THE 4X4 CONCEPT

The General Theory of Unifying Dynamic Organizational Self-regulation

(by Charles W. Jones, Decision systems, inc.)

This paper includes a restatement of the theory and concept contained in "The 4x4 Concept: The General Theory of Unifying Dynamic Organizational Self-Regulation" originally presented at the 1983 International System Safety Society annual conference by Charles Jones, originator of the concept and theory. The 4x4 General Theory provides the logic foundation upon which the REASON® methodology and computer software are based. The 4x4 Technology is a result of over twenty years of research, including ten years of applicational testing and verification in industrial and business environments. This paper also includes excerpts from a technical exposition on REASON® by Michael Carpenter, a member of Decision Systems, Inc.'s support team.

UNIFICATION

The major obstacle to scientific efforts to understand and control events within organizations has been the lack of a unifying theory, philosophy and methodology to fuse human behavioral factors with physical and organizational factors into a common language for scientific system analysis. The 4x4 Concept brings about a general level convergence of the "classical", "scientific", "behavioral" and "management systems" schools of organization management theory by focusing upon the fundamental principles of dynamic organizational self-regulation. This convergence supports universality and transferability of the 4X4 Organizational Principles, the natural laws of process and organizational control. These laws of process give us a way to look at our whole organization as a system that can be measured and analyzed for controls. From this perspective, hardware failure can be viewed within the same context as human failure. In fact, these events are products of subsystems functioning within a larger, manageable whole which adheres to function principles existing within a self-regulating organization.

Although statistical system approaches have been developed to detect the occurrence and incidence of counter-quality events reliably within the organization, until the advent of the 4x4 Concept, the problem-solving task of preventing and controlling counter-quality events has relied exclusively upon intuitive, experiential, and subjective methodologies. The new data format, analysis process, and application opportunities provided by the 4x4 Concept promise expanded scientific design and control capability to systems and management professionals. System disciplines have the trained personnel, the facilities, methods, lines of communication, and the special skills to view and analyze events in many meaningful ways. Indeed, they have the mandate from executive management to become event specialists; to predict and to prevent. The problem to date, however, has been the inability of system professionals to provide and consolidate event data into meaningful messages for top management's decisions.

SCIENTIFIC PROCESS

In 1974, Earl Lundgren wrote in his text, "Organizational Management Systems and Process":

> " The systems approach is a vital step toward development of a grand management theory which would permit total generalization, complete explanation for organizational phenomena.

If one could pin down the exact nature of the process, as well as identify the appropriate organizational subsystems, given certain common goals for all organizations, one could make broad generalizations not only about what happens in organizations, but about how and why. "

Clearly, he stated the biggest "if" the management system professional has ever faced.

The key to achieving this predicted capability to pin down the exact nature of the process lies in our ability to understand processes in terms of what produces them. George Homans, in his work, "Sentiments and Activities; Essays in Social Science", identified the first three steps toward control of events through scientific process:

1. Establish a means to observe events

2. Recognize and identify factor patterns
3. Devise a means to state the recurring causal relations of those factor patterns for study and application

The 4x4 Concept provides all professions engaged in the study and management of organizational phenomena with new, standardized ways to perceive, record, communicate and analyze the existence of counter-quality and unacceptable events. The concept looks at counter-quality events and conditions as products of systems within the total organization, 1) identifies the causal factors, 2) identifies the systems formed by those factors, 3) identifies the principles to which those systems adhere, and 4) identifies what part of the systems are internally controllable by the organization. These are the four capabilities necessary to control organizational phenomenon.

ORGANIZATION

When an organization has the capability to both repair itself and change in order to survive, we say it is a dynamic organization. We ourselves are examples of how cells, tissues, organs, and organ systems are teamed in common purpose. Similarly, when individuals come together to strive toward a mutual goal, they form a dynamic organization. When dealing at a general level with the subject of dynamic organization, the phrase "mutual effort toward mutual goals" serves us well as an operational definition of an "organization". That definition directs us to understand the system process within the organizational environment that generates and permits individuals to function together as a whole, achieving common purpose. In this context, human factors come together in process with physical and organizational factors to form the organizational environment. All internal events and processes are specific products of that organizational environment. In short, undesirable events - the tangible results of counter-quality (equipment breakdowns, production interruptions, damaged parts, personal injuries, missed schedules, etc.) are all specific products of our organizational systems. Prevention becomes a matter of perceiving and understanding organizational phenomena, just as Lundgren predicted.

The 4x4 Concept is an operational explanation of the dynamics of organizational phenomena, based on the premise that principles governing organizational control are naturally ordered into four clear levels, as are the principles involved in implementing such control. The interaction between the four 4x4 Governing Principles (associated with management actions) and the four 4x4 Implementing Principles (associated with supervisor actions) forms a dynamic control system. Exceptions to this concise control system are dealt with by a repair system of four 4x4 Enabling Principles (associated with actions taken by the organization to deal with individual exception) that either promote the reestablishment of the primary control system formed by the basic Governing and Implementing Principles, or produce the smallest incremental change to reestablish stability and control.

Unifying Dynamic Organizational Self-Regulation

The 4x4 Concept is expressed by three theorems:

THEOREM ONE

> Events within dynamic organizations can be expressed in terms of functioning principles, and those principles can be expressed in terms of actions; therefore, the identification of an event within a dynamic organization can identify the actions producing that event.

The first theorem describes the event as a product of an organizational system that adheres to process principles. The analysis focus is upon the process that produced the event, rather than what the event produced. It is this conceptual insight that suggested to me a format by which we could identify, record, model and analyze events in terms of causal factor patterns. It has guided and shaped the development of 4x4 methodology in terms of fundamental process principles.

THEOREM TWO

> All dynamic organizations share survival objective, and that shared objective is achieved by all dynamic organizations through common systems capabilities; therefore, all dynamic organizations adhere to general principles for survival.

This theorem details a unifying order for all dynamic organizations. Cells, tissues, organs, organ systems, organisms, and the organizations of man all serve as system models to demonstrate the universality and transferability of the 4x4 General Principles to minimize entropy.

THEOREM THREE

> All dynamic organizations adhere to general principles for survival, and those principles can be satisfied in human actions; therefore, the application of such principles in human actions within a dynamic organization directly produces the human behavior patterns best suited for the survival of that organization.

The power of this theorem rests in its prediction that man's knowledge and application of 4x4 will produce the human response behavior throughout the whole organization that fosters organizational health. Remember, these organizations are the ones upon which each of us depends for survival. They are of our making, and our choosing. When we apply this prediction to our companies, our cities, our states and country, it becomes a challenge and a promise to the designers, managers and leaders of our society.

The three 4x4 Theorems form the core of the theoretical foundation that supports REASON®, one of the computerized applications of the 4x4 Concept. This detailed examination of the 4x4 Concept explains the Theorems, and describes both the extrapolated systems principles and the resulting methodology for inquiry, modeling, quantification, and analysis. The intent is to provide a general level understanding of the Theorems, their successful application to achieve organizational control, and the step toward perfect data that the 4x4 Concept offers the organizational systems scientist, analyst, and manager.

4x4 Principles : The Laws of Organizational Self-regulation

The 4x4 Principles are not guidelines for management styles or techniques; they are not a menu of procedures for task accomplishment; they are not a list of tips found helpful in managing certain types of businesses; they are not task, discipline or skills related. The 4x4 Principles are the fundamental system process that all dynamic organizations must accomplish for survival as an entity. Properly applied, they establish organizational control. They are Laws of Organizational Self-regulation.

The term "principles" in 4x4 is an expression of the nature of process. Principles can be demonstrated and can expand our ability to understand, shape and control the environment in which they function. Understanding of the principles provides us with comprehension of the functioning system and its predictable product. For example, as children we were able to apply the principles of balance and leverage before we knew them as formal statements. We discovered that chubby little Johnny had to move closer to the fulcrum of the seesaw before he could balance on the board with the new little girl in the neighborhood. It was not long before we were using that knowledge to move heavy objects with leverage. We understood the principle, what made the system work, and how it translated into actions. We learned that if we properly applied the principle, we always got the result we wanted; if not, we always got system failure. Each result, both success and failure, is reliably predictable when dealing with principles at the functional level.

