineffective or even troublesome because people use methods they are familiar with from the domain of normality, and these methods don't work in the domain of complexity. That is why it is necessary to go down "the road less traveled", to find methods that are effective in the domain of complexity.

SLIDE 12. COMPONENTS OF A NEUTRAL SCIENCE. Systems science and its four component sciences must be neutral sciences. That is because the central purpose of systems science is to assist in resolving problematic situations that may arise anywhere on many topics. In order to be sufficient flexible and versatile to work in such a broad arena, systems science and its components must not be biased.

Because of the inherent broad scope, focus must be provided and quality control must be exerted on the sciences to position them for working with the breadth.

SLIDE 13. A CONSTRUCTIVE NEUTRAL SCIENCE. All four of the component sciences of systems science must be constructive neutral sciences, as indicated on this Slide.

SLIDE 14. THREE TYPES OF NEUTRAL SCIENCE. We see that there are three types of neutral sciences. One type has, as its central purpose, to support one or more others. Another type has, as its central purpose, to support many applications and can import into its domain methods from all forms of biased (non-neutral) sciences, in order to satisfy the conditions that are defined through the application of neutral sciences. The third type combines the attributes of the first two. Systems science is the third type.

SLIDE 15. SPECIFIC (BIASED) SCIENCE AND NEUTRAL SCIENCE. The opportunities for specific (biased, non-neutral) science to be part of any neutral science are non-existent or very limited. Such sciences can enter the domain of science through the relevant arena.

SLIDE 16. THE BASIC TRIAD OF ALL SCIENCE. The basic triad of all science includes the human being (and specifically, for our purposes, the behavioral pathologies that work against high quality products), thought about thought (also may be called second-order thought), and language. All of the neutral sciences draw on this basic triad and its derivatives.

SLIDE 17. GRAPHICAL VERSION OF THE TRIAD.

SLIDE 18. HUMAN BEINGS, WHEN WORKING TOGETHER ON PROBLEMATIC SITUATIONS, SHOW THREE MAJOR FLAWS. It is because of the pathologies shown here that stringent quality control must be placed on work done in groups. To benefit from the work of groups, it is best to think in terms of organizing beliefs, rather than knowledge, because each person in the group has a different set of beliefs, and it is only through taking part in highly-structured methodologies that these beliefs are altered in the direction of informed consensus.

SLIDE 19. THE INITIATION OF INQUIRY. The literature offers three distinctly different ways to initiate an inquiry. Only one of these passes the test of realism. That is the way of Charles Sanders Peirce, who recognizes the necessity of overcoming already-embedded cognitive burden, while striving to take advantage of emerging belief.

SLIDE 20. THE NEUTRAL SCIENTIST'S PROGRAM. Shown here are six aspects of the program of the neutral scientist. The neutral scientist may both develop and apply neutral science.

SLIDE 21. BEGINNING CONCERNS ABOUT QUALITY. Because of the behavioral pathologies and linguistic burden, it is well to be concerned from the outset of an inquiry with the quality of any

models that may be developed on the way to resolving a problematic situation. We see here the "three C's", but only one of these can be assured.

SLIDE 22. DEVELOPERS OF THEOREMS FOR QUALITY CONTROL IN MODELING. We see here photographs of two researchers who have developed very important theorems related to the quality of models:

George Friedman and Frank Harary

SLIDE 23. THE USE OF DERIVATIVES OF A TRIAD. I emphasize here the idea of derivatives from the basic triad, as crucial in developing high quality science and sound ways of resolving problematic situations.

SLIDE 24. A NEUTRAL SCIENCE OF MODELING (DESCRIPTION). Here we see once again the derivative hierarchy, and now emphasis will be directed to the science of modeling (description).

SLIDE 25. THE WORKSHOP FRAMEWORK. To work out through joint effort the behavioral pathologies, enroute to appropriate description of problematic situations, a workshop is held. The workshop involves context, content, and process. How can the workshop be focused?

SLIDE 26. AN INTERCONNECTION OF IDEAS. The topic of the workshop is the "problematic situation", a term coined by John Dewey (who was a student of Peirce at Johns Hopkins University). The description to be studied is the "problemization" of that situation, a term coined by Michel Foucault. Working within these focusing ideas, a local inquiry group, members of an informed community, add the necessary depth.

SLIDE 27. QUALITY CONTROL FOR A SCIENCE OF MODELING. Here are the three main QC factors for a science of modeling.

SLIDE 28. SHOWING THE QUALITY CONTROL TRIAD GRAPICALLY.

SLIDE 29. SOME THOUGHT LEADERS ON SECOND-ORDER THOUGHT. **The Workshop, involving the local inquiry group, takes advantage of the history of second-order thought, as it evolved through more than two centuries, beginning with Aristotle.**

SLIDE 30. MORE THOUGHT LEADERS ON SECOND-ORDER THOUGHT. **There are abundant reasons to incorporate the thinking of these thought leaders into the methods used in the neutral science of modeling (description).**

SLIDE 31. THREE STYLES OF BEHAVIOR IN A TRIAD. **Our neutral science of modeling, being responsive to the human derivatives from the Basic Triad of All Science, shall be responsive to these three types of behavioral pathologies; and note that they come together in the organization.**

SLIDE 32. BEHAVIORAL PATHOLOGIES TRIAD IN BULLETS.

SLIDE 33. THOUGHT LEADERS ON INDIVIDUAL BEHAVIORAL PATHOLOGIES.

These 20th century scientists have articulated the individual behavioral pathologies to which a science of modeling must be responsive.

SLIDE 34. THOUGHT LEADERS ON GROUPL BEHAVIORAL PATHOLOGIES.

These 20th century scientists have articulated the GROUP behavioral pathologies to which a science of modeling must be responsive.

SLIDE 35. THOUGHT LEADERS ON ORGANIZATIONAL BEHAVIORAL PATHOLOGIES.

These 20th century scientists have articulated the ORGANIZATIONAL behavioral pathologies to which a science of modeling must be responsive.

SLIDE 36. THE LINGUISTICS TRIAD. **The three components of language. Their usage is heavily asymmetric, and their separate attributes are very distinctive. The combinations, upon examination, reveal the necessity for prose-graphics communication in the domain of complexity.**

SLIDE 37. THOUGHT LEADERS ON LANGUAGE. **Here we see images of key thought leaders on language from whom we must take the ideas relevant to a science of modeling.**

SLIDE 38. REPLACING PROSE WITH A PROSE-GRAPHICS STRUCTURE.

An example of a prototypical statement.

SLIDE 39. PORTRAYING THE LEARNING OF FRACTIONS IN PROSE-GRAPHICS LANGUAGE.

This is an example of what I am talking about. We use something that ought to be familiar to everyone, and yet who could construct this portrait from their own memory? Please notice the non-linearity.

