MOLECULE AND GENERIC STRUCTURE FOR SYNERGY

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ABSTRACT

In the evolving terminology within the field of system dynamics, a "molecule" is the smallest combination of structural elements ("particles" and "atoms") necessary to represent a basic systems concept. A generic structure is the next largest combination of particles, atoms and molecules that conveys the most (or a) general form in which that concept can be identified in and/or represented for real systems. This paper proposes both a molecule and a generic structure for synergy.

INTRODUCTION

Professionals in the field of system dynamics have long understood that a relatively few basic concepts apply to all systems, whatever their apparent form or nature. A key characteristic of the evolution of the field has been the tendency to facilitate communication and teaching through a gradual standardization of terminology and symbols. In recent years this has been extended from basic elements of structure and behavior to include larger, recurring aggregates of structure that produce "typical" patterns of behavior in seemingly different macro systems.

Barry Richmond and John Morecroft are among those who have contributed to this evolution. In *A User's Guide to STELLA*, Richmond (1985) outlines six generic "atoms" of structure: self-generated production, self-generated flow-thru, non self-generated production, explicit goal-seeking, and co-flow. Morecroft (1984) outlines larger aggregates of generic structure which, by definition, can be adapted with minor changes (often only labels and parameters) from one business application to another. Structures for "addiction" are commonly used as examples of generic applicability to physical, psychological and social situations.

In this paper the author proposes that synergy, a phenomenon which occurs in many systems under certain conditions, can be conceptualized and represented as generic systems structure. The author acknowledges at the outset that the proposals would be more persuasive if accompanied by one or more dynamic models, but at publication time that work remained to be completed. Successful use of the proposed structures in actual models will undoubtedly suggest shortcomings and necessary changes, and the reader is invited to add his or her own contribution.

SYNERGY

For most of us, synergy is a metaphysical notion which relates the actual outcome of an event to our expected outcome for that event. When the actual outcome is different from the expected outcome in some special or significant way (usually special or significant to us), we tend to label either the difference or the entire event as a manifestation of synergy. A common expression is, "the whole is greater than the sum of its parts."

An ensemble is a coming together in time (and usually space) of a collection of people, ideas, inventions, events, etc., in such a way as to produce an apparent or actual compounding effect that is greater than (or different from) the sum of the parts. In a metaphysical sense, ensembles and the ensemble effect probably always involve synergy as conceptually described in this paper.

In his book, *Synergetics*, Buckminster Fuller (1975) offers several definitions of synergy, including:

> "102.00 Synergy means behavior of integral, aggregate, whole systems unpredicted by behaviors of any of their components or sub assemblies of their components taken separately from the whole."

While the majority of Fuller's examples involve geometrics and/or other physical attributes of matter or systems in combination, this author infers that his concept encompasses the propositions and examples set out in this paper.

Although a metaphysical component is an essential part of the examples and the generic structure described below, all involve the release of available but latent physical energy, yielding an actual outcome greater than the expected outcome. The generic structure should be readily adaptable to totally physical or totally metaphysical applications.

ALIGNMENT

Synergy is a function of alignment. Energy, or the application of energy, can be aligned in time, frequency, space, or along such metaphysical continua as vision, goals, values, political orientation, etc. (See Fig.1.) In any system where latent energy is present, its release will be a function of the system's sensitivity to alignment.

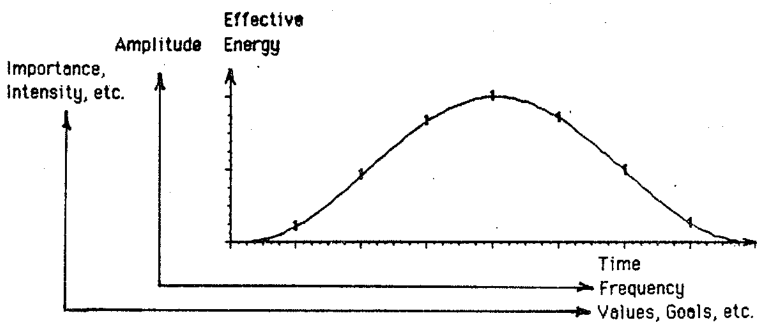

Fig. 1 Representative distribution of energy vs. other variables.

Since synergy tends to be a special event, rather than an every-day occurrence in systems we participate in and are familiar with, it can be inferred that in most systems the release of latent energy is highly sensitive to alignmnent. In the limit, the release of latent energy may require perfect alignment.