Theorem One says that events within dynamic organizations are products of systems, and that these systems adhere to principles that are universal in nature and function within all dynamic organizations. It follows then, since the organizations of man are dynamic organizations, that if we know these principles, and can properly satisfy their application, we can actually design the dynamic systems within our organizations to control and prevent unacceptable events. Conversely, when we do not properly apply these principles, the opposite effect is achieved: lack of control and lack of efficiency. Systems shaped by improper or inadequate satisfaction of the 4x4 Organizational Principles produce counter-quality and unacceptable events.

CAUSALITY

The phrase "cause and effect", for our purposes here, has little meaning until we can gain visibility of the system process in which cause and effect are only two of four essential factors. That visibility includes (1) the identification of generating (active) and permitting (passive) causal influences in the system, (2) the interaction of functioning system principles, (3) the organizational levels at which the processes occur, and (4) the specific effect of the system process in the particular organizational environment. This is to say that causality is a function of process within the organization.

The perception that causality is a function of process helps us deal with David Hume, who cautioned us not to say that we can identify causality, because there may be some undetectable factor in the process that accounts for the causal input to the system. 4x4 answers this caution by asserting that the process of organizational causality is premised upon the universal principles functioning within all dynamic organizations, and that Hume's undetected factors must be either functionally universal (and therefore constants), or subject to detection in organizational context through analysis of the function of the 4x4 Principles.

In the laboratory environment, each time we repeat a scientifically controlled process procedure, and produce the predicted result, the result itself provides us with a verification that the procedure has been properly executed. When we do this, the procedure itself has provided us with a type of definition for what produces that result. Now, if we can all agree and demonstrate that this procedure in this given environment will reliably produce a predictable result, it can then be said that the system formed by the procedure, as it functions within the environment, functionally causes the result. Further, we can say that each factor necessary to the interaction within the system is functionally causal, because its contribution to the function of the system is essential to the result. In this context, there are no major or minor causes; each is essential to the function of the system. Each must be accounted for in the system model and quantification. It is this logic construct upon which The 4x4 Concept is supported, and which provides a reliable method for quantifying, and testing the necessity and sufficiency of each step in the process, as-well-as each factor in the procedural step.

Returning to Lundgren's statement of need for "certain common goals for all organizations", the 4x4 Theory asserts that survival is the common goal shared by all dynamic organizations, and survival systems present the avenue for understanding organizational principles at a general level - indeed, the understanding of organizational phenomena at a general level.

The 4x4 Process

The 4x4 Concept is mathematically well defined and simple, although perhaps not immediately evident. The process can be described as three functional steps:

- bounding the system
- quantifying the system
- manipulating the quantification

A 4x4 event model formulated using the 4x4 Concept describes a bound physical system.This system exhibits fundamental, quantifiable properties which can be manipulated. These manipulations produce decision making data, derived directly from the model in an immediately usable form.

Investigating / Bounding

What Is Being Bound?

To "bound" a 4x4 process model is to establish a system boundary around the relevant organizational phenomena. Within every organization, factors exist that combine according to specific principles, the 4X4 Organizational Principles, to produce events. The result of modeling an event using the 4x4 Logic Rules for Investigation is a well defined and completely bound event model made up of organizational factors. The investigation process and the bounding process are one and the same, a single process, completely defined by the 4x4 Logic Rules for Investigation which establish the top, bottom, and width of the 4x4 event model. The significance is of course that once a boundary can be ascribed to a discrete part of the process, quantification becomes possible.

Nature of the Event Model

"...some kind of logical structure, or model, is implicit in every...analysis of a...system." (1) Likewise, the logical structure represented by a 4x4 event model is implicit in every physical system that produces an event within an organizational environment. A 4x4 event model represents a bound physical system that is fully functional, mathematically determined, and logically valid. A properly constructed 4x4 event model, in the sense that the data are correct, and the 4x4 Rules for Investigation were thus obeyed in formulating the model, is a deterministic organizational representation of the system which produced the specific event outcome. "...each decision in a deterministic problem is known to lead invariably to a specific outcome under conditions of certainty; ..." (2). The conditions for certainty are satisfied within the limits of the data because the event model deals only with reality - the event did occur, and the system which caused it did exist.

The bounding process identifies organizational control points. Prevention of the event system may be attained by disabling the system at any organizational control point. The methodology identifies an internally controllable point, and in the 4x4 event model marks it with a corrective opportunity terminator code. The exercise of organizational control at an identified decision point would, because the system represented by the event model is deterministic, change the "specific outcome".

The event system can be prevented from recurring by disabling the sub-systems which produced it, but this is only one aspect of the prevention opportunities made available to the organization by the identification of event control points. Of greater importance is the disabling effect that the correction of identified control points has on other potential event systems. By implementing the corrective options made available to the organization through the identification of control points, the organization effectively reduces the number of causal factors existing within the organizational environment that can interact to produce other unwanted events and counter-quality. Root Causes are control points at the bottom of the 4x4 event model that can be identified with improper or inadequate application of the 4x4 Principles.

The Logical Bases of the 4x4 Rules for Investigation

The 4x4 Rules for Investigation define the event process. The investigation process filters out irrelevant data. THE 4x4 LOGIC RULES FOR INVESTIGATION ARE NOT "GUIDELINES" - THEY REPRESENT LOGIC RULES FOR DISCOVERING, DEFINING, AND BOUNDING A SYSTEM OF CAUSAL RELATIONS. If the rules are not followed exactly, the validity and logical truth of the quantification and manipulation will be impaired.

The 4x4 rules operate according to logic principles. Among these are deductive and inductive reasoning. While these principles are critical to the investigation process, their applications are so well known as to be implicit in any process of inquiry. Therefore, rather than examine the applications of deductive and inductive reasoning, this section will focus on the demonstration of the 4x4 Rules' unique status as a method for generating causal analogical arguments.It is this quality that sets 4x4 investigation and analysis apart.

Analogical Argument

Analogical argument is a vital part of the model generation process. "...an analogical argument is one in which the truth of the premises is not held logically to entail the truth of the conclusion, but neither is the truth of the conclusion established by any investigations other than those used in establishing the truth of the premises." (3) (4) The information input to a 4x4 event model, as well as the results of the analysis are organization-specific, based upon analogical description of the circumstances that distinguish the causal process as exceptions to normal or proper operations.

The substance of the analogical argument is provided by two aspects of the 4x4 Concept. First, application of the 4x4 Rules results in isolating a segment of process in time. This segment has a starting point and ending points established by the Rules. The analogical argument is thus provided a before and after convention. Secondly, the 4x4 Principles provide a logic foundation that is predicated upon the fact that the root causes of unwanted events in organizations are either the lack or the inappropriate application of the 4x4 Principles. Thus, when the Principles have not been satisfied, there is presence of causal energy within the organization. In application, the factors in the event model are a result of applying the Rules to identify the existence causal conditions, the occurrence of causal events, and the causal influence of unsatisfied Principles.

The preceding definition demonstrates the most important role of the organization in formulating an event model using the 4x4 Rules: to establish the truth of the premises. "If an incorrect premise is assumed, no amount of mathematical rigor or elegance can save the resulting system from the error of misjudgment." (5) The validity of the results, therefore, depends entirely on the organization's ability to provide good data and follow the 4x4 Rules in formulating the model.

As a final note on analogical arguments, the following section on causal arguments demonstrates a unique feature of the 4X4 Concept that allows it to be more broadly applicable than other knowledge systems: because 4x4 event data has been ordered according to the 4x4 Logic Rules for Investigation, the truth of the premises may logically be held to entail the truth of the conclusion. This refinement of definition for the analogical argument greatly enhances its practical application, and removes for this special case much of the ambiguity associated with the subject in related writing. (6)

Causal Argument and Syntactic Logic

A 4x4 event model has the form of a causally connected series of causal arguments, arranged from left to right, as the argument it represents. For example, assume that the event under analysis is:

0: A fuel gas explosion occurred.

