THE DYNAMICS OF THE DEVELOPMENT OF CREATIVITY IN CHILDREN

A THESIS

Presented to

The Faculty of the Division of Graduate

Studies and Research

By

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In Partial Fulfillment

of the Requirements for the Degree

Master of Science

in the School of Industrial and Systems Engineering

Georgia Institute of Technology

August, 1973

THE DYNAMICS OF THE DEVELOPMENT OF

CREATIVITY IN CHILDREN

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ACKNOWLEDGMENTS

I would like to thank those who helped me in the preparation of this research.

In particular, I am grateful to my advisor, Professor Willard Fey, for developing my interest in feedback dynamics. This thesis could not have been done without his excellent advice, encouragement, and patience.

I would also like to thank Drs. Thomas Sadosky and Wood Smethurst for serving on my reading committee. I am grateful for their suggestions and comments.

My thanks also go to Dr. Nancy Daniels for her valuable assistance.

I wish to express my appreciation to Miss Pat Allen and Mr. Edward Bell for their assistance with the illustrations, to Miss Barbara Davidson and Miss Susan Reim for their typing of the draft, and to Mrs. Betty Sims for typing the final manuscript.

Lastly, my special thanks go to my parents for their consideration, love, and understanding throughout my studies.

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CHAPTER I

INTRODUCTION

The development of creativity in children, as measured by Doctor Torrance (45, p. 74), experiences an oscillating growth rather than a smooth one as educators would like. This is believed due to the internal and external pressures imposed on the child throughout his development. Ordinarily the external pressures have been studied without analyzing their effects on the child's internal system.

Since these pressures are interrelated, the purpose of this study will be to analyze the total system. This will be accomplished by using the methodology associated with feedback (industrial) dynamics, i.e. identifying the major feedback loops, building a mathematical model and simulating its performance on a large scale computer. The study is concerned primarily with the qualitative patterns of behavior of the feedback loop structure and only secondarily with the accuracy of the data.

The art of industrial dynamics was developed by Dr. Jay Forrester in 1960 at Massachusetts Institute of Technology. Forrester conceived industrial dynamics as a philosophy that attempts to explain how the world operates through the concepts of feedback systems. In its philosophy industrial dynamics tries to analyze the causality of events. The world is looked upon as being composed of accumulations that create pressures and forces, that in turn influence the flows into and out of

the accumulations. Thus a closed feedback loop is constructed causing patterns of growth (decline) and/or oscillation depending on the nature of the loop.

Recently, industrial dynamics has been referred to as feedback dynamics, since the studies are no longer primarily concerned with industrial problems. Today, the area of application has expanded to urban (18), world (20) and social systems (15).

Several studies of social systems are in progress at Georgia Institute of Technology under the direction of Professor Willard Fey. These studies investigate the dynamics of educational institutions (15), the evolution of a typical grassland (27), the development of small groups relating task and interpersonal factors and the organizational structure of the group (16) and the criminal justice system for use as a training model for the Law Enforcement Assistance Administration (17).

CHAPTER II

LITERATURE SURVEY

Motivation is defined as the inner thrust that drives an organism to activity; it is what impels an individual to perform certain acts. In short, motivation guides behavior.

Some psychologists classify motives as primary or secondary (4, p. 240). Primary motives are directly needed for the preservation of the species--hunger, thirst, sex. Secondary motives are not directly necessary for preservation; these may be innate (like primary motives) although they are usually acquired.

Secondary motives are further classified into two groups--personal and social. Personal motives are relatively independent of social groups and social dynamics, they are forces generated to satisfy needs and resolve internal conflicts. Social motives on the other hand, are motivations to comply with societal customs and motivations toward social obedience (8, p. 5).

Abraham Maslow (21, pp. 83-87) developed a theory of motivation based upon needs. He established a hierarchy of human needs, arranged from the lowest to the highest as follows:

1. Physiological needs--visceral needs of food, water, sleep; sex needs; sensory and motor needs of bodily movement if it (the body) is to function properly.

2. Safety needs--security.

3. Love needs--love, affection, acceptance and a feeling of belonging.

4. Esteem needs--self-esteem and confidence in one's worth and adequacy.

5. Need for self-actualization through creative self expression in personal and social achievement to satisfy one's curiosity, to strive for independence, to hold unconventional views, to be unique.

According to Maslow's theory an individual must satisfy his lower needs (to some extent) before he engages in an activity to satisfy his higher needs. This thesis attempts to study the highest need in Maslow's hierarchy, that of creative self-expression.

Since the literature in the field of creativity is so vast and the definitions of creativity are various, this survey of creativity will be restricted to include only the definition, views and theory of E. P. Torrance, who is perhaps the major worker in the field.* Other views (but by no means all) will be referenced and only briefly mentioned.

Torrance defines creative thinking as

> the process through which a person becomes sensitive to or aware of a problem, a deficiency, or a gap in knowledge; formulates hypotheses and experiments to find a solution; modifies and corrects hypotheses; and communicates the results. Implied is the creation of something new, something which has

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*E. P. Torrance, Professor and Chairman of the Department of Educational Psychology at the University of Georgia, has published well over 200 articles, research monographs and books concerning the identification, development and utilization of creative talent. His books *Guiding Creative Talent* and *Education and the Creative Potential* have won awards by national organizations in education as outstanding original contributions in their fields (44, p. 70).

> never been seen or something which has never before existed. It involves adventurous thinking, getting away from the obvious and commonplace (44, p. 62).

In other words, creative thinking is the process whereby a person produces ideas or products that are essentially new and previously unknown to him. Thus an idea that might be considered creative in one child might be commonplace in another. Torrance took this into consideration when he studied creativity and administered his test to children in different cultures--Samoa, India, United States (43, pp. 69-74).

In his studies Torrance tries to measure a child's creative capability by administering a series of tests divided into two categories: figural and verbal.

The figural test consists of three parts: a child is asked to complete the figure; think of how many objects can be drawn with circles as their main part, for example a frying pan, a round table, etc.; think of a picture you can draw with a given shape as its part.

The verbal test consists of six parts. A child is shown a picture of a nursery rhyme and is asked to make guesses about previous events that might have led up to the pictured event (Guess Cause Test), also to make guesses about possible events that might follow as a consequence (Guess Consequence Test). Still showing the child the same pictured nursery rhyme he is asked if the following questions can be answered by looking at the picture (Ask Question Test).

The last part of the verbal test consists of giving the child a toy, for example a toy dog, and asking him to think of the most

interesting and unusual ways he can to improve the toy dog so it would be more fun to play with (Product Improvement Test), think of interesting and unusual uses for it (the toy dog) other than as a toy (Unusual Use Test). The last test confronts the child with three events that will never exist (example: clouds having strings attached that hang down to earth) and he is asked what he thinks would happen if they came to pass (Just Suppose Test).

The tests are scored on the basis of ability: to produce a variety of ideas concerning possible solutions (fluency), to use a number of principles or approaches, i.e. to vary one's ideas over a wide range (flexibility), to produce uncommon responses, i.e. remote, unusual, unconventional ideas (originality), and the amount or degree of detail and specificity incorporated into the response (elaboration) (43, p. 140).

To illustrate the scoring procedure, take the six responses from the record of one boy in the third grade who suggested the following improvements for the toy dog: (1) Give him feet that would go round so that as he moves he would dig a hole; (2) make his tail longer; (3) put a hero medal on him or a medal he won at a dog show; (4) put a tiny tape recorder inside him so that what you say is recorded in dog language so he can answer you; (5) put fleas on him--or flies; (6) hook him up so that he can drink water from a bowl and so it will run down through a little tube and run back in the bowl and won't mess things up.

Each response received a point for fluency (score: 6). The first response illustrates the principle of giving sensory appeal

(motion); the second, magnification; the third, addition; the fourth, addition; the fifth, addition; and the sixth, combination. The boy received a score of 3 on flexibility. Only the second response, which was given by a high percentage of the children, was not judged to have qualities of cleverness. Consequently he received a score of 5 on cleverness (45, p. 141). In total, this third grade boy received a score of 14 on the product improvement test. For a more detailed discussion of the test and its scoring see *Torrance Test of Creative Thinking*.

Although Torrance's creativity tests are widely accepted in the field of educational psychology, Michael Wallach, Professor of Psychology at Duke University, attacks Torrance's tests. Wallach's attack concerns the four variables--fluency, flexibility, originality and elaboration--used to score creativity tests. He feels they should not be added together to give an overall score. Wallach believes this is erroneous since two of these variables, namely flexibility and elaboration, seem to be similar to general intelligence. He states: "The set-shifting ability that the flexibility concept implies is more closely identified empirically with the traditional intelligence domain than with . . . an aspect of creativity" (60, p. 1223). Also, "Elaboration seems more appropriately construed as relevant to convergent than divergent thinking, since it refers to a propensity for interpolating or filling in details" (60, p. 1233). Thus Wallach feels Torrance's test seems to function as a battery of general intelligence assessors.

Wallach also does not recommend using the test since he feels it

is only a substitute for a general intelligence test and will mislead many by the creativity label (59, p. 840). Additional criticisms can be found in *Buros' Mental Measurement Handbook* (59) and Carmichael's *Manual of Child Psychology* (60). Torrance, however, claims there is a low positive correlation between measures of creative ability and measures of intelligence (52, p. 148, Table 1).

In Appendix A there are several tables giving the mean and standard deviation by grade (1-6) and sex for five of the tests administered. It can be noticed there is a drop in all four areas: fluency, flexibility, originality, and elaboration at the fourth grade level. Torrance observing this dip extended his study to include children from age 3 to high school graduation--the twelfth grade. He found the following:

> . . . beginning at age 3 there is an increase until a peak is reached at about age 4-1/2, a drop occurs at about age 5, at about the time the child enters kindergarten, and is followed by increases in the first, second, and third grades. At about age 9, near the end of the third grade or at the beginning of the fourth grade, there is a rather severe decrement in almost all the creative thinking abilities. [See Table 1.]
>
> Then comes a period of recovery . . . After this, another decrease in the seventh grade is followed by recovery in the eighth and continued growth until a peak is reached in the eleventh grade. After this, there is a leveling off or slight drop near the end of the high school period. (45, p. 74.)

If one follows the pattern that emerges from the above discussion (Figure 1) and Sullivan's stages of development (45, p. 75), namely:

0- 4 years	childhood
4- 8 years	juvenile
8-12 years	preadolescent
12-17 years	early adolescent
17-	adulthood

Table 1. Longitudinal Development of Creative Thinking Abilities from Third Through Fifth Grades for 100 Children (54, p. 196)

Measure	Third		Fourth		Fifth		F-Ratio
	Means	St. Dev.	Means	St. Dev.	Means	St. Dev.	
Fluency	53.11	7.62	47.28	7.11	48.45	9.54	14.29*
Flexibility	52.60	8.74	47.59	9.46	51.29	8.70	8.37*
Originality	50.22	8.12	47.61	9.14	52.53	10.17	7.19*
Elaboration	50.21	8.52	45.84	9.61	54.29	12.03	12.56*

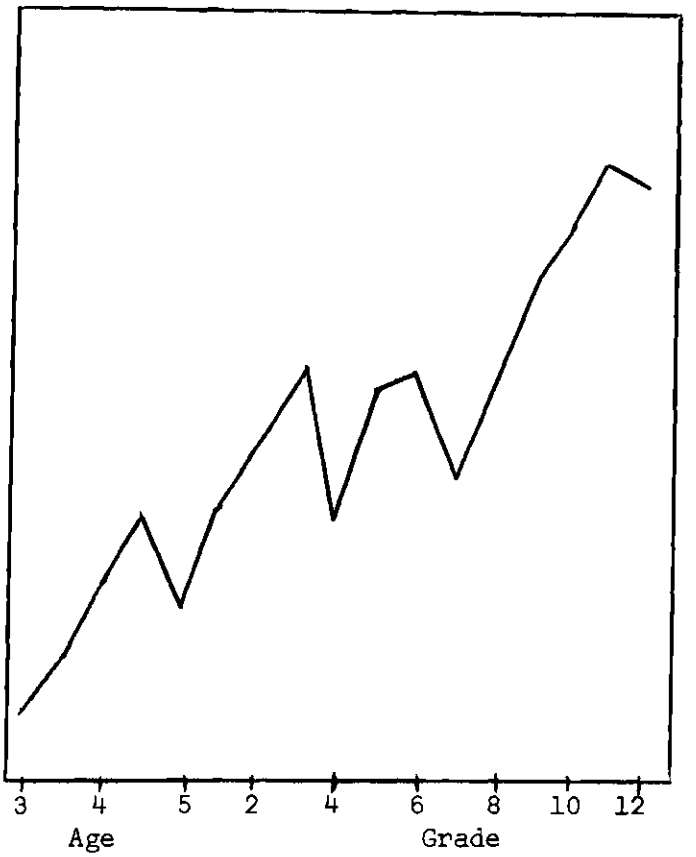


Figure 1. Generalized Developmental Curve of the Creative Thinking Abilities (45, p. 42)

it becomes clear that a child's creativity suffers as he leaves one stage of development and enters another. This can be attributed to the discontinuities in our culture--for at these stages of development the environment makes abrupt changes in the behavioral standards it is willing to accept. This curve is quite different from the developmental curves of other cultures that have been studied (45, pp. 75-79; 43, pp. 70-74).

Torrance's theory attributes the dip in the curve (Figure 1) that occurs at 4-1/2 years to a child's concern about social accommodation and compromise, and the environment's pressure demanding a child's acceptance of authority outside the home. This decrease in creative ability is manifested in the child's behavior. "All too often a five year old loses much of the curiosity, imagination and excitement about learning . . ." (43, p. 69).

The next dip occurs at the beginning of the fourth grade. Environmental pressures upon the child are greatest at this stage. Parents and teachers become more critical of behavior; they feel that the child has now graduated from primary school and in so doing should behave more like a grown-up. Classroom activities become more organized and formal; homework is now assigned; the subject matter of their studies changes from child-like fairy tales to an introduction to history and geography (43, p. 76; 45, p. 77). Accompanying this change in the educational system the fourth grader now becomes more concerned with peer approval and hence sacrifices his creative activities in order to conform to peer norms.

The seventh grade drop coincides with the child entering junior high school. New pressures and anxieties are manifested at this stage of development. Demands for conformity are increased in school and in the social life of the individual. Divergent behavior becomes the target of peer pressures to conform.

There are no drops in the curve (Figure 1) when a child leaves junior high and enters senior high, as one might expect from the increased pressure, etc. However, Torrance's studies were done on students from schools having both the junior and senior high schools in the same building; therefore the child knew what to expect--the strange atmosphere was eliminated, the organization structure was continuous, and his social group remained intact. Continual growth occurs from this period until a peak is reached in the eleventh grade. After this, there is a slight drop near the end of the high school period.

Although Torrance's major studies have ended with the eleventh grade, he attributes the drop in the senior year to the transition that takes place from high school to the college, military or business world. Greater demands for adult behavior are also imposed at this time and any regression to childish thinking is disciplined.

In light of the above it seems clear a child that remains creative may have several problems. Since his actions and behavior do not conform to the norm he is often getting into trouble in school, being ostracized by his peers, etc. Hence loneliness and conflicts may be the initial "reward" for his creativity. Therefore it is essential that parents, teachers, and those in authority have the ability to recognize

this type of child. Below are several characteristics according to Torrance that distinguish a creative child (56):

1. *Inquisitiveness*--ask penetrating questions, is not put off by overly simple answers, likes to explore new ideas.

2. *Originality*--arrives at original and unusual solutions to problems.

3. *Imaginativeness.*

4. *Humorousness.*

5. *Independence*--often he likes to go off and "do his thing," therefore he may be categorized sometimes as an introvert, unsociable, etc.

6. *Intuitiveness.*

7. *Sensitivity*--manifests a high degree of sensitivity to situations encountered.

8. *Flexibility*--an ability to start with certain ideas and be able to change goals as work is in progress.

9. *Divergent thinking*--deviates from established norms; nonconformist; therefore he may run into trouble frequently in school.

10. *Self-esteemed*--must have a high regard for himself, for without it the individual will lack the self-confidence needed to venture into new areas without fear of losing his direction or respectability (9, pp. 56-59).

11. *Courage and conviction*--the individual with a drastically different perspective must be convinced that the fruits of his labor are valuable and at the same time have the assurance he can cope with any

adverse reaction. Courage is the ability to express one's convictions and tolerate any adverse reaction that might occur.

To foster creative behavior Torrance (44, pp. 61-66) has developed a guide for teachers and parents in which he stresses them to encourage questions, inventiveness, self-initiated learning--too often sanctions against questions and explorations are given; youngsters should not be made to feel that errors are sinful; develop habits of constructive criticism, i.e. creative evaluation whereby possibilities for additions, changes, etc. are suggested rather than pointing out errors--the common critical evaluation that so often exists; be tolerant of new or divergent ideas and most of all develop a creative atmosphere.

Silberman says it is this creative atmosphere that is lacking in the majority of American schools today. "It is not possible to spend any prolonged period visiting public school classrooms without being appalled by the mutilation visible everywhere--mutilation of spontaneity, of joys in learning, of pleasures in creating . . ." (42, p. 10). Students soon learn the most important strategy for survival is docility and conformity. "The tragedy is that the great majority of students do not rebel; they accept the stultifying rules, the lack of privacy, the authoritarianism, . . . as The Way Things Are" (42, p. 155).

Other Theories, Views and Comments

Perhaps more has been written describing the characteristics and abilities of the creative thinker than other comments in the field. Drevdahl (12) agrees with Torrance that a creative person's ability is measured by fluency, flexibility, originality and elaboration. Guilford

(25,26) adds to these basic four a synthesizing and analyzing ability as well as an ability to reorganize and redefine existing knowledge.

Almost every article on creativity devotes at least a paragraph to the characteristics of the creative child. In addition to those already cited Schoel and Busse (40) show there is a strong positive relationship between humor and creativity in children and young adolescents. Cohen (7) in addition to describing the characteristics discusses the barriers to individual and group creativity, and the training needed to develop and nurture this gift, namely brainstorming, sensitivity training, etc.

The stages in the process of creative thinking was the topic of concern in Hutchinson (30) articles and Guilford (25) also elaborates on the stages of creating--the incubation period followed by a moment of inspiration and lastly a period of evaluation or verification.

Guilford (26) has done much work in the field relating IQ with creativity. His conclusion (similar to Torrance's) is that creativity lies outside the domain of intelligence. Getzel and Jackson (22) have also come up with similar findings that performances on IQ tasks have relatively little relation to performances on creativity tasks.

Weisberg and Springer (61) studied the environmental factors in the development of creativity. They found certain family characteristics correlate with creative performances in children, namely: (1) Open expression of feelings without domination by the parents. (2) There is not a demand for constant maturity of behavior; i.e. the child is allowed to regress comfortably without undue pressure placed on him by

the parents. (3) The parents do not force the child to accept their values, attitudes, etc. Getzel and Jackson (22) also studied the effects of family environment on the child and came up with similar findings.

Holland (28) concluded from his study that teachers' ratings are good predictors of academic achievement and leadership potential but not as predictors of creativity.

Golan (23) is the only author who differentiated between various levels of creativity. The higher level is that of introducing some new element of meaning while the lower gives further development to an established body of meaning.

Ogletree (37, p. 516-A) in his dissertation, studied creativity in England, Scotland and Germany using Torrance's test. He was primarily concerned with assessing the creativeness of children in the state schools which used the intellectual-academic approach as opposed to the Steiner Schools with their activity approach largely through the use of the arts. His findings showed that Steiner pupils scored significantly higher scores on the test than state school pupils.

Perhaps the two most useful studies were done by Torrance and Vaughn, a recent doctoral student of Torrance's. Torrance (52) in his "Minnesota Studies of Creative Behavior" has listed and summarized almost 300 reports, abstracts, and journal reprints that study the four basic issues constantly referred to: (1) the validity of creativity tests, (2) the relationship between creative thinking ability and intelligence, (3) the relationship between creative thinking ability

and school achievement, (4) the facilitation of creative development, through specific kinds of educational experience.

Vaughn (57, pp. 122-116) in her dissertation gives an excellent review of the theories, models, and statements concerning creativity by 34 of the leading scholars.

I suggest the above two studies for those interested in a comprehensive survey of the literature in the field of creativity.

CHAPTER III

OBJECTIVES AND PROCEDURE

Objectives

The objectives of this research are threefold:

1. To learn the methodology needed to conduct a feedback dynamics study.

2. To see how this type of approach can be utilized in solving today's complex social problems.

3. To apply the knowledge gained to the field of creativity specifically to the development of creativity in children, subject to the standards and beliefs of our culture.

Methodology

In order to study a feedback system the following procedure is necessary (19, p. 13).

1. Define the dynamic problem--identify the variable and the performance patterns that are causing the problem.

2. State the objective of the study.

3. Determine the dominant feedback loops that create the patterns of behavior (dynamic hypothesis).

4. Construct the mathematical model.

5. Simulate the model and compare the actual patterns with the ones assumed in (1).

6. Revise the model until it is an acceptable representation of the real system.

7. Modify the model to obtain the desirable patterns given the objectives.

8. Implement the model in a real system.

9. Evaluate the real system to see if the desired change was accomplished.

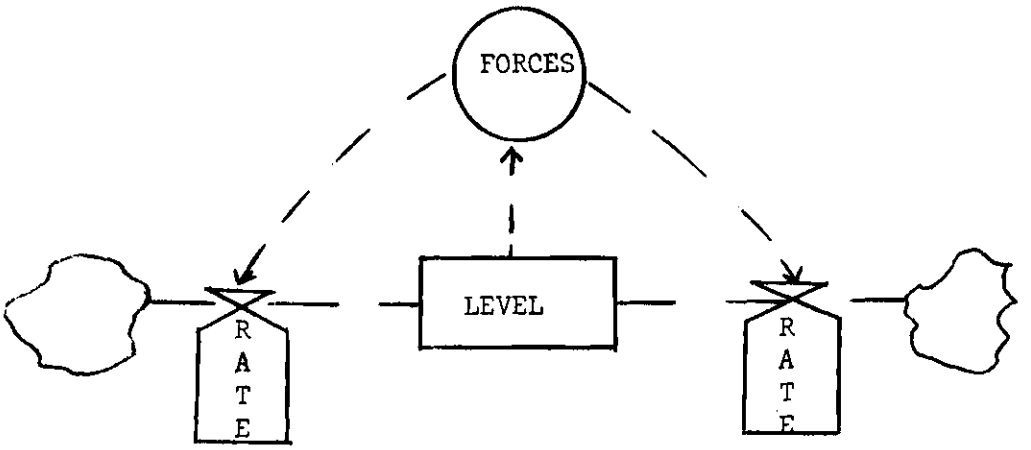
10. Redesign and restudy must be constantly done in dynamic situations.