SLIDE 40. SYLLOGIZING GRAPHICALLY. **Today the syllogism still stands as the foundation component of inference. But now we can show it graphically, and this GREATLY extends its utility, moving it into the domain of complexity as a key component.**

SLIDE 41. TWO COMMON PRODUCTS COMPRISED OF LINKED SYLLOGISMS.

These two products enable us to carry out the combined program of Aristotle, John Dewey, and Michel Foucault, doing problemization of a problematic situation and showing how the problems are related syllogistically, in terms of how each problem influences and/or is influenced by other problems. And then grouping problems syllogistically into categories.

SLIDE 42. EXAMPLE (Type 2) PROBLEMATIQUE FOR DISARMAMENT AND DEMOBILIZATION IN LIBERIA.

Carol Jeffrey's work with warlords and warriors to bring an end to major hostilities. Please notice the non-linearity.

SLIDE 43. OPPORTUNITY STRUCTURE FOR INEA IN MEXICO

Jorge Rodriguez work with the educational system in Mexico. Please notice the non-linearity.

SLIDE 44. LINGUISTIC COMPONENTS OF NEUTRAL SCIENCE

SLIDE 45. MOVING ON TO THE GENERIC DESIGN SCIENCE IN THE DERIVATIVES HIERARCHY

SLIDE 46. THE IMPACT OF ASHBY'S LAW (THEOREM).

SLIDE 47. ASHBY'S THEOREM (LAW).

SLIDE 48. DIMENSIONALITY AND ASHBY'S LAW.

Dimensionality can be formalized through the Problems Field. It can be used in direct application of Ashby's Law in forming the Options Field, so there is a one-to-one correspondence between categories in the Options Field and Categories in the Problems Field.

SLIDE 49. THE HUMAN QUALITY CONTROL TRIAD OF SYSTEM DESIGN.

Photos of Friedman, Harary, and Ashby, linked as a Quality-Control Triad.

SLIDE 50. TWO METHODS ARE SUFFICIENT IN THE SCIENCE OF DESCRIPTION AND THE SCIENCE OF GENERIC DESIGN:

- **Nominal Group Technique (NGT)**
- **Interpretive Structural Modeling (ISM)**

SLIDE 51. THREE BOOKS PROVIDE THE ESSENCES OF THE SCIENCE OF MODELING, THE SCIENCE OF GENERIC DESIGN, AND THE SCIENCE OF COMPLEXITY

One reason these books illustrate "The Road Less Traveled" is that they are really neutral sciences; open to supporting other sciences, and forming key components of systems science.

SLIDE 52. MOVING ON TO COMPLEXITY SCIENCE.

SLIDE 53. TWENTY LAWS OF COMPLEXITY.

These 20 Laws were published in SR&BS. More than 50% pertained to the behavioral pathologies. Some pertained to media of presentation. A few pertained to the mathematics of structure.

These laws form much of the theory of the science of complexity. The sciences of modeling and generic design form part of the theory as well, and all are liked to the basic triad of all science and its derivatives.

SLIDE 54. MEASURING COMPLEXITY.

Metrics are found in most sciences. In the science of complexity, several metrics have been defined, and several are named after the investigators who did the fundamental research. Four of the five metrics are defined so that the value 1.0 represents the boundary between the domain of normality and the domain of complexity. Values greater than 1.0 indicate that the problematic situation lies in the domain of complexity. The fifth metric (Situational Complexity Index) is the product of three of the others.

A lot of empirical work has been done with a variety of problematic situations in a variety of locations, in which these metrics have been evaluated. They all invariable take values well above 1.0.

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SLIDE 55. PRODUCTS OF THE SCIENCE OF COMPLEXITY-1: the Work Program of Complexity

The Work Program of Complexity is formulated as a product of the science of complexity, and is delivered as a general program to the science of action.

SLIDE 56. PRODUCTS OF THE SCIENCE OF COMPLEXITY-2: Infrastructure Requirements.

A second product of the science of complexity is the nature of the infrastructural requirements to resolve problematic situations. Physically these take the form of the "situation room" and the "corporate observatorium".

SLIDE 57. PRODUCTS OF THE SCIENCE OF COMPLEXITY-3: the Coherent Organization Model.

SLIDE 58. COMPLEXITY SCIENCE AND THE SCIENCE OF ACTION

By taking in the ideas from the science of complexity, the science of action proceeds to illuminate the actions involved in modeling and in generic design, within the coherent (virtual) organization, benefiting from the infrastructural requirements set forth in the science of complexity.

SLIDE 59. TYPICAL VALUES OF METRICS FROM APPLICATIONS.

SLIDE 60. ARISTOTLE INDEX VALUES FOR SEVERAL APPLICATIONS-1.

SLIDE 61. ARISTOTLE INDEX VALUES FOR SEVERAL APPLICATIONS-2.

SLIDE 62. ARISTOTLE INDEX VALUES FOR SEVERAL APPLICATIONS-3.

SLIDE 63. INTERPRETING THE ARISTOTLE INDEX.

SLIDE 64. STRUCTURE-BASED SCIENCE OF COMPLEXITY.

The science of complexity described here is based in structure. It promotes the development of the problematique, the problems field, the optionatique, the options field, and has the main attributes shown on this slide.

SLIDE 65. DETAILS OF THE WORK PROGRAM OF COMPLEXITY-1.

Empirical evidence has taught various lessons about the components of the Work Program of Complexity, and what is required to carry them out successfully.

SLIDE 66. DETAILS OF THE WORK PROGRAM OF COMPLEXITY-2.

SLIDE 67. MOVING ON TO THE SCIENCE OF ACTION.

SLIDE 68. THE HANDBOOK OF INTERACTIVE MANAGEMENT.

This book completes the group of four that lay out the component sciences of systems science:

The science of description: Societal Systems: Planning, Policy, and Complexity

The science of generic design: A Science of Generic Design: Managing Complexity Through Systems Design

The science of complexity: Understanding Complexity: Thought and Behavior

The science of action: The Handbook of Interactive Management

SLIDE 69. MOVING ON TO SYSTEMS SCIENCE.

SLIDE 70. A DEFINITION OF COMPLEXITY.

SLIDE 71. THE PATHOLOGICAL INQUIRER'S PROGRAM.

SLIDE 72. THE IMPERATIVE OF SYSTEMS SCIENCE.

The system scientist may safely give up the pathological inquirer's program and take on the derivative structure shown here as the basic definition of systems science.

Coming from the application of systems science, consisting of the integrated sciences of modeling, generic design, complexity, and action, systems science can knowingly take into its arena whatever methodologies are required in light of the findings from its underling sciences.

Through this means, it can serve humanity proudly, knowing that its quality is controlled by all know means, and that whatever mistakes are made are a consequence of human misbelief, rather than as a result of failure to apply the most carefully thought-out results from the great minds of the past.

