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Systems, Adaptations, and The Business Firm

Jerry Goen

SYSTEMS, ADAPTATION,

AND THE BUSINESS FIRM

by

Jerry Lee Goen

An independent study

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This independent study report submitted by [illegible] in partial fulfillment of the requirements for the Degree of Master of Business Administration from the University of North Dakota is hereby approved by the Faculty Advisor under whom the work has been done.

Advisor

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Advisor

PERMISSION

Title: Systems, Adaptation, and the Business Firm

Department: School of Business and Public Administration

Degree: Master of Business Administration

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CHAPTER I

Another Definition of System

In defining anything, our perspective and intended use of a concept colors our definition. This is a natural process and is done unconsciously by most people. It should be no surprise that we find 15 definitions of the abstract concept system in Beckett.[1] Some of the definitions emphasize practical application, "a system is an organized or complex whole." Others emphasize more mathematical approaches, "a system is, roughly speaking, a bundle of relationships" or "a system is a distribution of the members in a dimensional domain." Another approach is philosophical, as this tautology shows, "a system is a collection of interacting systems."

With a concept such as systems, it is crucial to recognize the coloration or distortion that comes with definition. In the final analysis it is impossible to completely avoid this problem although it is less bothersome with less abstract concepts. The abstract nature of systems and our perception of reality work together to assure that no matter how clearly we understand the concept, our definition will have some distortion.

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[1] John A. Beckett, Management Dynamics: The New Synthesis (Mc Graw-Hill Series in Management, New York 1971), p. 25-30

One way to minimize the distortion of a definition is to recognize that distortion. We can do this by emphasizing the abstract nature of the concept in our definition. Similar recognition of the use of the concept will have a positive effect on the definition.

The final use of the system concept is its problem solving approach. Two classical examples of this are closed and open system analyses. Closed system analysis is primarly an energy study of physics. It is a well advanced and rigorous discipline. Open systems analysis, on the other hand, is currently less rigorous and attacks problems where less is known and probability considerations must be made. The point is, the system concept is a frame of reference with which to analyze reality and solve problems. It is an approach, a way of thinking.

In analyzing the use of the systems concept we have pointed to its abstract nature. Because it is an approach or way of thinking, then it is internal to the person's mind. Philosophy asks the question, "is there sound when a tree falls in the forest with no one to hear it?" Layman's wisdom says no, "beauty is in the eye of the beholder." Then the systems concept definition should also point out that system is an abstraction and in the mind of the beholder.

A system is a perceptive thought process where there are three or more functions, where, at least two or more of the functions have at least one common term, and at least one other function is a statement of the interaction of the other functions. An example is a rock on a hill side. The rock has at least the following properties: mass, position, volume, and time. The hillside also has the properties of mass, position, volume, and time. Only one of these terms need be common. The common term is not mass unless the rock is considered part of the hill. It is not position or volume for the same reason. Time may be considered as a common term with the rock and hillside as separate entities or functions. The rock may move down the hillside as time passes so that relative position changes. Both hill and rock may be eroded with time, mass, and volume changes. The choice of the common term is arbitrary in this example, however time ties the two together in a system. The third function is then the rock with respect to time, and the hill with respect to time. Another example is the rock, where the functions of mass, position, volume, and time are tied together in our mind by the concept of rock. Here the choice of the common term is not so arbitrary.

Mathematically this appears:

$$F(R) \approx m, p, v, t \qquad \text{Equation A}$$

$$F(H) \approx m, p, v, t \qquad \text{Equation B}$$

$$F(S_{RH}) \approx \partial R/\partial t, \partial H/\partial t \qquad \text{Equation C}$$

$$F(S_R) \approx \partial m/\partial R, \partial p/\partial R, \partial v/\partial R, \partial t/\partial R \qquad \text{Equation D}$$

Equations A, B, and C demonstrate a mathematical statement of the hill and rock example. Equation D is a statement of the rock example.

Open or Closed System

Traditionally beginning thermodynamics courses start with or quickly become a discussion of closed systems analysis emphasizing the nature of the arbitrarily placed artificial boundaries. Although the boundary placement is arbitrary, it is a very important consideration to thermodynamics. Another element of closed system boundaries receiving emphasis is what may or may not cross the boundaries. When a discussion of closed versus open systems analysis begins it traditionally starts with boundaries, their placement, and what may cross them.

A more useful approach is to examine the analysis in terms of the property time.[2] If system and/or environment properties are considered in terms of change of rates with respect to time, then we have an open systems approach. If changes with respect to time are not considered, then we have a closed system. An analogy is the comparison of a snap shot camera's record of an event versus a movie camera's record. The snap shot camera will tell what the situation is and maybe something about change. The movie camera will tell what the situation is and how quickly it is changing. Considering our rock and hill example, $F(S_R)$ is closed system analysis and $F(S_{RH})$ is open system analysis.

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[2] Robert A. Birtsch, private interview, Minot AFB, ND, August 1977

Closed system analysis is the beginning phase of all disciplines. Each discipline must first catagorize, label, and measure the various properties and characteristics. Then the "still shots of our camera" may be compared to each other. Once the analysis proceeds past closed system analysis, accurate prediction of coming events is possible. This represents the transition from rapid succession of still shots to the movie camera era (dynamics) for the discipline.