This thesis deals with points (1) through (7).

Hypothesis

The fundamental hypothesis in any feedback dynamics study is the statement of the nature of the closed feedback loops that principally control the system's behavior. Once this has been achieved a general diagrammatical and mathematical representation of these loops is required.

A simple information feedback loop is represented below.



Accumulations are represented by rectangles. Flows that enter and leave those levels are shown as arrows with valves. Forces and pressures (auxiliary variables) are circles, sources and sinks are clouds, and information flows are represented by dashed lines. An arrow between two variables, ex. [x] ⟶ (y) means that x influences y after a time delay. Important delays will be represented separately.

Mathematically, accumulations are functions of former accumulations (ACC), auxiliaries (AUX) and rates measured at a point in time.

$$ACC.K = ACC.J + (DT)[f(RATES.JK,ACCS.J,AUXS.J)]$$

K present time.

J past time.

DT length of computation interval.

Rates or flows are calculated for an interval of time (KL) during which they are constant. They are functions of accumulations and auxiliaries.

$$RATES.KL = f(ACC.K,AUX.K)$$

Auxiliaries may be algebraic, logic or table functions based on other auxiliaries and/or accumulations at the same point in time.

$$AUX.K = f(\text{other } AUX.K,ACC.K)$$

Information feedback loops are always composed of accumulations (called levels), rates that flow into and out of the accumulations causing them to vary with time, and pressures and forces (auxiliaries)

created by the changes in the accumulations. These pressures and forces influence the decision process that control the rates. Finally, changes in the value of the rates produce new changes in the accumulations, thus closing the loop.

Information feedback loops may be of two types: positive or negative. A positive loop occurs when an increase (decrease) in one variable causes action around the loop that reinforces the change. Thus a positive feedback loop often creates growth (decline). A negative loop occurs when an increase (decrease) in one variable causes corrective action to be taken around the loop. Often the corrective change is larger than the initial one and overshooting results. Thus a negative feedback loop often creates oscillations.

For a more detailed discussion of the diagrams and equations used in feedback (industrial) dynamics the reader is referred to Forrester's *Industrial Dynamics* book, Chapters 7 and 8.

CHAPTER IV

DESCRIPTION OF THE PROBLEM

The developmental curve for creative thinking ability as established by Torrance, does not increase steadily with age; rather it has several drops around age 4-1/2, 9, 12, and again at 17 (Figure 1).

Torrance attributes these drops to discontinuities in our culture (45, pp. 75-79). He feels if the environment placed a small amount of stress continually on the child, i.e. if their demands were gradually changed, creativity would continue to increase without any setbacks. However, at present, the environment abruptly changes its standards and imposes additional pressures on the child at the onset of the various stages of development causing the child's inability to cope with all the changes at once--hence creativity suffers (56) as is seen in Figure 1.

This research attempts to show the behavior patterns of the developmental curve of creativity that could emerge if the environment were to change gradually the standards it imposes on the child.

Several types of children will be studied: the creative child with a determination to follow his natural inclinations despite the pressures to conform placed on him by the environment; the creative child with the same determination but raised in an environment that fosters creativity; the creative child that wishes to satisfy his environment at the expense of his creativity and the uncreative child in similar situations.

CHAPTER V

STRUCTURE OF THE MODEL

This chapter develops the structural relationships among the variables in the model. The development of the model's equations, including the table functions and parameters is contained in Appendix B.

These relationships may be conveniently analyzed in three sectors:

SECTOR 1 Creative Behavior--Capability and Usage

SECTOR 2 Environment's Responses

SECTOR 3 Individual's Internal Responses

Each of the above sectors is discussed in detail in a separate section with a description of the loops embodied within the respective sectors.

Sector 1, Creative Behavior--Capability and Usage

This sector is composed of one main loop coupled with two smaller ones and represents the relationship that exists between use of creative talent and creative capability. Since there are one positive and two negative loops the effect of a change in either variable may be reinforcing or compensating, depending on which loop is the dominant one. Figure 2 depicts this relationship. The sequence of steps around the main loop is:

1. increase use of creative talent.

2. increase actual fraction utilization.

3. increase fraction change of capability.

4. increase creative capability.

5. increase fraction change of usage.

6. increase use of creative talent.

Similarly a decreased use of creative talent would lead to a decrease of creative capability and a consequent decreased use of creative talent. This is a positive reinforcing loop. Figure 3 depicts this relationship again but in flow diagram form.

The two smaller loops are negative in sign. In the first loop an increase use of talent results in a decrease in capability influence and a consequent decrease use of creative talent. In the second loop an increase in creative capability would lead to a decrease in actual utilization and thus a decrease in fraction change of capability resulting in a decrease of creative capability.

Within this negative loop there is a very important positive loop. Net change in creative capability and creative capability are mutually reinforcing with the magnitude of reinforcement being controlled by fraction change of creative capability.

The increase or decrease in use of creative talent is measured by the net inflow rate--fraction change of usage. This rate is a weighted sum of two variables total change (to be discussed in Sector 2) and capability influence, the difference between comfortable behavior and use of creative talent divided by the adjustment time. Since capability influence is the variable that couples a positive and negative

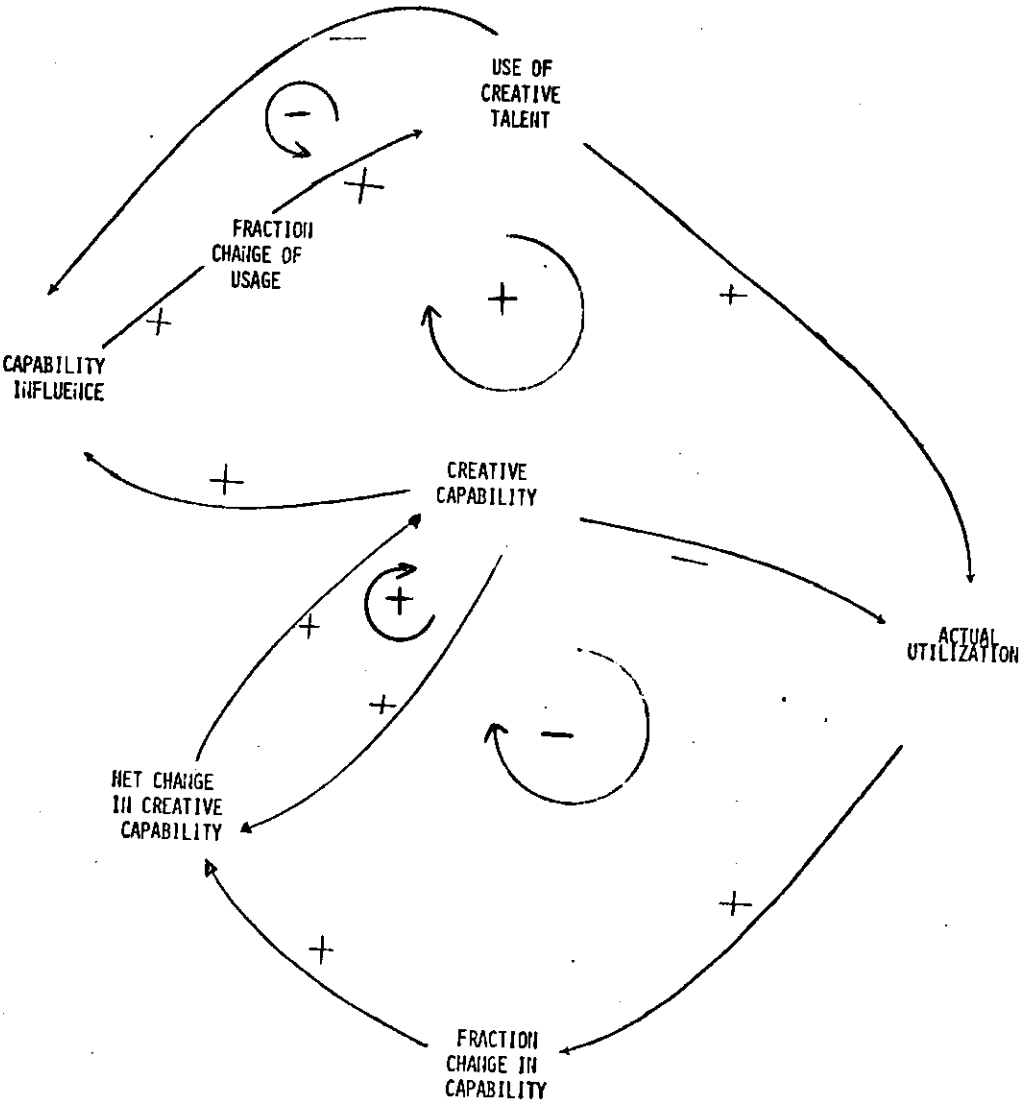


Figure 2. Sector 1, Creative Behavior--Capability and Usage

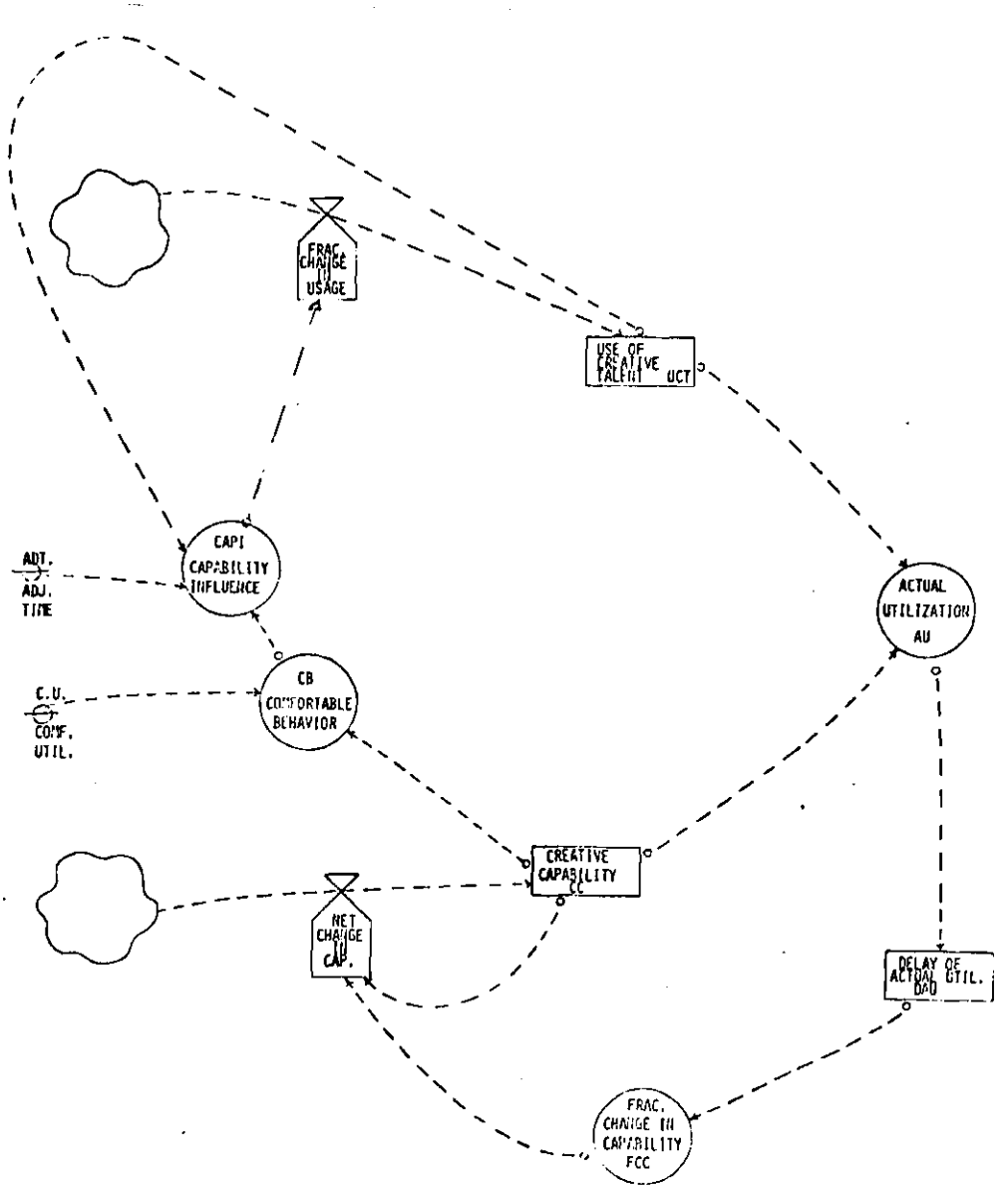


Figure 3. Sector 1, Creative Behavior--
Capability and Usage, Flow Diagram

loop, its effect on fraction change of usage may vary depending on which loop is the dominant one.

Actual fraction utilization, the quotient of the use of creative talent and creative capability, may have a positive or negative effect on use of creative talent. Low values in utilization will cause capability to decrease, high values will cause it to grow.

Thus we see the main loop by itself will lead to growth, but when coupled with the smaller loops a variety of behavior patterns may develop.

Sector 2, Environment's Responses

The environmental sector consists of three loops coupled together to form the behavior change influenced by the environment.

Loop 1 Normal Rate of Change

Loop 2 Ability to Change

Loop 3 Desirability to Change

Each of the above loops is discussed separately and then coupled together in Figure 7, in flow diagram form.

Loop 1, Normal Rate of Change

This loop is negative in sign and is depicted in Figure 5. The sequence of steps around the loop is:

1. increase use of creative talent.
2. decrease actual behavior error.
3. decrease normal rate of change.
4. decrease behavior change.
5. decrease total change.

6. decrease use of creative talent.

Similarly a decrease in the use of creative talent would lead to an increase in behavior change and consequently an increase in the use of creative talent. Figure 6 depicts this relationship in flow diagram form.

Actual behavior error is the difference between behavior desired by the environment and the environment's perception of behavior. In this model behavior desired is assumed to be one of two table functions represented below. Figure 4 represents the behavior desired by an environment whose demands gradually change as the child increases with age.

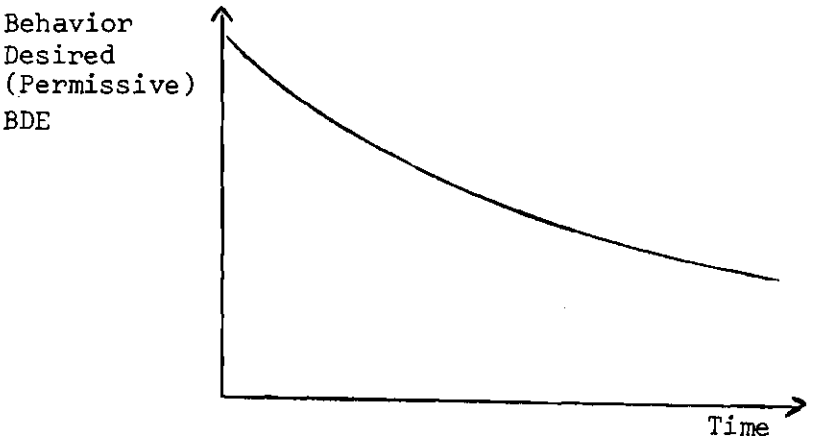


Figure 4. Behavior Desired by a Permissive Environment

Figure 7 represents the behavior desired by the environment whose standards abruptly change at the onset of each of the stages of child development.

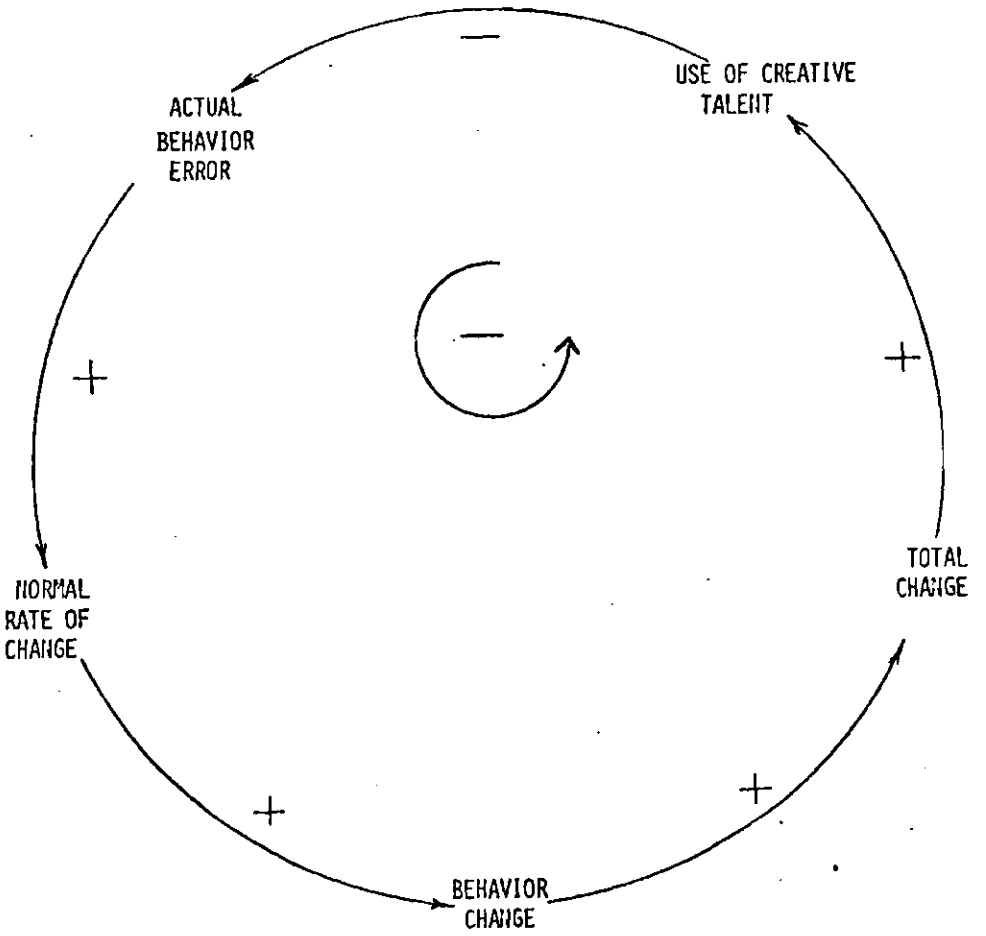


Figure 5. Sector 2, Loop 1, Normal Rate of Change

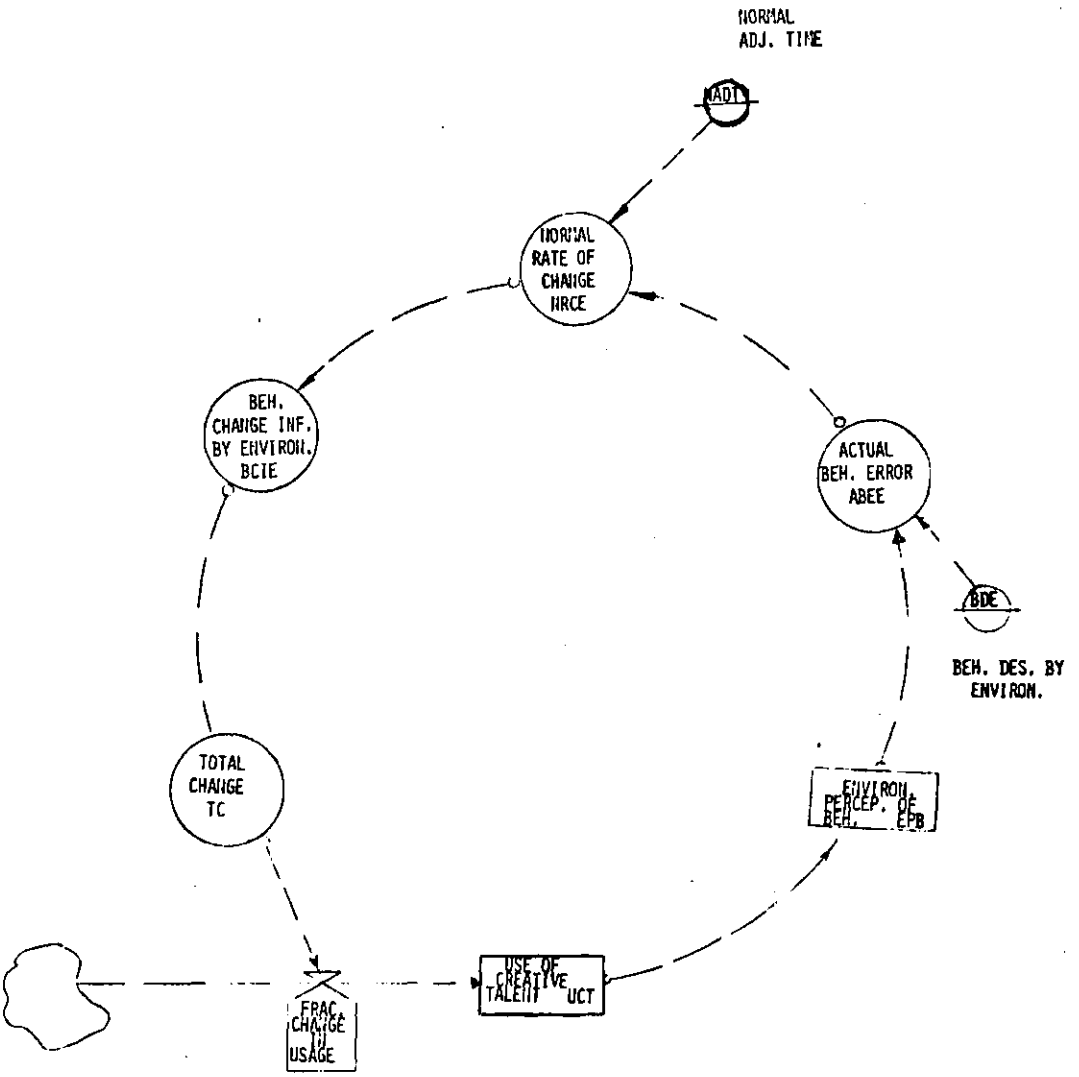


Figure 6. Sector 2, Loop 1, Normal Rate of Change, Flow Diagram

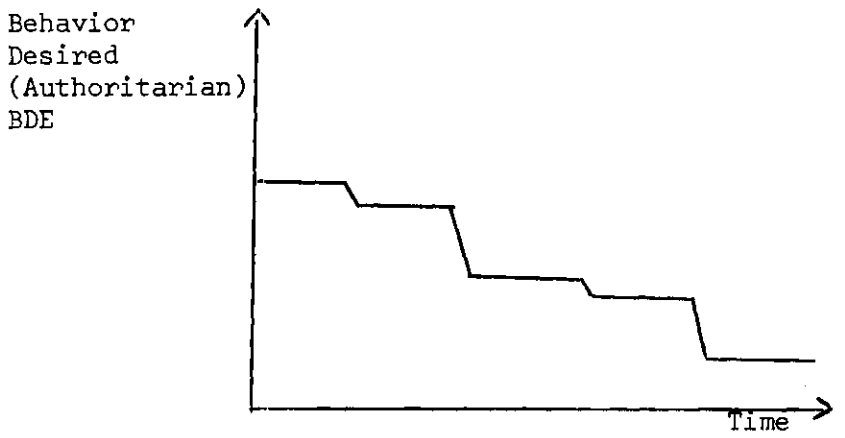


Figure 7. Behavior Desired by an Authoritarian Environment

For the purpose of this thesis, the environment whose standards are represented by Figure 4 will be referred to as the permissive environment, and those represented by Figure 7 as the authoritarian environment.