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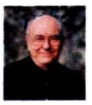
THE ROAD LESS TRAVELED

CONSTRUCTING SYSTEMS SCIENCE FROM THE BASIC TRIAD FOR ALL SCIENCE



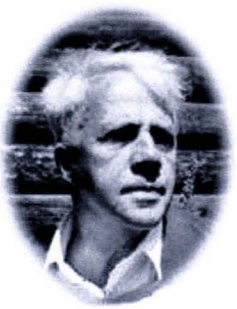
JOHN N. WARFIELD

PREPARED AS THE BERTALANFFY LECTURE

1

LUDWIG VON BERTALANFFY

2



ROBERT FROST, A POET, AN AMERICAN ICON

3

THE ROAD LESS TRAVELED

1 "Two roads diverged in a yellow wood,
And sorry I could not travel both
And be one traveler, long I stood
And looked down one as far as I could
To where it bent in the undergrowth;

2 Then took the other, as just as fair,
And having perhaps the better claim,
Because it was grassy and wanted wear;
Though as for that the passing there
Had worn them really about the same,

3 And both that morning equally lay
In leaves no step had trodden black.
Oh, I kept the first for another day!
Yet knowing how way leads on to way,
I doubted if I should ever come back.

4 I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a wood, and I--
I took the one less traveled by,
And that has made all the difference."

---Robert Frost (1874 - 1963)

4

THREE WHO TOOK THE ROAD LESS TRAVELED

GALILEO, PUT IN PRISON FOR LIFE

LAVOISIER, SENT TO THE GUILLOTINE

PEIRCE, EXILED FROM ACADEMIA, DIED IN EXTREME POVERTY

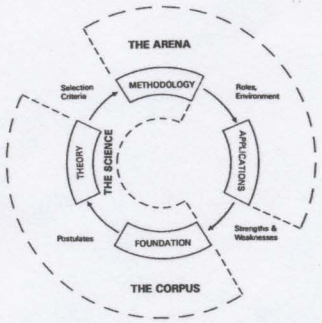
5

THE DERIVATIVES HIERARCHY

DOMAIN OF SCIENCE MODEL — **SUMMARIZING TRIADS**

THE TRIAD FOR THIS LECTURE

6



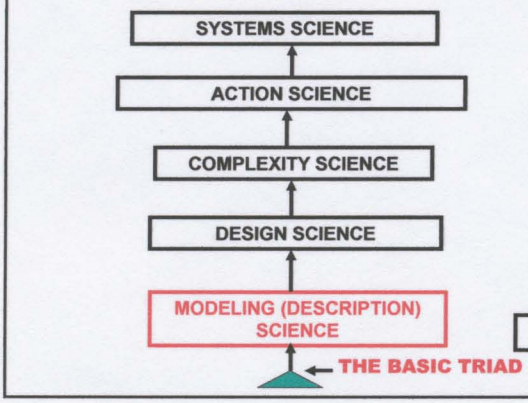
THE DOMAIN OF SCIENCE MODEL

7

3 PURPOSES FOR THE DOMAIN OF SCIENCE MODEL

- IT IS INTENDED TO HELP IN DESCRIBING *ANY* SCIENCE
- IT IS INTENDED TO DISCIPLINE THE DEVELOPER(S) OF *ANY* SCIENCE DURING THE DEVELOPMENT
- IT IS ALSO INTENDED TO HELP IN DISCUSSING HOW *TWO SCIENCES* MIGHT BE RELATED: IN OTHER WORDS, HOW DO THE *TWO DOMAINS* INTERRELATE?

8



9

THE SUMMARIZING TRIADS

- The Contextual Triad of the Presentation— DOSM-DH-STs
- Three Proposals for Initiating Inquiry— T-D-P
- The Three Components of a Science— F-T-M
- The Basic Triad of all Science— H-L-T
- The Three Types of Neutral Science— IF-MI-Hy
- The Three C's of Structural Modeling (Friedman & Harary)
- Quality-Control Triad of Structural Modeling— F-H-A
- The Behavioral Styles Triad (Miller, Janis, Argyris)— I-G-O
- The Collective Flaws Triad— C-G-S
- The Linguistic Triad— P-M-G
- Three Workshop Components— C-P-C (Dewey, Foucault, the Client)
- The Coherent (Virtual) Organization— S-M-P

10

TWO-DOMAIN THEORY OF ACTION

THE NORMAL DOMAIN:	THE DOMAIN OF COMPLEXITY:
• What is taught in higher education	• Where normal methods don't work
• What you do most of the time	• Where normal assumptions break down
• Where you develop most of your habits	• What must now be faced up to by practitioners
• From which you derive most of your assumptions	• Where problematic situations abound

11

COMPONENTS OF A NEUTRAL SCIENCE

- ESSENCE (CORPUS, showing feeders, if any)
- METHODOLOGY (how to serve the purpose)
- PURPOSE (ARENA, showing receivers, if any)
- DEFINED PRODUCTS
- QUALITY CONTROL COMPONENTS FOR DEFINED PRODUCTS

12

CONSTRUCTIVE NEUTRAL SCIENCE

A Constructive Neutral Science is one whose purpose is to be the essence (corpus) of one or more higher-level neutral sciences.

The purpose of such a higher-level neutral science will incorporate the purpose of the lower-level neutral science, along with extension of that purpose.

13

THREE TYPES OF NEUTRAL SCIENCE

- TYPE 1. A SCIENCE THAT SUPPORTS ONE OR MORE OTHER SCIENCES: ITS COMPONENTS MAY BECOME INTEGRAL PARTS OF COMPONENTS OF THE SCIENCES IT SUPPORTS
- TYPE 2. A SCIENCE THAT SUPPORTS MANY APPLICATIONS, ENABLING OTHER SCIENCES TO BE IMPORTED INTO THOSE APPLICATIONS, AS REQUIRED
- TYPE 3. A SCIENCE THAT COMBINES THE ATTRIBUTES OF TYPE 1 AND TYPE 2

14

SPECIFIC SCIENCE AND NEUTRAL SCIENCE

- A "SPECIFIC" (I.E., NON-NEUTRAL) SCIENCE CAN BE PART OF THE *THEORY* OF A NEUTRAL SCIENCE IF AND ONLY IF IT CAN BE PART OF THE THEORY OF *ANY* SCIENCE
- A COMPONENT OF A SPECIFIC SCIENCE CAN BE IMPORTED AS *CONTENT* INTO APPLICATIONS OF A NEUTRAL SCIENCE, BUT *NOT* INTO THE *CONTEXT* OR *PROCESS* OF THE NEUTRAL SCIENCE, UNLESS IT CAN BE PART OF THE CONTENT OF *ANY* SCIENCE

