From Cyclical to Systems Thinking: Cycle Time Reduction in Complex Systems

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While the cycle time research literature often advocates the principle of "cyclical thinking," it also often fails to disclose important assumptions, requirements, and ramifications of the use of this tool. As a result, practitioners may encounter significant roadblocks in applying "cyclical thinking" to their cycle time reduction projects. These critical prerequisite and ensuing conditions have been widely discussed in the "systems thinking" and general systems theory literatures. The usefulness and practicality of systems thinking to cycle time reduction are demonstrated in this study of a complex system, the Memphis/Shelby County Criminal Justice System.

"Cyclical thinking" entails "envisioning processes as interconnecting circles happening simultaneously" rather than as "boxes occurring sequentially in a straight line" (Wetherbe, 1995). Almost inevitably, cyclical thinking leads cycle time researchers and practitioners to recognize "systems of cycles" in which "multiple sets of circular processes [are] interdependent at one or several points" (Wetherbe, 1995). While the recognition of systems of cycles helps researchers and practitioners develop more realistic models of practices and processes at hand, it also has the unwelcome side-effect of producing Byzantine models that are difficult to understand and apply.

Model complexity can become a major obstacle in cycle time reduction projects because it significantly complicates the task of determining which of the five major constructs and 46 “ING” words of cycle time reduction (Wetherbe, 1995) are most appropriate for a given situation. Wetherbe (1995) acknowledges the limitations of the usefulness of such a list, encouraging researchers “to more fully develop the framework as a rigorous methodology to be applicable to a wide variety of cycle time reduction opportunities.”

The purpose of this paper is to address these opposing needs for model realism and usefulness in complex cycle time reduction projects. While “systems of cycles” are the origin of this dilemma, they are also a potential source of its resolution. Complex systems of cycles have been studied for centuries, ranging from ancient crude studies of stellar and planetary motions in astronomy to sophisticated contemporary studies of subatomic, molecular, and ecological entities in the physical, chemical, and biological sciences. More recently, systems of cycles have been analyzed in such human social sciences as psychology, sociology, and organizational behavior.

A promising approach to the study of complex systems of cycles can be found in General Systems Theory (Bertalanffy, 1940), a body of work that originated in attempts to understand the fundamental natures of physical, biological, social, and other types of complex systems. One outgrowth of General Systems Theory research in the field of organizational behavior was systems thinking, an epistemology which
“makes conscious use of the particular concept of wholeness captured in the word ‘system’, to order our thoughts” (Checkland, 1984). By encouraging basic understanding of the system—rather than simply providing a list of possible “pressure points”—General Systems Theory (GST), systems thinking, and their associated methodologies may help meet Wetherbe’s (1995) call for a “more rigorous methodology” for cycle time reduction.

This report on the applicability of systems thinking to cycle time reduction is organized as follows. First, the foundations of GST and systems thinking are examined in order to identify useful concepts that are either missing from or undeveloped within the cycle time literature. Second, the usefulness of systems thinking concepts is investigated in a study of a complex system, the Memphis/Shelby County (Tennessee) Criminal Justice System. Finally, conclusions are drawn regarding the generalizability of systems thinking in cycle time reduction.

Complex Systems

Essentially, General Systems Theory rests upon two pairs of ideas: hierarchy and emergence, and communication and control. The characteristic of hierarchy reflects the way in which complex systems are organized from smaller, less complex “sub” systems. Examples include the organization of cells into organs, organs into organ systems, and organ systems into animals. Other examples include the organization of engine, transmission, cooling, and fuel systems into an automobile, as well as the organization of individuals, work units, project teams, programs, and strategic business units into large corporations. When all of its “sub” systems are working together in an integrated coordinated fashion, the system exhibits emergent properties that are characteristic of the entire system itself, and not of a subset of that system’s components. For example, the characteristic of life “emerges” from the integrated functioning of all of an animal’s organ systems. “Life” is a recognizable characteristic yet cannot be isolated to one or all organ systems. Indeed, should one organ system fail, the entire animal will die.