The factors directly under the event in the model are:

1: Oxygen was present.
2: Fuel gas was present.
3: Paul lit a match.

When dealing with the reality of an explosion, the form of the logically correct and deductively valid causal argument is:

> If oxygen is present AND if fuel is present AND if an ignition source is present, an explosion will occur.

The preceding causal argument can be considered incomplete; the degree to which oxygen and fuel gas are present is critical to the validity of the argument. Further, if these essential elements are present in correct degree, but neatly sealed in tanks, the argument is invalidated. However, it is certainly possible to complete the causal argument. The environment could be specified as that of an outdoor forklift refueling station under earth-normal atmospheric conditions with fuel present to interact with the environment because of a fuel line leak. Thus, the first premise of the preceding argument could be rewritten as follows:

> If the level of oxygen contained in an earth-normal atmospheric environment is present AND if sufficient fuel is present AND if an ignition source is introduced AND if the oxygen, fuel, and ignition source are free to interact, an explosion will occur.

The form of the syntactic logic used by REASON can be simultaneously demonstrated while completing the causal argument:

"AS"

The level of oxygen contained in an earth-normal atmospheric environment WAS present AND free to interact.

AND **"AS"**

Sufficient fuel gas WAS present AND free to interact.

AND **"BECAUSE"**

An ignition source WAS introduced AND free to interact.

"THEREFORE"

A fuel gas explosion occurred.

The structure of the 4x4 event model, however, subsumes all of the points noted above which were not part of the initial causal argument. The 4x4 event model deals with reality - the fuel gas explosion did occur. It is not organizationally necessary to specify the exact mixture of fuel and oxygen - it is already apparent that the oxygen and fuel gas were free to interact, and that the mixture was sufficient and necessary to produce the explosion when the ignition source, which was free to interact with the mixture, was introduced to the system.

Some logic texts assert: "Logic cannot provide rules for the discovery of causal relations." (7)

However, the 4x4 Rules for Investigation, which provide the process for formulating a 4x4 event model, represent an explicit process for discovering, defining, and bounding a system of causal relations. The set of factors in the preceding example was generated in the analysis of an actual event using the 4x4 Rules for Investigation. A complete event model represents a bound set of causal relations specific to the event and to the organization in which it took place. The 4x4 theory implies a fundamental, special-case, revision to current logic theory, and expands its practical utility. More discussion on causal relations can be found in the section on terminator codes.

Rule One: Why?

> "Start at an End Result and keep asking why until you have established a corrective opportunity at the worker, supervisor, or management level, or you have eliminated one or more of those with your answers."
>
> Paraphrased for application:

> "Start at an End Result. Keep asking why until you can stop with a Corrective Opportunity, a Non-Correctable, or an Insufficient Data factor.

Rule One is the logic constraint that determines the beginning and the end of the investigation, thus accomplishing part of the bounding process by establishing the top and bottom of the event model. The rule requires that the question "Why?" be answered at each investigative step, beginning with the end result. How the question must be answered is specifically addressed by the Rule Two, Rule Three and Rule Four.

As with all of the Four 4x4 Rules, Rule One is a Boolean constraint. More precisely, it is a hierarchy of three Boolean constraints.

One constraint involves the determination of organizational control over the process at the investigative point. If the current point in the investigation can be organizationally controlled, then the current point must be terminated with a corrective opportunity terminator code (discussed under terminator codes). When this constraint is satisfied, the 4x4 Principles have been violated, and the violation exactly describes the organizational level and the control actions that must be implemented at that level in order to establish sustaining control. In risk assessment, the incidence and cost-effectiveness of identified corrective opportunities is a decision guide for establishing and relying upon internal loss controls.

A second constraint is satisfied if the organization either cannot or will not establish control at the current investigative point. If this constraint can be satisfied, the current investigative chain must be terminated with a non-correctable terminator code. In risk assessment, the high incidence and ratio of non-correctable to correctable factors in the causal system may indicate a need for externalizing the loss risk.

The third constraint is the "Why?" constraint: can the question "why?" be answered? If it cannot (in that case a logical value of zero is returned for the constraint), then Rule One terminates the investigative process in the current chain with an insufficient data terminator code. In risk assessment, the high incidence of insufficient data factors can be a cautionary flag against relying upon internal loss controls.

Rule Two: Who or What?

> "Your answers must tend to raise the level of generating responsibility."
>
> Paraphrased for application:
>
> "Say who or what did or did not do something."

Rule Two is a culmination of two Boolean logic constraints. The first of these Rule Two constraints determines inclusion of relevant data. A level of perspective is established. The constraint is satisfied, and the level under consideration is included in the model, if the level represents a point of system anomaly. In most cases this equates to modeling failure points. However, if the level represents a process step in properly functioning systems, the constraint is not satisfied and the level is not included in the model.

The second constraint concerns the determination of causal energy within the level. If an answer supplies information on "who or what did or did not do something", then the answer factor is identified as possessing causal energy, and the second Rule Two constraint is satisfied. This constraint must be satisfied at least once in every level. The factors expressing "NOT" identity where organizational control either existed but did not function, or should have but did not exist in the organizational environment.

Rule Three:

> "Your answers at each sequential step must include only those generating and permitting influences necessary for the occurrence of that step."
>
> Paraphrased for application:
>
> "Include only the active and passive things that must be there to explain WHY."
>
> Occam's Razor - "Essentia non sunt multiplicanda praeter necessitatem"

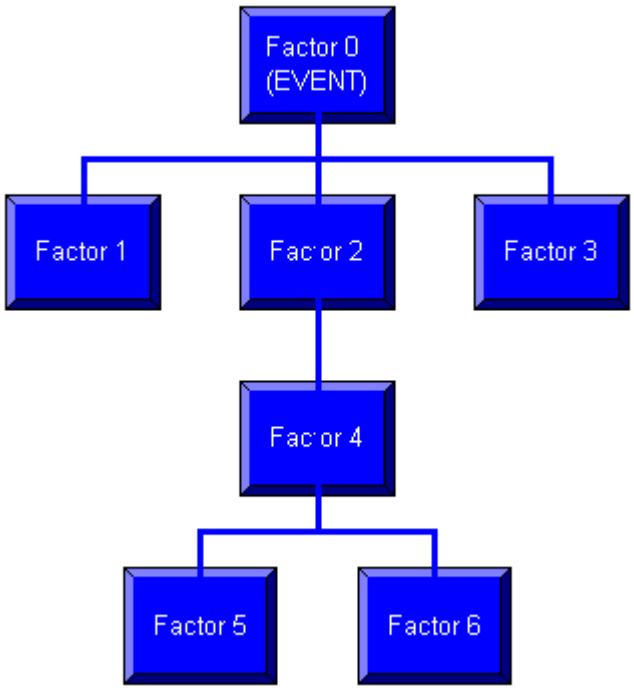
Stated in English, Herbert Simon interprets Occam to mean "make no more assumptions than necessary to account for the phenomena." (8) The 4x4 Concept's interpretation is "include no more data than necessary to account for the event." Occam's Razor is critical to the 4x4 Concept [c.f. Occam (9), John Stuart Mill's method of difference (10), induction by elimination (11), and necessary and sufficient logic (12)]; in fact. This logic rule insures that exactly the factors necessary and sufficient to produce the event are included in the model. If any necessary factor is removed from the model, the event cannot occur; if any factor is added to a sufficient model, irrelevant data will be processed. Rule Three also establishes and limits the nature of available causal factors in the event process to only elemental generating (active) and permitting (passive).

Rule Four: Separation of Data

> "If your question requires more than one answer, each must be taken through the WHY sequence separately."
>
> Paraphrased for application:
>
> "Do not lump factors together."