Loop 2, Ability to Change

This loop represents the ability of the child to change his behavior as it deviates from that desired by the environment. The sequence of steps around the loop depicted in Figure 8 is:

1. increase use of creative talent.
2. decrease actual behavior error.
3. increase (or decrease) ability to change.
4. increase (or decrease) behavior change.
5. increase (or decrease) total change.
6. increase (or decrease) use of creative talent.

Similarly a decrease in the use of creative talent may lead to a decrease (or increase) in the ability to change, consequently a

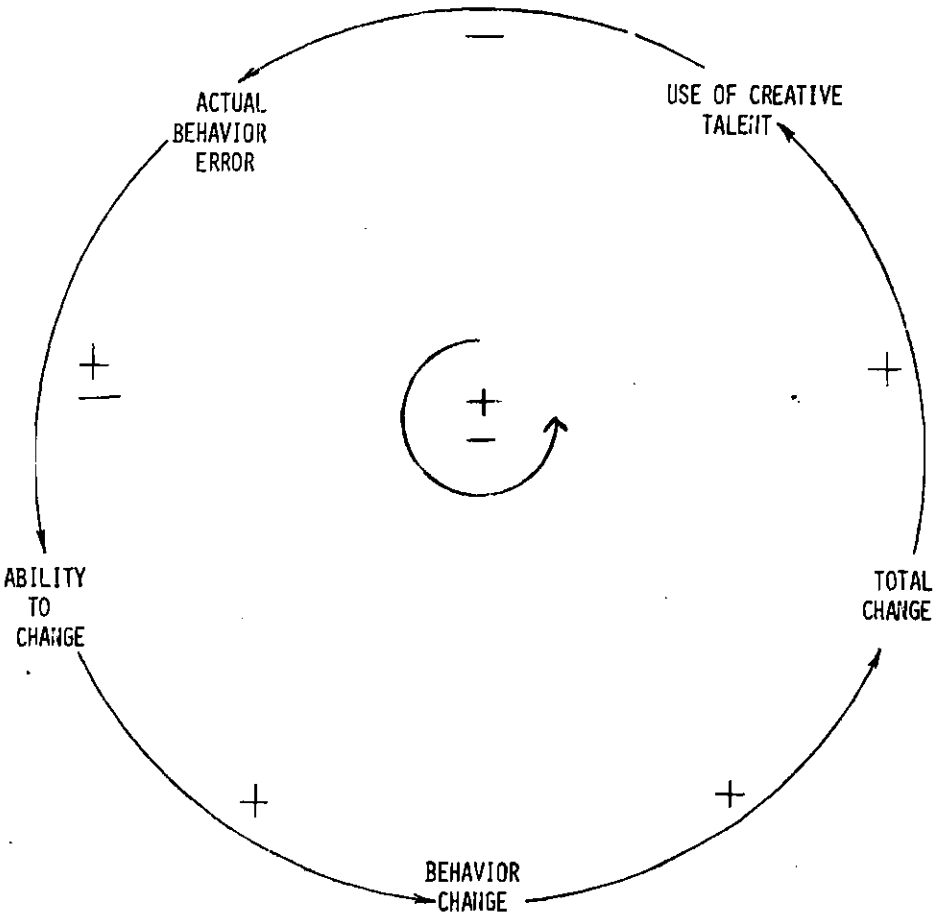


Figure 8. Sector 2, Loop 2, Ability to Change

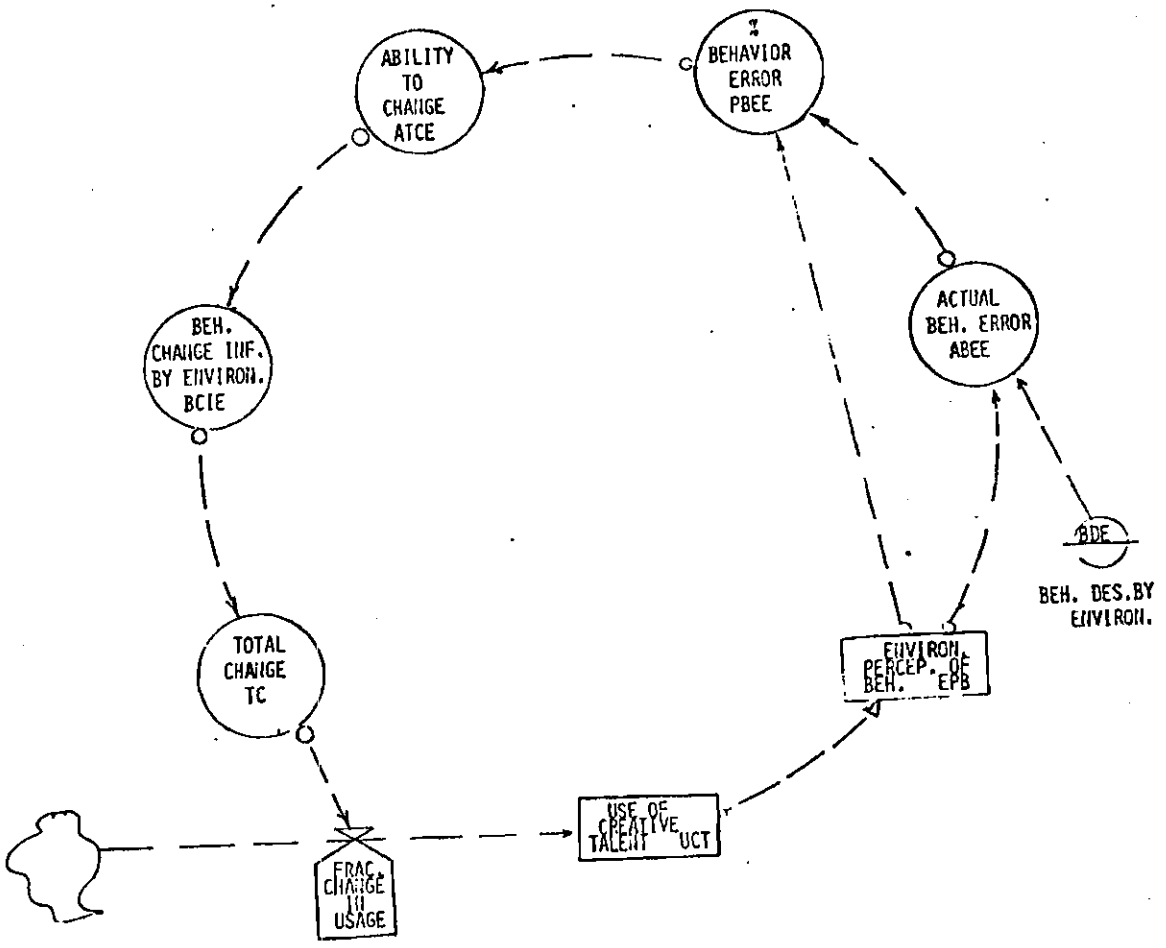


Figure 9. Sector 2, Loop 2, Ability to Change, Flow Diagram

decrease (or increase) in the total change and a decrease (or increase) in the use of creative talent. Figure 9 depicts this relationship in flow diagram form.

The sign of this loop is determined by the direction the ability to change moves as percentage of behavior error changes. If, as the percentage of behavior error decreases, the ability to change decreases, the loop is negative; on the other hand if these two variables move in opposite directions from one another the loop is positive.

The child's ability to change is represented by Figure 10.

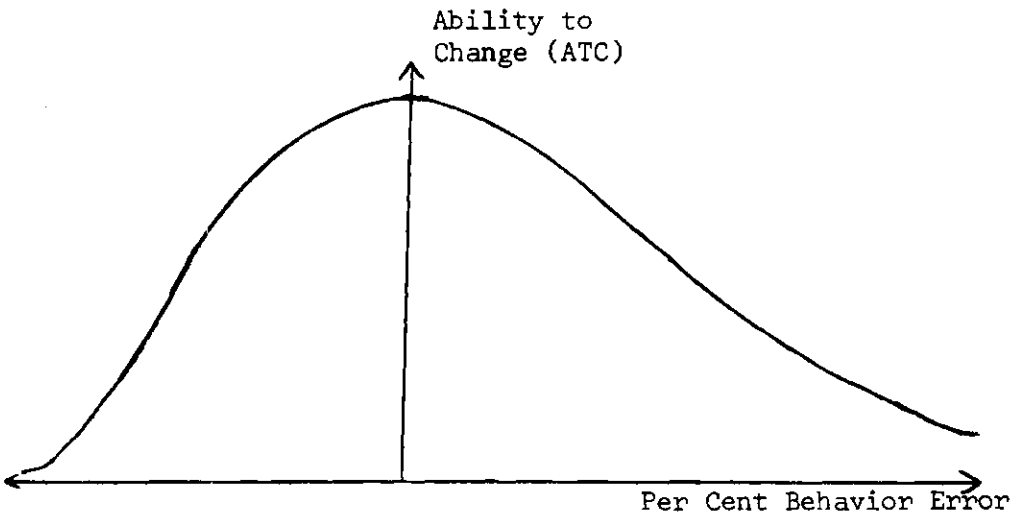


Figure 10. Ability to Change

At the origin behavior desired and behavior perceived are equal. To the right of the origin perceived behavior is less than desired; to the left greater than desired.

As the percentage of behavior error increases to the right of the origin and decreases left of the origin, it becomes more difficult to

adjust behavior to that desired by the environment and therefore the influence the ability to change has on behavior decreases. The lower bound--100 per cent--is reached when behavior desired by the environment is zero; theoretically there is no upper bound. It is assumed that it is harder for a child to decrease his behavior to zero than to increase it by 100 per cent; thus the ability to change curve is not symmetrical.

Loop 3, Desirability to Change

The sequence of steps around this loop, depicted in Figure 11, indicating the child's desire to respond to the environment's wishes is:

1. increase use of creative talent.
2. decrease actual behavior error.
3. increase (or decrease) desirability to the environment.
4. increase (or decrease) environment's reinforcement.
5. increase (or decrease) percentage deviation from needed reinforcement.
6. increase (or decrease) desirability to change.
7. increase (or decrease) total change.
8. increase (or decrease) use of creative talent.

This loop may be positive or negative depending on the signs of the two variables--desirability to the environment and desirability to change behavior. Figure 12 depicts this relationship again, but in flow diagram form.

The desirability to the environment represented in Figure 13 has as its independent variable percentage of desired behavior error which is the quotient of actual behavior error and behavior desired.

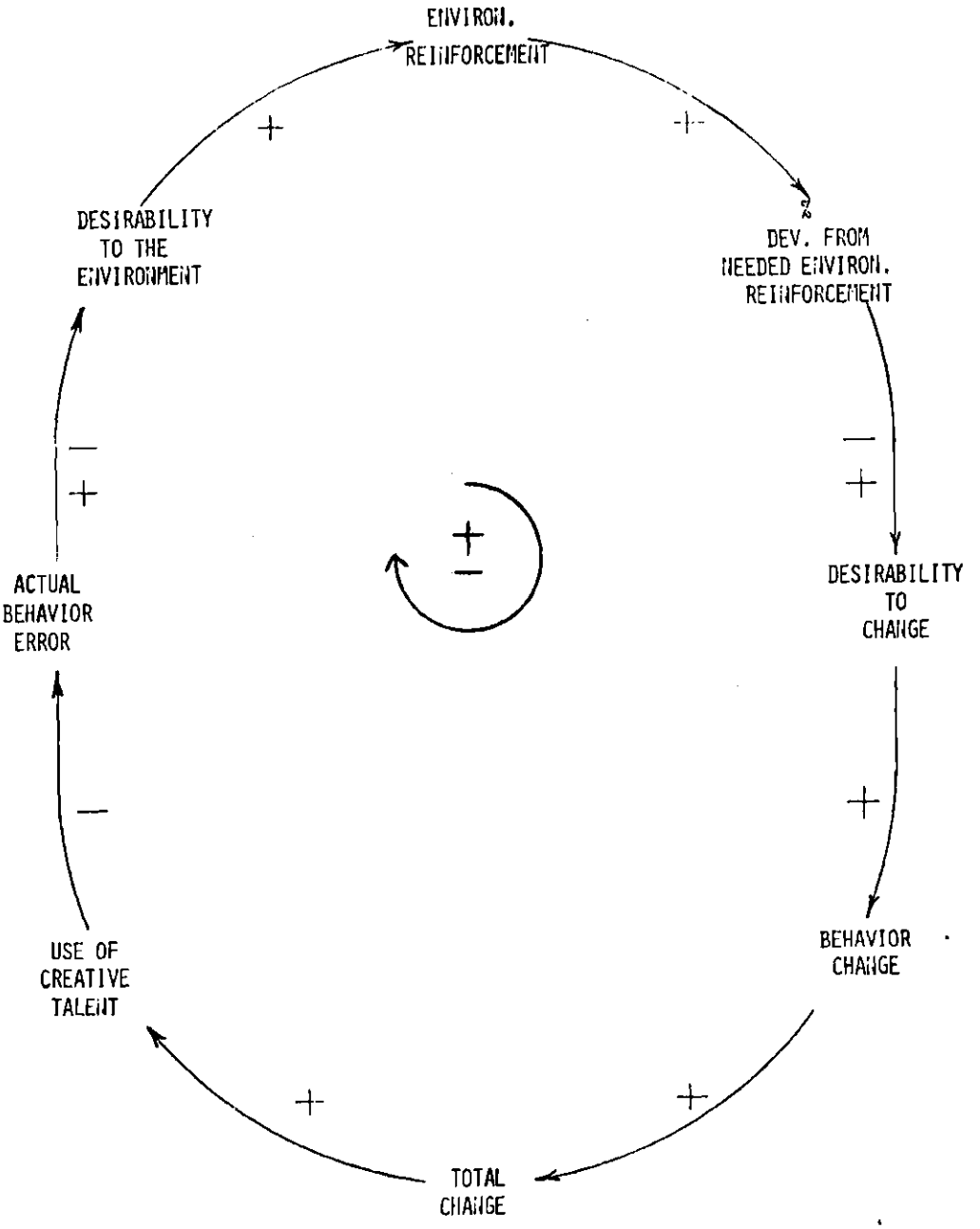


Figure 11. Sector 2, Loop 3, Desirability to Change

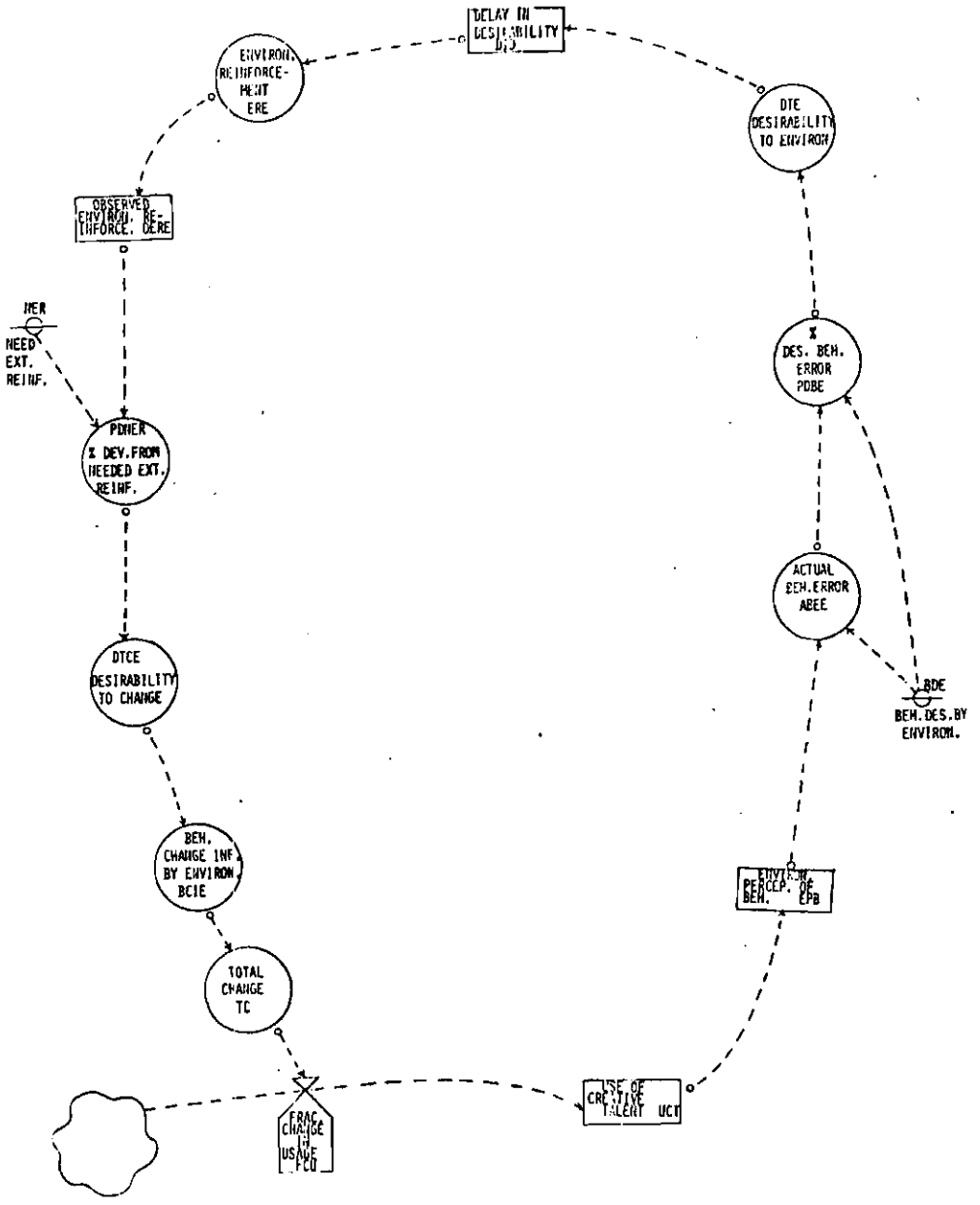


Figure 12. Sector 2, Loop 3, Desirability to Change, Flow Diagram

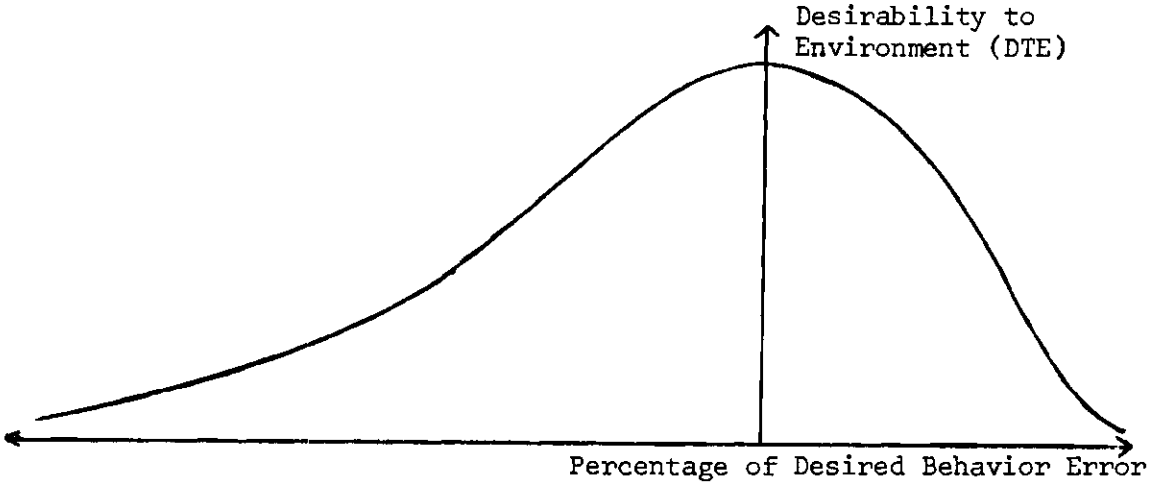


Figure 13. Desirability to the Environment (or Individual)

At the origin behavior desired equals behavior perceived. To the right of the origin perceived behavior is less than desired; to the left greater than desired. Percentage of desired behavior error is similar to percentage of behavior error represented in Figure 10; the difference appears in the denominator. In the latter the divisor was the perception of behavior; here it is desired behavior. The upper bound +100 per cent is reached when the environment's perception of behavior is zero; theoretically there is no lower bound. It is assumed that no behavior--motionless, speechless child--is less desirable than a child whose behavior exceeds that desired by 100 per cent; thus the curve is not symmetrical. The relationship between percentage of desired behavior error and desirability may be positive or negative as discussed in conjunction with Figure 10 and therefore is significant in determining the sign of the loop.

The environment's reinforcement is represented by Figures 14 and

15. Assuming a permissive environment, whose desired behavior is represented in Figure 4, then Figure 14 will represent its pattern of reinforcement.