The Point

I have attempted to review general systems theory and shift emphasis from classical approaches to areas that reveal more insight The definition of system that I choose does not ignore or over-emphasize subsystems. Rather, it allows subsystem to follow naturally. Open system differences are evaluated in terms of time and the boundary differences follow as a result.

In proceeding further, closed system analysis will not be persued. A branch of open system analysis will be reviewed, and I will attempt to expand it. This is not to imply that closed system analysis can not be carried down the ladder of hierarchy further, or that other analysis does not fit into the hierarchy. I have simply developed it to the point where it meets my needs.

CHAPTER II

Assumptions and Definitions

It is necessary to divide the parameters of open system analysis into two types. The first type I will call characteristics, and restrict their use to parameters of the system. The second type I will call properties, and restrict their use to parameters of the environment.

It is traditional to list 9 common characteristics of an open system: 1) importation of energy, 2) through-put (reorganization or input), 3) output, 4) cyclic pattern (may be events), 5) negative entropy, 6) feedback (coding and selection of inputs), 7) steady state and dynamic homeostasis, 8) differentiation (development of specialized functions), and 9) equifinality.[3] I will examine negative entropy, steady state and dynamic homeostasis, and equifinality.

I propose that negative entropy is not a decrease in entropy. Originally, entropy was the domain of closed system analysis, specifically thermodynamics. It describes the probability of what will happen. In closed system analysis, entropy does not say how soon the expected change will take place, but only the direction it will eventually pursue. In fact, fluctuations and perturbations

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[3]D. Katz and R. L. Kahn, "Common Characteristics of Open Systems", Systems Thinking Selected Readings, ed. by F. E. Emery, (Penguin Modern Management Readings, Harmondsworth, Middlesex, England Penguin Books Ltd. 1969) p. 92-100

are expected. The problem arises when the concept is forced on open systems analysis by over zealous souls. In fact entropy has nothing more to say about open system analysis than it did in closed system analysis: The system will degenerate eventually. This is what it says with closed systems analysis and nothing more. The fluctuations and perturbations are what is commonly called negative entropy. This implies that all life, commonly grouped under the open system label, is a fluctuation or perturbation from the normal. This is not in disagreement with cosmology. We living are the exception. Rather than negative entropy we have a temporary deviation from the predicted path. The nature of the concept of entropy is not compatible with open system analysis as I defined it in Chapter I. It cannot be used with the movie camera analysis to predict frame by frame occurences, but may be used to determine the plot of the movie, that is, to tell how the movie must end.

Dynamic homeostasis is a fundamental assumption of classically defined open system analysis. It requires the parts of a system to work together to maintain the system's characteristics in spite of property changes in the environment. In my hierarchy of system, it sets apart a class of open systems. Open system analysis, as I defined it, can occur without this property. There are many systems which exhibit this property to some degree, and they may be grouped under this classification to the extent that the assumption of dynamic homeostasis applies to that system. This concept then sets apart all classical open system analysis as a specialized discipline within my definition of open system analysis. We may make a "movie analysis" of our solar system and the solar system will react, but not in a fashion which will negate the negative internal effects of the property change. This is a subtle difference, that is, the system reacting or reacting so as to return to or nearly to a particular state.

Equifinality is the key test for the type of reaction discussed in the previous paragraph. Equifinality requires the system to interact with the properties and move to a reference configuration regardless of the direction of deviation from the initial reference.

