

Information for Control: Another Management Proverb?

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Cybernetic theory—what possible relevance can it have for public administration? E. Sam Overman and Donna T. Loraine emphasize its usefulness in decision making and control in the public sector. Their study empirically examines the signal hypothesis in the context of management control systems for 99 defense contracts. They find no empirical evidence to support the signal hypothesis that information is used for controlling project cost, schedule, or quality. However, qualitative findings, they argue, suggest that information does have considerable symbolic value, especially as potential signal. Information for control, they contend, is more proverb than principle. The authors discuss chaos theory as an alternative to the cybernetic theory of information for control.

As Herbert Simon (1946) pointed out decades ago, some ideas are so powerful that they become uncritically absorbed into the theory and practice of public management. The cybernetic theory of information for control is just such a powerful idea (Deutsch, Markovits, and Platt, 1986), and nowhere is this idea more obvious than with information and management control systems (Stout, 1980). A great deal of intellectual and financial resources have been invested in the creation and maintenance of management information systems, nearly all of it grounded in the "principle" that information increases management control. Yet, the basic cybernetic principle of information increasing control remains largely unproven and certainly problematic in public management. In this research, we ask the question, Do management information systems lead to greater management control?

The presumption of information for control is as pervasive in our personal lives as it is in public management. For example, we presume that more and more information about our checking accounts such as the average daily balance on a detailed bank statement, the last three checks to clear as told by a touch-tone teller, or the available balance as reported by the automatic teller helps us to control expenditures, prevent overdrafts, and balance the budget at home. Right? The same presumption is true in public management and particularly in project management of large contracts, which is the focus of this research. Public management theorists and practitioners presume that the more and better the information on project cost, schedule, and quality in their computer systems, the greater the project control and the less the actual performance variances (Cleland, 1990; Steiss, 1982). Our research tests the information for control proposition by looking at the management information systems of a random sample of 99 U.S. Air Force defense projects.

The unit of analysis in this study was the individual Air Force contract or project. A random sample of 99 Air Force projects ($n = 99$) was taken from the universe of projects completed between 1968 and 1989 that were available at the Aeronautical Systems Division Cost Data Center at Wright-Patterson Air Force Base in Ohio. Each project is required to have a management information system with specific reporting instructions that vary across projects. For example, one project may require elaborate work breakdown structures and reports every month, while another may require work structures of very little detail and reports only once every quarter. The records were reviewed for each of the sampled projects and variables were coded to obtain data. The variables and measures for the data used in the quantitative portion of this study are listed in Table 1.

In addition to the quantitative data gathering, we discussed our research and findings with many individuals who worked either on project teams or in cost control offices. In an unstructured interview, everyone was asked the same basic questions about the effects of managerial information systems on project control. Obviously, such observations are more illustrative than testable, but our main interest was to explore the potential symbolic dimensions of information and control that are suggested in the literature.

Information for Control

Information is what is communicated about a particular event or situation. Information theory has three strong and persistent assertions: (1) information decreases uncertainty, (2) information slows entropy, and (3) information increases system control (Weiner, 1948; Yates, 1989). *Control* is the managerial process of decreasing or dampening variance in a system (Anthony, 1965). Just like the quintessential cybernetic thermostat, the process of information increasing control in organizations is presumed to be a natural process of information feedback and deviation correction (Beniger, 1986). Feldman and March (1981) label the cybernetic or engineering approach to information in organizations as the signal hypothesis—the direct, systematic application of information for organizational control.

A great deal of management practice and literature continues to enthusiastically support the signal hypothesis. Organization and decision theorists consider information as a prerequisite for control and rational decision making (Lord and Maher, 1990; Steinbruner, 1974). Nowhere is the cybernetic optimism more exuberant, however, than in the design of management information systems for organizations (Senn, 1982). The cybernetic model is not only pervasive but has hardly changed since its inception. Yet, experts now caution that, “The more the MIS paradigm relies on the cybernetic model, the more it weakens its own legitimacy” (LeMoigne and Sibley, 1986, p. 241).

Increasingly, practical experience and grounded research are finding the connection between information and control to be less certain. On the cover of a National Academy of Public Administration report (1983) is the picture of Gulliver tied to the beach by hundreds of tiny Lilliputians. The picture and the report vividly present the problem of federal managers tied down by their own management control systems. Other research finds that information can have dysfunctional uses such as misrepresentation (Lawler and Rhode, 1976), and rational expectations of using information for decisions is both limited and apparently unordered (Simon, 1957; March, 1988). Behavioral researchers have amended the cybernetic theory to demonstrate how information is governed by managerial behaviors and organizational norms (Sproull and Larkey, 1984). Feldman and March (1981) label the behavioral approach to information in organizations as the symbol hypothesis—information is embedded in social and organizational norms making it highly symbolic.