Control and communication follow upon emergence and hierarchy. Control is regulation of activities between subsystems. In all cases this regulation is based upon needs for the entire system, which pass up and down the system’s hierarchical structure. The interface is the point at which control is conducted. Communication is the means by which controlling information is transmitted between subsystems.

Hierarchy, emergence, control, and communication provide foundational descriptors of system integrity and functionality. Should hierarchical, control, or communication structures become ineffective or inefficient, system performance—as measured along the system’s emergent properties—will degrade. This point has not been lost on those who study and build organizations. An organization’s emergent properties of viability and success “emerge” from the effective and efficient integration of an organization's hierarchical structure, management control, and intra- and inter-organizational communications. Accordingly, "systems thinking" (Checkland, 1984; Senge, 1990, Sterman, 1994) provides a useful way for conceptualizing, building, and managing organizations in general, and in optimizing cycle time performance in particular.

Organizations as Complex Systems

Business and organizations have also been conceptualized as systems of systems. For example, a corporation typically consists of accounting, marketing, manufacturing, distribution and other systems—or more
properly, subsystems. The number of subsystems and the degree of interaction between them can be used to measure an organization's complexity: the more subsystems and interactions, the greater the organizational complexity.

Organizational complexity is often driven by the complexity of the organization's environment. The more inputs an organization faces (e.g., types of consumers, number of legal requirements and constraints, number and strength of competitors) and outputs it must produce (e.g., products, legal reports, stakeholder payments), the more processes it must employ to convert those inputs into outputs. Appropriate process development and implementation thus become a critical requirement for organizational success. Underestimations of environmental complexity risk the development of inflexible, ineffective organizational structures, but overestimations can waste precious resources. Either miscalculation can complicate attempts to implement process cycle time reduction.

Organizations can manage such risks by limiting their exposure to environmental complexity. This strategy typically involves restrictions upon the number and variability of inputs. For example, physicians face a number of environmental variables as well as a wide variety of values of those variables. Variables include diseases, patients, governmental restrictions, surgical procedures, and drug treatments. The wide range of values can be seen in the variable patient. Patients can be young or old, fit or overweight, compliant or non-compliant; they may have allergies, suffer from multiple ailments and illnesses, be taking other medications and supplements, or oppose certain treatments. Individual physicians typically limit the complexity of their practices by limiting the number and variability their inputs. Limitations upon such factors as specialization (e.g., primary care, cardiology, oncology), patient (e.g., pediatrics, gerontology), and financing (e.g., private, HMO) simplify a physician’s practice by reducing the number of processes (e.g., treatment, testing, billing, nursing) that must be mastered for the practice to compete and survive.

In turn, simpler internal environments simplify cycle time reduction because there are fewer processes and clearer interrelationships to be decomposed and analyzed. However, some organizations do not have the luxury of simplifying their environments through input and output restriction. This reality means not only that organizational design and construction under such circumstances involve myriad processes with innumerable dense relationships, but also that cycle time reduction within those resulting structures becomes a Byzantine undertaking.

The relationship between system integrity and cycle time reduction (CTR) can be seen in the way in which hierarchy, emergence, control, and communication underlie the five cycle time constructs of management/organization, human resource, product management, operations, and interorganizational. Each CTR construct depends upon hierarchical organizational structures to carry out processes, emergent properties to define measurements of efficiency and effectiveness, control mechanisms to regulate organizational structures and processes according to standards developed from emergent properties, and communication to transmit control messages between organizational subsystems. The conditional quality of hierarchy, emergence, control, and communication also means that CTR researchers and practitioners must first ensure that these characteristics meet recognized or acceptable standards before CTR efforts can realistically be expected to succeed. In other words, CTR practitioners must engage in systems thinking to judge system effectiveness.
before they apply CTR principles to improve system efficiency.
The relationship between systems thinking and CTR can also be demonstrated in their agreement on the importance of learning. Unlike physical and chemical systems, human social systems are characterized by the ability of their participants to learn and thus adapt their behaviors to environmental constraints and opportunities. The adaptive benefits of learning are perhaps the major reason why it has been continually recognized as an important activity in cycle time reduction (Wetherbe, 1995; Hult et al., 1995; Janz, 1996; Bashaw and Ingram, 1996; Janz et al., 1997). Systems thinking fleshes out the notion of learning in cycle time reduction projects by emphasizing an understanding of the ramifications of learned behaviors on the system at large; that is, how learning may improve a system’s emergent properties by inducing changes and innovation in communication, control, and hierarchical structure. Systems thinking can facilitate learning by providing a deeper understanding of the system at hand, thus allowing the value of new knowledge or innovative practices to be more easily recognized, evaluated, and incorporated by the CTR researcher or practitioner.