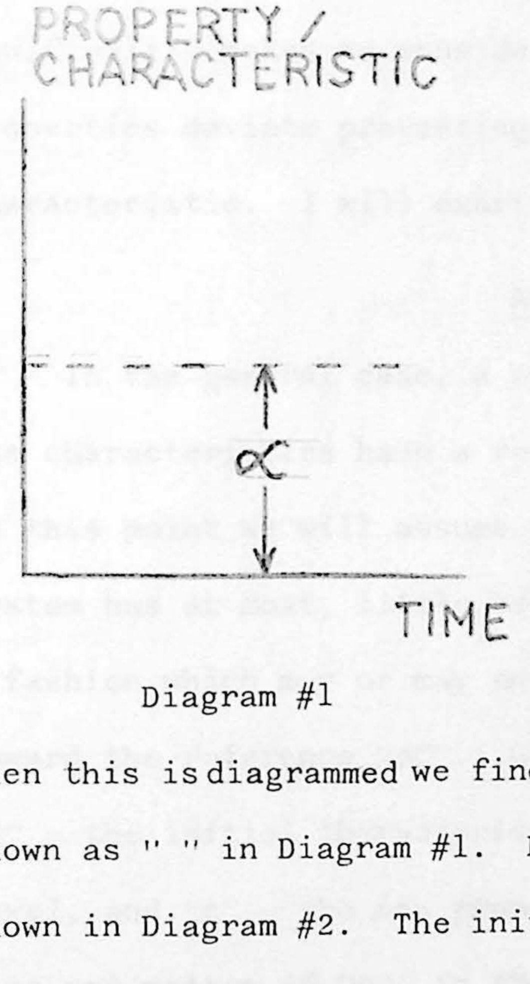

Diagram #1

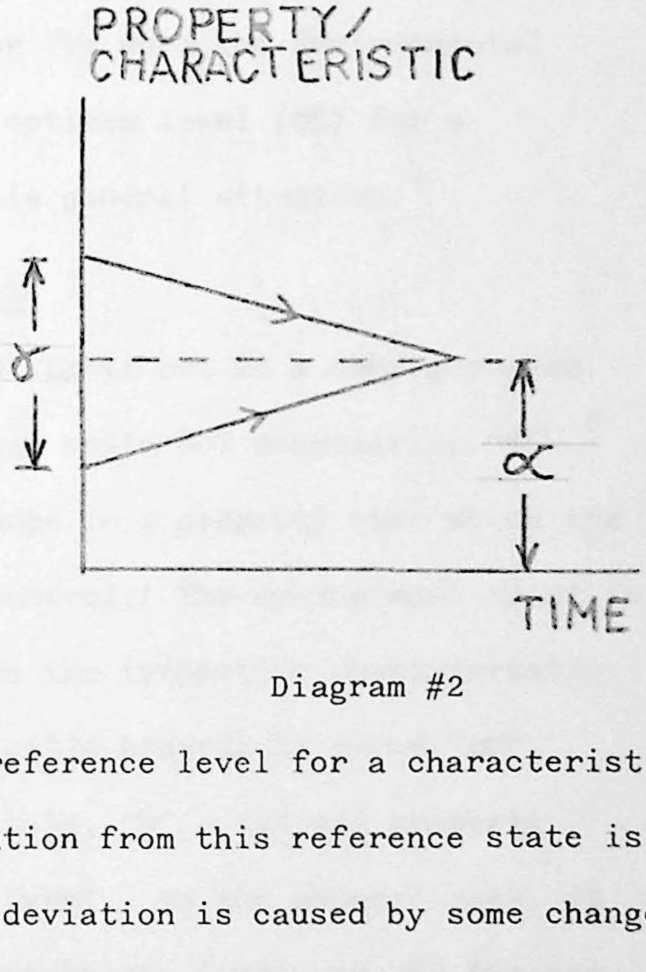

Diagram #2

When this is diagrammed we find a reference level for a characteristic shown as " " in Diagram #1. Deviation from this reference state is shown in Diagram #2. The initial deviation is caused by some change in properties or an anticipated change, and the system tries to return to the reference state. The system will have a limited property range (γ) from which it can successfully return to the reference "α". If the system qualifies in the specialized discipline of open system analysis, then it will at least attempt to return to the reference in spite of an obvious futile attempt.

CHAPTER III

Adaptation

Within the specialized open system analysis, adaptation is a key to system survival. The concept of equifinality is not a great help in predicting a system's adaptability, at least not in the terms discussed in the previous chapter. As discussed, equifinality looks at the system as it returns to its optimum characteristic level. Equifinality makes no consideration for when the environmental properties deviate preventing the optimum level (α) for a characteristic. I will examine this general situation.[4]

Analysis

In the general case, a system starts out in a configuration. The characteristics have a reference state not necessarily "α".[5] At this point we will assume a change in a property over which the system has at most, little or no control. The system must react in a fashion which may or may not move the respective characteristic toward the reference "α". Graphically Diagram #3 shows "α", "a" - the initial characteristic state, "b" - the old property level, and "c" - the new property level. In the general case, it does not matter if "c", is the old property level and "b" the new property level. The system must adjust from "a" to some new "a" to

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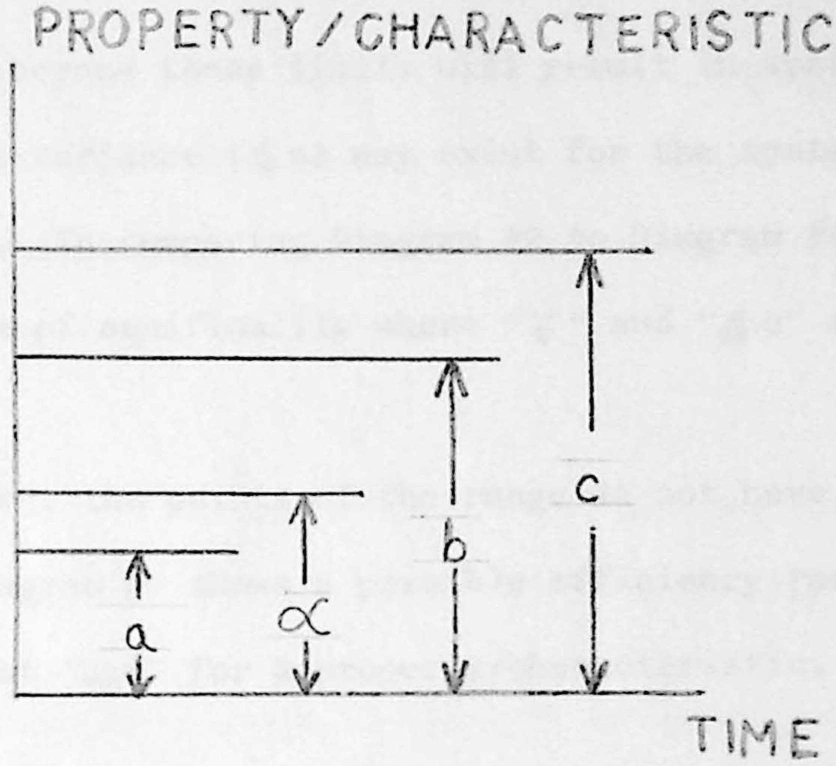
[4]G. Sommerhoff, "The abstract Characteristics of Living Systems", Systems Thinking Selected Readings, ed. F. E. Emery, (Penguin Modern Management Reading, Harmondsworth, Middlesex, England, Penguin Books Ltd. 1969) p. 149