Rule Four is a simple separation constraint, and is one of the primary uses of the Boolean Logical Operator. Each answer must be taken through the Boolean processes of the first three Rules independently for the logical structure of the event model to be maintained. The following section details this structure.

The Boolean Logical Operator



Digital logic and its constructs identify a 4x4 event model as one that is constructed using AND gates. No OR cases are processed - in cases of uncertainty, the investigator must enter an insufficient data terminator.

The AND gate construction of a 4x4 event model allows an important inference to be drawn. Consider the following example: (fig. 1)

We begin the analysis of this causal chain by stating that Factor 4 occurred because of Factor 5 and Factor 6. The only assumption necessary for this statement to be valid is that the 4x4 Rules were followed.

Stated in Boolean form, using the Boolean AND operator * and the YIELDS operator -->:

(Factor 5) * (Factor 6) --> (Factor 4)

(Factor 4) --> (Factor 2) Continuing the operation:

(Factor 3) * (Factor 2) * (Factor 1) --> (Factor 0)

Simple substitution results in:

(Factor1)*(Factor5)*(Factor 6)*(Factor 3) --> (Factor 0)

We may conclude that the set of the terminating factors, Factors 1, 3, 5, and 6 above, are the essential causal set of the event under analysis. The tag "terminating factor" is used when working DOWN the model during formulation - these factors appear at the end of the causal chain. During analysis, however, once the model is constructed, the focus is on the process leading UP to the event. Thus, these factors are in that context considered to be the "initiating factors" from which the causal chains leading to the event are derived. They are said to form the "essential causal set."

The Essential Causal Set

Recognizing that the 4x4 event model is a segment of process occurring through time which has been isolated and bound, we can say that the ends of the causal chains form the essential causal set that eventually produced the end result. In general concept, any identified points along a causal process could be termed the starting, or initiating or essential set, provided that consistent criteria were applied to select the points. In the case of the 4x4 bound model, the essential causal set is established by the organizational termination of the causal chains. The essential causal set of a bound event model is made up of organizational factors, identified by corrective opportunity terminator codes, or non-correctable terminator codes, or the organizational determination that insufficient data exist. As demonstrated in the section on the Boolean Logical Operator, the inquiry process leads to the essential causal set of an event is the set of initiating factors whose resultant sub-processes combined to cause the final event. Each cause in the essential causal set is identified with a Terminator Code.

What the Terminator Codes Represent

The terminator codes identify the factors that form the initiating set which is responsible for the event. These factors appear directly above the codes in the model. As demonstrated above, it is literally possible to state that the event occurred because the set of initiating factors either occurred or were present in the environment. The initiating factors complete the bounding of the system in all cases except those of insufficient data factors, further examined below. The terminator codes represent the types of information indicated by their respective initiating factors, information which the organization must have in order to assess the capability to control: what the organization cannot or will not control, what the organization does not know, and what the organization can control.

Terminator Codes Function in Decision Support

The terminator codes used to end causal chains in the event model, and to thus bound the event process, are designed to separate the event data into decision support categories. The intent of the knowledge system formed by the 4x4 Concept is to provide quantified data to support decision making. It seeks to identify something that someone can do something about. Hence, the causal chains in the event model are terminated in a basic decision data format: something we know that we can do something about (Corrective Opportunity - "CO"), something we know but cannot do any thing about (NonCorrectable - "NC"), and something that we do not know (Insufficient Data - "ID").

Insufficient Data Factors - ID

Insufficient data factors represent areas in which the organization cannot provide complete information. In application, the ability to record the absence of data disallows assumptions. Insufficient data factors effect quantification reliability for comparative analysis. For instance, a model may identify two opportunities for correction. Regardless of the quantification reliability, each will prevent the event system from occurring again in the environment. However, if quantification reliability is low, the calculations cannot be used reliably to compare the two options for benefit and cost-effectiveness. In the absence of insufficient data factors within a model, the reliability of the quantification is absolute, if the data are accurate. Quantification reliability in an event model is simply a measure of the amount of the bound model that is identified with insufficient data. The greater the

number of insufficient data factors and the higher up they occur in the model, the lower the quantification reliability of the model.

Corrective Opportunities - CO

Corrective opportunities represent preventive opportunities over root causes within the system boundary. A root cause represents a failure in organizational control - either a complete lack of control in a particular area, or the failure of an existing control. Once a control is instituted or modified, the factor identified as a corrective opportunity will never occur again in a system, unless there is a breakdown in the application of the 4x4 Principles.

Non-Correctable Factors - NC

Non-correctable factors are those factors which contribute to the event, yet are considered uncontrollable by the organization. Such factors can be ones which are considered impractical to control, or are desirable or essential to the organization. An example is the presence of oxygen in the atmosphere. While it is possible to design, construct and maintain oxygen-free fuel locations, most organizations will consider such steps to be organizationally impractical, and therefore noncorrectable.

The Quantification Process

Overview

Having established the structure of the event model, it becomes necessary to define the process through which the information for decision-making contained within the model can be extracted. The function of this process is to "link mathematics and physics ... implying relevance to one and precision to the other." (13) The event model represents the physical reality and the quantification process must provide definitions for measurable fundamental properties of the model. "...we find that the conceptual model must reflect the characteristics of the real system which [is] to be investigated." (14)

The Function of Measurement

The quantification process "presupposes something to be measured." (15) Further, "The essential function of measurement is the setting in order of a class of events with respect to its exhibition of a particular property, and this entails the discovery of an ordered class the elements of which can be put in a one-to-one correlation with the [event] in question." (16) More plainly, the "class of events" is the set of factors contained within the event model, which "exhibit" a combination of two fundamental properties. The "ordered class" is the event model itself, and the method for creating the "one-to-one correlation with the [event] in question" is the 4x4 Rules for Investigation. The Rules represent a causal function for ordering the factors in an organization according to their fundamental properties, and the hierarchy of their process relations.

Requirements for a Quantification Process

Cassirer (17) asserts that quantification must be "conceived and sought" before it can be related to physical reality, a process which involves several steps. First, the fundamental properties of the system, in this case a causal system, must be conceptualized. An operational definition must be derived from the resulting scientific construct, defined by Caws as "... a concept deliberately ... invented with a view to erecting ... a theory." (18) The operational definition defines the physical quantity used in the description of the phenomenon, a necessary precursor to the measurement of the quantity because " ... it is meaningless to speak of measurement unless there is already available some form of definition." (19) Finally, through the manipulation of the physical quantity described by the operational definition, other physical quantities may be calculated.

Conceptualization

A fundamental strength of 4x4 is its ability to build and quantify organizational systems - systems that are capable of incorporating both physical and behavioral elements within a single logic construct. In the 4x4 System of Quantification, the fundamental properties of the causal factors are existence and causal energy. Causal energy is defined as the power to produce uncontrolled change. Consider the simple physical system outlined previously. Oxygen and fuel gas had existence within the system, but possessed no causal energy. Paul provided an ignition source with both existence and causal energy, causing an event. Factors within a physical system have existence in the system. These factors are media for causal energy within the system. Causal energies flow through media to produce events. Without causal energy and a medium, no event can occur.

Operational Definition

"Any number or set of numbers used for the quantitative description of a physical phenomenon is called a physical quantity. To define a physical quantity we must either specify a procedure for measuring the quantity, or specify a way to calculate the quantity from other quantities that can be measured ... A definition in terms of a procedure for measuring the defined quantity is called an operational definition. Certain fundamental quantities can be defined only with operational definitions (authors' emphasis)." (19)

Existence and Energy

The two fundamental physical quantities of the 4x4 Concept, existence and causal energy, are quantities of the second type - they may be defined only through the use of operational definitions. The operational definitions make use of the Boolean logical operator. If a factor does not exist within a model, it will not be considered by the model. If the factor possesses existence within the model, it is operationally defined to have existence, and is assigned the existence quantifier. In a similar fashion, if a factor possesses causal energy, it is assigned an additional causal energy quantifier.