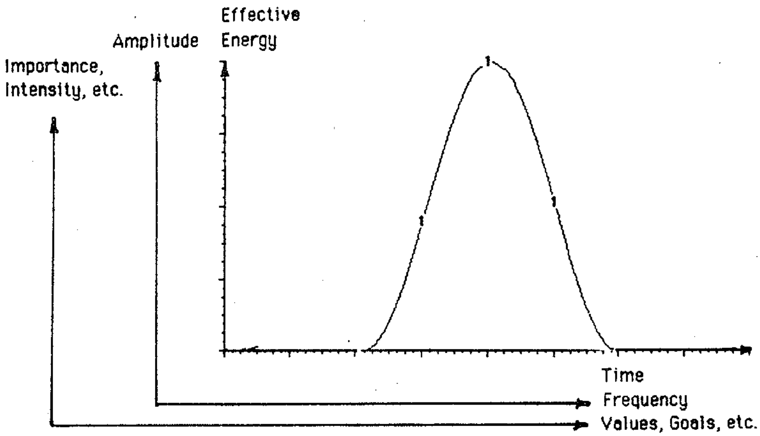

Fig. 2 More highly aligned distribution of energy than in Fig. 1.

Fig. 2 represents the same energies depicted in Fig. 1, but more highly aligned (not to exact scale). Using terms from statistics, the smaller the standard deviation of the distribution curve, the higher the alignment. From electrical engineering, the narrower the frequency band-pass of a filter, the higher its "Q". From system dynamics terminology, the greater the changes in rate become as one approaches or leaves the center of the distribution curve, the greater the alignment.

BASIC SYNERGY MOLECULE

Fig. 3 represents the first step in constructing the synergy molecule. Usually, Effective Energy consists only of Normally Expected Energy. When the conditions for synergy are present, the Latent Energy source may be tapped, thus increasing Effective Energy.

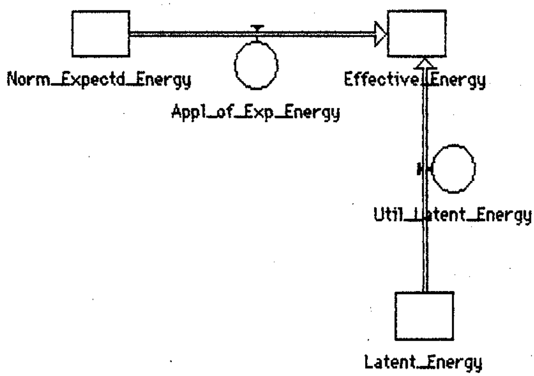

Fig. 3 Basic levels and rates of the synergy molecule.

Fig. 4 is a more complete representation of the synergy molecule. Alignment is a function of the rate (and/or the change of rate) at which Normally Expected Energy is applied (to the task) to become Effective Energy and (or instead) of the Desired Application rate of Expected Energy. The rate of Utilization of Latent Energy is a function of the Sensitivity to Alignment and the amount of Latent Energy available.

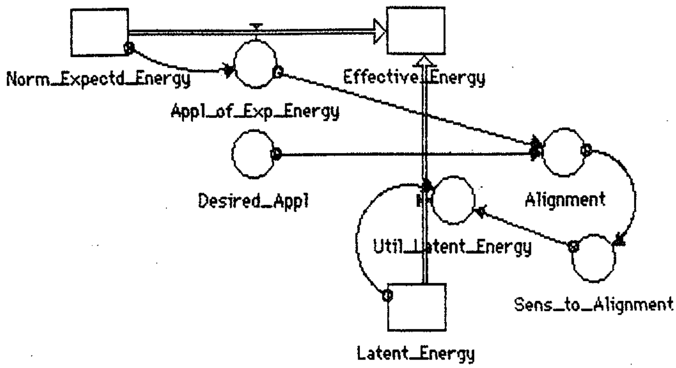

Fig. 4 Basic synergy molecule

BASIC GENERIC STRUCTURE: CONSERVATION OF ENERGY

In any closed system, energy must be conserved. Fig. 5 depicts the basic generic structure that accounts for the Available Energy. Most systems have a Normal Efficiency of less than 100%. The availability of Normally Expected Energy is a function of that Normal Efficiency. The balance of the Available Energy becomes Latent Energy, which in turn can (at least in some systems) be dissipated unless it becomes added to Effective Energy.

