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Accounting for Errors when using Systems Approaches

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Abstract

Complex systems problems require the use of a formal philosophical construct and dictate the use of a rigorous systems approach. A systems approach may utilize one of a variety of proven methods, but in each case it involves the imposition of order that ranges from the philosophical to the procedural. Independent of the construct or rigor used to address the complex systems problem is the opportunity to commit a number of errors as part of a systems approach. This paper will discuss six classifications for problem solving errors that may be experienced during the application of a systems approach as part of understanding and treating complex systems problems.

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1. Introduction

Most complex systems problems can be characterized by (1) uncertainty, (2) complexity, and (3) conflict. Based on this point-of-view, it seems reasonable to assume, for example, that the way in which a complex systems problem is perceived by its solution participants is a major determinant of the degree of uncertainty, complexity, and conflict that each of the solution participants are able to clearly identify as part of the problem context.

Solution participants ensure that the context of the complex systems problem under review includes a definition of human activity in the formulation, analysis, and solution of the problem. This is routinely accomplished through the use of one of a number of systems-based approaches [1-3]. However, none of these systems-based approaches explicitly addresses the errors that may be committed as part of the formulation, analysis, and solution to the problem being addressed by the approach.

Analytical and interpretational errors occur regularly during the formulation, analysis, and solution of systems problems. These errors are committed independent of method (e.g., qualitative or quantitative) and epistemological tradition (i.e., positivist or post-positivist). The errors, of both commission and omission, complicate solutions to these *wicked* problems [4].

We intend to present a typology of six (6) errors derived from the extant literature and use this as a construct, to be included in systems approaches, for avoiding common errors during the formulation, analysis, and solution to *messy* [5] or wicked problems encountered in modern, complex systems.

2. Typology of Errors

There is not general agreement on a single taxonomy for errors in systems approaches. However, our review of the literature on errors has revealed that researchers from four of the 42 internationally agreed upon fields of science

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[6] have conducted inquiry with respect to errors where they have assigned some sort of designation for the error; thus a typology is able to be constructed. Figure 2 includes references from the relevant fields of science.

Table 1. Science Sector and Field of Science that have Conducted Inquiry on Errors

Science Sector	Field of Science	Reference
Social Sciences	Educational Sciences	Betz & Gabriel [7] Kaufman, Dudley-Marling, & Serlin [8] Marascuilo & Levin [9, 10] Onwuegbuzie & Daniel [11] Rosnow & Rosenthal [12, 13]
	Psychology	Games [14] Kaiser [15] Leventhal & Huynh [16] Levin & Marascuilo [17, 18] Meyer [19] Mitroff & Featheringham [20] Mitroff [21]
	Economics and Business	Boal and Meckler [22] Umesh, Peterson, McCann-Nelson & Vaidyanathan [23]
Natural Sciences	Mathematics	Kimball [24] Mosteller [25] Neyman & Pearson [26-28] Tracz, Nelson, Newman & Beltran [29]

From our review of the literature in Table 1 we have constructed a typology of six common errors that we feel systems practitioners will encounter during the formulation, analysis, and solution to complex systems problems.

2.1. Type III Error

We start our description with the Type III error. We know that you will immediately ask, *what happened to the Type I and Type II errors?* We ask you to keep an open mind and it will become obvious why we describe the Type III Error prior to the older and more widely known Type I and Type II errors.

The extant literature on the Type III (γ) error originated in statistics. Frederick Mosteller [1916-2006], one of the most eminent statisticians of the 20th century, reported:

> *In other words it is possible for the null hypothesis to be false. It is also possible to reject the null hypothesis because some sample O_i has too many observations which are greater than all observations in the other samples. But the population from which some other sample say O_j is drawn is in fact the right-most population. In this case we have committed an error of the third kind*. (p. 61)

This is commonly referred to as "the error associated with solving the wrong problem precisely" [21, p. 15].

Type III errors normally occur during the formulation of systems problems, the phase in which the actual details surrounding the reported problem are exposed, validated and verified as part of the process of problem reformulation (reformulation is where the initial *reported* problem statement is validated by the solution participants). Failure to reformulate the reported problem is the most common source for a Type III error.

The systems practitioner faced with a reported problem needs to act much like a physician. The physician listens to the symptoms reported by a patient, but does not accept the diagnosis of the patient. The physician cannot rely solely on the patient's story and symptoms, but must gather empirical data by conducting tests, taking physiological measurements, and conducting a physical examination. The systems practitioner is in a similar professional relationship with the client that has a systems problem. Problem reformulation ensures that the scope of the problem is properly abstracted from the real-world and defined. The problem system must be adequately bounded, include empirical data of both the quantitative and qualitative types, and include an understanding of both the environment and relevant stakeholders:

> *The initial representation or conceptualization of a problem is so crucial to its subsequent treatment that one is tempted to say that the most important as well as most difficult issue underlying the subject of problem solving is precisely 'the problem of how to represent problems.'* [20, p. 383]

Failure to properly define the scope of the problem results in inadequate problem statements and is commonly referred to as "the error committed by giving the right answer to the wrong problem" [24, p. 134].