The 4x4 theory requires that existence be treated as a physical property of a factor in the event model, just as mass is treated as a physical and operationally defined physical property of an object. Both operational definitions are solely measures of existence at this level - the existence of a factor within the system boundary and the additional existence of causal energy within a factor.

One can think of this stage of the 4x4 quantification process as measuring the existence of qualities. Mass is a quality of an object at one level, a measurable quantity at another. Before we can determine the quantity of a property possessed by an object or factor, we must first verify the existence of the property. To verify the existence of a property is to assign a quality to an object or factor. The verification of a factor's fundamental properties is built into the investigation process outlined in the 4x4 Rules for Investigation.

The 4x4 quantification process combines the two measures of existence, so that the value assigned to a factor reflects exactly the fundamental properties of the factor. Since the Boolean operator is valid as long as one value indicates "TRUE" and the other value indicates "FALSE", the combined scale represents a single Boolean scale which returns a value of "TRUE" if the factor possesses causal energy. Because the bounding process ensures that all factors within the model possess existence, the only test necessary is for the existence of causal energy.

Energy as defined in the 4x4Concept differs substantially from the way in which the term is commonly used. Energy is a pure mathematical quantity when its existence is quantified in 4x4, with "pure" meaning possessing no units. A factor with causal energy is a factor that has the ability, when introduced to a system, to produce uncontrolled change and process.

Causal energy exists irrespective of other forms of energy possessed by a factor. Other types of energy (i.e. kinetic, thermal, hydraulic, electrical), if any, possessed by a factor do not affect whether or not the factor possesses the causal energy to produce uncontrolled change.

Without the presence of at least one factor with causal energy, no system exists. This fact is reflected by Rule Two, simply phrased for generating factors as "State who or what did or did not do something." Without someone or something actively adding causal energy to the media, represented by those factors which possess existence within a set, the factors will never change state or achieve process. The causal energy contained by an active cause actually bonds causal factors into an interacting system set.

Manipulation

The purpose of manipulation is to produce data useful for a particular purpose. In the case of the 4x4 event model, that purpose is decision making. Manipulation isolates the causal energy and the causal stress within the model. Measurements of these two properties, derived from the fundamental properties and quantification of systems, aid the decision maker in determining the effectiveness of establishing organizational control at a particular point. Part of the uniqueness of the 4x4 Concept stems from its ability to produce objective decision support data through the measurement of the event process and the manipulation of those values.

Generating and Permitting Factors

Implicitly defined in previous sections are two types of causal factors - those with existence only and those with both existence and causal energy. Factors with existence only are referred to as "permitting". Factors with existence

and energy, the 4x4 Concept refers to as "generating". The type of input to the causal process is expressed by the nature of the factor and the role it plays in the process. For instance, when a falling tree damages a roof, we can say that the existing roof is a permitting factor, its location under the tree is a permitting factor, and the fact that the tree fell is a generating factor. All 4x4 quantification is based solely upon the combinations of fundamental properties exhibited by the factors themselves. Generating and permitting factors are the base manipulations from the measures of the fundamental properties.

Permitting factors are the media through which the causal energy contained in generating factors is brought to process. The more that the permitting factor was a product of systems within the organization, the larger the sub-system that will appear in the model under the permitting factor, and the more organizational stress it can be said to represent.

Generating factors provide the trigger energy to release stress into process. It is helpful to think of the generating factor or factors as "locking" the causal set in place at a specific point in time. They are the actions, decisions, failures and inactions that occur at one point in time that provide us with a means to systematically define and detail the process as a series of steps identified by the combinations of causes forming sets.

Generating Causality

Inferences can be drawn about the nature of the event being modeled. The measure of Generating Causality is a numerical means to detect and identify when several generating factors were required to occur at the same time within one causal set of factors to produce a next step in the causal process. Generating Causality refers specifically to the manner in which generating factors combined within the sets of factors in the event model. That remarkable combination of factors is an item of interest as a target for control design. Two separate measures of generating causality are employed to indicate the distribution of factors within the model - relative and proper.

Relative versus Proper Generating Causality The farther a set of generating factor occurs "down" in the model - away from the event - the less direct effect the causal energy from that set of factors will have on the production of the event. The relative measure reflects modification of the value by the level at which the factor resides in the modeled process. Thus, the basis for the relative generating causality measure is both the incidence of generating factors combined within a common set of factors, and the level location of that set within the event model. Proper generating causality is a similar measure of the combining of generating factors within a common causal set, but unmodified by level.

Calculations and comparisons of proper and relative measures give specific information about the nature and construction of the causal process. For example, when proper generating causality is compared to relative generating causality, the relationship reveals where the energy for change exists within the model. If the number which identifies the unmodified total amount of energy (proper) is close to the number which identifies the amount modified by level (relative), we can conclude that most of the sets that contain several generating factors are located in the upper levels of the event model. The event process is considered imminent when such a condition exists. This type of analysis is particularly applicable when assessing the risk of loss existing at a particular site. Such a condition indicates that the identified loss systems are a result of what is happening at the site, rather than the inherent or given conditions at the site. The opportunity to gain control through application of the 4x4 Principles is significant.

Causal Stress

The causal stress measure is a view of the interaction of both generating and permitting factors. As with generating causality, there are both proper and relative measures of causal stress. Again, proper causal stress is an unmodified measure of the characteristic, and relative causal stress is a measure modified for the level of occurrence within the model. Measures of causal stress aid the decision maker in determining which options for control are most attractive. Typically, a total benchmark number is used as a basis for comparing how much causal stress is removed from an event process by the exercise of particular corrective opportunities. The analysis can be thought simplistically as first measuring the model, then removing the chain of factors above a corrective opportunity, then remeasuring the causal stress represented by the remaining factors in the model in order to determine what percentage of the causal process was removed by each action.

The 4x4 Principles of Organizational Control

The 4x4 Principles can be thought of as forming three system sets. To start the process of organizational control, the set of four Governing principles must be satisfied. In the case of man's organizations, the principles are satisfied by specific human actions.

(fig. 2)

Principles	Code	Action
Governing (Management Actions)		
Command	M1	Establish and communicate policy / procedure
Apply	M2	Apply policy / procedure consistently where applicable
Monitor	M3	Establish and communicate procedural monitoring
Enforce	M4	Enforce policy / procedure based upon procedural monitorir
Implementing(Supervisor Actions)		
Command	S1	Communicate what is wanted
Marshal	S2	Assure the means for compliance
Model	S3	Be consistent in good example
Enforce	S4	Be consistent in enforcement
Enabling(Organizational Actions)		
Enable	W1	Remove obstacles to proper performance
Command	W2	Communicate what is wanted
Respond	W3	Train / Motivate / Enforce
Enforce	W4	Recognize / Reward improved performance

Governing The 4x4 Governing Principles speak of principles in terms of actions we must take to effectively begin the organizational control process. The set is identified as "Management Action". Note that a clear hierarchy of function exists within this set of principles, a hierarchy applicable to system discipline. Once there has been an expression of command, each governing action is conditional upon the satisfaction of its next higher principle. Consequently, there cannot be consistent enforcement (M4) until a consistent means of monitoring (M3) is established. There cannot be consistent monitoring until there has been consistent application (M2) of command. There cannot be consistent application until a statement of command (M1) has been made. This is the beginning of the process that we hear expressed in the phrase, "First came the word". These are the universal principles of organizational control.

Implementing

The 4x4 Implementing Principles are expressed here as actions taken by supervisors to implement the Governing command. They can be thought of as forming a subsystem that gets the process going and keeps it going. The implementing process has, in effect, been delegated to a subsystem for accomplishment. Note that there is a functional effect at the Governing level when the Implementing principles are not satisfied. That is, when the system identifies a break-down at the supervisor level (Implementing), it has identified an erosion in consistent application at the Governing level as well, and thus degrades the quality of monitoring and enforcement capability of management.