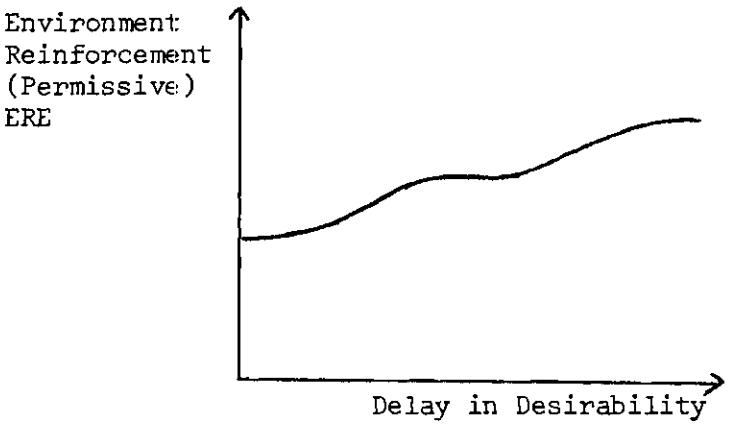


Figure 14. Permissive Environment's Reinforcement

Figure 15, on the other hand, represents the authoritarian pattern of reinforcement, whose desired behavior is represented in Figure 7.

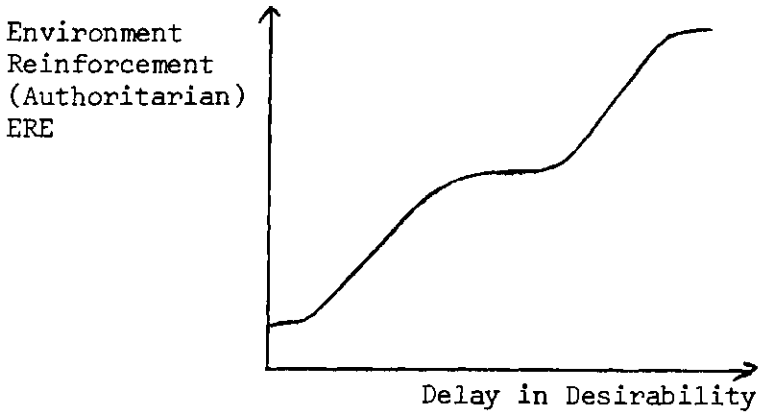


Figure 15. Authoritarian Environment's Reinforcement

Both variables, delay in desirability (an averaging equation of desirability to the environment) and environment's reinforcement, are represented on a relative scale with zero being the least desirable or extreme punishment and ten the most desirable or maximum reward.

Comparing these two figures using the same level of desirability, the different responses elicited by each of the environments can be seen. The authoritarian environment is quicker to react to any behavior that deviates from the norm (represented by a desirability of five), while the permissive environment not only gives the child greater freedom to deviate from the norm before it responds, but in responding it neither punishes nor rewards to the extent that the authoritarian environment does. The relationship between desirability and reinforcement is positive throughout the range and therefore does not determine the sign of the loop.

The child's desirability to change, shown in Figure 14, has as its independent variable percentage deviation from needed reinforcement, the quotient of deviation from needed reinforcement (the difference between observed and needed reinforcement) and needed reinforcement.

At the origin need for reinforcement, a function of time, and observed reinforcement, an averaging of actual reinforcement, are equal. To the right of the origin reinforcement is greater than need; to the left less than need. The lower bound--100 per cent--is reached when the environment gives the child no reinforcement whatsoever; theoretically there is no upper bound.

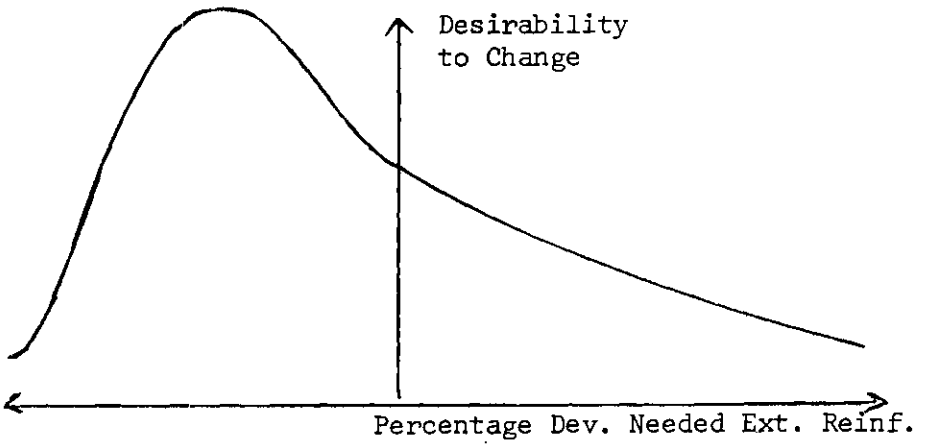


Figure 16. Desirability to Change

As percentage deviation from reinforcement increases to the right of the origin, the child is getting more reinforcement than needed and therefore his desirability to change his behavior to meet the environment's demands decreases. To the left of the origin the child is not getting the required amount of reinforcement he needs, and therefore his desire to change his behavior to please the environment increases. Beyond some point, however, the child feels he is being overly punished and could not please the environment no matter how hard he tries to correct his behavior, so he adopts the attitude "why bother" and thus his desirability to change his behavior quickly drops to around zero.

This relationship between desirability to change behavior and percentage deviation from needed reinforcement changes its sign and therefore contributes to the oscillation of the loop's sign.

Sector 2, In Its Entirety

The coupling of the three loops discussed above is depicted in Figure 17. The common variable behavior change influenced by the

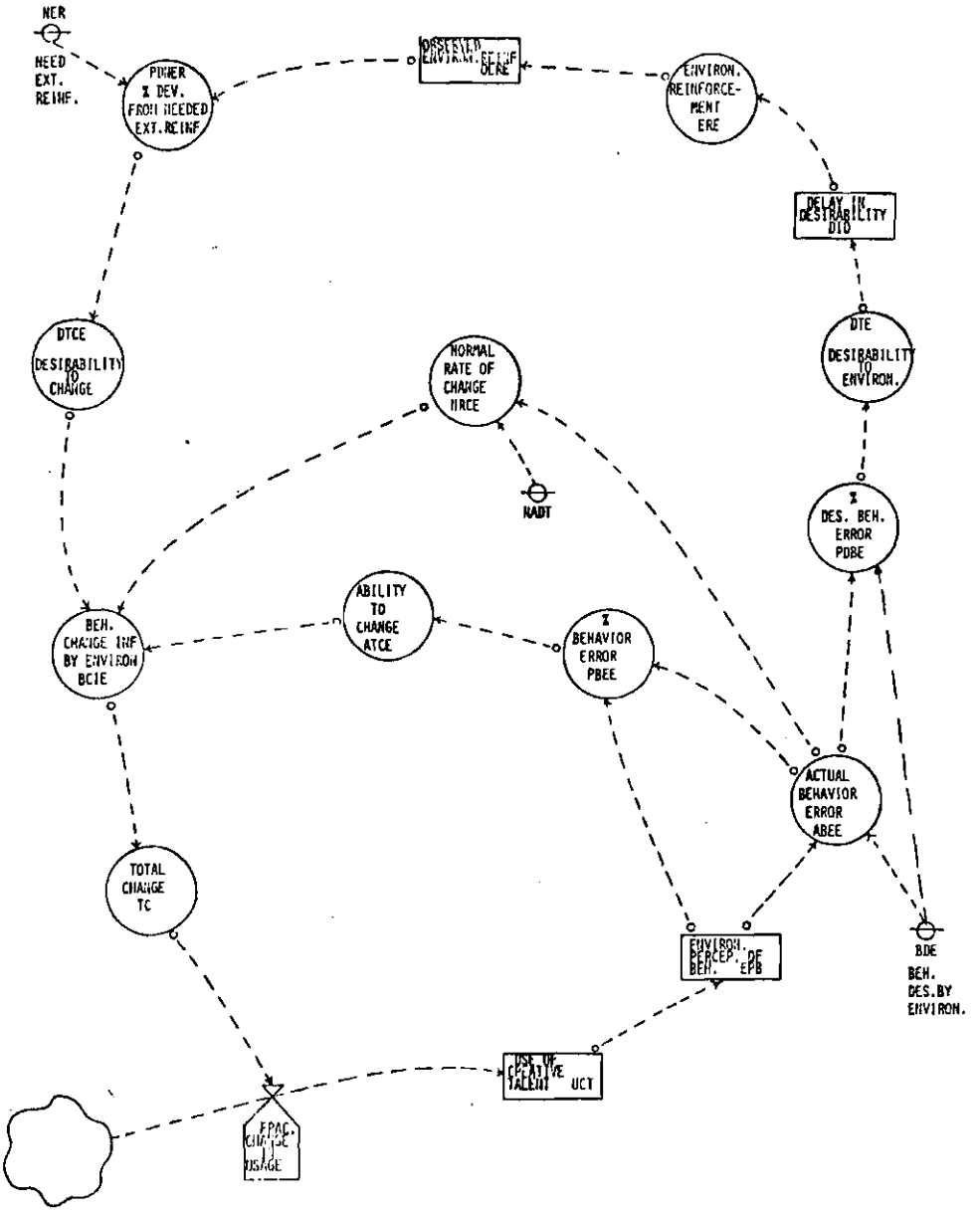


Figure 17. Sector 2, In Its Entirety

environment is a product of the normal rate of change, the ability to change behavior and the desirability to change behavior. When desired behavior equals perceived behavior there is no behavior error, the normal rate of change is zero and therefore behavior change influenced by the environment is also zero.

The normal rate of change is affected by the ability and desirability to change. As perceived behavior deviates from desired behavior, the ability to change, Figure 8, decreases thereby decreasing the normal rate of change. When need for reinforcement equals observed reinforcement, Figure 14, the desirability to change is one and the normal rate of change remains the same. However, as these two variables deviate from one another the child either wishes to please the environment and thereby increases his desirability to change behavior, which increases the normal rate of change or he is satisfied with the present situation or no longer cares to please the environment; in either case his desirability to change decreases and the normal rate of change decreases.

As behavior change influenced by the environment increases, total change increases and use of creative talent increases. The effect behavior change has on use of creative talent will be discussed in greater detail in conjunction with the coupling of the three sectors in Figure 24.

Sector 3, Individual's Internal Responses

The individual sector also consists of three loops coupled together to form the behavior change influenced by the individual.

Loop 1 Normal Rate of Change

Loop 2 Ability to Change

Loop 3 Desirability to Change

Each of the above loops is discussed separately, then coupled together in Figure 23 in flow diagram form.

Loop 1, Normal Rate of Change

This loop is similar to loop 1 in sector 2; the difference between the two loops is that this one deals with the individual--his needs, goals, desirabilities, etc.--while loop 1 of sector 2 deals with the environment's desires.

The sequence of steps around this loop and the influence diagram are identical to those represented by loop 1, sector 2. Therefore, the reader is referred to Figure 5 and the introductory paragraphs of this section. Figure 18 depicts the flow diagram for this loop which differs from Figure 6 in only two points. Firstly, since it is the individual sector that is being analyzed, it is the individual's (or self) perception of behavior rather than the environment's perception that is used. Secondly, this perception of behavior is compared to the individual's innate need to create rather than the environment's desired behavior. This innate need to create is represented on a relative scale with zero indicating a child with no creative drive and ten one with a very strong drive.

Loop 2, Ability to Change

This loop is similar to loop 2 in sector 2, the difference being the former represents the ability of the child to change his behavior as

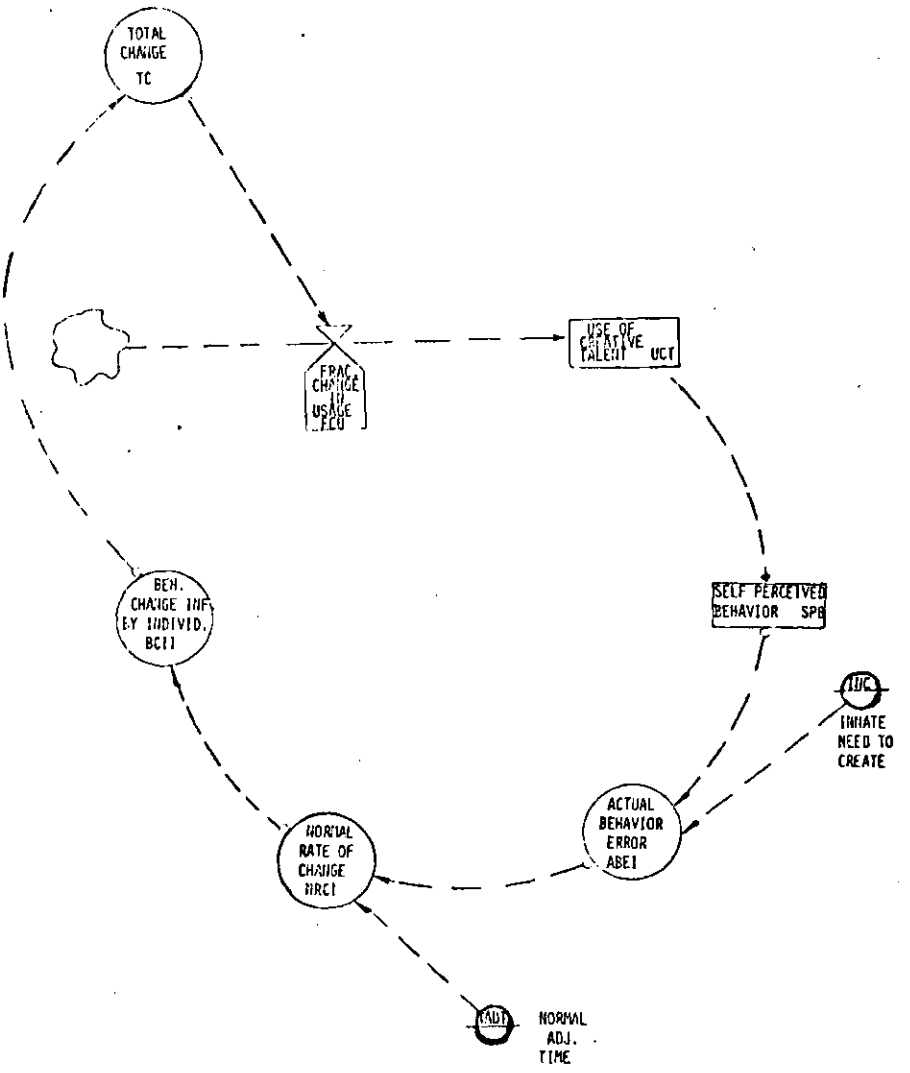


Figure 18. Sector 3, Loop 1, Normal Rate of Change, Flow Diagram

it deviates from his own innate need to create; while the latter represents the child's ability to change his behavior as it deviates from that desired by the environment. Both of these abilities are represented by Figure 10 in conjunction with a discussion regarding the influence the ability to change behavior has on the sign of the loop. The sequence of steps around the loop and its influence diagram (Figure 8) are identical to that in loop 2 of sector 2's discussion. Figure 19 depicts the flow diagram for this loop which differs from Figure 10 only in the two points discussed in the previous section (Loop 1--Normal Rate of Change).

Loop 3, Desirability to Change

The sequence of steps around the loop depicted in Figure 20, indicating the child's desire to change his behavior in order to satisfy his internal need to create is:

1. increase use of creative talent.
2. decrease actual behavior error.
3. increase (or decrease) desirability to the individual.
4. increase (or decrease) self-reinforcement.
5. increase (or decrease) percentage deviation from needed self-reinforcement.
6. increase (or decrease) desirability to change.
7. increase (or decrease) total change.
8. increase (or decrease) use of creative talent.

This loop is similar to loop 3 in sector 2 and may be positive or negative depending on the signs of the two variables--desirability to the individual and desirability to change. Figure 21 depicts this