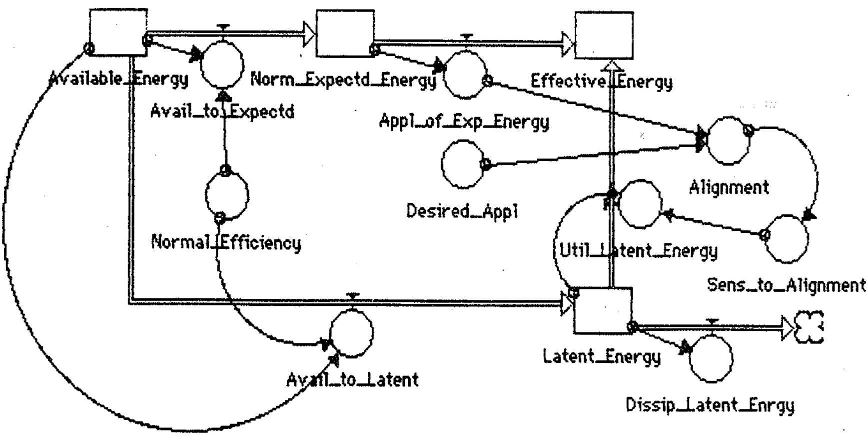

Fig. 5 Basic generic structure includes conservation of energy.

GENERIC STRUCTURE: COMBINATION OF PHYSICAL AND METAPHYSICAL EFFECTS

Fig. 6 adds the effect of alignment in a metaphysical dimension on a physical system (Fig. 5 with the modifiers "task" and "physical" added). In this illustration, Goals represents the metaphysical dimension (or an aggregation of all such factors). Effective Energy is applied to a "task", producing a degree of Task Alignment. The degree of Goal Alignment is at least one determinant of the amount of Total Energy that the system can or will allocate as Available Energy; the balance of Total Energy becomes one of the two sources of Latent Energy. Energy is conserved.

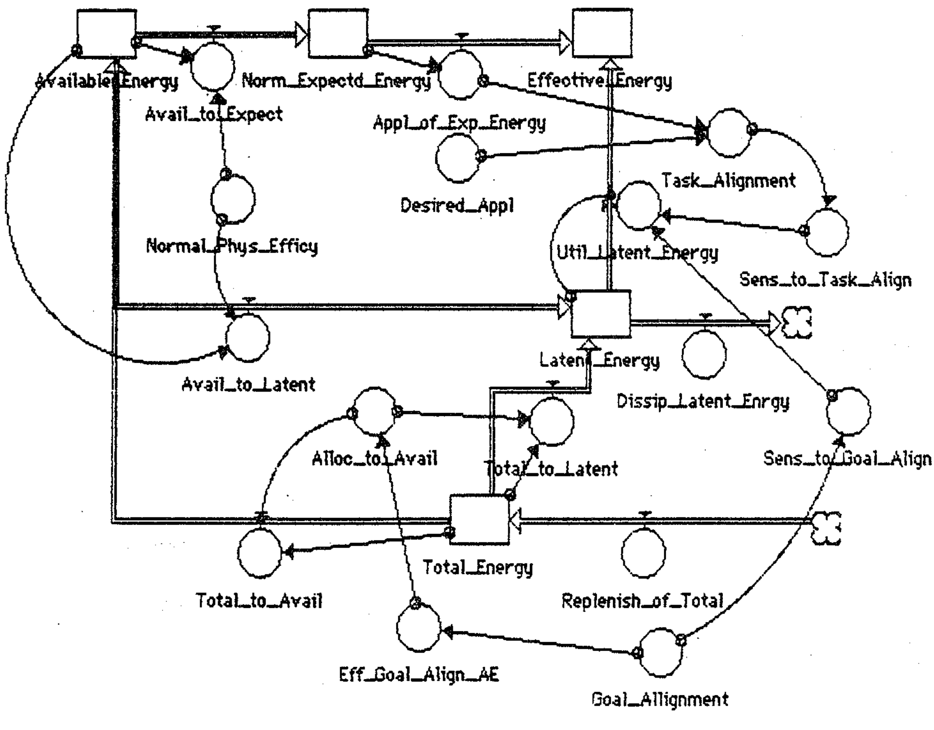

Fig. 6 Generic structure including metaphysical effects

Before taking into account any other coupling or feedback effects that most likely occur in any real system, it is significant to note than in any system combining metaphysical and physical characteristics, it would appear to be the metaphysical state (or sub-system) that predetermines and proscribes the proportion of total energy normally available to the physical sub-system for accomplishing the task(s) at hand. Thus the generic structure is congruent both with prevailing experience and wisdom, as well as with the growing body of psychological literature on the subject as it applies to personal, business or other social systems.