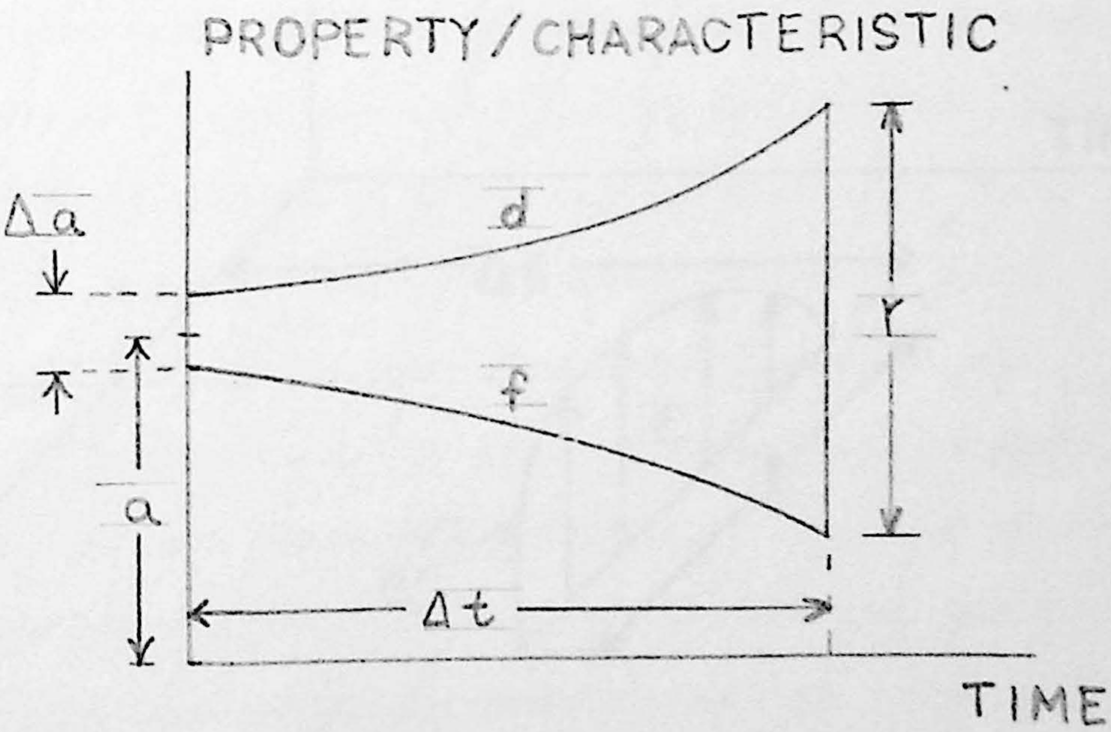
[5]Ibid., p. 197, 198

Diagram #3



survive and maintain balance. In making the adjustments discussed above, the system has a definite range of adaptation it can successfully make, within a specified time of adaptation (Δ t).[6] Dropping "α", "b", and "c", Diagram #4 shows the range "r".