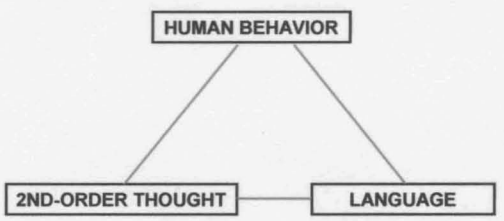
15

THE BASIC TRIAD OF SCIENCE

- THOUGHT ABOUT THOUGHT

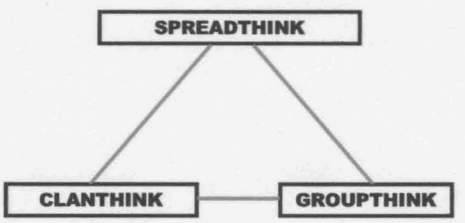
  (2ND ORDER THOUGHT)
- BEHAVIORAL PATHOLOGIES
- LANGUAGE

16



THE BASIC TRIAD OF ALL SCIENCE

17



THE COLLECTIVE HUMAN FLAWS TRIAD
(Think BELIEF, NOT Knowledge)

18

PROPOSED INQUIRY-INITIATION STRATEGIES

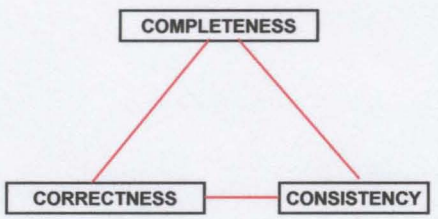
- The Tao of Science (per Ralph Siu)
- The "Clear the Mind" Descartes Strategy
- The "Start Where You Are" Strategy of C. S. Peirce ("unshakeable cognitive burden")
- The Minimum-Essential Strategy

19

THE NEUTRAL SCIENTIST'S PROGRAM

- Peirce Inquiry-Initiation Strategy Applies
- "Domain of Science Model" Disciplines Inquiry
- "Basic Triad" and its Derivatives Inform Future Developments
- "Awareness Group" Collaboration is Required to Resolve Complexity
- NGT and ISM are Sufficient Methods for Neutral Sciences
- The "Feeder/Receiver Model" Serves Neutral Science

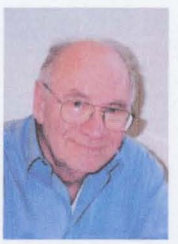
20



THE THREE C'S OF STRUCTURAL MODELING---
ONLY ONE OF THESE CAN BE ASSURED

21

DEVELOPERS OF THEOREMS FOR
QUALITY CONTROL IN MODELING



GEORGE
FRIEDMAN

FRANK
HARARY

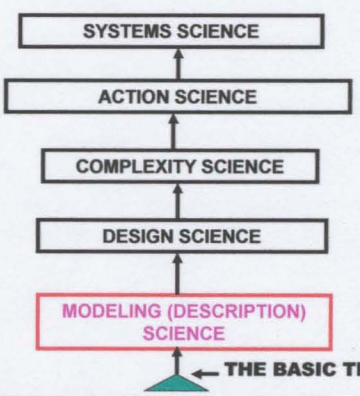
22

DERIVATIVE OF A TRIAD

- A DERIVATIVE OF A TRIAD IS ANY CONCEPT THAT DRAWS ITS MEANING FROM ONE OR MORE MEMBERS OF A TRIAD.

- FOR THE BASIC TRIAD OF SCIENCE (WHICH CONSISTS OF THE HUMAN BEING, THOUGHT ABOUT THOUGHT, AND LANGUAGE); ANY BEHAVIORAL PATHOLOGY THAT IS KNOWN TO LIMIT SIGNIFICANTLY HUMAN PERFORMANCE IN DEVELOPING A SCIENCE IS A DERIVATIVE.

23



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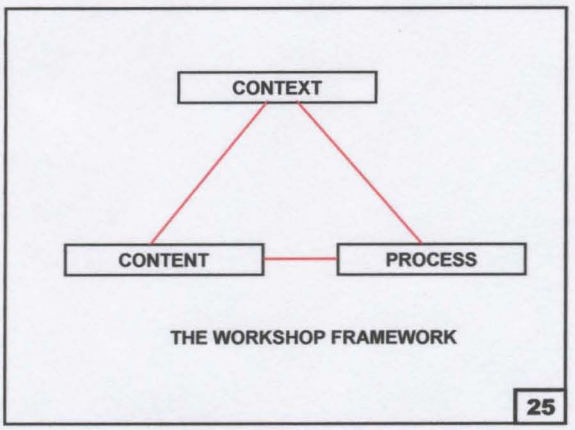
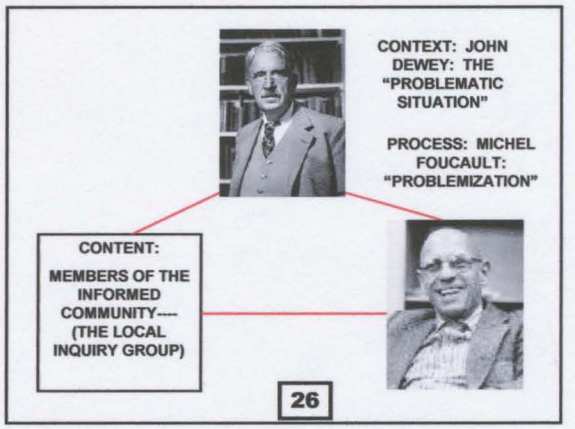
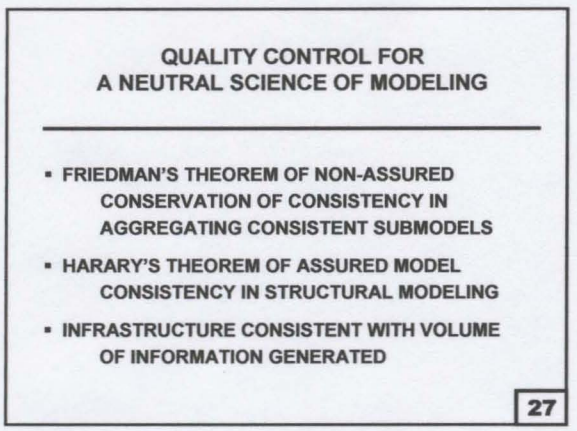
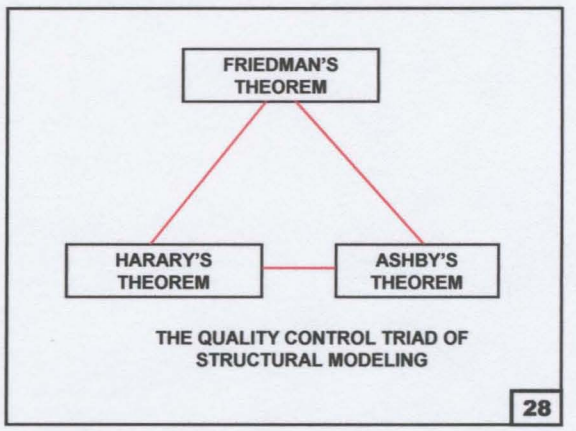
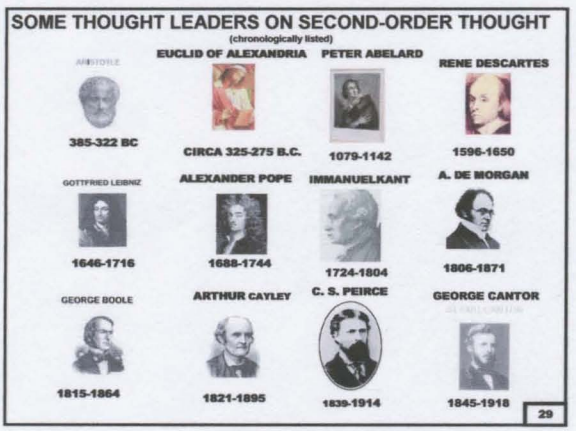
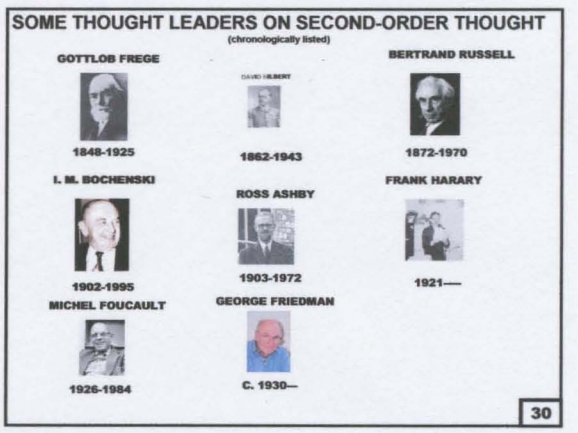