Research Question and Hypotheses

We are interested in understanding how well management information systems control large public projects. What is the effect of

Table 1
Variables and Measures Used in the Study

Independent Variable:	Measures
V1 Information frequency	Total number of reports submitted
V2 Information quantity	Total number of report pages
V3 Information timeliness	Report submission frequency
V4 Information detail (vertical)	Number of work breakdown structure summary levels
V5 Information detail (horizontal)	Number of work breakdown structure elements at lowest level
V6 Information cost	Percent of reporting cost to total budget
V7 Information access	Type of information system
Control Variables	
V8 Project budget	Total dollar amount of project
V9 Project duration	Total number of months of project
V10 Project type	Type of contract (production or R&D)
Dependent Variables	
V11 Cost variance	Percent difference between actual project cost and total budget
V12 Schedule variance	Percent difference between actual schedule cost and budgeted cost of work schedule
V13 Quality variance	Percent difference between cost of quality corrections and total budget

managerial information on project control? Cybernetic theory and the signal hypothesis states that a direct, positive linear relationship exists between the information being collected and various aspects of project control. We expected that the increased quantity, timeliness, detail, access, and decreased cost of information from the management information systems would enhance project control by decreasing project cost, schedule, and quality variances. Three multivariate models test the signal hypotheses:

- H1: Information decreases cost variance;
- H2: Information decreases schedule variance; and
- H3: Information decreases quality variance.

Results

Testing the Signal Hypotheses

A positive relationship between information and control was expected, but the overwhelming impression from the data was the lack of any consistent relationships between the information collected and reported for a project and overall project control. For each model reported in Table 2, the overall regression coefficients R^2 were only

.041, .035, and .055 for cost variance, schedule variance, and quality variance, respectively. None of the overall *F*-ratio statistics are significant at the .05 level of significance for each of the three models ($p = .952, p = .973, p = .878$).

These empirical results clearly do not support the signal hypothesis. The quantity, detail, timeliness, and cost of information do not have a positive effect on project control. In fact, these results were more notable for their insignificance. This lack of empirical support for the signal hypothesis raises still further questions about the cybernetic vision and the principle of information for managerial control.

Exploring the Symbolic Dimension

In contrast to the signal hypothesis, the symbol hypothesis states that the relationship between information and control is much less direct and governed by social norms and managerial behaviors regarding both information and control. Information can symbolize other values in the organization. As expected, substantial evidence exists to support the symbolic hypothesis. Specifically, many project managers felt that report formats and information requirements were cumbersome and confusing, so much so that they doubted if the information was even being systematically reviewed by the government cost controllers. They openly stated their suspicions that information was used more for audits and potential control than for immediate project control. Their clear belief was that information was collected to maintain the appearance of accountability and a commitment to rationality. There was an underlying sense of distrust between contractor and government, and information was one symbol of this distrust.

Despite this distrust and pessimism, faith in the signal value of information was shown by the existence of management information systems paralleling those required by the government. Many project managers kept separate information on projects, often using some of the same information collected and reported to government contract offices, but in systems of their own design. The need to collect and store information was part of the established project management task. For these project managers, it was clearly better to have information that was not needed, than to not have information that was needed.

Government reviewers, on the other hand, expressed doubts about the accuracy of the information provided in the management control systems, believing that project managers typically overestimated program cost in particular. To contract monitors, information is amenable to strategic misrepresentation. Yet, also among government officers was the consistent belief that despite the potential for misrepresentation, information remains necessary for control. Contract officers consistently bemoaned the problem of timeliness—information was not readily available from contractors when decisions regarding project control were imminent. Government officials desired a state in which contractors could provide “real time” information on project performance. Failing this real time ideal, information provides an audit trail for project control, i.e., retrospective surveillance, thereby confirming the contractors distrust.

One finding not anticipated was the concern expressed by both contractors and government officials about personnel turnover and its effects on management information and control systems. System analysts and project managers move on, but the information and control systems they implement persist. Information and reports that may have once made sense to both parties are now historical artifacts only maintaining the appearance of accountability and control. In this sense, the causal arrow is reversed as the need for control causes information to be produced. In the minds of managers, information is often collected only to support the illusion of control. In the language

Table 2
Regression Analyses Predicting Project Control

Variable	Model 1: Cost Variance	Model 2: Schedule Variance	Model 3: Quality Variance
Information			
Frequency	.197	-.345	-.066
Quantity	-.082	.032	-.082
Timeliness	-.011	.134	-.041
Detail _V	-.248	.006	-.153
Detail _H	.109	-.099	-.026
Cost	.015	-.033	.161
Access	.014	.043	-.076
Control			
Project budget	.077	-.010	.185
Project duration	-.173	.420	-.024
Project type	-.026	.119	-.172
R ²	.041	.035	.055
F ratio	.381	.324	.511

N = 99; no missing cases.