Diagram #4

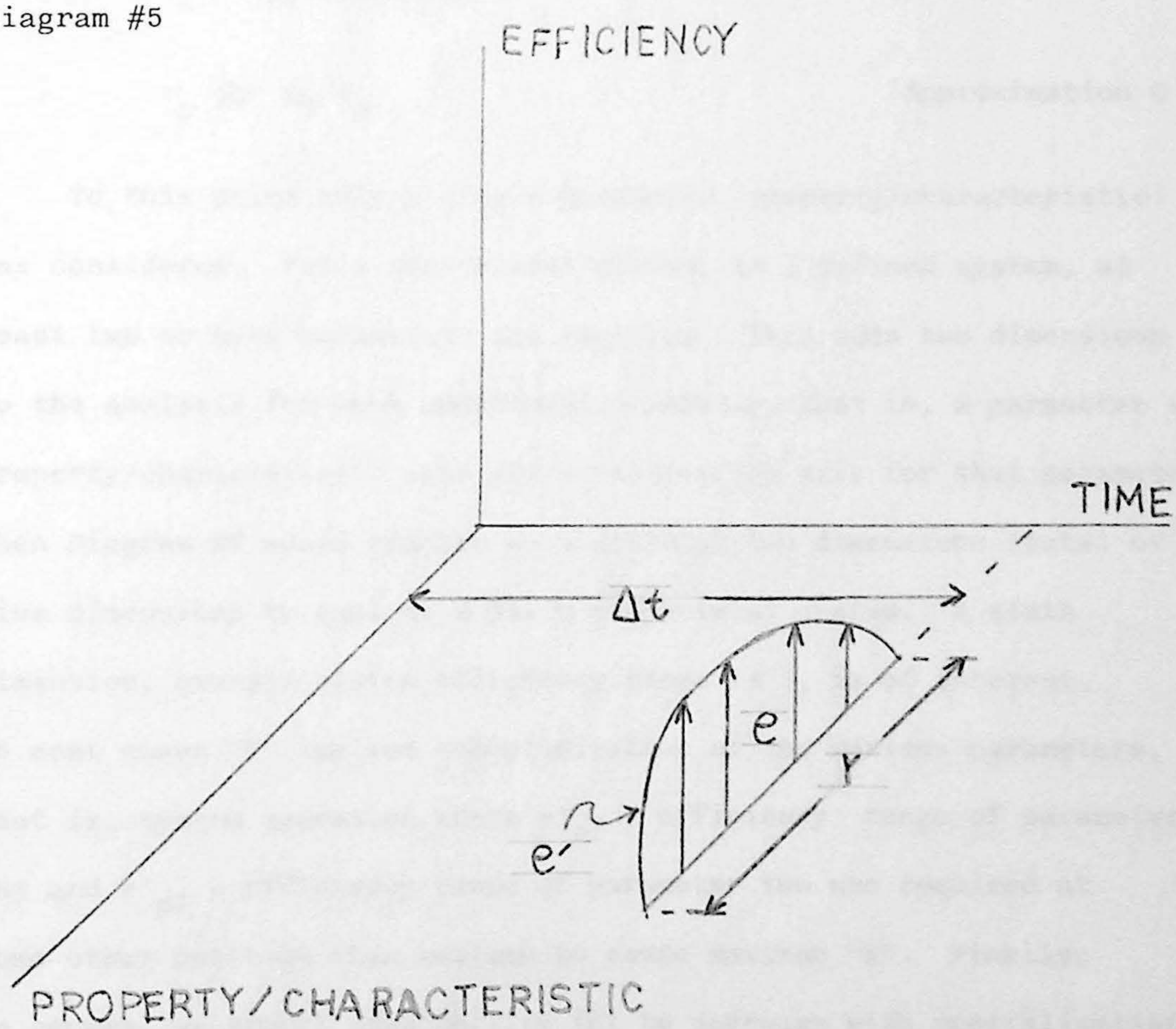


[6] Ibid., p. 176

Diagram #4 also shows "d" and "f", the paths of maximum successful adaptation. Adaptation beyond these limits will result in system termination. Also, some variance (Δa) may exist for the system at the beginning of Δt. In comparing Diagram #2 to Diagram #4 we find a mirror like image of equifinality where "γ" and "Δa" are the same range.

Within the range "r", the points of the range do not have equal efficiencies. Diagram #5 shows a possible efficiency range (e') for the range "r" at "Δt" for a property/characteristic.

Diagram #5



In general, as time of adaptation, "Δt", increases we expect some increase in the range "r" (Approximation E), and as time of adaptation, "Δt", increases we expect the efficiency "e", to increase (Approximation F). The efficiency "e", I refer to is output/input and "g_1" and "g_2" are constants.

$\Delta t \approx g_1 r$ Approximation E

$\Delta t \approx g_2 e$ Approximation F

In addition to the relationships above, in general we expect that if "r_p" ($_p$ being a general parameter) increases, then the maximum e_p will decrease (Approximation G).