CONTEXT
CONTENT
PROCESS
THE WORKSHOP FRAMEWORK
25

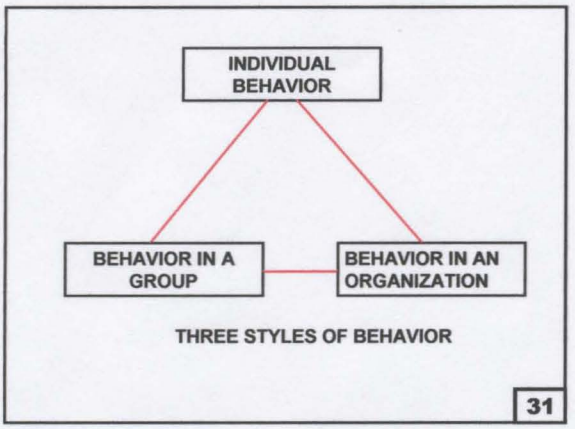

CONTEXT: JOHN DEWEY: THE "PROBLEMATIC SITUATION"
PROCESS: MICHEL FOUCAULT: "PROBLEMIZATION"
CONTENT:
MEMBERS OF THE INFORMED COMMUNITY---- (THE LOCAL INQUIRY GROUP)
26


QUALITY CONTROL FOR A NEUTRAL SCIENCE OF MODELING
▪ FRIEDMAN'S THEOREM OF NON-ASSURED CONSERVATION OF CONSISTENCY IN AGGREGATING CONSISTENT SUBMODELS
▪ HARARY'S THEOREM OF ASSURED MODEL CONSISTENCY IN STRUCTURAL MODELING
▪ INFRASTRUCTURE CONSISTENT WITH VOLUME OF INFORMATION GENERATED
27


FRIEDMAN'S THEOREM
HARARY'S THEOREM
ASHBY'S THEOREM
THE QUALITY CONTROL TRIAD OF STRUCTURAL MODELING
28


SOME THOUGHT LEADERS ON SECOND-ORDER THOUGHT
(chronologically listed)
ARISTOTLE
385-322 BC
EUCLID OF ALEXANDRIA
CIRCA 325-275 B.C.
PETER ABELARD
1079-1142
RENE DESCARTES
1596-1650
GOTTFRIED LEIBNIZ
1646-1716
ALEXANDER POPE
1688-1744
IMMANUEL KANT
1724-1804
A. DE MORGAN
1806-1871
GEORGE BOOLE
1815-1864
ARTHUR CAYLEY
1821-1895
C. S. PEIRCE
1839-1914
GEORGE CANTOR
1845-1918
29

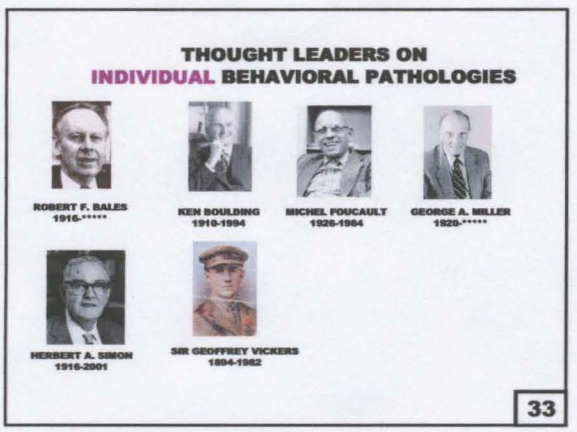

SOME THOUGHT LEADERS ON SECOND-ORDER THOUGHT
(chronologically listed)
GOTTLOB FREGE
1848-1925
DAVID HILBERT
1862-1943
BERTRAND RUSSELL
1872-1970
I. M. BOCHENSKI
1902-1995
ROSS ASHBY
1903-1972
FRANK HARARY
1921----
MICHEL FOUCAULT
1926-1984
GEORGE FRIEDMAN
C. 1930--
30