When the four 4x4 Governing Principles interact with the four 4x4 Implementing Principles, they form the internal system of dynamic organizational control. That's why the concept is called "4x4".

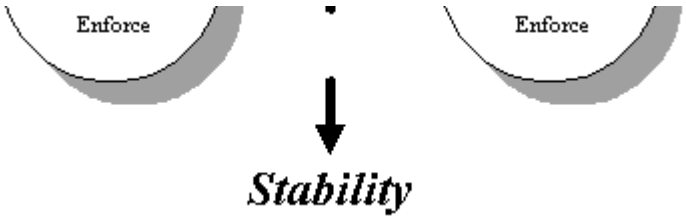
System of Dynamic Organizational Control

Governing - The governing process provides the design of the organization. It describes the boundaries of influence, the "kind" of entity it will be, the nature of its goals, its values, and its requirements.

Implementing - The job of translating governing design into internal expression is delegated to subsystems for implementation.

Stability - The product of this functioning system(Governing/ Implementing) is internal organizational stability.

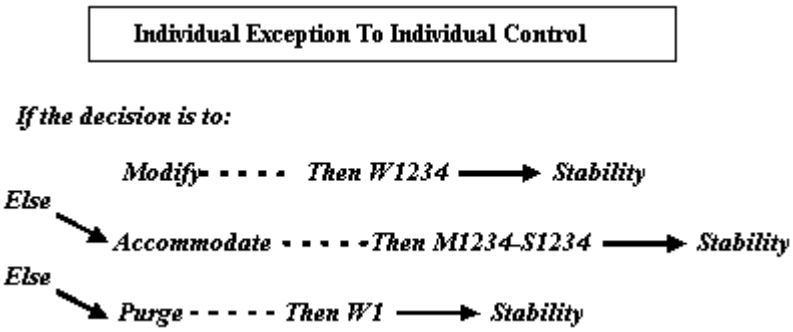
(fig. 3)



Enabling

Fig. 4 shows the natural system process through which dynamic organizations deal with individual exceptions to control. It is a decision - action process where the organization assesses the nature of the exception to control, and decides how best to deal with it, in order to benefit the whole organization. It is the process through which dynamic organizations self-regulate to survive.

(fig. 4)



The 4x4 Enabling Principles form an internal system for dealing with individual exceptions to organizational control. They can be thought of as a standby "immune" system ready to deal with internal exceptions to control that exceed established levels of tolerance. When an individual exception upsets the stability of the organization, the enabling process comes on-line.

MODIFY - The exception is modified to comply through restatement of governing common proper response to the individual's need, and enforcement through recognizing performance improvement; thus removing the obstacle to proper performance (W1234).

ACCOMMODATE - The exception is accommodated through change in command; thus removing the obstacle to proper performance. This process produces an internal change. It is the process through which organizations remain sensitive to the needs of the individual, and retain the ability to grow, evolve and acclimate for survival. It is accomplished by setting in a new command through application of the Governing and Implementing Principles (M1234-S1234). The obstacle to proper performance is removed.

PURGE - The exception is perceived to be a threat to the survival and well-being of the whole organization, and cannot be tolerated. The obstacle to proper performance of command is cast out (W1), reestablishing stability. In practice, individuals can often be reassigned or moved to other locations or operations.

The 4x4 Organizational Principles never dictate method, approach, style or technique; instead, they identify the basic action goal to be accomplished (i.e., M34) in order to reestablish organizational control of the loss producing pattern. Enforcement, for example, is the process that produces compliance to the preestablished standard of performance. It can be accomplished in many ways: through peer pressure, a praising word, discipline, or punishment. How the principle is satisfied is a product of the style, personality, and approach of the organization. Therefore, 4x4 gives us a convenient benchmark to test and measure the effectiveness of different management styles in our designed organizations. It lets us understand why certain management styles work well in one type of organization and not in another.

The characteristics inherent in the function of the 4x4 Principles not only define the human actions necessary for organizational control, but also stimulate human response patterns best suited to produce and sustain stability and harmony within the organization. This process shapes the behavior of persons as individuals and groups within the organization. The visibility of human behavior as response to the application of organizational principles provides new parameters for understanding and research by all disciplines interested in why things occur as they do within a particular organizational environment. Of particular interest to business and industry will be the implications to relations between Labor and Management. With their understanding of each other's roles and the part each plays in the creating of systems that satisfy the 4x4 Principles, will come a natural, common, conceptual framework through which each can work toward maximizing the success of the organization as a common goal. 4x4 brings persons together into problem specific groups within the organization. Thus, as a part of routine problem solving activity all members of the organization may uniquely contribute toward the stability and success of the organization. One result of applying 4x4 Concept is the increase in tangible value and importance of each person to the overall success and survival of the organization.

The Process of Self-Regulation

STEP 1

A SENSOR WITH MEMORY OF WHAT IS UNACCEPTABLE, AND THE ABILITY TO BOTH DETECT AND COMMUNICATE, PERCEIVES INSTABILITY AND ALERTS AN ANALYSIS/ DECISION CENTER.

STEP 2

THE ANALYSIS/DECISION CENTER ASSESSES THE NATURE OF THREAT AND IDENTIFIES THE FUNCTION FOR PROPER RESPONSE.

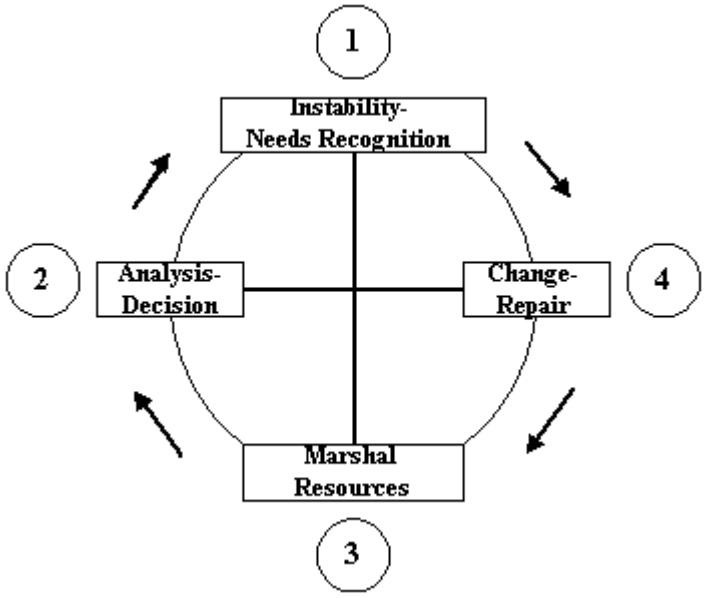
STEP 3

THE FUNCTION FOR PROPER RESPONSE MARSHALS THE RESOURCES OF THE ORGANIZATION

STEP 4

THE PROCESS OF REPAIR OR CHANGE IS ACCOMPLISHED

(fig. 5)



The goal of the self-regulation process is to maintain organizational control by reestablishing stability through either repair to retain previous stability status, or process to achieve the smallest incremental change that will establish new stability status. It is this latter type of change that produces evolution within the organization.

Governing Principles and Their Relation to Policy

The body of policy within an organization represents the organization's attempt to control its activities. Policies to be effective, however, must obey certain principles, just as the systems they are intended to control. These principles are the Governing Principles, discussed above. If policies are not designed to insure that the Governing Principles are satisfied, control in the areas governed by those improperly formulated policies will be at best incomplete. Sustaining organizational control can never be more complete than the body of policy upon which it depends.

Control

Control points are identified in formulating the event model. The measures derived from the fundamental model quantification discussed above provide the decision maker with a basis for determining how effective it will be to act at a particular control point. The Governing Principles describe what general actions can be taken to produce control. Short examples of the types of inferences that the measures of causal energy and causal stress make possible are presented below.