Thus, systems thinking can provide a useful means for generating hypotheses and recommendations as to which CTR constructs and “ING” words are most appropriate for a given situation. The application of systems thinking to CTR analysis is demonstrated in a study of a complex system, the Memphis/Shelby County Criminal Justice System.

The Memphis/Shelby County Criminal Justice System Study

Located in the southwestern corner of Tennessee, Shelby County has one of the higher poverty rates in the United States. In 1999 Memphis, the largest city in Shelby County, had the tenth highest crime rate of American cities with a population of over 500,000 (Shelby County District Attorney General’s 2000 Annual Report). It is therefore not surprising that the Shelby County Jail has become extremely overcrowded and violent. Indeed, one act of violence within the jail induced a federal court to order an evaluation of Shelby County Jail operations. This combination of high poverty, high crime, an overcrowded jail, backlogged courts, and other social and political factors creates a difficult environment for the Memphis/Shelby County Criminal Justice System (MSCCJS).

As a result of the above problems, the Shelby County Crime Commission initiated a cycle time research project with the FedEx Center for Cycle Time Research (FECCTR). A project team consisting of faculty from Operations Research, MIS, and Criminal Justice was assembled. While the project members brought a wide range of expertise to the team, they nonetheless encountered numerous difficulties in applying their past CTR experiences to this project. As a result of those difficulties, a more fundamental approach to CTR analysis was required. Systems thinking provided such a means. Systems thinking was operationalized through its concepts of hierarchy, emergent properties, control, and communication. The usefulness of systems thinking was operationalized by the number of recommendations that could be generated over and above those originating from accepted principles of cycle time reduction.

Research Methodology

A system’s complexity is often determined by the variability of its inputs. Like physicians, managers within the MSCCJS face a highly variable lot. Defendants are all presumed
innocent until proven guilty, but nonetheless vary across a number of dimensions. A defendant’s unique set of values for the variables of mental stability, drug or alcohol dependency, tendency to violence, economic status, medical status, peer group, and familiarity with the criminal justice system will likely determine the unique sequence of subprocesses to be brought into play during incarceration and adjudication. In addition, that set of variables may in some cases predict the likelihood that the defendant will become trapped within repetitive cycles in particular parts of the criminal justice system.

Unlike the physicians, the MSCCJS cannot reduce the variability of its inputs, and so cannot reasonably reduce the number of processes or the density of process interrelationships. The MSCCJS is an extremely complex system; in fact, several senior members of the MSCCJS study team stated that this project was by far the most complicated in the history of the FECCTR. In addition to the high levels of complexity was the lack of performance measurements. This created a major stumbling block for this research and led the project team to caution MSCCJS officials that all recommendations were conditioned upon detailed supporting cost/benefit studies.

As a result of these difficulties, the project team decided that research into most traditional cycle time issues would be premature, and that an examination of more fundamental issues was required. As previously discussed, General Systems Theory and systems thinking provided a means of conceptualizing those issues, thus providing the research with a theoretical framework.

Given the dearth of objective data, an interpretive methodology appeared to provide the most reasonable course of action. An excellent description of interpretive research has been provided by Orlikowski and Baroudi (1991):

**Interpretive** studies assume that people create and associate their own subjective and intersubjective meanings as they interact with the world around them. Interpretive researchers thus attempt to understand phenomena through accessing the meanings that participants assign to them. In direct contrast to the “descriptive” studies… interpretive studies reject the possibility of an “objective” or “factual” account of events and situations, seeking instead a relativistic, albeit shared, understanding of phenomena.