GENERIC STRUCTURE: CONNECTION TO THE MACRO SYSTEM

The synergy structure will always be part of a larger system. Ultimately, the impact and/or significance of synergy lies in the accomplishment of a "relevant" task. Accomplishment often depends on timing: applying energy effectively to a high-leverage point at a high-leverage time in the larger system. Analogously, Relevance often depends on the congruence of the goal(s) with those of the larger system. Fig. 7 depicts these two generic points of connection to the macro system. Timing becomes another factor in determining Task Alignment. Congruence is the macro-system metaphysical input to Goal Alignment.

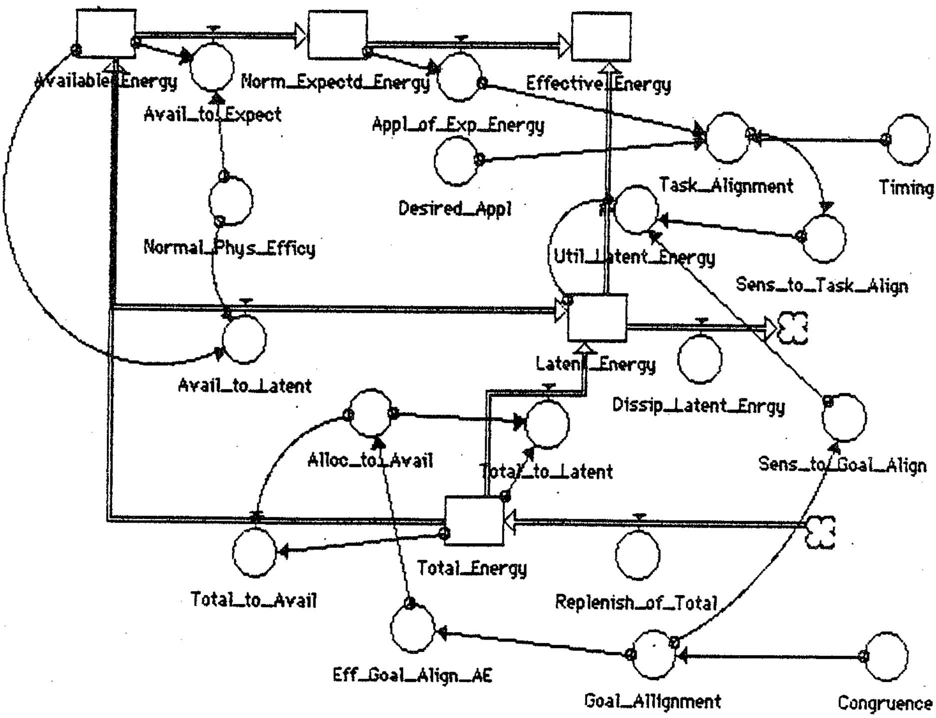

Fig. 7 Generic structure including connections to the macro-system

EXAMPLE AND DISCUSSION

The sport of rowing has often been cited as an example of synergy in sports, based on anecdotal descriptions of particular races by members of (usually winning) crews. In American rowing vernacular, when a crew is highly motivated and rowing particularly well together, a point will come in a race when the shell (boat) will start to "swing". This has a positive effect on mood, including concentration as well as ability and willingness for exertion, and the result is noticeably improved performance with apparently the same or less effort.

Undoubtedly some of the effect is due simply to improved mechanical efficiency in applying the "same" force to the oars, primarily through improved timing. However, in those cases that are most memorable to the individuals involved, something more appeared to be added, not the least of which was an unexpected expenditure of energy on the part of each person. Descriptions of similar phenomena in virtually every sport have appeared in print in recent years. In every account this author has read, the individuals and/or teams have been not only highly skilled but also highly focused and motivated toward the goal of winning, or at least accomplishing a "personal best".

In the case of a rowing crew, with which the author is personally familiar, the physical concepts proposed in this paper are quite straightforward and theoretically measurable. Each rower applies energy to the oar at each "stroke", which begins with the "catch", is sustained through the "drive" and ends with the "release". A graph of the energy of each rower as applied at each stoke would resemble the bell-shaped distributions of Figures 1 and 2. Similarly, the aggregate of the entire crew would be a taller curve of similar width.