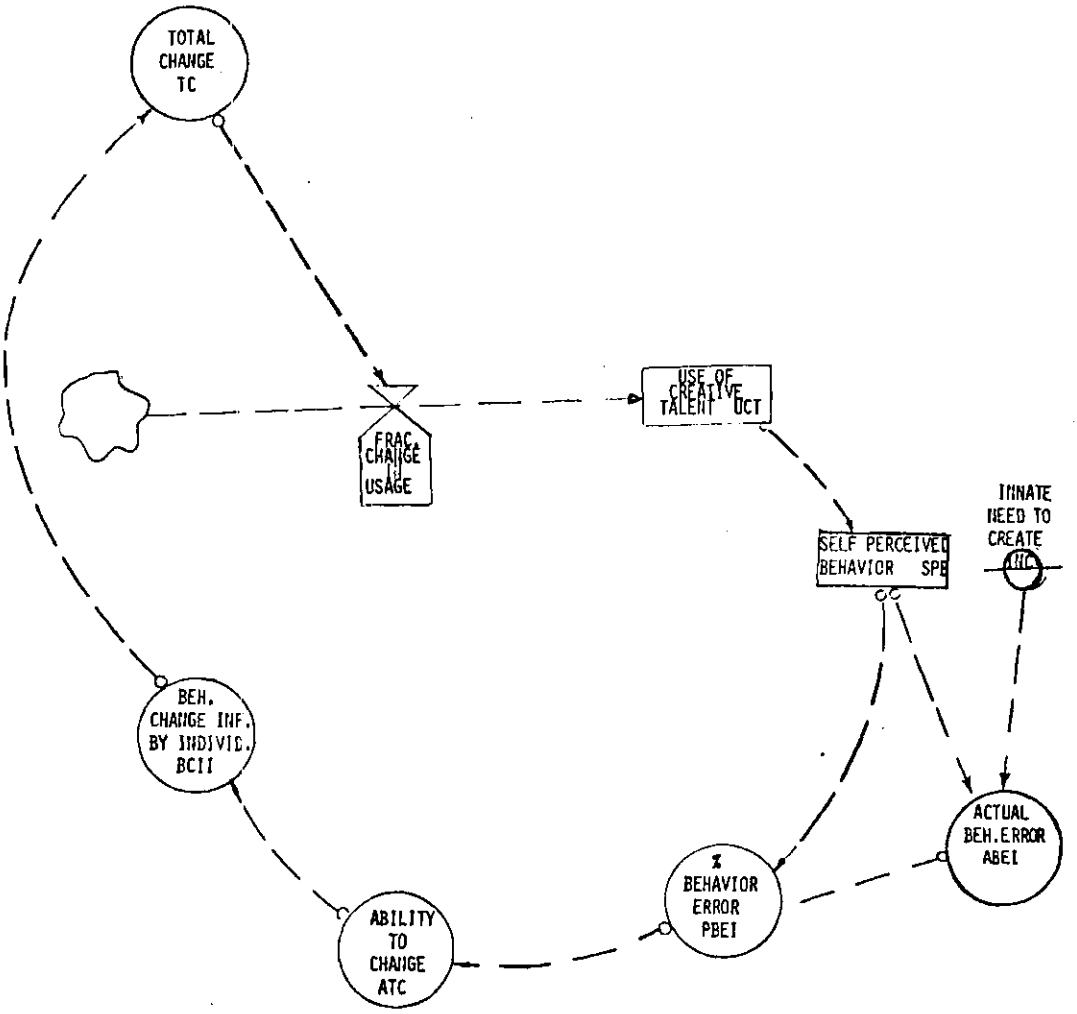


Figure 19. Sector 3, Loop 2, Ability to Change, Flow Diagram

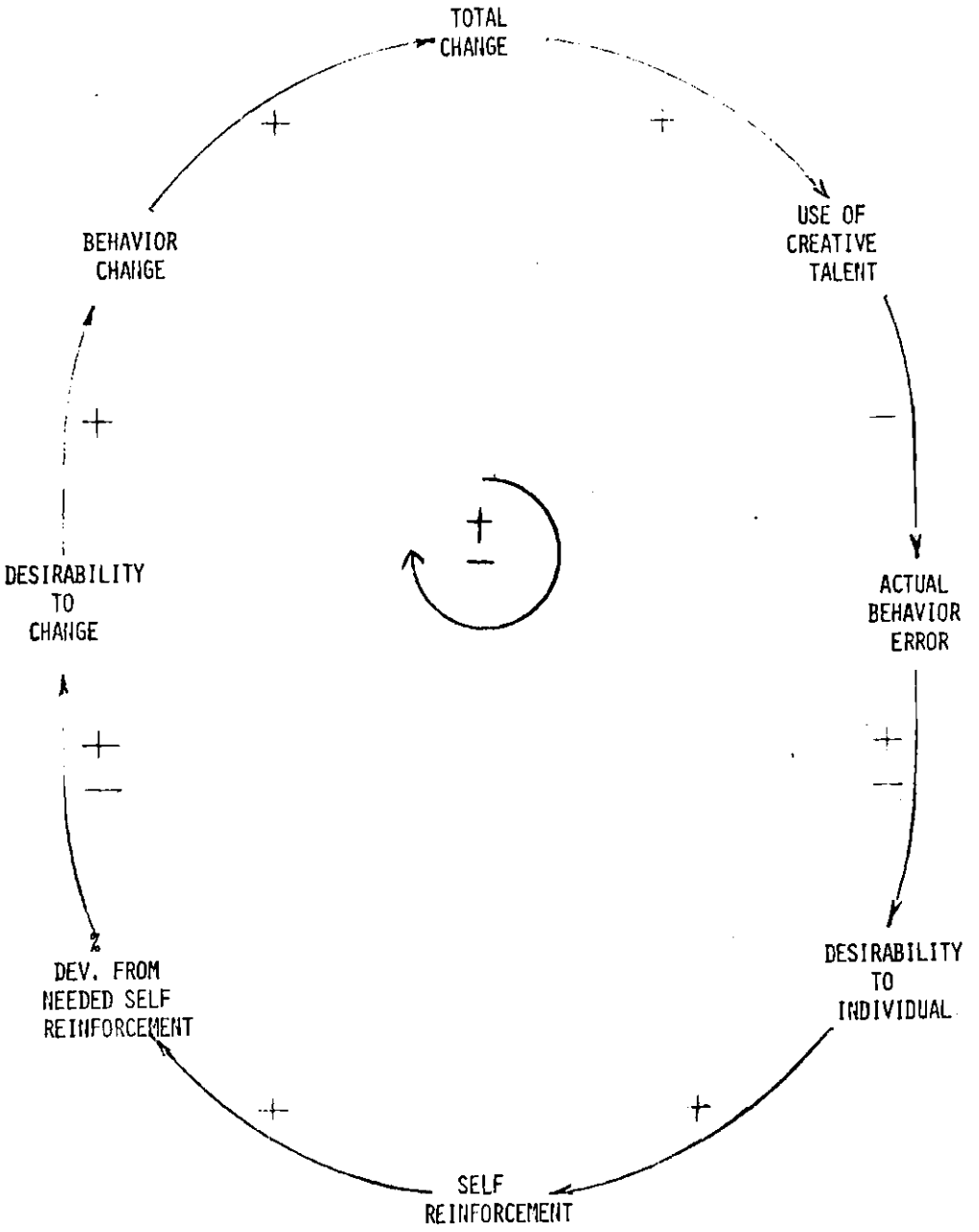


Figure 20. Sector 3, Loop 3, Desirability to Change

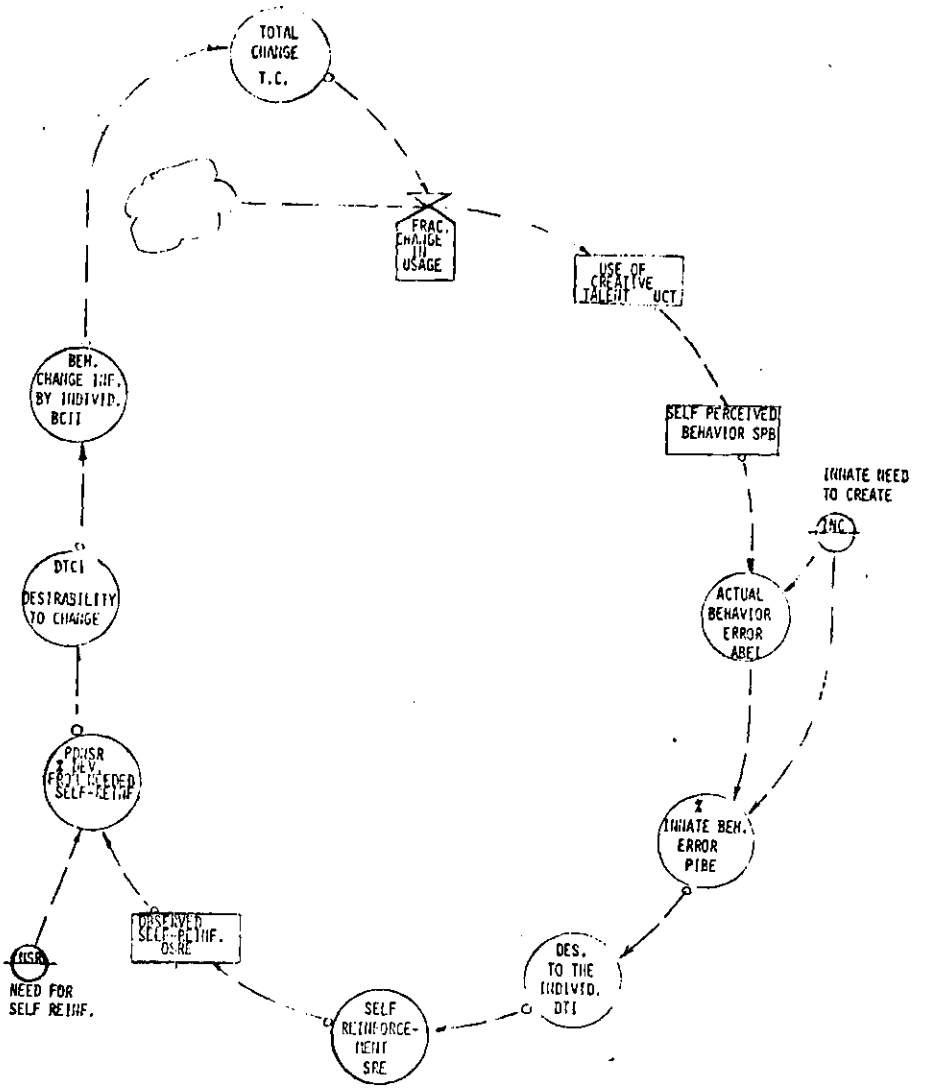


Figure 21. Sector 3, Loop 3, Desirability to Change, Flow Diagram

relationship again, but in flow diagram form.

Desirability to the individual is represented in Figure 13 with desirability to the environment. Although the discussion that follows refers to the environmental sector, it can be applied to the individual sector. Percentage of desired behavior error is now percentage of innate behavior error, the quotient of actual behavior error (the difference between self-perceived behavior and innate need) and innate need to create.

Self-reinforcement represented by Figure 22 has as its independent variable the desirability to the individual. Both variables are represented on a relative scale with zero being the least desirable or maximum self-rejection and ten the most desirable or maximum self-acceptance.

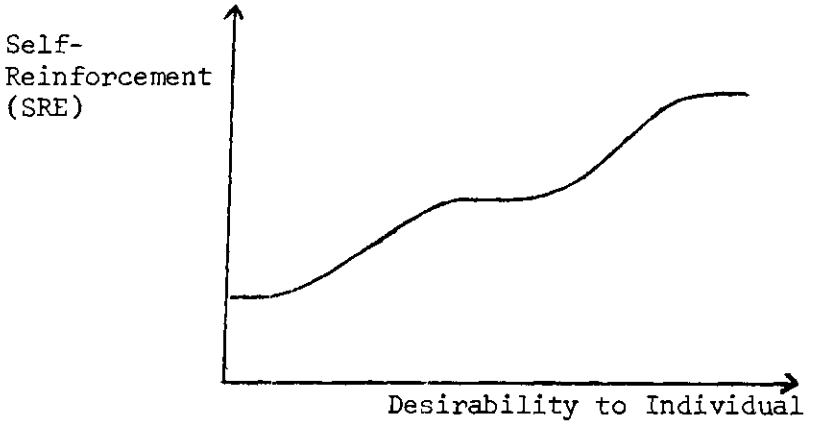


Figure 22. Self-Reinforcement

Desirability to change behavior is represented by Figure 16. Although the discussion that follows refers to the environment's reinforcement, it can be applied to self-reinforcement. The difference

appears in the need for reinforcement; it is no longer a function of time but rather a parameter.

Sector 3, In Its Entirety

The coupling of the three loops discussed above is depicted in Figure 23. The variable common to all three loops is behavior change influenced by the individual. It is a product of the normal rate of change, the ability to change and the desirability to change behavior. When the individual's innate need to create equals self-perceived behavior there is no behavior error; thus the normal rate of change is zero and so is the behavior change influenced by the individual.

The normal rate of change is influenced by the ability and desirability to change. As percentage of behavior error moves away from the origin the ability to change decreases (Figure 10) thereby decreasing the normal rate of change. The effect the desirability to change has depends on the degree the child's need for self-reinforcement is satisfied. When his need and observed reinforcement, an averaging of actual self-reinforcement, are equal (Figure 16) the desirability to change is one and therefore the normal rate of change remains unchanged. As these two variables deviate from one another the child either strives to satisfy his need to create, thereby increasing his desire to change and the normal rate of change or he feels content with the present situation or he feels he could never satisfy the drive within him. In both these cases his desire to change decreases, the normal rate of change decreases and so does the behavior change influenced by the individual.

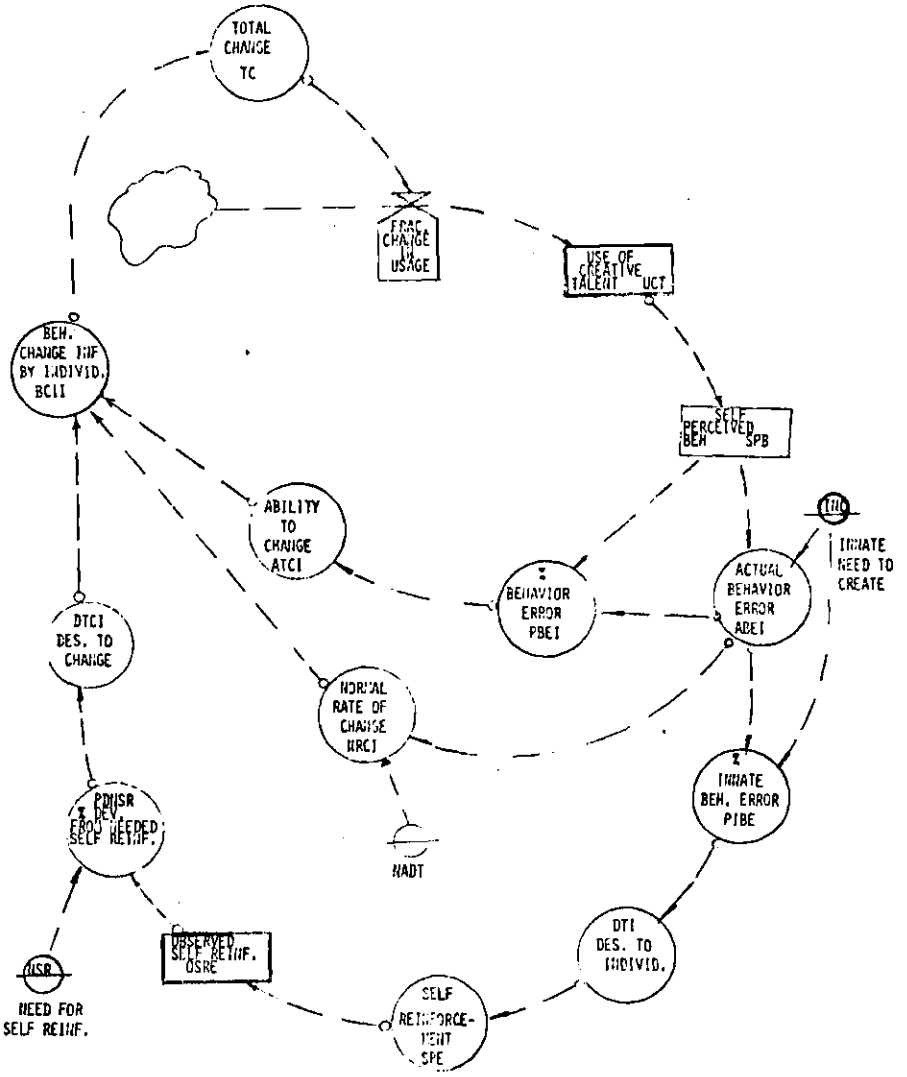


Figure 23. Sector 3, In Its Entirety

The Model in Its Entirety

The complete model is depicted in flow diagram form in Figure 24. Sectors 2 and 3 representing the internal and external pressures placed on the child to change his behavior are coupled together by total change, a weighted summation. The weights are established by a choice mechanism that represents the child's determination to please the environment or to satisfy his innate need to create. These two loops are then coupled with loop 1 having as their common variable fraction change in usage, a weighted sum of the forces (internal and external pressures and capability) that influence use of creative talent.

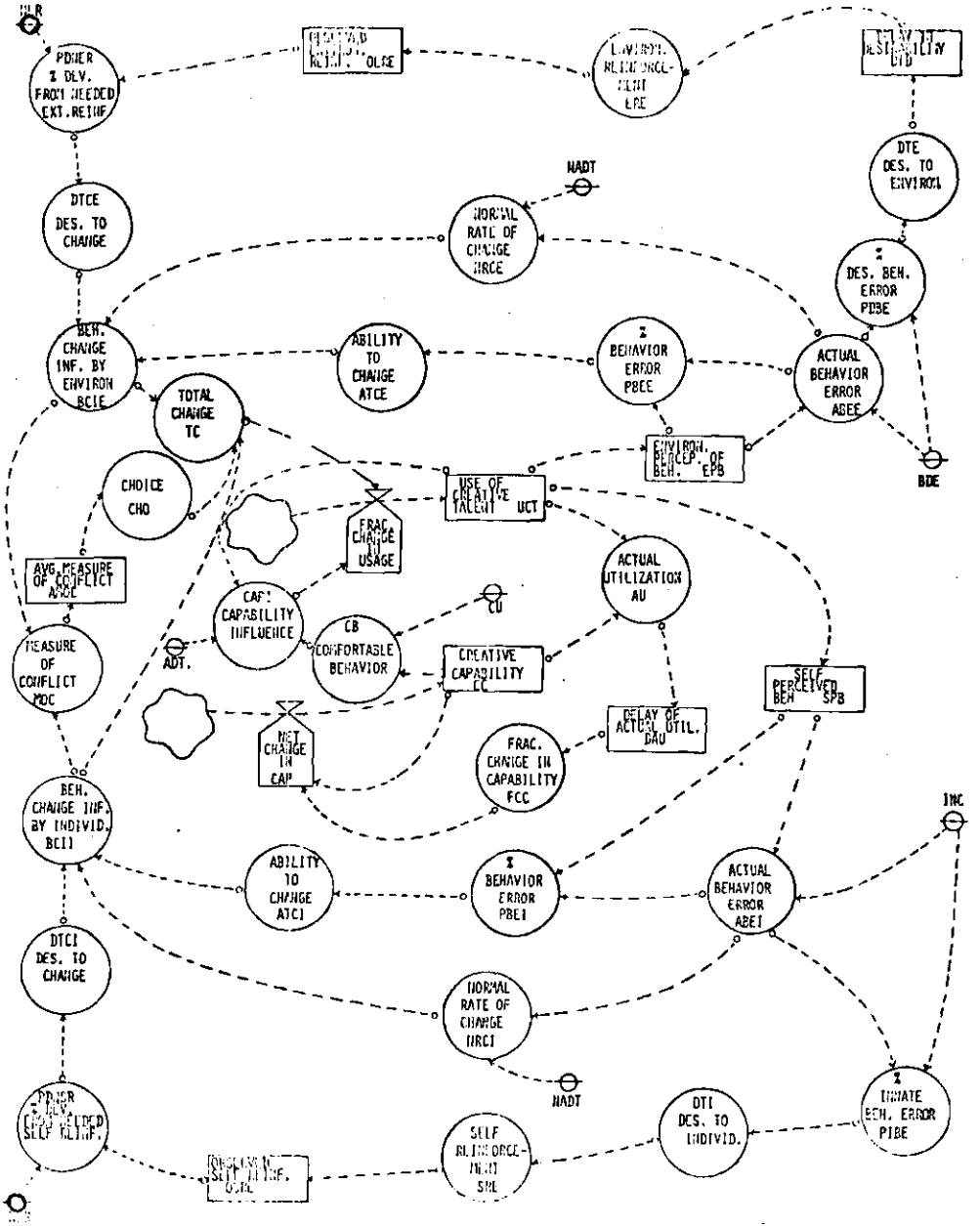


Figure 24. The Flow Diagram of the Complete Model

CHAPTER VI

BEHAVIOR OF THE MODEL

This chapter will be divided into four sections:

1. The Uncreative Child
2. The Creative Child
3. Sensitivity of the Model
4. Validation of the Model

The first two sections will be subdivided into four smaller ones that analyze the behavioral patterns that emerge when a child chooses to satisfy his natural inclinations or the environment's desires. Each situation is simulated first in the context of an authoritarian environment and then with a permissive environment. The third section will discuss the sensitivity of the model to changes in several of the parameters and table functions. The simulations described in all three sections will run from birth to age 20. Before these simulations are analyzed several variables and parameters need to be discussed further.

Creativity, like other behavioral traits, is determined by aptitudes, interests, attitudes and temperamental qualities (25, p. 444). Aptitude is determined by hereditary and environmental factors. Heredity accounts for the initially different creative capabilities of the two types of children--creative and uncreative--represented in the model. Interest is defined as the child's inclination or urge to engage in an activity. In this model, interest is represented by the innate

need to create. Although a child's need could vary, it was assumed a creative child would have a constant high need to create and an uncreative child a low need.

Attitude is the third factor that must be present for an individual to be creative. If a child does not desire to be creative or if he is not willing to change his behavior in order to be creative, then having the ability and the drive will not result in creative behavior. This attitude is represented in the model by the desire to change (DTC).

Lastly, Guilford describes the temperamental qualities an individual must possess to exhibit creative behavior. These qualities of self-confidence, optimism, self-esteem, etc., represented as the need for self-fulfillment (NSR), are recognized by many as being among the primary qualities an individual must possess to be creative. "Lacking a sense of personal worth . . . we would have difficulty proceeding to our next order of needs--the need for self actualization through creative expression" (21, p. 110). "The importance of self-esteem for creative expression appears to be almost beyond disproof" (9, p. 59).

Several other assumptions in the model are: the permissive environment desires a child to be creative and the authoritarian environment desires conformity. Although this might not be characteristic of all permissive and authoritarian environments, the assumptions were chosen in order to avoid testing the large number of alternatives that exist. Based on Torrance's suggestions (56) the curves represented in Figures 4 and 7 were chosen as being representative of their environment.

The choice functions chosen are independent decisions not influenced by forces in the model. A more realistic choice function might fluctuate between satisfying the internal and external forces as the child matures. However, in order to avoid the complications resulting from a fluctuating choice function, the more straightforward approach is used.

The Uncreative Child

Four simulations will be represented in this section representing the behavioral patterns of the uncreative child. The first two simulations represent the uncreative child following his natural inclinations in an authoritarian and a permissive environment. The last two simulations represent the child's desire to satisfy his environment's wishes, again, both environments are represented.

Several initial values are the same in all four simulations. These are: creative capability will be equal to 10; use of creative talent, 2; innate need to create, 3; and comfortable utilization of creative capability, 20 per cent.

Internal Choice, Authoritarian Environment

In this simulation the child follows his natural inclinations and satisfies his innate need to create while living in an authoritarian environment. Simulated time histories for several important variables are shown in Figure 25. At the start of the simulation the child's use of creative talent has a value of two. The behavior desired by the authoritarian environment, as represented in Figure 7, approximates a step function with an initial value of five and a final value of one.

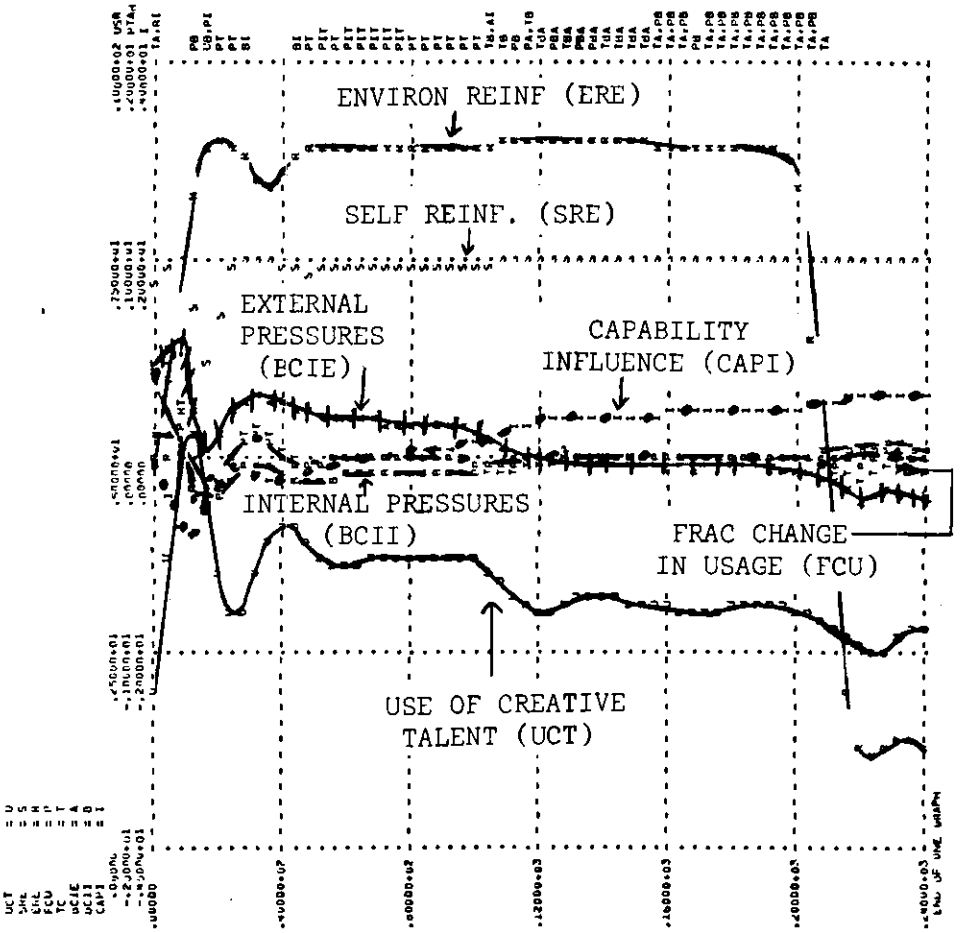


Figure 25. Simulation of Uncreative, Authoritarian, Internal Situation

At birth or time equal to zero months, the internal (BCII) and external (BCIE) pressures exerted on the child to change his behavior are positive, since his behavior (UCT=2) is below both his need to create (INC=3) and the environment's desires (BDE=5). These positive pressures result in an increase in behavior to 5.3 (the initial amplitude being equal to 3.3). This increase in behavior is greater than the individual desires; therefore, the internal pressures reverse their direction and sign, and are now negative. The initial increase in behavior to 5.3, however, approximates the behavior desired by the environment; therefore, the environment no longer exerts a large positive pressure on the child to change his behavior. This decrease in both the internal and external pressures causes behavior to decrease to 2.9. At this level, the child's need is almost satisfied and for the remainder of the simulation (17 years) the internal pressures are approximately equal to zero with two small deviations.

Although the child follows his natural inclinations, the environment still has some influence on behavior. These influences cause behavior to increase once again. This time, since the internal pressures are approximately equal to zero, behavior only rises to 4.0. The period of this oscillation from the initial peak in behavior of 5.3 to the second peak of 4.0 is 28 months. This peak value is not maintained, and behavior once again decreases, this time to 3.6 as the internal pressures slightly deviate from zero. The percentage decrease of the amplitude during the first cycle--is calculated as follows:

$$\frac{(5.3-2.9) - (4.0-3.6)}{(5.3-2.9)} \cdot 100 = 83\%$$

This means that the oscillation persists for only a short time; the adjustment behavior needed to reach a stable state does not take very long. Behavior stabilizes now at the current value of 3.6 for a period of five years until the child is nine years of age. At this time, the external pressures are once again large enough to offset the greater weight placed on the internal pressures and creativity experiences a slight setback (UCT=3.0). This increase in the external pressures results from a decrease in the behavior desired by the environment (BDE decreases from 4.5 to 3.0). The next drop in desired behavior occurs at age 14. However, this time creative behavior remains unchanged. This stabilization occurs because capability influence (which tries to keep behavior equal to 20 per cent of creative capability) no longer remains zero and offsets the negative pressures resulting from the environment.

Behavior once again stabilizes for another six years, until the last drop in desired behavior results in a large enough negative pressure to outweigh the increasing influence of capability. This causes behavior to decrease to an all-time low of 2.5. At this time (age 18), the internal pressures deviate from zero and exert a positive influence on behavior, resulting in an increase in behavior to 2.7 when the simulation ends at age 20.