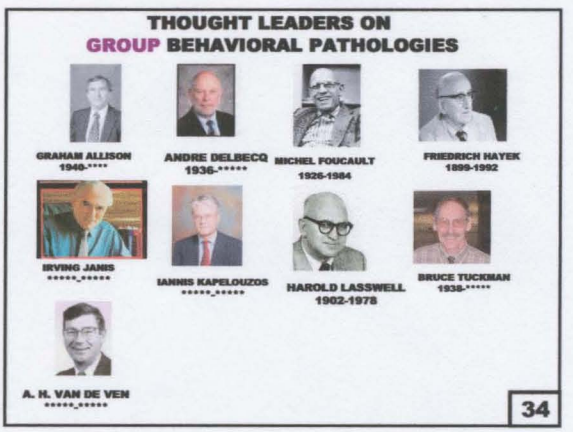


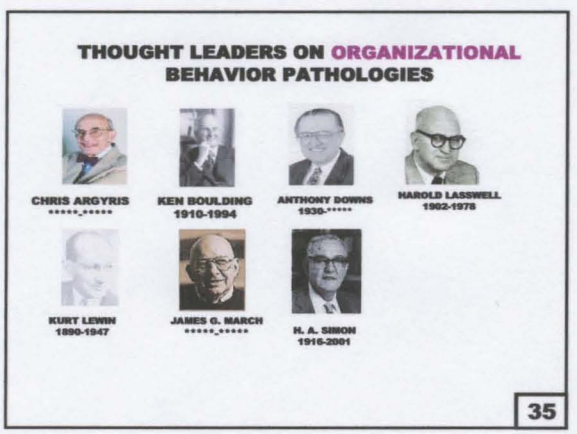
BEHAVIORAL PATHOLOGIES TRIAD

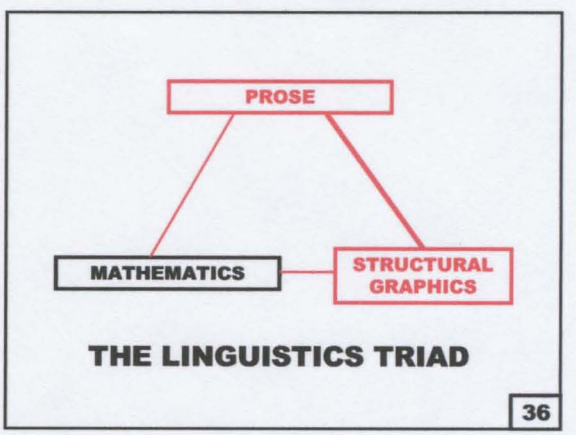
- The Lone Individual (re Miller, Simon)
- The Individual in a Small Group (re Janis, and the Spreadthink Empirical Findings)
- The Individual in an Organization (re Empirical Findings from Alberts and Perino) and including the Clanthink Syndrome

32









THOUGHT LEADERS ON LANGUAGE

(IN CHRONOLOGICAL ORDER BY YEAR OF BIRTH)

ANTOINE LAVOISIER
1743-1794

1815-1864
GEORGE BOOLE

ARTHUR CAYLEY
1821-1895

C. S. PEIRCE 1839-1914

GEORG CANTOR

DAVID HILBERT

BERTRAND RUSSELL

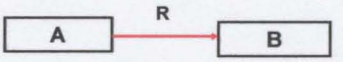
1872-1970

1845-1918

1862-1943

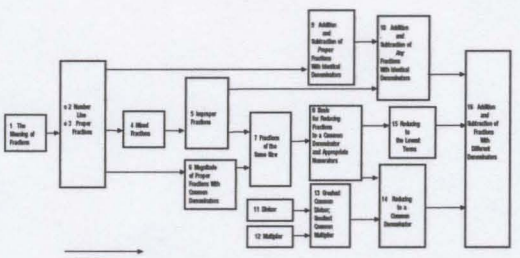
KLAUS KRIPPENDORF

37

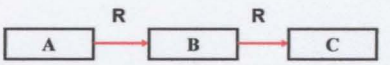


GRAPHICAL STATEMENT: "A IS RELATED TO B"

38



39



SYLLOGIZING GRAPHICALLY

If A is related to B, and if B is related to C, then A is related to C, provided the relationship R that is in common is transitive. Many prose versions of the syllogism were rendered both by Aristotle and those who followed. None apparently realized how important the extension to many linked syllogisms would be in describing complexity. Nor did they understand how difficult it would be, not knowing of human cognitive limitations.

40

TWO COMMONLY PRODUCED TYPES OF INTERPRETIVE STRUCTURAL MODEL COMPRISED OF LINKED SYLLOGISMS

- ***Problematique***, problems related by "significantly aggravates"; I.e., Problem A significantly aggravates Problem B"
- ***Opportunity Structure***, options related by "significantly enhances the benefits of"; I.e., If Option A is successfully carried out, that significantly enhances the benefits of carrying out Option B"

41

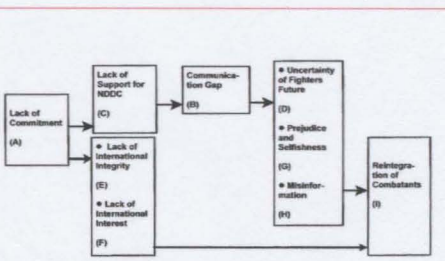


Figure D-13 Problematique for Disarmament and Demobilization in Liberia
(How barriers to peace are interrelated)–Courtesy of Ms. Carol Jeffrey, Jeffrey Group.
The arrows represent "significantly aggravates".

42

FRIEDMAN

QUALITY CONTROL LEADERS FOR MODEL DEVELOPMENT

HARARY

ASHBY

49

WHAT YOU HAVE JUST SEEN FORMS THE FOUNDATIONS OF A SCIENCE OF DESCRIPTION and A SCIENCE OF DESIGN.

TWO METHODS ARE SUFFICIENT TO IMPLEMENT THESE SCIENCES:

- Nominal Group Technique (NGT)
- Interpretive Structural Modeling (ISM)

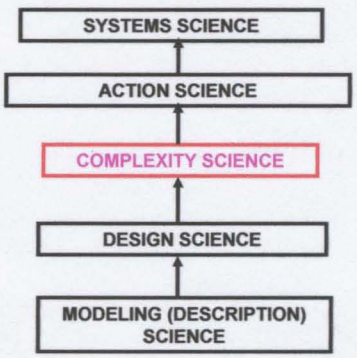
50

THREE BOOKS

- 1976: SOCIETAL SYSTEMS: PLANNING, POLICY, and COMPLEXITY
- 1990, 1994, A SCIENCE OF GENERIC DESIGN: MANAGING COMPLEXITY THROUGH SYSTEM DESIGN
- 2002: UNDERSTANDING COMPLEXITY: THOUGHT AND BEHAVIOR

THESE THREE PROVIDE THE SCIENCE OF STRUCTURAL MODELING (DESCRIPTION), THE SCIENCE OF GENERIC DESIGN, AND THE SRUCTURE-BASED SCIENCE OF COMPLEXITY

51



52

TWENTY LAWS OF COMPLEXITY

- THIS SCIENCE DRAWS ITS FOUNDATIONS FROM THE SCIENCES OF DESCRIPTION AND OF GENERIC DESIGN. TWENTY LAWS OF COMPLEXITY FORM THE CORE OF THE SCIENCE OF COMPLEXITY. SEVENTY PERCENT OF THESE LAWS ARE FOUNDED IN HUMAN BEHAVIOR.
- THESE LAWS ARE THE BASIS FOR THE "WORK PROGRAM OF COMPLEXITY", WHICH IS THE BASIC CONTRIBUTION TO THE SCIENCE OF ACTION.
- RESULTS FROM APPLYING THIS SCIENCE PROVIDE EMPIRICAL BASES FOR VARIOUS METRICS OF COMPLEXITY.