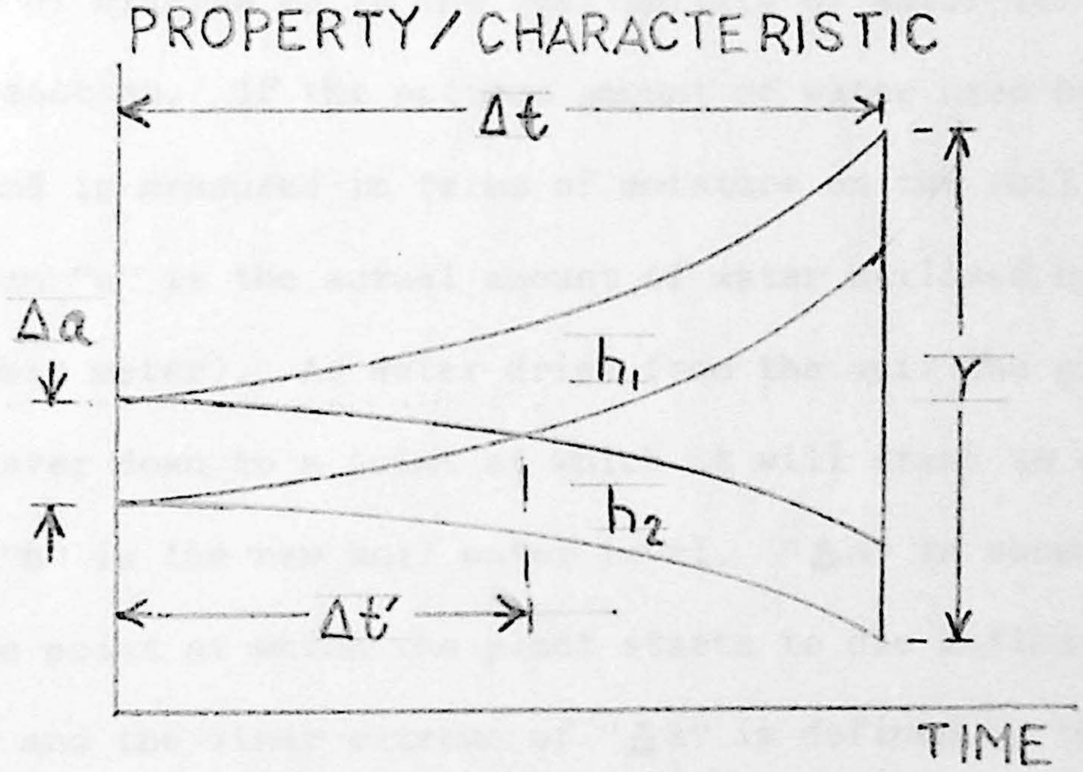
$r_p \approx g_3/e_p$ Approximation G

To this point only a single parameter (property/characteristic) was considered. For a non-trivial system, as I defined system, at least two or more parameters are required. This adds two dimensions to the analysis for each additional parameter, that is, a parameter - property/characteristic axis and an efficiency axis for that parameter. Then Diagram #5 would require an additional two dimensions (total of five dimensions to analyze a basic non-trivial system. A sixth dimension, overall system efficiency range (E), is of interest. In most cases "E" implies suboptimization of the various parameters, that is, system operation where e'_{p1} - efficiency range of parameter one and e'_{p2} - efficiency range of parameter two are required at some other position than maximum to cause maximum "E". Finally, in general we expect adaptability (E) to decrease with specialization, that is, as specialization increases - efficiency increases, but adaptability will decrease.

Before attempting to apply these relationships, they should be examined as assumptions for validity when applied to a particular system. An exception follows: The human system has the most specialized brain but it aids in adaptation and is an exception to the adaptability/specialization relationship.

Diagram #6 shows a lag time ($\Delta t'$) for the general case. This results in two areas of exclusion (h_1 and h_2) when a system moves to an extreme of "Δa". When the system moves to the extreme of "Δa" it opts to be able to utilize one of the areas of exclusion and not the other.[7]

Diagram #6



Equations of the Special Open System

The conservation of energy equation is: energy in - E_i', minus energy stored - E_s', minus energy out - E_o', equals zero (Equation H). The conservation of mass equation is: mass in - m_i, minus mass stored m_s, minus mass out m_o, equals zero (Equation I). These two equations are valid in non-nuclear reactions.

$$E_i' - E_s' - E_o' = 0 \qquad \text{Equation H}$$

$$m_i - m_s - m_o = 0 \qquad \text{Equation I}$$

The actual application of these equations is often nearly impossible for biological and business systems. Often, the process of gathering enough information to use the conservation laws causes changes in the system and/or environment interaction. The relationships, discussed in the previous section, may be viewed as a multi-axis problem with a single range of intersection defined by "E". The range of "E" will cover only those regions where all parameter efficiencies overlap.