Throughout the 20 years, the overall decrease in the slope of creative behavior was .005 creative behavior units per year. Behavior remained relatively stable except for a couple of initial fluctuations

in the first three years, and two decreases at age 10 and 16. The environment was generally pleased with the child's behavior and rewarded the child accordingly (average value of ERE=8.9). At age 16, however, behavior did not decrease as much as the environment desired and the child was punished for his behavior (ERE=1.2). The individual was satisfied with his performance (SRE=7.5) and a strong feeling of self-confidence, optimism, and self-esteem prevailed. Since the individual followed his natural inclinations, the pattern of the total change variable followed the behavior change influenced by the individual. Similarly, the pattern of the fraction change in usage, a weighted sum of total change and capability influence, was similar to total change because total change had a weight of .9.

In summary, when the simulated uncreative child is placed in an authoritarian environment with an internal choice function, his behavior is relatively stable after the initial oscillations, and stabilizes around his innate need. Since the child is internally oriented and his innate need is fulfilled, he experiences a feeling of security and becomes confident in his behavior.

Internal Choice, Permissive Environment

As in the previous simulation, the child follows his natural inclinations; however, this time he is raised in a permissive environment. The behavior desired by this environment, represented in Figure 4, is a downward sloping curve with an initial value of nine and a final value of seven.

Initially, the interna.. (BCII) and external (BCIE) pressures

exert a positive influence on the child to change his behavior, since his behavior (UCT=2) is below his need (INC=3) and the environment's desires (BDE=9). These positive pressures result in an increase in behavior to 5.3 (the initial amplitude being equal to 3.3). This new level of behavior is greater than the individual desires; therefore, the internal pressures on the child become negative. Simultaneously, the environment's desires are satisfied as behavior increases and the external pressures, although still positive, are not as large. This decrease in both the internal and external pressures result in a decrease in behavior to 1.7. Once again, the child is behaving below his need and the environment's desires and pressures to increase his behavior are exerted. This results in behavior increasing to 5.0.

The cycle described above is repeated throughout the simulation. The amplitudes and periods of oscillation remain almost constant for the first ten years. After age ten the amplitudes begin to decrease while the periods of oscillation increase, then stabilize. This decrease in amplitude is a result of the decrease in pressure exerted by the environment as their desires (BDE) decrease. The table below illustrates this situation. The reader will notice the increase in the values of the troughs and the decrease in the peaks' values. These appear to converge around 4.0.

Although the child uses an internal choice function, the environment does have some effect on his behavior, resulting in the child's need to create (INC=3) being surpassed with a final value in behavior equal to 4.2. Throughout the simulation the child is relatively

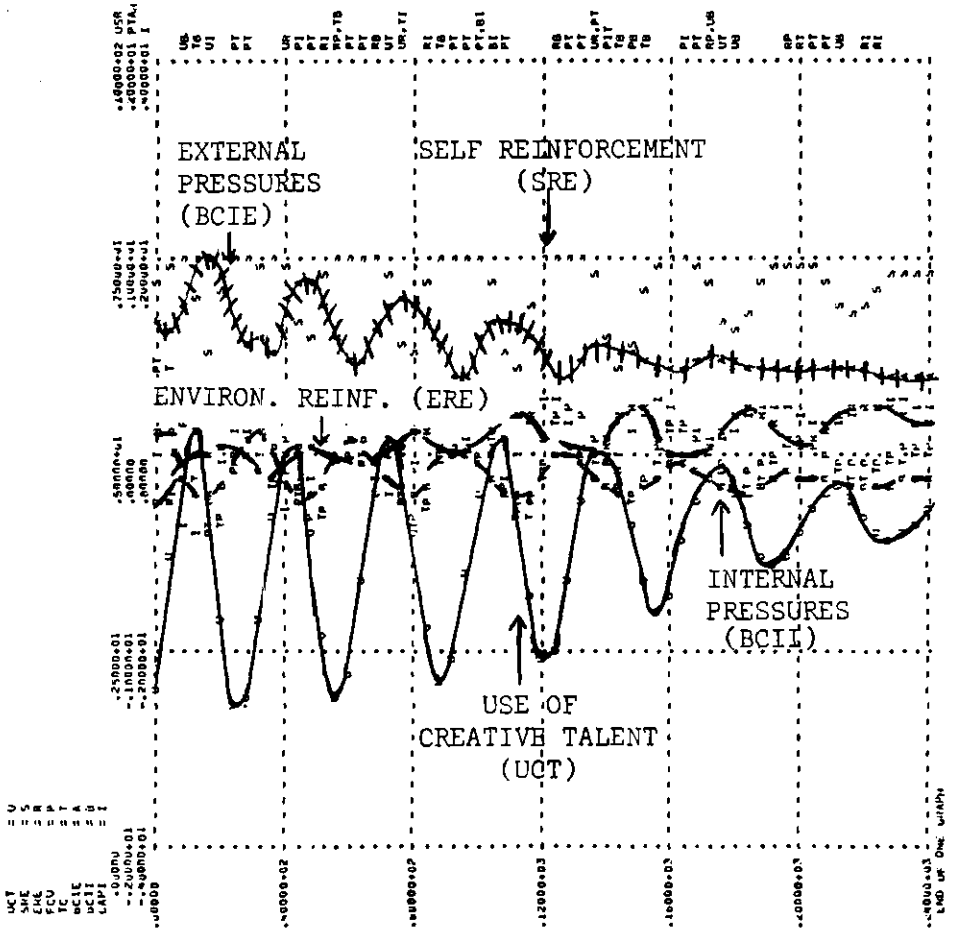


Figure 26. Simulation of Uncreative, Permissive, Internal Situation

satisfied (SRE ranges from 6.0 to 7.5), since his behavior fluctuates around his need of three. However, as the child's behavior fluctuates the environment's reinforcement (ERE) also fluctuates between reward and punishment.

Table 2. The Amplitudes and Oscillations of the Uncreative Child with an Internal Choice Function in a Permissive Environment

Cycle	Value of Trough	Value of Peak	Height of Amplitude	Time from Peak to Peak (in Months)
1	2.0*	5.3	3.3	-
2	1.7	5.0	3.3	32
3	1.9	5.2	3.3	28
4	2.0	5.2	3.2	32
5	2.3	5.1	2.8	36
6	3.0	4.7	1.7	36
7	3.5	4.5	1.0	36

*Value at the beginning of the simulation.

In summary, when the simulated uncreative child is placed in a permissive environment with an internal choice function, his behavior will oscillate approximately every three years with some decline in amplitude. This constant state of fluctuation may cause the child to feel insecure. The conflicts that result could lead to some psychological disturbances later in life.

External Choice, Authoritarian Environment

The authoritarian environment is once again represented; however, this time the child places more emphasis on the environment's wishes than on his natural inclinations.

Initially, the internal and external pressures exerted on the child to change his behavior are positive, since he is behaving (UCT=2) below his need (INC=3) and the environment's desires (BDE=5). These positive pressures result in an increase in behavior to 7.5 (the initial amplitude being equal to 5.5). This new level of behavior is greater than the individual and environment's desires. Consequently, the internal and external pressures decrease and exert a negative influence on the child's behavior. These negative pressures result in overcorrecting and a decrease in behavior (UCT=2.1) results. Once again, the child's behavior is below his need and the environment's desires and positive pressures are exerted on him to increase his behavior. Since these pressures, both internal and external, are less than the initial pressures, behavior does not increase as much (UCT=5.9, an amplitude of 3.8).

The cycle described above, and represented in Figure 27, has an initial period of oscillation of 28 months. This cycle continues to repeat itself approximately every 28 months, with a percentage decrease in amplitude initially of 55 per cent followed by a 46 per cent decrease, etc., until the child reaches ten years of age. By this time behavior has dropped to 2.9, and the environment's desires (BDE=3) and the child's innate need (INC=3) are satisfied. Therefore, the external

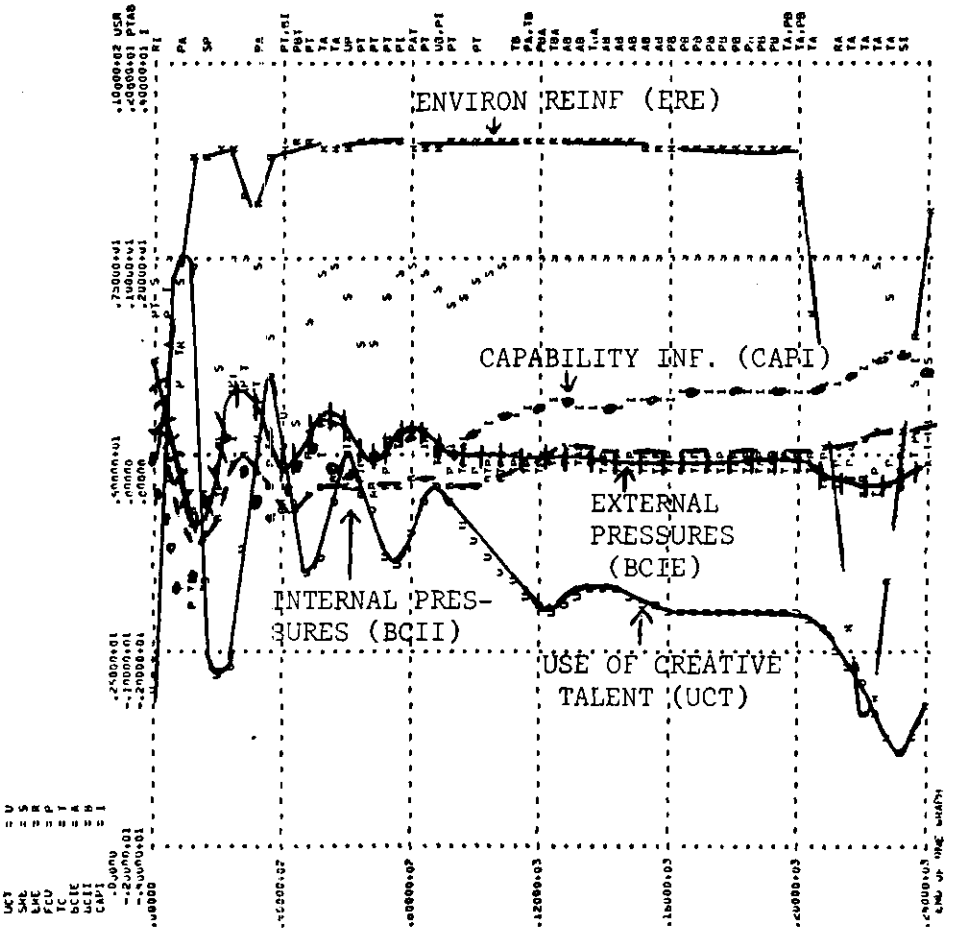


Figure 27. Simulation of Uncreative, Authoritarian, External Simulation

and internal pressures are zero and behavior stabilizes around this point (2.9) for the next six years.

At 16 years of age the environment's desires once again decrease (BDE=1). Although the external pressures also decrease at this time, the child's behavior only slightly decreases (UCT=2.3). This results from an increase in the internal pressures (behavior is below the need), coupled with an increase in capability influence (creative capability has increased over the years to 25 and the child is behaving less than the comfortable utilization level of 20 per cent). Consequently, the environment no longer rewards the child for his behavior. This change in external reinforcement from reward to punishment results in a further decrease in behavior (UCT=1.2). A slight recovery, however, is experienced during the next year and at the end of the simulation the final value of behavior is 1.8.

In summary, when the simulated uncreative child is placed in an authoritarian environment with an external choice function, his behavior oscillates for the first ten years due to an initial overcorrection. Behavior then stabilizes for the next eight years around 2.9 and after its last decrease, the simulation ends when behavior is recovering from its final dip on an upward swing. The results seem to indicate that this uncreative, externally oriented child will remain uncreative, but will be a happy individual since his desire to please his environment is fulfilled (the average value of ERE being equal to 8.9).

External Choice, Permissive Environment

The last in this set of simulations representing the uncreative child is shown in Figure 28. In this simulation the child wishes to satisfy the desires of his environment, a permissive one.

Initially, as in the prior simulations the pressures exerted on the child to change his behavior are positive because neither his need nor the environment's desires are fulfilled. However, unlike the simulation represented in Figure 26 (internal choice, permissive environment), the child chooses to satisfy his environment, so the greater weight is placed on the external pressures. This results in an increase in behavior to 15.7 (the initial amplitude being equal to 13.7). This new level of behavior far surpasses the individual and environment's desires. Therefore, the pressures exerted on behavior are now negative resulting in behavior decreasing to 1.1. Once again, the child's behavior is below his need and the environment's desire. A strong positive pressure is exerted on behavior, resulting in its increase to 14.9.

The cycle described above repeats itself every 24 months throughout the simulation. The amplitudes decrease, however, as is shown in Table 3. It can be assumed that if the trend continues, the final value of behavior should range between 6.3 and 6.7. At the end of the simulation (see Figure 28), behavior is recovering from its last dip and ends at a level of 6.3.

In summary, the model of an uncreative, externally oriented child who is raised in a permissive environment, exhibits behavior that oscillates every 24 months with some damping and an apparent

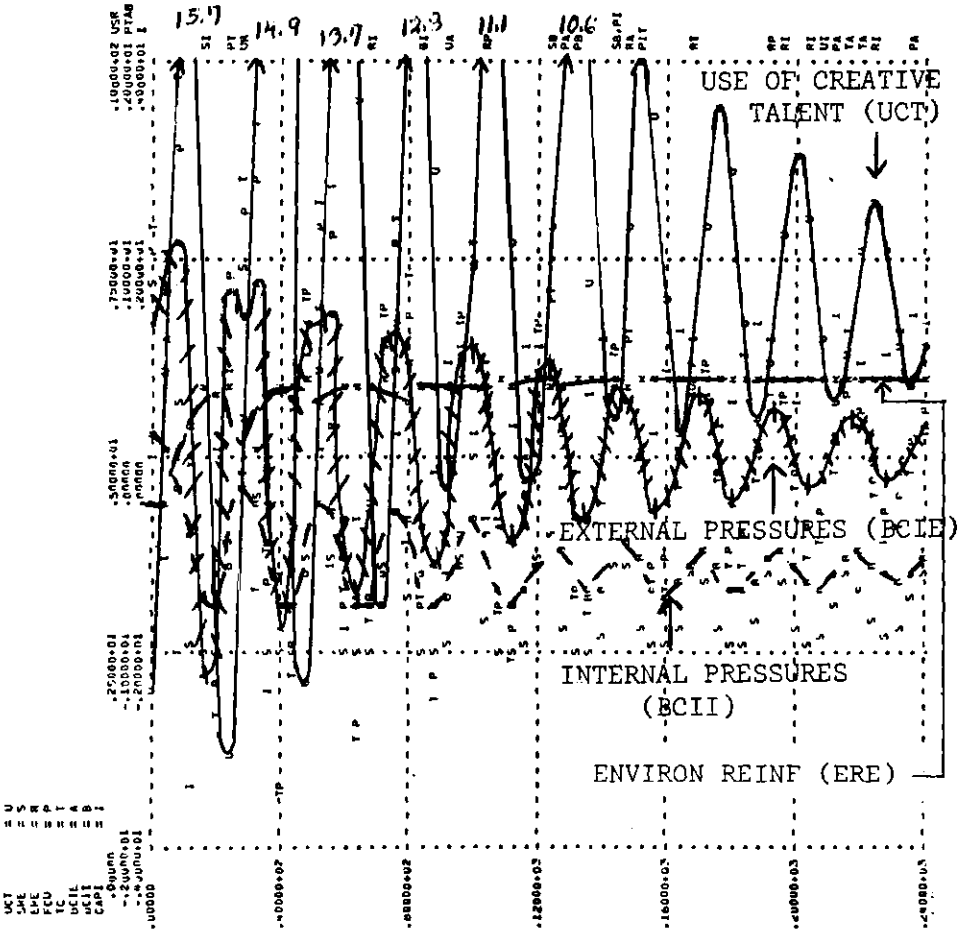


Figure 28. Simulation of Uncreative, Permissive, External Situations

convergence near the environment's desires of seven. Since the child's desire to satisfy his environment is fulfilled, he is happy. However, unlike the uncreative, externally oriented child in the previous section, this child's behavior is in a constant state of oscillation. These oscillations may cause sufficient psychological problems that outweigh the benefits of the increase in creativity.

Table 3. The Amplitudes and Their Percentage Decrement of the Uncreative Child with an External Choice Function in a Permissive Environment

Cycle	Value of Trough	Value of Peak	Height of Amplitude	Percentage Decrement of Amplitude
1	2.0*	15.7	13.7	-
2	1.1	14.9	13.8	11
3	2.0	23.7	11.7	17
4	3.0	12.3	9.3	21
⋮	⋮	⋮	⋮	⋮
9	5.5	8.7	3.2	-
10	5.7	8.2	2.5	46

*Value at the beginning of the simulation.

Summary of the Uncreative Child

When the simulated child used an internal choice function, he remained uncreative despite the environment's desires. However, in the authoritarian environment his behavior (UCT=2.7) almost completely

satisfied his need to create (INC=3); therefore, the child was satisfied and a feeling of self-confidence, optimism, etc., prevailed. In the permissive environment, behavior fluctuated with a damped oscillation around 4.0. This constant state of fluctuation resulted in feelings of insecurities and conflicts, which may result in some psychological problems later in life.

When the child used an external choice function his behavior varied with the environment. In the authoritarian environment his behavior (1.8) approximated the environment's desires. Thus the child remained uncreative, but was happy since his desire to please the environment was fulfilled and it rewarded him accordingly. On the other hand, the child raised in a permissive environment also was rewarded since his behavior increased from 2.0 to 6.3 approximating the environment's desires (BDE=7). However, the constant oscillations in his behavior may cause psychological problems that outweigh the benefits of the increase in creativity.

The Creative Child

Four simulations are represented in this section. The first two represent the patterns of behavior that exist when a creative child follows his natural inclinations in an authoritarian and a permissive environment. The last two simulations represent the child's desire to satisfy his environment's wishes; again, both environments are represented.

Several initial values are the same in all four simulations. These are: creative capability will be equal to 24; use of creative

talent, 8; innate need to create, 9; and comfortable utilization of creative capability, 33 per cent.

Internal Choice, Authoritarian Environment

In this simulation, represented in Figure 29, the child follows his natural inclinations and satisfies his innate need to create. At the start of the simulation, the child's use of creative talent has a value of eight. The behavior desired by an authoritarian environment, represented in Figure 7, has an initial value of five and a final value of one.

Initially, the internal pressures (BCII) exert a positive influence on the child to change his behavior, since his behavior (UCT=8) is below his need to create (INC=9). At the same time, the external pressures (BCIE) are exerting a negative influence, since their desires (BDE=5) are surpassed. The greater weight is placed on the internal pressures, since an internal choice function is chosen, resulting in an increase in behavior to 9.3 (the initial amplitude being equal to 1.3). This increase in behavior is greater than the individual desires; therefore, the internal pressures along with the external pressures decrease resulting in behavior decreasing to 8.6. Once again the child's behavior is below his need and positive internal pressures are exerted on him to increase his behavior. Behavior increases to 9.1 (the period of oscillation being equal to 28 months) and for the remainder of the simulation (16 years) the internal pressures are approximately equal to zero.

Although the child follows his innate need, minor oscillations do

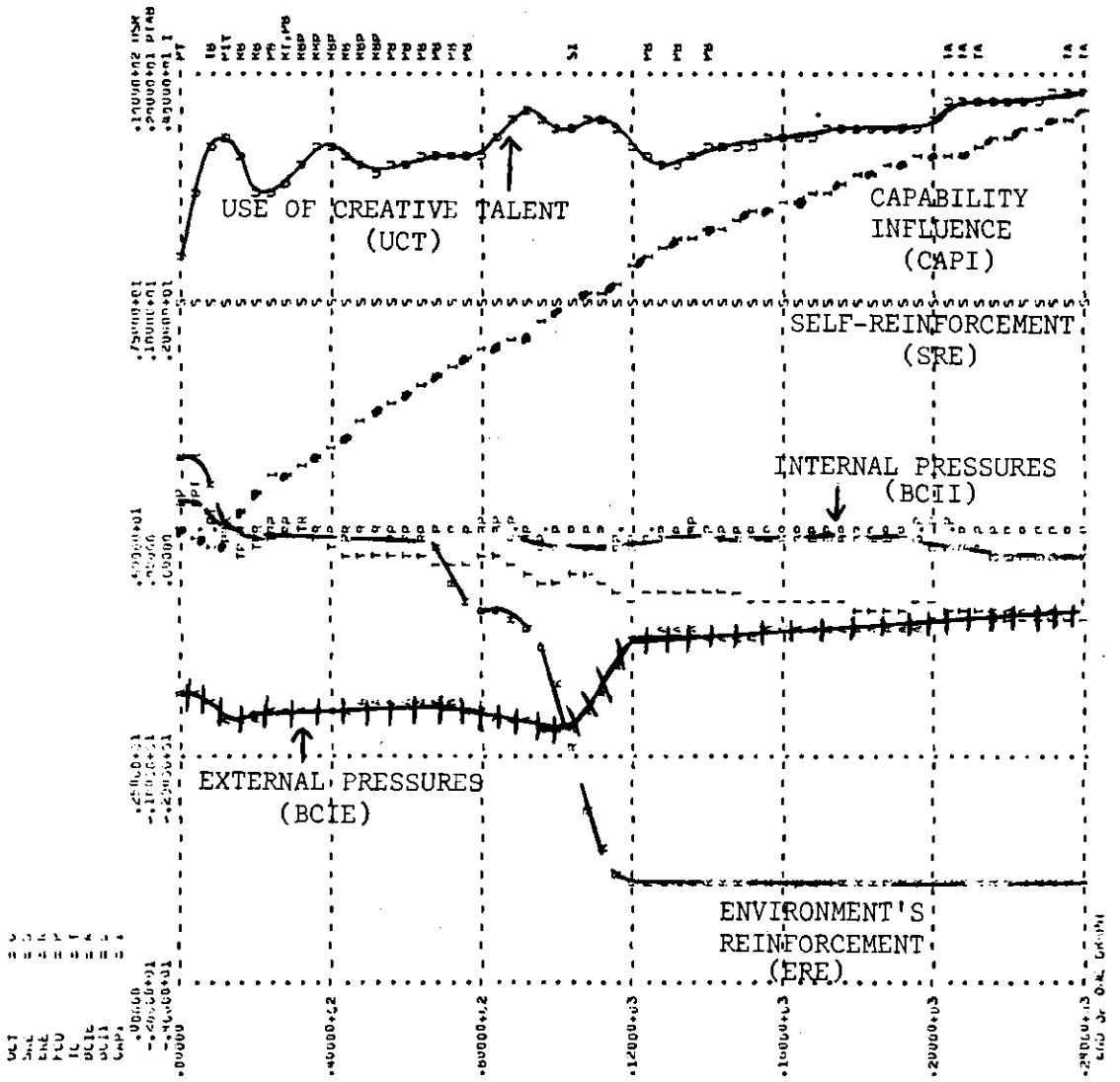


Figure 29. Simulation of Creative, Authoritarian, Internal Situation

exist in his behavior during the first several years. These can be attributed to the initial overcorrecting and to the strong need for external reinforcement (NER) the child has during these early years. In spite of these setbacks, the child remains creative and at age 20, when the simulation ends, behavior has a final value of 9.8. This final value has surpassed the child's need and the environment's desires as a result of the positive pressures exerted on behavior by capability influence. Creative capability has increased over the years to 73 and the child is behaving at less than the comfortable utilization level of 33 per cent.