Entries are standardized regression coefficients.

of reinventing, “These systems live not because anyone likes them, but because they are like furniture: they’ve been in place so long we assume they belong there” (Osborne and Gaebler, 1992, p. 136).

What these interview results show is that information does have considerable symbolic value, e.g., distrust, misrepresentation, and commitment to rationality (Feldman and March, 1981). Most remarkable to us, however, was the finding that primary among the symbolic values, was the perceived value of information as a signal. Despite the negative research findings on the signal hypothesis, most managers still believed that collecting and reporting information led to project control. As managers reported to us, the presence of symbolic value did not eliminate the signal value of information, but enhanced it. There was a strong and persistent commitment to rationality and the cybernetic vision.

The signal hypothesis may not be so much wrong, as it is incomplete. It is empirically difficult, if not impossible, to establish the direct signal value of information in an organizational context. Yet it is hard to categorically deny the signal value of information, particularly since the symbolic evidence supports the cybernetic ideal of information for control. It appears that there are symbolic reasons when signal evidence is present, and signal reasons when symbolic evidence is present. The story has lost its simplicity, and traditional signal vs. symbol ways of telling it will not suffice. The relationship of information to control is more complicated than the cybernetic or behavioral theories suggest.

Conclusion

Both organizational researchers and managers require new explanations of information and control. One promising alternative to the cybernetic theory of information for control is what has come to be known as chaos theory, or the study of complex systems. Although its applications in management are still underdeveloped, it is particularly instructive for examining the relationship of information and control.

Chaos theory has as its focus systems that are far-from-equilibrium (i.e., very dynamic and unstable). Most of us would agree that public organizations, even under the best of circumstances, usually fit this description. Chaos theory (Kiel, 1989; Pagels, 1988; Prigogine and Stengers, 1984; Waldrop, 1992) suggests that complex systems, such as those projects studied in this research, are self-organizing and have

the ability to renew, reorganize, and regulate themselves—called autopoiesis. In the longer term, the sources of control and order in self-organizing systems are not static, mechanistic, and controllable, as presumed by the cybernetic theory, but natural and evolutionary. Information may speed change in these complex systems, but as we see from our findings, it does not control it.

Sometimes, seemingly at random, these complex systems can break into apparent disorder or chaos, e.g., the project may slip behind schedule, costs can go up dramatically, and the quality of work may drop off. This phenomena is not unlike traffic flow becoming gridlocked, stock prices plummeting, or a school of fish breaking apart. The smallest most undetectable thing can cause this perturbation, known to chaos theorists as the “butterfly effect” when the disturbance of air from a butterfly’s wings in Beijing can affect the weather in Boston. It is at this point, called a bifurcation, that managers and controllers most require information for control, desperately searching through their management information systems for some signal as to why the project has lapsed into chaos. It is also at this point that we spend 90 percent of our effort to control 10 percent of the project. In these control circumstances, the information is of limited use—too unreliable, too aggregate, or just too old. By the time a description of the problem is pieced together, the system has changed structure, and the management information system loses even more signal value. Managers who rely not on the institutionalized management information systems but on direct experience and on direct, sometimes intuitive, information soon recognize that the very chaos they see is the source of new order (Lloyd, 1989). It is the new order they begin to manage, not the old order they attempt to control with information, and this is the essential difference between chaos and cybernetics.

Chaos theory suggests that researchers and managers should seek to understand the apparently chaotic conditions of their organizations rather than simply requiring more information and means of controlling them. When managers recognize chaos as a source of change, not as a need to control and manipulate project performance, then

new information can contribute and speed the continuing evolution of organizational systems. In the case of project management, it would mean that rather than using existing cost data to control a project’s inputs, it would be better to acquire new information on future spending to guide expenditures in the most productive directions. Accountability is not found in the inflexible management information systems and the outdated principle that information is for control, but in the evolving results of the organization.

Simon remarked in his seminal essay (1946) how proverbs always occur in mutually contradictory pairs. The principles of scientific management were his target. Today, decades later, management proverbs like “information for control” are still mutually contradictory, passing as principles of systems management. Enough anecdotal and empirical evidence shows that the cybernetic theory of information for control is incomplete. The relationship of information and control is much more chaotic than simple cybernetic theory suggests. The cybernetic interpretation is flawed largely because it is based on simple atomistic conceptions of information as bits, bytes, and signals, and a misdirected desire to control our organizational reality (Overman, 1989). It brings to mind an old Taoist proverb:

Once the whole is divided, the parts need names.
There are already enough names.
One must know when to stop.

(Lao Tsu)



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