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BASES FOR METRICS OF COMPLEXITY

- THE MILLER INDEX (re: number of problems)
- THE DE MORGAN INDEX (re: number of relationships)
- THE SPREADTHINK INDEX (re: breadth of differences)
- THE ARISTOTLE INDEX (re: number of linked syllogisms)
- THE SITUATIONAL COMPLEXITY INDEX (SCI, overall indication of complexity)

EACH INDEX EXCEPT SCI IS DEFINED SO THAT THE VALUE OF 1.0 SEPARATES THE DOMAIN OF NORMALITY FROM THE DOMAIN OF COMPLEXITY.

54

THE WORK PROGRAM OF COMPLEXITY

To the science of action, the science of complexity offers the *Work Program of Complexity*, and the infrastructure requirements for developing and carrying out the action program.

Receiving these concepts from the science of complexity, the science of action contains a process called *Interactive Management*, which is designed to implement the Work Program of Complexity.

55

THE COHERENT (VIRTUAL) ORGANIZATION

Complexity arises in organizations, and organizations have awareness populations and resources to apply to the resolution of complexity. Typically the problematic situations are best dealt with in a three-level "virtual organization".

Level 1 (lowest level): The *Producing Level*, where many problems are recognized across the organization

Level 3 (highest level): The *Strategic Level*, where high-level organizational purpose is synthesized, and where resources are allocated.

Level 2 (middle level): The *Mediating Level*, where lowest-level problem solving is rationalized with high-level strategy by cross-level discussion and activity.

56

COMPLEXITY SCIENCE AND THE SCIENCE OF ACTION

Complexity science furnishes to the science of action the concept of the Coherent Organization Evidence is provided to show that work on a problematic situation should begin at the lowest level, where problem sets and problem categories are defined, and local language is established.

The product of Level 1 work includes not only the problem set, but a much smaller set of categories of problems; and then finally a still smaller set of categories of categories, called "Areas".

57

Numbers from two projects are {678, 20, 6} and {275, 20, 4} representing {elements, element categories, areas}. This is how the work of the organization is made coherent, with middle managers working out linkages.

INFRASTRUCTURE FOR NEUTRAL SCIENCE IN THE DOMAIN OF COMPLEXITY

- Staff with Process Expertise
- Software to Support Nominal Group Technique (NGT)
- Software for Interpretive Structural Modeling (ISM)
- Dedicated Situation Room
- Dedicated Observatorium

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VALUES OF METRICS OF COMPLEXITY ROUNDED TO NEAREST WHOLE NUMBER; (MIN, MAX, AVERAGE)

▪ MILLER (55 CASES)	{ 5	19	10 }
▪ SPREADTHINK (55 CASES)	{ 4	13	7 }
▪ DE MORGAN (12 CASES)	{ 11	51	26 }
▪ SCI (12 CASES)	{ 511	7640	2551 }
▪ ARISTOTLE (next slide)			

NOTE HOW REMOTE THE VALUES ARE FROM 1.0

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ARISTOTLE INDEX "A" FOR SEVERAL PROBLEMATIC SITUATIONS

• Joint Operations Planning & Execution Type 2	3.4
• Teaching Fractions to 2nd Graders	18.2
• Computing Gear Design for Manual Transmission	27.8
• Joint Ops Planning & Execution Strategy Type 1	32.4
• Ford/Volvo Joint Process Info Management	50.0
• Large-Pump Manufacturing for Farm Equipment	86.9
• Declining Church Membership in England	97.2
• US Defense Acquisition (categories)	112.8
• Restoring the Sahel (desert) Region of Africa	924.0

Note: Boundary Between Normality and Complexity is A = 1

60

ARISTOTLE INDEX "A" FOR SEVERAL PROBLEMATIC SITUATIONS

- Demobilization in Liberia, Type 2 5.6
- Communication in Prob.-Solving Groups, Type 2 7.8
- Regional Development in a state in Mexico 8.3
- Gender Issues for Women in Liberia, Type 2 15.6
- Communication in Prob.-Solving Groups, Type 1 15.6
- Tribal Participation in Federal System (Strategy) 29.2
- Rapid-Response Manufacturing 51.4
- Analytical Power Train, Type 2 81.0
- Analytical Power Train, Type 1 96.5
- Peace-Building in Cyprus 773.6
- Note: Boundary Between Normality and Complexity: A = 1

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ARISTOTLE INDEX "A" FOR SEVERAL PROBLEMATIC SITUATIONS

- Single-Product Info Management System 75.4
- Single System by Process Info Mgt System 188.5
- Hybrid Product Info Management System 235.0

Note: Boundary Between Normality and Complexity is A = 1

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INTERPRETING THE ARISTOTLE INDEX

Remember that this index is one of several that can be interpreted in the light of the definition of complexity.

A value only modestly greater than 1 means that the problematic situation is relatively well understood. Very likely with modest resources applied and with the benefits of seeing the specific components of the descriptions that are responsible for the largest contributions to the indexes, the actors can develop a strategy for learning what is needed to resolve the complexity.

A very large value means that the situation is far from being understood, further measures being required to advance understanding.

63

STRUCTURE-BASED SCIENCE OF COMPLEXITY

- Incorporates the science of structural modeling and the science of generic design
- Adds to those sciences concepts of infrastructure, including the Situation Room, the Observatorium, and the Work Program of Complexity
- Incorporates 20 Laws of Complexity founded in the Basic Triad of all Science
- Emphasizes the role of thought and behavior in working to resolve complexity
- Emphasizes the importance of empirical evidence to support all scientific claims

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THE WORK PROGRAM OF COMPLEXITY CONSISTS OF TWO PARTS, WHICH ARE CARRIED OUT IN SEQUENCE:

Part 1

- Discovery, comprised of:
  - Description of the situation
  - Diagnosis of the situation

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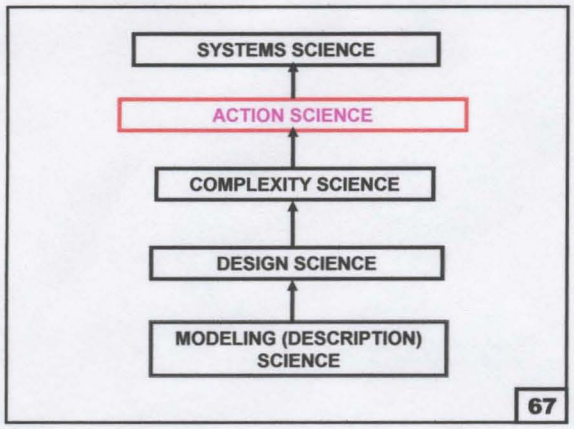
THE WORK PROGRAM OF COMPLEXITY CONSISTS OF TWO PARTS, WHICH ARE CARRIED OUT IN SEQUENCE:

Part 2

- Resolution, comprised of:
  - Design of the desired situation
  - Implementation of that design

66



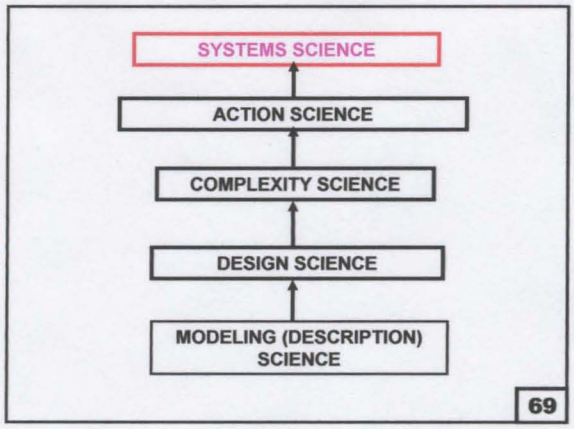
A SCIENCE OF ACTION

THE WORK PROGRAM OF COMPLEXITY IS CARRIED OUT ACCORDING TO A SCIENCE OF ACTION. THIS SCIENCE INCORPORATES THE SCIENCE OF MODELING, THE SCIENCE OF DESIGN, AND THE SCIENCE OF COMPLEXITY.

THE METHODS COMPONENT OF THE SCIENCE OF ACTION IS CALLED "INTERACTIVE MANAGEMENT". IT IS THOROUGHLY DESCRIBED IN THE BOOK:

A HANDBOOK OF INTERACTIVE MANAGEMENT

68



WARFIELD DEFINITION: complexity

*The sensation of **frustration** experienced by all human beings in an awareness group, when confronted with a **problematic situation** that is not understood by anyone, and which every member is motivated to resolve.*

70

THE PATHOLOGICAL INQUIRER'S PROGRAM

- Continue in the 300-year old "scientism" mode of Comte
- Ignore the Basic Triad of Science
- Ignore the Behavioral Pathology Triad
- Allow the language of the Domain of Complexity to be largely dominated by disciplinary cartels, process cartels, metaphor merchants, and word bandits
- Eschew discursivity that could be based in application of findings re second-order thought
- Leave key process decisions to disciplinary cartels, process cartels, or clients

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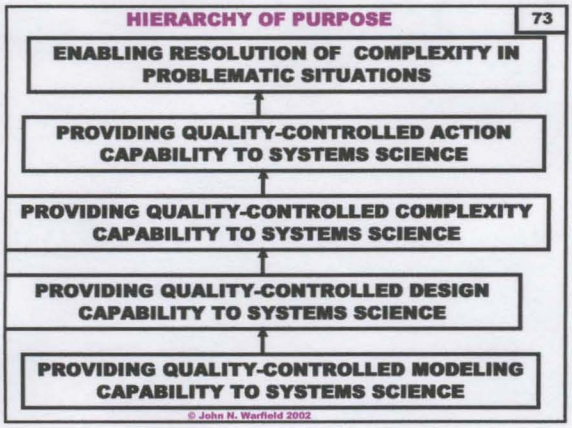
SYSTEMS SCIENCE

SYSTEMS SCIENCE INCORPORATES ALL OF THE COMPONENTS DISCUSSED SO FAR. LIKE THEM, IT IS A NEUTRAL SCIENCE.

BUT IT DIFFERS FROM THEM, IN THAT ITS CENTRAL PURPOSE IS ***NOT*** TO SUPPORT THE DEVELOPMENT OF OTHER SCIENCES, BUT RATHER **TO ENABLE RESOLUTION OF COMPLEXITY IN PROBLEMATIC SITUATIONS.**

HENCE IT MUST BE RESPONSIBLE FOR INTEGRATING SPECIFIC SCIENCES OR OTHER KINDS OF INFORMATION IN ITS ARENA, ACCORDING TO THE DEMANDS OF THE SITUATION.

72


HIERARCHY OF PURPOSE
73
ENABLING RESOLUTION OF COMPLEXITY IN PROBLEMATIC SITUATIONS
PROVIDING QUALITY-CONTROLLED ACTION CAPABILITY TO SYSTEMS SCIENCE
PROVIDING QUALITY-CONTROLLED COMPLEXITY CAPABILITY TO SYSTEMS SCIENCE
PROVIDING QUALITY-CONTROLLED DESIGN CAPABILITY TO SYSTEMS SCIENCE
PROVIDING QUALITY-CONTROLLED MODELING CAPABILITY TO SYSTEMS SCIENCE
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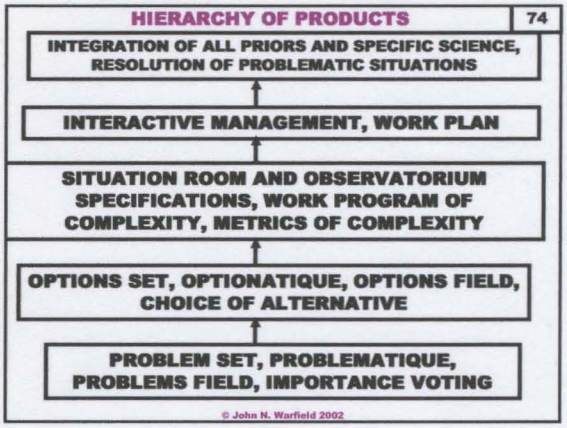
HIERARCHY OF PRODUCTS
74
INTEGRATION OF ALL PRIORS AND SPECIFIC SCIENCE, RESOLUTION OF PROBLEMATIC SITUATIONS
INTERACTIVE MANAGEMENT, WORK PLAN
SITUATION ROOM AND OBSERVATORIUM SPECIFICATIONS, WORK PROGRAM OF COMPLEXITY, METRICS OF COMPLEXITY
OPTIONS SET, OPTIONATIQUE, OPTIONS FIELD, CHOICE OF ALTERNATIVE
PROBLEM SET, PROBLEMATIQUE, PROBLEMS FIELD, IMPORTANCE VOTING
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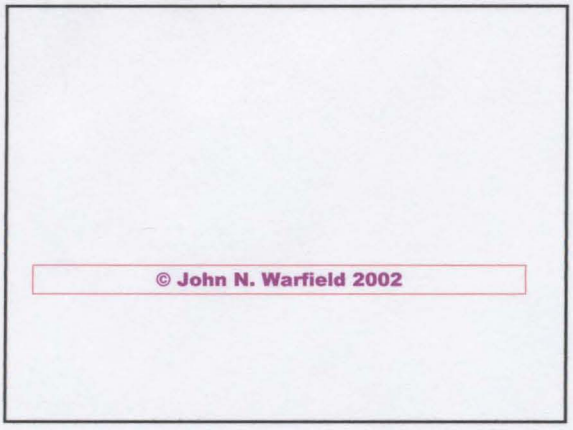
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