The individual is extremely satisfied with his behavior (SRE=7.5, the maximum positive reinforcement possible) throughout the simulation. On the other hand, the environment is extremely dissatisfied and punishes the child.

In summary, when the simulated creative child is placed in an authoritarian environment with an internal choice function, his behavior exhibits a positive trend with some initial minor fluctuations. These result from the initial overcorrecting and the child's strong need for external reinforcement early in life. Since the child is internally oriented and his innate need is fulfilled, he experiences a strong feeling of self-worth, and becomes confident in his behavior.

Internal Choice, Permissive Environment

As in the previous simulation, the child follows his natural inclinations, however, this time he is raised in a permissive environment. The behavior desired by this environment, represented in Figure

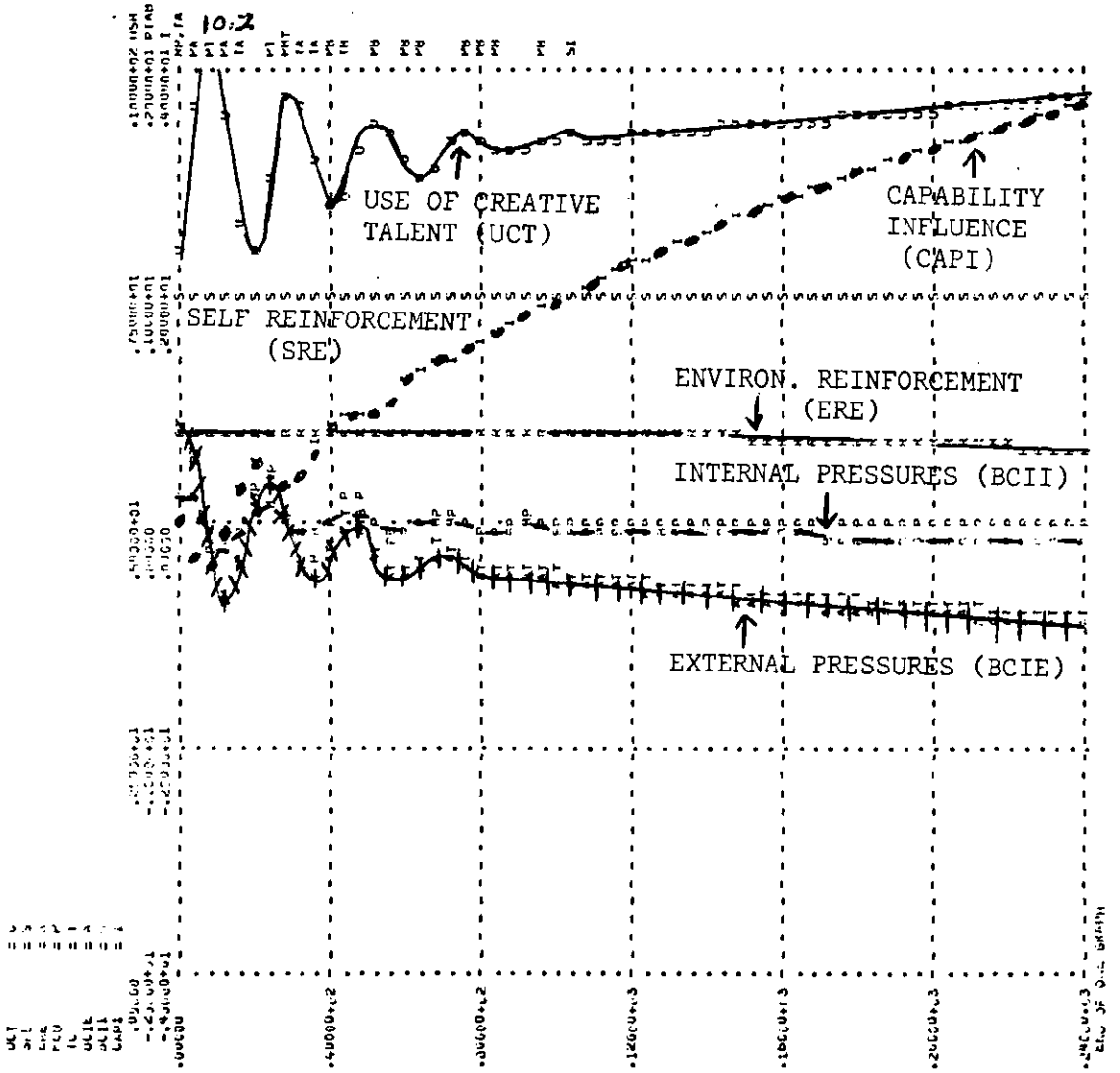


Figure 30. Simulation of Creative, Permissive, Internal Situation

4, is a downward sloping curve with an initial value of nine and a final value of seven.

Initially, the internal (BCII) and external (BCIE) pressures exert a positive influence on the child to change his behavior (UCT=8) since his behavior is below his need (INC=9) and the environment's desires (BDE=9). These positive pressures result in an increase in behavior to 10.2 (the initial amplitude being equal to 2.2). This new level of behavior is greater than the individual and environment's desires. Consequently, the internal and external pressures decrease and exert a negative influence on behavior. These negative pressures overcorrect and a decrease in behavior (UCT=8) results. Once again, the child's behavior is below his need and the environment's desires and positive pressures are exerted on him to increase his behavior resulting in behavior increasing to 9.6.

The cycle described above and represented in Figure 30 has an initial period of oscillation of 20 months. This cycle continues to repeat itself approximately every 20 months (with a percentage decrease in amplitudes of 45 per cent, 50 per cent, etc.) until the child reaches seven years of age. At this time behavior has a value of 9.0, satisfying the child's need to create (INC=9). Although the environment's desires (BDE=8.2) are surpassed, the negative, external pressures are not strong enough to cause behavior to decrease. Consequently, behavior stabilizes with a slight upward trend and at the end of the simulation the final value of behavior is 9.7.

The final value and those of the last 13 years are above the

child's need and the environment's desires as a result of the positive pressure exerted on behavior by capability influence.

In summary, when the simulated creative child is placed in a permissive environment with an internal choice function, his behavior oscillates for the first seven years due to overcorrecting. Behavior then stabilizes with a slight upward trend. Since the child is internally oriented and his need is fulfilled, he is extremely satisfied with his behavior (SRE=7.5). However, in contrast to the internally creative child in the previous simulation, this child is also highly praised and rewarded by his environment. Thus a happy, confident, secure child with a high degree of self-esteem seems to develop.

External Choice, Authoritarian Environment

The authoritarian environment is once again represented; however, this time the child places more emphasis on the environment's wishes than on his natural inclinations.

Initially, the internal pressures (BCII) exert a positive influence on the child to change his behavior. At the same time, the external pressures (BCIE) are exerting a negative influence. Since the child is externally oriented, the greater weight is placed on the external, negative pressures and behavior decreases to .5 (a drop of 7.5). This decrease in behavior is much greater than the environment desires; consequently, the external pressures along with the internal pressures now exert a positive influence and behavior increases to 9.0 (an initial amplitude of 8.5). This new level of behavior far surpasses the environment's desires (BDE=5); therefore, the external pressures exerted on

behavior are once again negative and behavior decreases to 3.4.

The cycle described above and represented in Figure 31, repeats itself every 28 months for the first ten years with a decreasing amplitude. After age ten, the amplitudes and periods of oscillation increase. These oscillations appear to have a downward trend with an overall slope of -1.6 creative behavior units per month. The table below will verify the above discussion.

Table 4. The Amplitudes and Oscillations of the Creative Child with an External Choice Function in an Authoritarian Environment

Cycle	Value of Trough	Value of Peak	Height of Amplitude	Time from Peak to Peak (in Months)
1	0.5	9.0	8.5	-
2	3.4	7.6	4.2	28
3	4.4	6.1	1.7	28
4	5.0	5.5	0.5	28
5	3.7	5.5	1.8	48
6	3.2	5.4	2.2	44
7	2.1			

Although the child uses an external choice function, the simulation ends with behavior increasing (UCT=3.7) despite the strong negative reinforcements of the environment. This results from an increase in capability influence coupled with a slight increase in the internal pressures.

In summary, when a simulated creative, externally oriented child

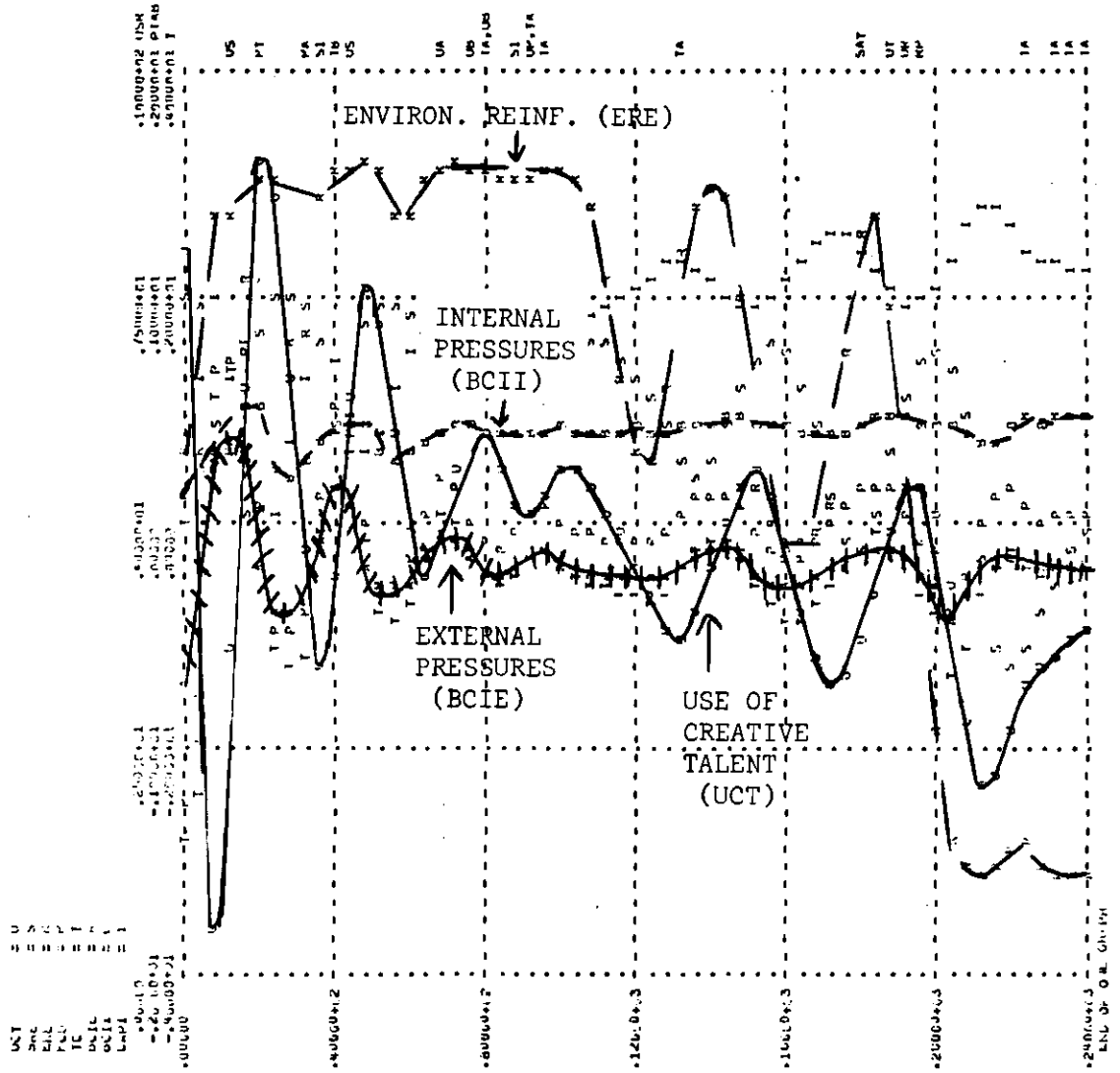


Figure 31. Simulation of Creative, Authoritarian, External Situation

is placed in an authoritarian environment he sacrifices his creativity in order to satisfy his environment's desires. Since he is rewarded (most of the time) for his behavior, he will be a relatively happy individual; however, the fluctuations that exist in his behavior may lead to a state of confusion and conflicts which may result in some psychological problems later in life.

The reader will notice the simulation just discussed resembles Torrance's theory of creative development. Creative behavior does dip at the various points of discontinuities in our culture (see page 9 for a review of these points). Torrance's curve, however, has an upward trend which is not present in this simulation. This positive trend will be further discussed in the next section--the sensitivity of the model.

Torrance asserts his curve measures creative capability. My opinion is that it measures creative performance rather than ability, and based on the performance (tests' results) it can be inferred (most of the time) that an individual has at least a certain amount of capability. I also feel that Torrance in grading his tests did not allow for differences that may exist among various ethnic groups, localities, etc., in a given culture; although he did take this into consideration when studying different cultures.

Although I disagree with Torrance on several points relating to his tests, I believe that creativity does experience setbacks because of the abrupt changes in demands the environment places on the individual at various stages in his development.

External Choice, Permissive Environment

The last of the simulations representing the creative child is shown in Figure 32. In this simulation the child wishes to satisfy the desires of his environment, a permissive one.

Initially, the pressures exerted on the child to change his behavior are positive since neither his need nor the environment's desires are fulfilled. These positive pressures result in behavior increasing to 10.7. This new level of behavior surpasses the individual and environment's desires; therefore, the pressures exerted on behavior are now negative, resulting in behavior decreasing to 6.9. Once again, the child's behavior is below his need and the environment's desires and positive pressures are exerted on behavior to increase. The cycle described above and represented in Table 5, repeats itself every 20 to 24 months, until the child reaches 13 years of age. At this time behavior stabilizes around 8.8 with a slight downward trend, and at the end of the simulation the final value of behavior is 8.5. This final value is greater than the environment's desires (BDE=7) due to the positive pressures exerted on behavior by capability influence.

The environment and the individual are satisfied with the child's performance and maximum external and internal reinforcements (ERE=6; SRE=7.5) are given the child.

In summary, when the simulated creative child with an external choice function is placed in a permissive environment, his behavior is characterized by damped oscillations and finally stabilizes with a downward trend at 13 years of age around 8.8. The results seem to indicate

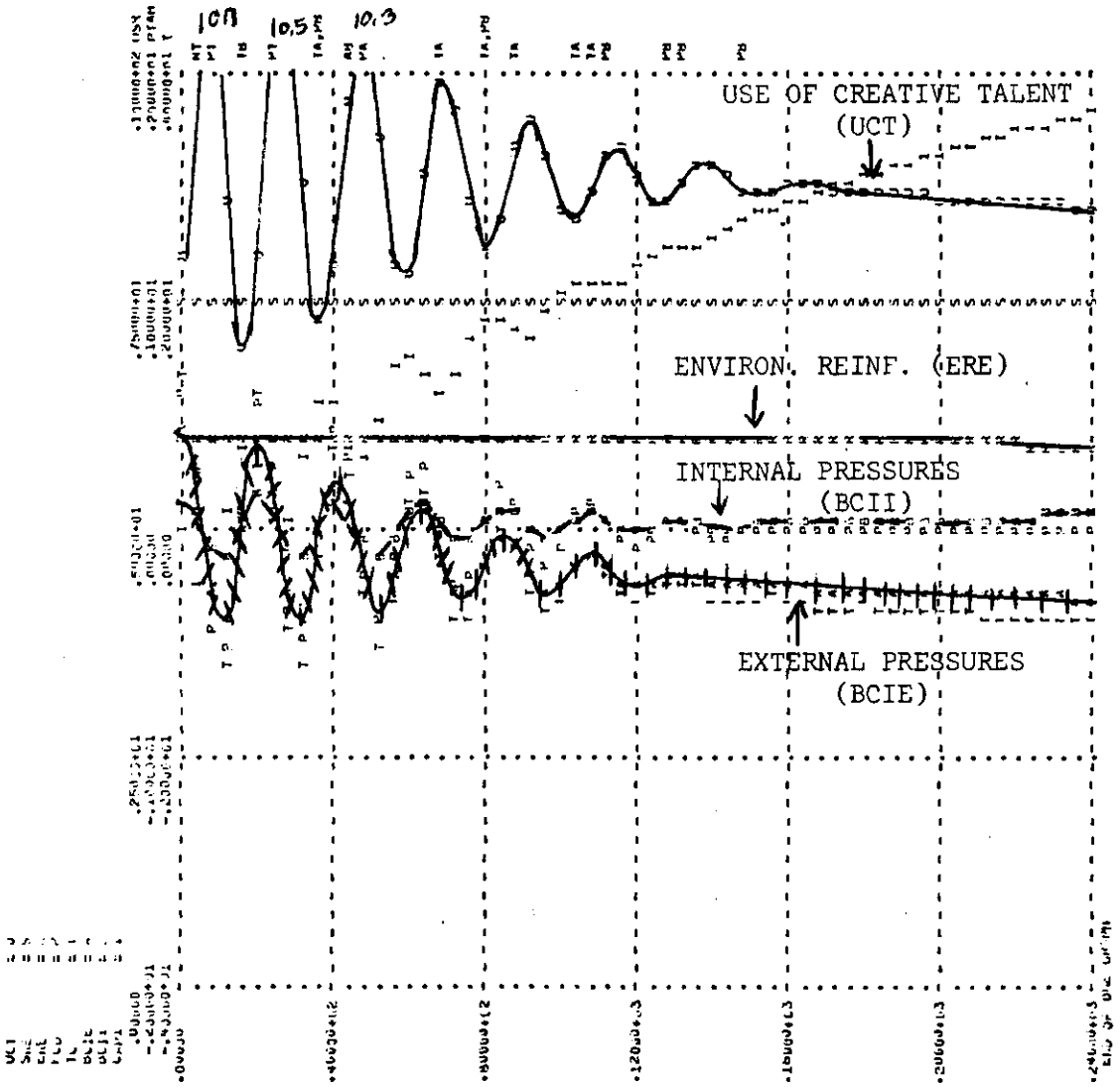


Figure 32. Simulation of Creative, Permissive, External Situation

that this creative, externally oriented child will remain creative and be a happy individual since his desire to please his environment is fulfilled.

Table 5. The Amplitudes and Their Percentage Decrement of the Creative Child with an External Choice Function in a Permissive Environment

Cycle	Value of Trough	Value of Peak	Height of Amplitude	Percentage Decrement of Amplitude
1	8.0*	10.7	2.7	-
2	6.9	10.7	3.6	15
3	7.3	10.3	3.0	16
4	7.7	9.8	2.1	30
5	8.0	9.4	1.4	44

*Value at beginning of the simulation.

The environment and the individual are satisfied with the child's performance and maximum external and internal reinforcements (ERE=6; SRE=7.5) are given the child.

In summary, when the simulated creative child with an external choice function is placed in a permissive environment, his behavior is characterized by damped oscillations and finally stabilizes with a downward trend at 13 years of age around 8.8. The results seem to indicate that this creative, externally oriented child will remain creative and be a happy individual since his desire to please his environment is fulfilled.

Summary of the Creative Child

When the simulated child used an internal choice function, he remained creative despite the environment's desires (UCT=9.8, 9.7). However, in the authoritarian environment, his behavior did not satisfy the environment's desires and he was punished. Since the child was internally oriented and his need was satisfied a feeling of self-confidence, self-worth, etc., prevailed. On the other hand, in the permissive environment, the child's behavior satisfied his need as well as the environment's desires. Therefore, a happy, self-confident, secure chid developed.

When the child desired to satisfy his environment, his behavior varied accordingly. In the authoritarian environment his behavior dropped from 8.0 to 3.7. This decrease in behavior pleased the environment and the child was rewarded. In the permissive environment the child's behavior (UCT=8.5) satisfied his need as well as the environment's desires; therefore a happy, secure, self-confident, creative child developed.

The table below summarizes the results of the past two sections. The reader is reminded that the creative child's need to create is nine, the uncreative three; the permissive environment's standards range from nine to seven, the authoritarian's from five to one.

In summary, the table suggests that a permissive environment may foster creativity. The amount of influence the permissive environment has on the child depends on which of the two pressures he chooses to respond to--his internal one or the environment's.

Table 6. Final Values of Use of Creative Talent

Choice	Environment	Creative Child	Uncreative Child
Internal	Permissive	9.7	4.2
Internal	Authoritarian	9.8	2.7
External	Permissive	8.5	6.3
External	Authoritarian	3.7	1.8

Sensitivity of the Model

Most of the simulations discussed in this section represent the uncreative child in an authoritarian environment with an internal choice function. This situation appeared to be most representative of the real world with illustrations clear enough for the reader to follow the behavioral patterns that will be discussed.

Fraction Change in Usage

The model appears to be sensitive to the weight attached to the variables, total change (TC) and capability influence (CAPI), comprising fraction change in usage. As the greater weight is shifted from total change to capability influence, use of creative talent rises more rapidly.

As Table 6 indicates, the results of shifting the greater weight to capability influence are:

1. Use of creative talent increases and surpasses the child's innate need to create (INC=3), in spite of an internal choice function.

The internal pressures comprise more than half the value of the total change variable. As the greater weight is shifted away from total change the system becomes less responsive to the internal pressures.

2. The initial amplitude of the oscillations gradually decreases, resulting in fewer cycles as overshooting no longer occurs.

3. The dips that occur at 120 and 220 months gradually decrease and eventually disappear as less weight is attached to total change and consequently to the external pressures comprising total change.

4. The environment and the individual's reinforcement change from positive to negative as their desires are not satisfied.