Inferences From Causal Stress

Causal Stress is a measure of the total event process as defined by the 4x4 logic process. When a decision maker chooses to establish control at a point within the causal system, the causal chain above the control point is disabled. A measure of the attractiveness of a control point is the amount of relative causal stress the option removes from the model. This measure, in conjunction with cost data from the organization, yield management decision data for cost/benefit analysis. The option which removes the greatest amount of causal stress provides the greatest prevention benefit to the organization.

Cost / Benefit Analysis

Ideally, organizations have the resources at their disposal to take advantage of all corrective opportunities. In the real world, organizations must often make difficult decisions as to how to allocate limited resources to address their problems. A 4x4 cost / benefit analysis process yields the amount of causal stress relieved per dollar. Once a corrective opportunity is identified, the amount of stress relieved by correction can be calculated directly from the model. If the decision maker can provide the cost of correction, a measure of the ratio of benefit per dollar from the correction results. Thus a 4x4 model provides decision support data that compares decision options for projected control effectiveness, and yields a measure of prevention benefit per dollar.

Sensitivity Analysis

Sensitivity analysis is narrowly applicable to the 4x4 Concept. The input to the model is factual to the best knowledge of the organization, and any change in the data will have an effect on the analysis of the model commensurate with the degree of the change and the level of the change within the model. The values returned from a 4x4 analysis are derived from direct measurements, and any change in those measurements would be the result of a change in the data input by the organization. In only one instance will the reader note a measure that is highly sensitive to small changes - the instance of generating causality. In this case, the measure is very sensitive to any set within which more than two generating factors exist.

The generating causality measure is designed for this sensitivity - the existence of two generating factors within a causal set is identified with a common causal process pattern, and is therefore not a phenomenon for alarm. However, more than two generating factors within a set significantly increases the role of causal energy in producing that set, identifying the strongly causal set as a target for control design. Optimally, the corrective opportunity selected will chain up through the strongly causal set to interfere with the interaction of the factors within this highly energized set, and thus disable the set.

The ability to express the organizational factors as an interacting process system in alphanumeric terms provides the profession with capability to symbolically represent the event in computer compatible terms that speak of who can do what to establish control. Unique analyses become available through direct input of the process in terms of the totality of the organization. This approach associates the identified decision option with the specific policy governing such a decision area. Typically, several policy areas may be involved in an event process. 4x4 provides a

view of the normally hidden interaction of policy effects as it relates to the production of unwanted events. It is common to find recurring patterns of policy interaction associated with locations and processes.This visibility provides new, site risk assessment capability.

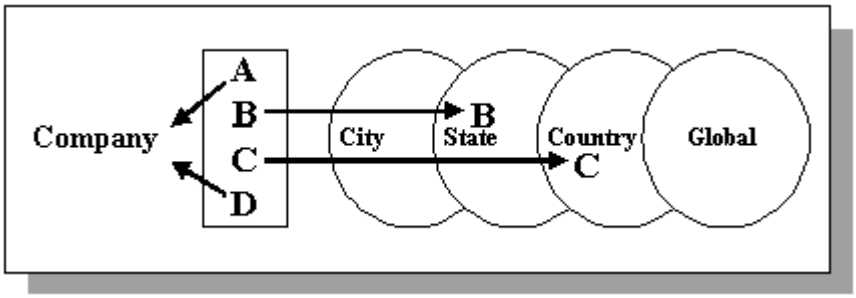
Organizational Totality

With the ability to express events in terms of the total organization, the profession can at last model all of the controllable systems structuring an event---from a microscopic analysis of the reliability of one electrical interface connector, to the macroscopic analysis of the reliability of organizational controls. These factors can be included within the same analysis process and within the same unified event model. Further, as promised by the 4x4 Theorem One, identification of the event in terms of actions that satisfy principles describes the solution alternatives for input to the executive decision making process.

System of Organizations

When we view and perceive events as a natural process within organizations, much of the mystery of unexplained organizational phenomena is displaced by fundamental understanding of process. The key to understanding an event is to trace each identified causal factor to the system of organization in which it is controllable.

(fig. 6)



In fig.6 an event is identified as occurring within a company. The event is represented by the factors A, B, C and D that formed the system that produced the event. In this graphic, factors A and D are shown as controllable within the company itself. Factor B is controllable only at the state level. Factor C is controllable only at the national level. The concept here is not to get out-side the organization in order to see what is happening, but rather to perceive things as happening within a network of interacting systems of organization.

By definition, factors originating externally to an organization are not controllable by that organization. However, management will want to procedurally monitor the data for causal factors that have been considered noncorrectable for opportunities to internalize these factors. For instance, if state law is pinpointed by an industry as having consistent causal effect upon certain workers' decisions that are resulting in their risk-taking on the job, the companies may elect to become part of a larger organization in order to bring about a change in the law. When the needed change occurs at the state level, the state will have then satisfied the Enabling Principles by accommodating the threat of control. The state requirement is changed, applied consistently, monitored and enforced. Stability is reestablished.

4x4 Organizational Data

The 4x4 inquiry method starts with a rule guided, standard operating procedure for directed thinking . The discipline of the method focuses upon only factors causally relevant to the event. The investigator examines a series of points in time marked by events that eventually produced an organizationally unacceptable result. The four rules of investigation form a scientific inquiry process by heuristically qualifying the data into an organizational system context, and identifying the nature of each factor as related to the nature of its input to the system.

4x4 Event Modeling

I am going to describe and briefly illustrate 4x4 event modeling in a tree format. I urge you to look beyond the use of familiar trees and terms to the unique process that qualifies the content of the model. As I noted earlier, the rules are designed to produce scientific inquiry process; that is, reproducible from multiple sources. The rules form an operational event model by defining the characteristics of the data and the tests to which they are put.

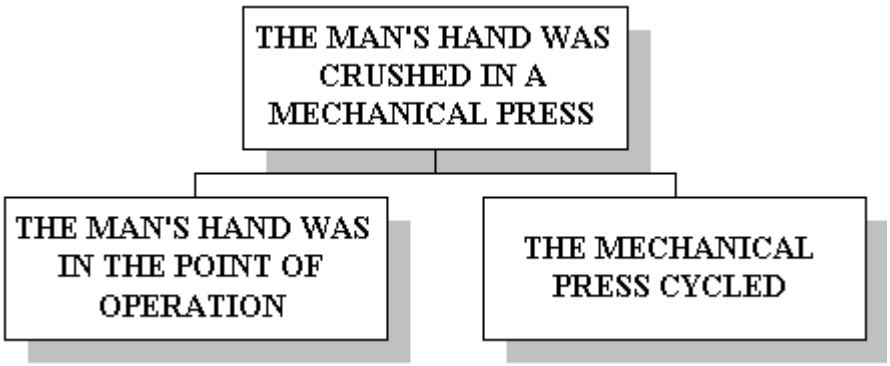
NARRATIVE

> "A man is operating a small mechanical forming press. He is removing a part by hand when the press cycles, crushing his hand in the point of operation." Starting with the selected end-result of the crushed hand, we ask WHY the hand was crushed in the press...

WHY WAS THE MAN'S HAND CRUSHED IN THE PRESS?

To that question we bring all generating and permitting factors necessary for the occurrence of that sequential step.

(fig. 7)



Rule Three, based upon "Occam's Razor", restricts unnecessary complexity and, together with the application of "necessary and sufficient" logic construct provides a test for accuracy. Are other factors essential to explain the occurrence of the event? Will the event occur if any are removed?

Decision Data

When the 4x4 event model is closed (all cause chains terminated), we can say that all contributing factors have been identified in terms of internal control. The 4x4 model is an ordered structure of the event process, a graphic depiction of our understanding of the system that produced the event. In practice, some causal chains may terminate as external to control by the organization (not correctable NC); others may terminate as an expression of insufficient data (ID); others may be identified as specific corrective opportunities for organizational prevention (CO).