Details of the shape of each individual's curve would be partly a function of the style he or she had learned (particularly at the catch and release) and of conditioning and skill (affecting energy output as well as consistency and timing from one stroke to the next). The shape of the aggregate energy curve for each stroke for the crew would be a measure of the crew's skill, timing, energy and commitment, as a crew.

In the dynamics of a race, each rower contributes several hundred strokes, providing input to the whole effort and continuously receiving feedback from the collective result. Many aural, visual and tactile stimuli provide measurements of balance, timing, exertion and motivation of fellow rowers, and of relative performance. These are continuously being compared mentally by each individual to at least an expected standard, and perhaps as well to a "perfect" standard.

The achievement of "swing" and its synergistic effects appears to be highly sensitive to the complex alignments of both the physical and metaphysical realities and expectations of the individuals and the crew as a whole. If and when during a race a crew moves toward greater alignment, individual sensitivities to that alignment will tend to trigger the release of more energy, contribute to greater concentration, suppress the sensation of pain, etc. Initially, the additional energy will be the last of the normally expected energy; subsequently it will be the beginning flow of latent energy.

These results, even though they vary with each individual, will tend to increase the alignment of the crew as a whole, which change will in turn tend to be sensed by each rower. Beyond a critical point, as with a powerful exponential, the growing alignment of the crew as a whole and of each individual with the crew will tend to release a significant amount of the latent, or "unexpected" energy available in each rower.

CONCLUSIONS

One aspect of recent evolution in the field of system dynamics has been the articulation of an increasingly ordered set of generic structures built up from various combinations of the basic elements of all systems. These generic structures serve the professional system dynamicist in the development of actual models to understand "new" problems. Perhaps more importantly, generic structures can greatly facilitate the learning and application of system principles by the average person through the tendency of the structures to underscore the commonality and similarity among systems which often appear, and are therefore assumed to be, different.

This paper proposes that synergy, an important phenomenon observed under some conditions in a wide variety of systems, can be conceptualized and represented by generic systems structure. Synergy is broadly defined as an actual outcome differing in some significant way from an expected outcome: "The whole is greater than (or different from) the sum of its parts."

The terminology used in the illustrations and examples involves the application of energy as a function of some physical or metaphysical variable, such as time, frequency, space, values, goals, etc. Synergy is postulated in these illustrations to involve the release of "latent" energy in addition to the amount normally expected to be released. Because synergy does not always occur and is not always predictable, it is presumed to be very sensitive to "alignment". In a complex, human system, alignment can have both physical and metaphysical components, and includes such concepts as motivation, timing, relevance and concentration of energy.

The illustrations presented meet such qualitative tests as the conservation of energy, the apparent transferability of structure between physical and metaphysical applications and among different types of systems, and the connectability of the synergy substructure to larger macro systems. However, a more rigorous demonstration of the validity and utility of the proposed structures requires successful incorporation into actual dynamic models. While the author has begun that task, it is his hope that more experienced modellers will find the concepts presented here sufficiently valuable to revise and improve them through application.

ACKNOWLEDGEMENTS

The idea for the synergy molecule came to the author on May 2, 1985 at the Lake Morey Inn in Fairlee, Vermont, during the third day of a four-day introduction to the use of STELLA™, the new-generation systems simulation software for the Apple Macintosh™. The Ensemble Effect and its relationship to the notion of synergy had been of particular interest to him for nearly a year, and in the highly stimulating environment of the first public introduction of STELLA™, perhaps the immersion in the graphic symbolism of the visually powerful new software triggered this mental ensemble.

A version of the basic molecule was first sketched for Barry Richmond and Peter Vescuso, the principal co-developers of STELLA™, who affirmed the validity of the idea. This paper has been written at their encouragement, along with that of David Kreutzer. The author is indebted to Jim Todd and Marianne Büttner who, independently, made clear the importance of making explicit the conservation of energy, which in turn led to the extension of the generic structure to include both its physical and metaphysical components.

The readers of the first draft of this paper strongly suggested the importance of at least one dynamic model to provide validity for the proposals as well as rigor for the paper. The author acknowledges the soundness of those suggestions and the corresponding weakness of the paper as it stands. All other errors, omissions and shortcomings are, as well, the sole responsibility of the author.

Management of Boise Cascade's Specialty Paperboard Division, while not yet committed to the use of dynamic modeling for policy analysis or strategic planning, has nonetheless provided time, encouragement and financial support to the author for his professional development activities in the field of system dynamics.

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