Interviews provided the major form of data gathering. Officials in many different agencies of the MSCCJS were interviewed. Shelby County agencies include the Sheriff’s Office, County Jail, District Attorney’s Office, General Sessions and Criminal Court Clerks, Public Defender’s Office, and Pretrial Services. In addition, the members of the Memphis Police Department were also interviewed. Two rounds of interviews were conducted. The first round allowed the researchers to gain an overall view of the system, while the second round facilitated deeper understandings of processes and allowed the researchers the opportunity to explore contradictions encountered in the first round of interviews.

The interviews provided data for the construction of detailed process maps, as well as for indications of system performance. Although the data was not “hard,” it was considered useful nonetheless because it provided insights into how MSCCJS members understood and acted within that organization.

GST provided the framework for analyzing data gleaned from the interviews. In particular, the constructs of hierarchy, emergent properties,
control, and communication forwarded in GST allowed the research team to identify problematic areas of concern and to make reasonable recommendations.

Analysis and Interpretation of Results

The interviews provided a wealth of qualitative data. The GST framework (i.e., hierarchy and emergence, control and communication) provided the means for organizing and evaluating that data.

Hierarchy and Emergence

The hierarchical structure of the MSCCJS is demonstrated in the organizational charts, displayed in Figure 1. Unlike most organizations that are designed to facilitate quick, cohesive decision making by concentrating power in a unified executive level, the criminal justice system is designed to safeguard civilian rights by distributing power among disparate governmental bodies in a system of “checks and balances.” The pinnacle layer of the MSCCJS consists of four competing and counter-balancing subdivisions: law enforcement, the District Attorney’s Office, the bar (i.e., private lawyers and the Public Defender’s Office), and the judiciary. While it could be argued that the Memphis and Shelby County electorates constitute the “top-level” of the MSCCJS, they do not provide an active coordinating leadership role that would be found in the Board of Directors or upper management of an organization. Therefore, for the purposes of this research, the electorate can be ignored as a significant part of the MSCCJS.

It is the counter-balancing structure of the MSCCJS that is both its major strength and challenge. That structure of “checks and balances” helps ensure fairness, but it also engenders complex sequences and cycles of legal processing and maneuvering. CTR constructs and “ING” words offer little help in understanding or addressing this complexity because the success of CTR—like its cousins Total Quality Management and Business Reengineering—is fundamentally dependent upon the existence of “strong, visible, consistent leadership from top management” (Wetherbe, 1995). Unlike most organizations in which departments are oriented in more-or-less the same directions (e.g., reducing costs, increasing revenues, reducing risk, and improving customer satisfaction levels), agencies in the MSCCJS are often working toward opposite ends. The Police, Sheriff’s Office, and District Attorney’s Office want “to put the bad guys in jail” quickly and efficiently, while private attorneys and the Public Defender’s Office want to ensure that judicial decisions are deliberate, fair, and appropriate. Pretrial Services tries to increase the number of defendants who get out on bail to reduce jail overcrowding, while the District Attorney’s office tries to reduce the number of bonded defendants in order to increase conviction rates.

Conflicting subsystem objectives can be better understood through systems thinking, particularly via the notion of emergent properties. Emergent properties provide a commonality among a system’s various components, and for the MSCCJS that emergent property is justice. Justice does not originate from a subset of the system, but results from the full interaction of all components of the system. In fact, it only takes one recalcitrant agency to subvert the entire pursuit of justice.

The pursuit of “justice” may seem like a noble idealistic goal, but it provides the necessary commonality for unifying the disparate MSCCJS agencies. Given the heterogeneous nature of the MSCCJS hierarchy, emergent properties cannot “emerge” without some degree of unity—however small—among all agencies. The concept of the “pursuit of justice”
Figure 1.

**Typical Organizational Structure (Partial)**

![Organizational Structure Diagram](image)

**Memphis/Shelby County Criminal Justice System Structure (Partial)**

- **City of Memphis**
  - Mayor
  - Director of Police Services
- **Shelby County**
  - Mayor
  - Chief Admin. Officer
  - County Attorney
  - Public Defender
  - Div. of Correct.
  - Adult Offender Center
- **Shelby County Sheriffs Office**
  - Shelby County Sheriff
  - Jail Division
- **District Attorney General, 30th Judicial Dist (TN)**
  - District Attorney General
  - Deputy District Attorney
  - Chief Admin. Officer
- **Judiciary**
  - General Sessions Court
  - Districts
  - Criminal Court
provides this commonality because it allows competing elements of the MSCCJS to work together toward a common goal without jeopardizing their competing constitutional roles.