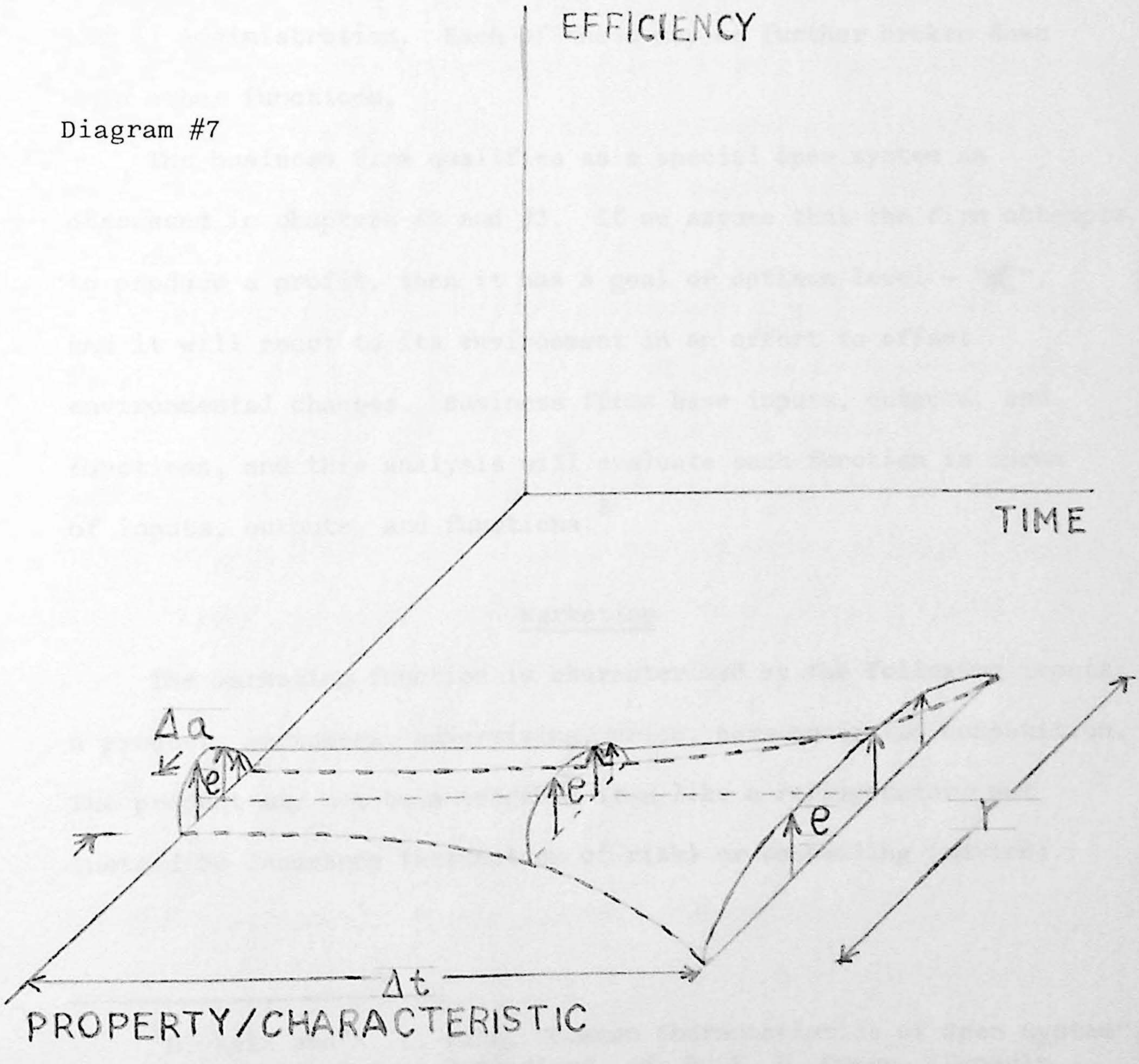
An Example

An example of Diagram #3 is the availability of water for a plant and its reaction. If the optimum amount of water used by a plant is "α" and is measured in terms of moisture on the soil (grams/cubic meter) then "a" is the actual amount of water utilized by the plant (grams/cubic meter). As water dries from the soil the plant will use less water down to a point at which it will start to die. Property level "b" is the new soil water level. "Δa" is shown in Diagram #4. The point at which the plant starts to die defines the bottom of "Δa" and the other extreme of "Δa" is defined by the plant dying because there is too much water.

Diagram #4 shows a time period of adaptation -Δt. This can be the time span of a single plant's life or several generations. If the plant can manage to substitute or partially substitute something for water and change its range of adaptability it would move to a new region of the water parameter. The new range of adaptation may not include any of the old range. A more realistic example of the plant and water consumption would follow its evolution through several generations. It would be possible for some of the plants to be in wet climates and others in dry climates. This could produce future generations at both extremes of the range of adaptation and might produce separate species with few similiarities.

Diagram #5 shows the relative efficiency the plant would experience once it adapted. Following paths of adaptation "d" and "f" would produce less efficiency than a more moderate path. Diagram #7 displays a possible efficiency for the adaptation time period.

Diagram #7



CHAPTER IV

The Business Firm System

I will outline an approach for analyzing business firms. The analysis will consider five functions common to most firms: 1) marketing, 2) production, 3) finance, 4) informal organization, and 5) administration. Each of these may be further broken down into other functions.

The business firm qualifies as a special open system as discussed in chapters #2 and #3. If we assume that the firm attempts to produce a profit, then it has a goal or optimum level - "α", and it will react to its environment in an effort to offset environmental changes. Business firms have inputs, outputs, and functions, and this analysis will evaluate each function in terms of inputs, outputs, and functions.[8]

Marketing

The marketing function is characterized by the following inputs: a product, customers, advertising, price, personnel, and competition. The product may not be a tangible item like a refrigerator, but instead be insurance (assumption of risk) or counseling (advice).

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[8] D. Katz and R. L. Kahn, "Common Characteristics of Open System", Systems Thinking Selected Readings, ed. By F. E. Emery, (Penguin Modern Management Readings, Harmondsworth, Middlesex, England Penguin Books Ltd. 1969) p. 89

Customers can be classified as consumers and/or commercial. Advertising can be multimedia, specific or general, and/or to segment the market. Price policy may be sensitive to competition, stable, or organized along a strategy. The marketing personnel may be experienced, loyal, and/or motivated. Competition may be extensive, aggressive, and/or cooperative. These inputs influence not only the current variance (Δ a), but also limit the range of adaptation (r).

The outputs of the marketing function are normally measured in terms of sales and the firm's overall image. The sales figures are easily obtained from modern accounting systems. The firm's image is difficult to measure. Public loyalty to products and reaction to publicity about the firm by independent sources are good gauges of image.

The property/characteristic of the marketing function involves getting the product to the customers and getting it there when they want it. In tangible aspects include assuring awareness of the product by the customer, and intensifying the need for the product at the proper time to assure sale. The influences of these functions are measured in terms of sales and sales on a recurring basis. The parameter (property/characteristic) is sales in dollars or volume.

In applying the analysis of Chapter #3, current sales is easily obtained ("a"). Most sales managers can make short-term future estimates of minimum and maximum sales ("d" and "f"). This future estimate normally can be accompanied by an estimate of cost at levels of sales, to produce efficiency of the marketing effort ("e")

Production

The production function is characterized by the following inputs: materials, labor, capital, and the environment. The availiability of materials for production is critical to the firm. Substitution of capital for labor or vice versa can have far reaching consequences for the firm. The importance of the discharges of production into the environment is an increasing concern for firms.