The terminator categories are the same ones into which our minds naturally sort data for decision and action. The model produced is in a literal sense a picture of the investigator's thought process. The administrator can now view the event through the eyes of the investigator. He can follow the investigator's logic, step by step; he can question, test, and measure the investigative accuracy; he can monitor the attitudes and decision guidelines existing in the operation; and he can monitor the continuity of data sources.

When we are able to then associate each corrective opportunity with either the absence or the presence of existing control policies/procedures, we produce a natural monitoring system of organizational control. Design of efficient organizational controls becomes possible when the identified causal systems and their products are quantifiable. Hence the significance of the 4x4 quantification system.

Monitoring and Audits

Mr. Ray Heiskala, while configuration management representative for NASA, wrote, "Until top management knows the relative health of their organization's individual activities, they will continue to be severely limited in knowing where their resources should be applied to guarantee safe, high quality operations." With audits based

upon 4x4 methodology, the organizational systems that generate or permit loss of control can be identified, quantified, analyzed, and redesigned by top management to maximize the quality goals of the organization. Any appropriate standard for organizational performance provides not only a criterion for assessment of compliance, but also the opportunity to assess the controls in place to accomplish compliance. Keying identified causal factors to the existence of appropriate control policies/procedures provides a real-time monitor of existing control effectiveness. Identifying a substandard condition presents only an opportunity to improve that condition, but identifying the organizational system that produced that substandard condition presents an even more important opportunity for permanently upgrading the organizational control affecting the quality of the operation. 4x4 data are the meaningful messages that have been needed by managers to unify and order the overall controls of those activities that dictate the kind of organization we are, the quality of our products, the profitability of our operations, the effectiveness with which we deliver our services and products, the very survival of our organization.

4x4 Managerial Data

Now let us look at some of the information, available from the REASON software, about an operations problem that the basic 4x4 investigation, model, and analyses can provide to managers.

- ¨ A report that identifies, measures, and compares every quality improvement decision option, prioritizing decision options from a stand point of both prevention effectiveness and cost-benefit;
- ¨ A report of loss factors considered external to the organization, a new opportunity for managers to assess existing capability to either internalize those factors, or seek improvement at a higher level of organization;
- ¨ A report of permitting influences as related to facilities and equipment: a project assessment sheet for Industrial Engineering, Maintenance, Housekeeping, and when related to employees, a monitor of behavior producing plant belief systems and morale for Personnel and Industrial Relations;
- ¨ A report of individual exceptions to organizational control that provides management with a sensitive monitor of stability, and detector of developing need for change;
- ¨ A report of internal systems that generate, permit, and sustain loss and failure within the organization, the most valuable data available to the executive manager.

Measuring Organizational Effectiveness

Of particular benefit to risk assessment is the 4x4 Concept's indirect measurement of organizational control effectiveness. If all unacceptable events were a product of individual exception to organizational control (worker corrective opportunity) we would say that organizational control produced by the body of control policy was perfect. In this case of individual exceptions, the organization would apply the 4x4 Enabling Principles in an effort to reestablish control. In short, management in this example is perfect in its satisfaction of the 4x4 Governing Principles, supervision is perfect in its satisfaction of the 4x4 Implementing Principles, and only individual exceptions to organizational group behavior are producing the unwanted events that are impairing quality goals. The organization cannot improve beyond this point without evolving into a different entity. Anything less than the above perfection in control would give us a baseline relationship to measure for analysis and directed redesign of control policies/procedures. If, as graphically shown in Fig. 7, in one year it was determined that 50% of the opportunities to prevent/correct causal influences existed at the management level, 30% of the opportunities

existed at the supervisor level, and 20% of opportunities existed at the worker level, we would have a baseline for measurement.

If, two years later, there has been a steady shift down the organizational scale from management to worker, so that now only 10% of the opportunities exist at the management level, 25% exist at the supervisor level, and 65% are now worker exceptions to organizational control, we have a measured demonstration of improved organizational control. Associated with this shift will be a reduction in the incidence rate of counter-quality conditions and events. With this audit method, one can employ the investigation of preloss events to actually measure the control effectiveness of supervisors, departments, shifts, operations, facilities, and locations over any quality goal activity, in order to determine the potential for loss as revealed by the degree of control over critical activities existing at the site.

Given the assertion that properly applied process principles produce system success, and that improper application produces system failure, the probability that an unremedied 4x4 corrective opportunity will produce a control failure event is 100%. Further, 4x4 quantification provides a measure for assessing the imminence of the control failure event, as an adjunct to traditional probabilistic techniques. Thus, 4x4 provides the process and structure to produce perfect process data up to the point in the risk assessment process at which a time constraint is applied. We know that system failure will occur . . . we do not know when.

Socioeconomic Problems

Mr. Vernon Grose, a leading space systems research manager has stated, "It could well be that applying the systems approach . . . could be the next step toward the solution of socioeconomic problems." He noted in his presentation that, "voices throughout our nation,... have challenged the aerospace community to help alleviate urgent social problems by applying the systems approach." Long a hope, this potential for systems understanding has awaited a precisely defined concept that could encompass the totality of the organization, a methodology that could quantify variable social parameters, and a philosophy that wide populations could endorse. In answer to those needs, 4x4 brings to the management profession a defined organizational concept that enables us to quantify social parameters as they function within an organizational scheme, and a philosophy that says simply that all dynamic organizations, including society, can accomplish harmony and control through understanding and application of fundamental 4x4 Principles. The implications to leaders and legislators are profound.

Application - Finding Root Causes

It is the ability to focus upon the special characteristics of each causal system, and to understand the nature of the process and how the factors came together to produce the unwanted event that enables the user to better assess the risks of loss and to design effective organizational controls to prevent losses.

When studying 4x4 event models, It is not unusual to find events that share in common a highly interactive causal system that exists throughout the organization. If the critical components of that causal system are destroyed and completely removed from the entire organizational environment, that one action broadly benefits the organization's controls.

For example, a major oil drilling firm used the 4x4 Concept to investigate and model three consecutive major loss events. One event, the premature bearing failure of a large diesel engine, would have been studied and resolved by

the Maintenance and Engineering Director. Another case involved the injury of several third-party employees who crashed to the ground in a manlift. The third case was a fatality that occurred when a crew was tearing down a drilling rig. These three cases would normally have never been investigated and recorded in a consistent manner that identified all of the existing causal systems in a form that could be compared. When the Risk Manager examined the three event models, he discovered one causal system shared in common, and a corrective opportunity that would permanently remove the one active factor that had already contributed to several major losses, and routinely threatened to produce other losses. The models were taken by the Risk Manager to the Operations Vice President who set in control with a five minute telephone call to the Purchasing Director. Many different things had contributed to each of the three events; but the one root cause that the three cases shared in common had generated a system that had resulted in the purchase of a substutute product that in each case was considered by a purchasing clerk to be "the same as or better than" the product requested on a original purchase requisition. Consequently, highly efficient oil filters were purchased that filtered out essential oil lubricants from the diesel engine; a faster manlift was obtained whose design prematurely fatigued a wirerope to the point of failure over a poorly engineered pulley system; and a less expensive mobile crane was leased that did not have appropriate stabilizers. One important change was made to a corporate purchasing policy that now requires verification of criteria before substituting products. That established policy is applied consistently, monitored, and enforced.

Conclusion

Use of The 4x4 Concept provides a new technology for discovering, defining, bounding, and analyzing causal systems. For the decision maker it answers fundamental questions about why counter-quality events occur, and what to do about them. Edwards and von Winterfeld define technology as "any collection of orderly and useful techniques." (21) The development of the REASON computer software and the 4x4 methodology represent the translation of my General Theory of Unifying Dynamic Organizational Self-regulation into practical technology. The simplicity of the investigation and quantification processes allow an operating organization to integrate this new technology easily and quickly into its environment

As to the possibility that 4x4 is the Grand Management Theory that explains all organizational phenomena at a general level, I leave that determination to time and my peers, content in my belief that 4x4 provides a system of thinking that better equips us to solve the problems that have been created by our previous level of understanding about the dynamics of organization

Endnotes

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