The practical ramifications of the notion of “pursuing justice” can be demonstrated in understanding the problem of how cases “fall through the cracks.” Unfortunately, information gleaned from interviews revealed that this was not uncommon, often due to unclear responsibilities or poor communication and control. The lack of a unified top-level structure in the MSCCJS means that there is no one party who is responsible for such cases. The literature search revealed that similar problems in other criminal justice systems have been rectified through the use of an oversight group. Systems thinking, particularly the concept of emergence, provided a powerful means of understanding the role of this committee. The word oversight means “supervision” and “failure to notice or consider” (Webster’s). It is the latter meaning that was intended by the project team. The recommendation for creation of an oversight committee was not intended to usurp the constitutional structure of the MSCCJS by creating a “top management” executive layer but to support the system of “checks and balances” by creating an integrating cross-functional “watchdog” entity to track problematic or exceptional cases without jeopardizing the balance of power. Examples of oversight committee responsibilities include monitoring system-wide performance, recommending changes, facilitating inter-agency improvement initiatives and training, and serving as a focal point for system-wide issues and operations.

The notion of emergent properties explained subtle nuances in performance standard development. The literature review revealed the difficulties of developing performance goals in law enforcement, judiciary, and other criminal justice subsystems. The emergent property of justice helped explain these difficulties by noting that agency-level performance goals must be mapped directly to the system-level notion of justice within the MSCCJS-at-large. Several examples were extracted from interview data indicating how the various agencies were often preoccupied with their particular part of the MSCCJS, with little regard or understanding of the ramifications of their actions (or inactions) on the performance of other subsystems or on the system as a whole. For example, law enforcement agencies are evaluated upon their ability to capture lawbreakers. While this performance measurement may seem beneficial from a law enforcement standpoint, it has the unintended consequence of increasing the population of an already overcrowded jail. A similar problem can be seen in efforts to reduce bail requirements. Reducing bail may relieve jail overcrowding, but may also increase the number of potential criminals on the street.

Once again, the CTR principle of learning might have led to the application of these standards to the MSCCJS. However, the notion of “justice” as an overarching emergent property of the entire criminal justice system provided a critical descriptive construct for contextualizing research literature, evaluating the applicability and limitations of individual recommendations within that literature, and ultimately in implementing recommended performance standards within the MSCCJS.

Control and Communication

Systems theory states that subsystems regulate and are regulated by other subsystems. The regulatory nature of control was used to explain many of the difficulties in the County Jail. The jail has no control over its inputs or outputs: it cannot turn away prisoners who are brought to the jail, nor can it release prisoners from the jail
unless authorized to do so via bond or release, or through transfer to another jail or penitentiary. Principles of CTR suggest that the jail should be empowered in some way to deal with these problems, yet it is difficult to understand how that strategy could be implemented without a major restructuring of the criminal justice system model. The notion of control, on the other hand, offers a descriptive concept. Because the jail has no control over its input and output rates, it is often forced to compromise the efficiency and effectiveness of such internal processes as inmate separation and timely inmate release. In other words, the Jail’s (sub)system integrity is seriously compromised.

There is thus a subtle but important nuance between the system thinking concept control and the CTR “ING” word empowering. The former reflects "the process by means of which a whole entity retains its identity and/or performance under changing circumstances" (Checkland, 1984:313), while the latter reflects "enabling people, by granting them authority, to make decisions at the lowest possible level in an organization, and goes hand-in-hand with flattening" (Wetherbe, 1995:15). The notion of empowering thus involves a repositioning of the status quo, while the notion of control reflects the integrity and performance of the overall system. Additionally, empowering implies a shift in power along the vertical dimension of organizational structure, while control implies the initiation, alteration, or termination of actions among vertical and horizontal dimensions.