The outputs of the production function are a product and a modified environment. The product may be varied and/or intangible (insurance for example). The environment is modified through removal of the inputs and discharge of the product and remaining partially modified inputs. These remaining partially modified inputs include the labor force as well as any excess materials. The partially modified inputs also make up, in part, the product's environment.

The parameter of production is the ability to change something into a product. This is measured in output of products for example: units produced, dollars of insurance coverage sold or in force, and hours of service provided to customers. The product has to be more than a change of inputs. It must have utility for someone and be produced at a cost that the customer is willing to pay.

The analysis of this function considers the current rate of production (units/day, week, month, or year) as "a" and the limits of production ("Δa") by layoffs, extra shifts and/or adjustments of overtime. The efficiency of production or dollars/unit gives the efficiency ("e"). The future capabilities can be estimated establishing "f", "d", and "r". These future limits will be affected by the finance and marketing functions.

Finance

The finance function is characterized by the following inputs: capital, risk of operation, methods of financing available, and competition for funds. Capital is the assets now owned by the firm. These assets include cash, securities, and/or plant. The risk of the operation is a summary of the success factor for all functions. The method of financing can be limited by prior financing and includes offering securities, short and long term loans, and issuing stock. The money market may place constraints on the finance function if competition is particularly strong or weak.

The output of the finance function is capital, usually in the form of increased plant. This gives the firm the ability to invest in other companies or expand their own plant. The other output of finance is leverage. This simply means borrowing at one rate of return and investing at another to provide profit or loss.

The function of finance is the structure of accounts. Accounts may be structured to emphasize inventory, plant, long or short term debt, receivables, and/or operating cash. By selection of emphasis or de-emphasis firms establish expansion patterns for growth of capital.

The current level of capital establishes "a". The possible structures of capital in the future give "f", "d", and "r". The capital level is measured by owners equity and the efficiency ("e") of the various structures is measured in terms of cost of capital.

Informal Organization

The informal organization[9] is unique when compared to the other functions of a firm. It is the one function that is not considered in formal organizational charts and yet it can break an firm just as surely as the other functions.

The inputs of the informal organization are the society, the workers-employees, and the administrators-supervisors. The society presents a distribution of people for possible integration into the firm. The distribution is around the society's norms of expectations and behavior patterns. The workers-employees are the individuals who perform the lowest line tasks of the firm. The administrators-supervisors are all those members of the firm who are not workers-employees.

The outputs of the informal organizational are group relationships and attitudes. There are many changing and necessary relationships of a firm that are never included in the formal organizational charts. These relationships make the firm work or not work just as much as the formal relationships. They include workers who can influence other workers (consciously or unconsciously) and are informal group leaders. This produces and modifies attitudes toward the firm and the tasks to be performed.

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[9]P. Selznick, "Foundations of the Theory of Organizations", Systems Thinking Selected Readings, ed. By F. E. Emery, (Penguin Modern Management Readings, Harmondsworth, Middlesex, England Penguin Books Ltd. 1969) p. 261-280

The functions of the informal organization are necessary communications and reconcilation of some conflicts between the individual workers and the firm. The communciation allows the workers and lower level supervisors to coordinate at the lowest levels of the firm. The natural conflicts of individuals are often made bearable by simply stating them to others in an informal setting. Additionally, the formal organization can be sensitive to these conflicts when they manifest themselves and, when appropriate, take action that will make the situation more tolerable for the workers. When these functions are malfunctioning the workers may act in opposition to the firms best interest. This has gone to the extreme of sabotage in a few cases reported in management literature. In general, the function of informal organizations within formal organizations is interpersonal relations.

The application of analysis to the informal organization is difficult. Normally, organization administration does not reflect the informal organization except in punitive matters. Unfortunately investigation leading to punitive action by the formal organization is often late in indicating dynamic interpersonal problems.

Administration

The inputs of the administration function are: the environment, people, material, capital, and competition. These all appear in the other functions. This is an example of the inclusive nature of administration. The key to administration is coordination and support of the other functions to guide the organization toward its overall goal.

The outputs of administration include: synergism, alternatives, and decisions. If administration is functioning properly then the interactive effect of the other functions will produce synergism. Administration will provide alternative plans or courses of action as preparation for environmental change. When the time comes administration will choose which alternative and implement it as a course of action for the other functions to implement.

The functions of administration are: providing structure, error determination, and suboptimization of the overall goal. Administration provides the structure for coordination. Generally, heads of other functions participate in the structure and work on coordination of the total organization. They participate in two functions. Administration watches the organization for deviations from the desired courses of action and attempts to correct the errors causing the deviations. Finally, administration must choose a course of action acceptable to several interest groups: the stockholders, employees, customers, and public. The interests of these groups are often in conflict. This requires tradeoffs to produce acceptable actions in all quarters. Administration must interpret reality for the firm to assure the firm is acting in its best interest.

Administration is evaluated in terms of return on investment ("a"). The potential for return on investment establishes "d", "f", and "r". The efficiency ("e") for administration is "E" and is defined by the efficiencies of the other functions.

Summary

I have attempted to define system and develop the concept down to the level of application in the area of adaptability. Then, I show how this applies to a business firm.

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