There are similar differences between the CTR “ING” word informing and the systems thinking concept communicating. Informing is simply “getting all the information flowing freely so everyone knows what is happening” (Wetherbe, 1995:20). Communication in a systems thinking context, on the other hand, is a purposeful exchange of information meant to enhance a system’s emergent properties by coordinating and integrating the behaviors of the system’s components. The purposeful nature of communication in a systems thinking context thus provides a context for developing standards of effective and efficient information sharing. In doing so, it mitigates information overload probabilities and reduces bandwidth capacity requirements that would arise from haphazard informing.

The usefulness of the “communication-for-control” concept was demonstrated in recommendations concerning interactions among the various MSCCJS agencies. The issue of cases of “falling through the cracks” can be traced to poor communication; that is, there was a failure to initiate, modify, or terminate a needed (or unneeded) process. In addition, the study found several examples of non-productive informing. In one example, data from two MSCCJS information systems—the Jail Management System (JMS) and the Judicial Support System (JSS)—were “shared” among the different agencies. Several subjects reported that while they could access data from both databases, they could understand the meaning of data in only one database. That problem sometimes originated in the lack of a common language and terms. For example, the terms “First Appearance” and “Initial Appearance” in the MSCCJS are not synonymous. “First Appearance” is a hearing to set bond, while “Initial Appearance” is a separate hearing to explain charges to the defendant. Despite the difference, members of the MSCCJS often used the terms interchangeably. To complicate matters, Initial Appearances are recorded in the Shelby County Information Systems database as “Arraignments.”

An additional problem involved the frequent use of batched paper-driven processes. The research team suggested increased use of interactive computer-based information systems (CBIS) to increase processing speeds and reduce data input errors. The first recommendation, while appropriate, can be derived from CTR
principles. The second recommendation is based on the communication concept of signal-to-noise; that is, reducing the number of times data is entered can reduce the possibility of data entry errors that may jeopardize system performance (i.e., compromise justice). Requiring agency members to check data on the computer screen several times during processing can also help identify those errors that do occur. As a result of these and other conflicts, the project team made a number of recommendations aimed at improving the pursuit of justice by improving interagency communication and process integration. Recommendations to improve communication included implementing programs for “breaking down” barriers between agencies, especially cultural barriers; implementing an integrated information system; using consistent, county-wide identification numbers to facilitate charging procedures and background checks; and supporting the General Sessions Court’s “Defendant Reminder Program” to reduce continuances stemming from forgetful defendants. Recommendations to improve process integration included expanding misdemeanor and felony bond schedules to reduce First Appearance processing; diverting petty offenders to alternative programs or community service to reduce County Jail incarceration and processing; and substituting “release on own recognizance” for bonds less than $250 to reduce Jail processing and overcrowding.

The above problems of responsibility without appropriate control, data-meaning confusion, untimely data transmittal, and narrow procedural focus were identified chiefly through systems thinking. On the other hand, resolving those problems would follow appropriate CTR principles (e.g., “partnering”). In this way, the descriptive nature of systems thinking and the prescriptive nature of CTR principles can work hand-in-hand in cycle time reduction projects.

Conclusions

The study demonstrated the complementary natures of systems thinking and CTR principles. Systems thinking provides descriptive constructs that facilitate problem identification by helping researchers and practitioners achieve a more fundamental understanding of the system at hand. Only after such understanding is reached can the prescriptive strategies of problem resolution advocated within CTR principles be properly evaluated and integrated. The study also showed that systems thinking concepts were particularly useful in conjunction with the CTR principle of learning. Several recommendations forwarded by the project team were lessons learned from the criminal justice literature. While learning provided a means for discovering “best practices,” the systems thinking perspective was useful nonetheless because it provided the context with which such findings can be evaluated and integrated.

The study contributes to CTR research and practice by demonstrating that assumptions and prerequisite conditions of system integrity must be recognized before the five principles of CTR can be applied. Systems thinking provides the means for conceptualizing and addressing those prerequisites. Once these systems requirements have been met (that is, the aggregation of multiple components is acting like one coherent system), cycle time reduction studies can commence. The usefulness of systems thinking can be seen as support for further research in the applicability of soft systems methodology (or other similar “action research” methodologies) to cycle time research and practice.
References


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