Table 7. Results of Increasing the Weight Attached to the Capability Influence Variable

Weight	Use of Creative Talent	Initial Amplitude	Number of Oscillations
.1	2.7	3.3	2
.3	3.5	2.3	1
.5	4.4	1.3	1
.7	5.4	0.7	0
.9	6.0	0	0

Comfortable Utilization

As the previous section indicates, when capability influence has the greater weight in the variable fraction change in usage a positive

trend develops. The slope of the trend, however, increases with any one given weight if comfortable utilization increases. With an increase in comfortable utilization, capability influence has a greater influence on behavior to increase. As use of creative talent increases, the percentage of actual utilization increases, resulting in an increase in capability. This positive loop continues to drive use of creative talent and creative capability higher and higher.

An example of the above situation is: When capability influence has a weight of .9 in the variable fraction change of usage and the level of comfortable utilization is 20 per cent of creative capability, use of creative talent increases to 6.0 approximately 20 per cent of the final value of creative capability (CC=32). However, when the percentage of comfortable utilization is increased to 50, all other things remaining equal, use of creative talent increases to 244, approximately 50 per cent of creative capability (CC=545).

It is in the balancing of capability influence and comfortable utilization along with the oscillating pattern represented in Figure 31 that a time history approximating Torrance's creativity curve in Figure 1 can be obtained.

Choice Function

In this section, the behavior patterns that develop when a child has a constant choice function of one will be analyzed. This type of choice function represents the equal weighting of the internal and external pressures. Four simulations will be discussed--the uncreative and the creative child raised in an authoritarian and a permissive environment.

Uncreative Child, Authoritarian Environment. At birth or time equal to zero months, the internal and external pressures exert a positive influence on the child since neither his need (INC=3) nor the environment's desires (BDE=5) are fulfilled. These positive pressures result in behavior increasing to 6.6 (the initial amplitude being equal to 4.6). This new level of behavior is greater than desired; therefore, the pressures reverse and become negative. Behavior then falls to 2.5. This pattern of behavior is similar to the pattern that represents the uncreative child with an external choice function (Figure 27). However, the initial amplitude is not as great (4.6 as compared to 5.5), because the internal pressures have a weight of 1.0 instead of -.36 as is the case with an external choice function.

Initially less overcorrecting occurs therefore the oscillations disappear more quickly and stabilization is reached at 120 months with behavior equal to 3.0 (one tenth of a point greater than with the external choice function). For the remainder of the simulation all three runs--internal, external, constant choice function--are stable and experience their final dip at 16 years. The simulations all end on an upward trend with behavior recovering from this setback.

In summary, the simulated uncreative child in an authoritarian environment will remain uncreative. His behavior will oscillate the first several years then stabilize. This behavior pattern lies somewhere between the patterns that represent the child using an internal and external choice function. The final value of behavior (UCT=2.1) lies between 1.8 and 2.7 the values reached with the external and

internal choice functions respectively. Therefore the amount of reinforcement the child experiences will vary accordingly.

Uncreative Child, Permissive Environment. The pattern of behavior that emerges when an uncreative child is raised in a permissive environment having a constant choice function is similar to the pattern of behavior that exists when a varying choice function (either an internal or external one) is used. When an uncreative child is raised in such an environment, an oscillatory pattern of behavior is manifested since the goals of the individual and the environment are conflicting.

When an internal choice function is used the oscillatory pattern has a slight upward trend converging to 4.0. The amplitudes of the oscillations range from 3.3 to 1.0. On the other hand, a downward trend is present with an external choice function converging to 6.5 (the value of the amplitudes ranging from 13.7 to 2.5). In the situation using a constant choice function the trend also is downward; however, the value of the amplitudes ranges from 8.9 to .3.

It appears that with a constant choice function the oscillations die out more quickly than with the varying choice functions (as is indicated by the size of the last few amplitudes). The final value of 6.0 indicates that the permissive environment has a stronger influence on the child than his own inclinations. In all three simulations the constant state of oscillation may result in conflicts and insecurities that may cause psychological problems that outweigh the advantages of the increase in creativity.

Creative Child, Authoritarian Environment. When a creative child is raised in an authoritarian environment, under the existing set of conditions, conflicts result. These conflicts manifest themselves by a series of oscillations characterizing the development of behavior. In the situation using an internal choice function, the oscillations damp-out and behavior stabilizes around 120 months with a slight upward trend. At the end of the simulation, the final value of behavior is 9.8. This value is above the child's need as a result of the positive pressures exerted on behavior by capability influence. When an external choice function is used behavior oscillates every 28 months with a downward trend resulting in a final value of behavior of 3.7. In the situation using a constant choice function, the oscillations damp-out and behavior stabilizes with an upward trend at 160 months. This trend continues until the simulated child is 18 years of age, at which time behavior reaches a plateau at a value of 8.7.

In summary, although the simulated creative child has a problem adjusting to an authoritarian environment, once the adjustment period is over (13 years) his internal pressures dominate. This results in the child remaining creative and self-confident in his behavior.

Creative Child, Permissive Environment. The pattern of behavior that emerges when a creative child is raised in a permissive environment having a constant choice function is similar to the patterns of behavior that exist when an internal or external choice function is used. At birth or time equal to zero months, the internal and external pressures are positive resulting in behavior increasing more than the individual

and the environment desires. This overcorrecting results in a series of oscillations until behavior finally stabilizes.

The time stabilization occurs and the slope of the trend that follows varies with the different choice functions. When an internal choice function is used, stabilization occurs at 80 months with an upward trend resulting in a final value of behavior equal to 9.7. On the other hand, stabilization occurs at 160 months with a downward trend when an external choice function is used, with a final value of behavior equal to 8.5. In the situation using a constant choice function stabilization occurs at 120 months. At this time the child's need (INC=9) is fulfilled; therefore no internal pressures are exerted on behavior to change. The negative external pressures that exist, since behavior is above the environment's desires, are balanced by the positive pressures exerted on behavior by capability influence. Creative capability has increased over the years to 72 and the child is behaving less than the comfortable utilization level of 33 per cent. Consequently, behavior stabilizes at 9.1 and remains constant for the remainder of the simulation.

In summary, in all three situations (using an internal, external and constant choice function) the simulated creative child remains creative and is a happy, secure, self-confident individual.

Adjustment Time

In an isolated negative feedback loop as the adjustment time increases, the response strength decreases, and fewer longer-period oscillations occur. In this model, as the child increases the time it

takes him to adjust his behavior to that desired, the initial amplitude decreases. This eliminates the second oscillation that occurs at 40 months and, in general, smooths out the behavior patterns that exist in the original simulation. The initial amplitudes that result when the adjustment time increases from 4 months to 9 and then 16 months are: 3.3, 2.6, 2.0. The final values in behavior (2.7, 2.6, 2.7) are approximately equal and the model is generally not too sensitive to changes in the adjustment times.

Since the child is internally oriented and his need to create is fulfilled, he is satisfied with his performance (SRE=7.5) and a feeling of self-confidence and self-worth prevails in all three simulations.

Delay Time

In an isolated negative feedback loop, as the average delay time increases the ability of the loop to absorb corrections increases, resulting in increased oscillations. In this simulation, the delay times used to average the environment (ATEPB) and the individual's (ATSPB) perception of behavior are increased from 4 months to 9 and then 16 months. Simultaneously, the delay times used to average the environment (ATOERE) and the individual's (ATOSRE) reinforcement are increased from 6 months to 9 and then 16 months.

The results of increasing these delay times are an increase in the initial period of oscillation from 28 months to 36 and 76 months, respectively; behavior which initially stabilizes at 56 months, now stabilizes at 156 and 160 months. Although the stabilization times vary, the value of behavior at these times is approximately equal with

the final value of behavior converging at around 2.5.

The child's behavior stabilizes nine years later when the delay times are increased. Therefore, the child remains in a conflicting state for a longer period of time, and his feelings of insecurity may prevail for a longer period also.

The above parameters (ATEPB, ATSPB, ATOERE, ATOSRE) were later held constant at their original values and the delay times used in averaging actual utilization (ATDAU), the measure of conflict (ATAMOC), and desirability (ATDID) were increased from 4 months to 9 and then 16 months.

The model appeared to be sensitive to changes in the delay times in the desirability and average utilization (DAU) variables despite the fact that average utilization is contained within a negative loop (see Figure 2). This is because this negative loop serves to set the gain of a positive loop that exists between creative capability (CC) and net change in creative capability (NCC). The positive loop dominates the behavior and neutralizes the normal patterns of the negative loop.

The model is initially sensitive to the different delay times in the average measure of conflict variable (AMOC). The average measure of conflict (the average difference between the internal and external pressures) controls the weights that the choice function places on the internal and external pressures. Therefore, as these pressures oscillate, the average measure of conflict varies and the choice functions varies its weights. This amplifies oscillations in the internal and external correction loops. When the delay times are increased, the

average measure of conflict does not vary as much. The choice function's weights then vary less, resulting in less amplification of the oscillating pressures. When this delay time is changed from 4 to 9 months, the initial amplitude decreases from 3.3 to 2.6 and stabilization occurs at 40 months rather than at 56 months.

Need for Self-Fulfillment (NSR)

The model appears to be quite sensitive to the need for self-fulfillment. Although the final values of behavior do not change significantly (from 2.7 to 2.8) for the different need for self-fulfillment values that are tested, the pattern differs substantially.

When the need for self-fulfillment is 5, the initial period of oscillation is 28 months, and after the second peak of 4.0 is reached, behavior stabilizes at 56 months with a slight downward trend to its final value of 2.7. However, when the need for self-fulfillment is 9, behavior oscillates approximately every two years with a damping effect. The initial amplitude of 3.8 followed by several others (2.8, 2.1, 2.0, ...) appear to fluctuate around 2.9.

When the child's behavior deviates from his need to create, the percentage deviation from his need for self-fulfillment increases (as the need for self-fulfillment increases), increasing the influence the internal forces have on behavior to change (BCII). Since the child has an internal choice function, this increase in the behavior change results in a behavior change greater than that desired. Consequently, overcorrecting occurs and negative pressures are now exerted on the child to decrease his behavior. Since these pressures decrease behavior

to 1.6, considerably less than desired, the cycle repeats itself.

This constant state of fluctuation may result in insecurities and conflicts that may result in psychological problems later in life.

Validation of the Model

The criteria used in validating any model are both quantitative and qualitative. Validation is needed for the structural components--loop organization, equations, and parameters--and for the performance patterns.

Quantitatively, the validation of the structure is beyond the scope of this thesis because data are not available for most of the variables in this intangible human system. Qualitatively, the equations and the organization of the loops were derived from logic and the statements of experts. Many of the relationships were constructed from interviews with Drs. Daniels (11b) and Torrance (56) as well as from the literature in the field. For example, "Self evaluation . . . refers to a judgemental process in which the individual examines his performance . . . and according to his personal standards . . . arrives at a decision of his own worthiness" (9, p. 7). This statement lead to the comparison of self-perceived behavior and innate need, and based on the percentage error a given amount of self-fulfillment was experienced.

The performance patterns also were not validated quantitatively due to the lack of data available. Qualitatively the characteristics that appear in some of the simulations, in particular the simulation represented in Figure 31, were similar to Torrance's creative development curve. As previously mentioned, behavior did oscillate and

experience a decrease at the points of discontinuities in our culture's desired creative behavior function. However, a positive trend was not achieved. When an increasing trend did occur (e.g., as a result of increasing the percentage of comfortable utilization and shifting the weight attached to capability influence) the oscillations disappeared. By experimenting with these parameters a balance could probably be achieved whereby a positive trend with oscillations is reached.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The conclusions that can be drawn from the behavior patterns represented in Chapter VI are:

1. The uncreative child with a determination to follow his natural inclinations remains uncreative. In the authoritarian environment the child's behavior decreases below his need. The permissive environment causes behavior to constantly oscillate converging to a value a little above his need.

2. The uncreative child who desires to satisfy his environment adjusts his behavior to the environment's desires. Therefore, his behavior falls below his innate need to create with an authoritarian environment, and rises above his need in a permissive environment.

3. The creative child with a determination to follow his natural inclinations in spite of environmental pressures remains creative. Behavior oscillates in both environments. However, in the permissive environment it stabilizes much sooner than in the authoritarian, though there is little difference in the final values of behavior.

4. The creative child who desires to satisfy his environment, even at the expense of sacrificing his creativity, alters his behavior accordingly. The more conforming and rigid the environment, the greater is the decrease in his creative behavior.

Several other conclusions related to those external variables, table functions, and parameters to which the model is sensitive are:

1. Fraction change in usage (FCU) is a weighted sum of total change (TC) and capability influence (CAPI). When the heavy weighting is shifted from total change to capability influence, use of creative talent rises more rapidly.

2. Increasing the comfortage percentage of capability utilization results in an even greater percentage increase in creative behavior.

3. Creative capability (CC) increases more rapidly if the slope of the curve representing fraction change in capability (FCC) is increased and/or if the entire curve is shifted upward.

4. The shape of the curve representing behavior desired by the environment (BDE) influences the pattern of behavior that develops. When behavior desired by the environment resembles a decreasing step function, oscillations occur in the child's behavior at the points of discontinuities in the curve representing the desired behavior.

5. As the shape of the curve representing the choice function is changed from concave upward to concave downward the oscillations and the final value of behavior also changes depending on the type of child and the environment.

Recommendations

The recommendations proposed are tentative and subject to change because this preliminary study is not based on extensive quantitative data and well-investigated conceptualizations by experts in the field. Qualitative relationships combined with a small amount of quantitative data have been used.

Based on the conclusions the recommendations proposed are:

1. If the development of creativity is the desired goal, an attempt should be made to create a permissive environment for the child.

2. A creative child, i.e. a child with the ability (CC), interest (INC), and desire (DTC) to be creative should be raised in a permissive environment, if that creativity is to be strongly envouraged.

3. An uncreative child may develop psychological problems when raised in a permissive environment. Therefore, those responsible for his development need to weigh such possible problems against the advantage of an increase in creative behavior that may be fostered.

4. If creativity is to be encouraged and an authoritarian environment is present, increasing the child's comfortable percentage of creative capability will achieve the desired results.

5. When an authoritarian environment is present, creativity can be increased by encouraging the child to be more self-confident in his behavior, to follow his interests, and not conform to the norms established by his culture (i.e., to encourage the simulated child to use the internal choice function).

Future Studies

Several suggestions for future studies are:

1. A study of the creative behavior in children raised in the different environments would be most informative. Torrance and his associates have never administered their creativity test to children who have attended the "free" or "open" schools of today. It would be most interesting to see the pattern of creative development of these children.

2. Innate need to create could be expressed as a function of creative capability. If this occurred, then a child's internal system (BCII) would have a greater influence on his behavior, especially with an internal choice function.

3. The choice function may be more adequately expressed as a function of time. In this way a child may oscillate between desiring to please his environment during one stage of his development and then becoming internally oriented in another stage of his development.

4. Need for self-fulfillment (NSR) might be better expressed as a function of time, as is the need for external reinforcement. According to Doctor Daniels (11b), this need increases with age then levels off. Research should be undertaken to determine what controls the magnitude of this need and the approximate age at which the plateau is reached. Having this variable a function of time would increase the sensitivity of the child's desire to change his behavior.

5. Several table functions representing the desirability of creative behavior to the environment (DTE) might be investigated. A different function could be used with each environment, as is the case with behavior desired (BDE) and environment's reinforcement (ERE). This may show an even greater difference in the behavior between the two environments.

6. The desirability to change curve (DTCI and DTCE) needs to be investigated. In particular, the shape of the curve is uncertain in the region representing the child who is not getting the reinforcement he needs. A change in this curve would result in different values for the

internal and/or external pressures.

7. Use of creative talent may be expressed as creative acts per month or as a percentage of all behavior. As a percentage it can be expressed as a quotient of the number of creative acts divided by the total acts performed or as a percentage of total time spent in performing creative acts.

8. Behavior desired by the environment could be replaced by behavior permitted by the environment or expected behavior. Parents' desires often differ from their expectations, based on a child's ability, and the behavior they would tolerate. They often base their reinforcements on expectations and behavior permitted.

APPENDIX A

RESULTS OF TEST

Table 8. Means and Standard Deviations by Grade and Sex on the *Figural Tests* of Creative Thinking in the U.S.A. Comparison Group (42, p. 47)

	Fluency		Flexibility		Originality		Elaboration	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
First Grade:								
Boys (N=36)	13.86	4.01	10.78	2.93	13.14	10.11	37.75	14.16
Girls (N=36)	13.75	4.28	11.39	3.36	10.11	5.84	54.08	17.71
Total (N=72)	13.80	4.12	11.08	3.14	11.78	8.31	45.92	17.92
Second Grade:								
Boys (N=58)	17.28	5.27	12.69	3.22	17.41	7.92	56.03	18.25
Girls (N=65)	17.38	5.36	13.26	3.11	12.37	6.81	59.65	17.20
Total (N=123)	17.33	5.27	12.99	3.16	14.75	7.75	57.94	17.72
Third Grade:								
Boys (N=59)	17.14	6.26	12.56	3.63	16.07	8.36	44.25	15.92
Girls (N=72)	17.26	4.28	12.79	2.80	13.62	6.40	53.11	18.01
Total (N=131)	17.21	5.25	12.69	3.19	14.72	7.42	49.12	17.60
Fourth Grade:								
Boys (N=35)	15.71	3.65	12.80	2.84	14.68	7.08	42.23	13.77
Girls (N=36)	15.94	4.77	12.47	3.59	11.44	6.56	51.28	15.43
Total (N=71)	15.83	4.22	12.63	3.22	13.04	6.97	46.82	15.23
Fifth Grade:								
Boys (N=71)	16.35	5.29	13.25	3.97	20.92	9.48	53.22	18.18
Girls (N=73)	17.45	5.68	14.03	4.38	17.71	7.04	58.40	18.31
Total (N=144)	16.91	5.50	13.64	4.19	19.29	8.46	55.85	18.36
Sixth Grade:								
Boys (N=38)	17.21	4.18	14.10	3.41	20.76	7.34	62.58	19.51
Girls (N=35)	17.72	5.62	13.23	3.75	15.43	8.28	69.91	17.91
Total (N=73)	17.45	4.89	13.68	3.58	18.20	8.19	66.10	18.99

Table 9. Means and Standard Deviations by Grade and Sex on the *Ask Questions Test* in the U.S.A. Comparison Group School (42, p. 49)

Sex and Grade	Fluency		Flexibility		Originality	
	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.
First Grade:						
Boys (N=36)	6.06	4.54	4.42	3.01	6.22	5.63
Girls (N=36)	7.19	5.54	5.08	2.96	6.28	7.18
Total (N=72)	6.63	5.06	4.75	2.98	6.25	6.40
Second Grade:						
Boys (N=58)	7.07	4.07	5.31	2.73	7.88	5.63
Girls (N=65)	6.19	3.00	4.86	2.33	5.77	5.09
Total (N=122)	6.59	3.52	5.06	2.51	6.71	5.41
Third Grade:						
Boys (N=59)	9.38	4.57	6.54	2.88	10.54	7.12
Girls (N=72)	9.07	4.96	6.62	3.15	10.74	7.93
Total (N=131)	9.22	4.75	6.58	3.01	10.65	7.51
Fourth Grade:						
Boys (N=35)	4.51	2.37	3.71	1.66	4.17	4.05
Girls (N=36)	4.51	2.73	3.89	1.68	3.76	2.56
Total (N=71)	4.51	2.54	3.81	1.66	3.96	3.35
Fifth Grade:						
Boys (N=71)	7.86	3.96	5.30	1.98	5.65	3.83
Girls (N=73)	7.74	3.96	5.78	2.50	5.58	3.99
Total (N=144)	7.80	3.95	5.54	2.27	5.61	3.90
Sixth Grade:						
Boys (N=38)	6.97	2.96	5.53	2.86	6.63	4.22
Girls (N=35)	7.37	3.33	6.00	2.04	5.75	2.49
Total (N=73)	7.16	3.11	5.75	2.50	5.51	3.89

Table 10. Means and Standard Deviations by Grade and Sex on the *Guess Causes Test* in the U.S.A. Comparison Group School (42, p. 50)

Sex and Grade	Fluency		Flexibility		Originality	
	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.
First Grade:						
Boys (N=36)	2.67	1.82	1.69	0.79	1.42	1.34
Girls (N=36)	3.28	1.92	2.47	1.18	2.97	3.32
Total (N=72)	2.97	1.88	2.08	1.07	2.19	2.63
Second Grade:						
Boys (N=58)	3.02	2.01	2.26	1.27	3.74	3.53
Girls (N=65)	2.77	1.93	2.23	1.34	1.98	2.76
Total (N=123)	2.88	1.96	2.25	1.30	2.77	3.23
Third Grade:						
Boys (N=59)	4.59	1.99	3.14	1.03	5.68	4.37
Girls (N=72)	5.05	2.53	3.81	1.55	5.90	4.38
Total (N=131)	4.83	2.29	3.49	1.37	5.80	4.35
Fourth Grade:						
Boys (N=35)	3.31	2.25	2.69	1.64	3.91	3.07
Girls (N=36)	3.16	1.95	2.32	1.27	4.05	2.84
Total (N=71)	3.24	2.09	2.50	1.46	3.99	2.93
Fifth Grade:						
Boys (N=71)	4.61	3.86	2.94	1.87	4.10	6.63
Girls (N=73)	5.53	4.37	3.42	1.95	5.26	5.11
Total (N=144)	5.08	4.14	3.19	1.92	4.69	4.47
Sixth Grade:						
Boys (N=38)	4.55	1.97	2.68	1.02	5.45	3.34
Girls (N-35)	5.00	3.35	3.00	1.33	5.63	4.57
Total (N=73)	4.77	2.71	2.84	1.18	5.53	3.95

Table 11. Means and Standard Deviations by Grade and Sex on the *Guess Consequences Test* in the U.S.A. Comparison Group School (42, p. 51)

Sex and Grade	Fluency		Flexibility		Originality	
	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.
First Grade:						
Boys (N=36)	4.14	2.03	3.06	1.39	3.61	3.21
Girls (N=36)	4.28	2.87	2.92	1.81	3.36	3.70
Total (N=72)	4.21	2.47	2.99	1.61	3.49	3.44
Second Grade:						
Boys (N=58)	4.50	3.25	3.12	1.81	4.88	4.52
Girls (N=65)	4.00	2.36	3.04	1.55	3.90	3.52
Total (N=123)	4.22	2.79	3.08	1.66	4.34	4.00
Third Grade:						
Boys (N=59)	6.46	3.24	4.16	1.69	8.94	6.68
Girls (N=72)	5.95	3.49	3.95	2.07	8.48	6.45
Total (N=131)	6.19	3.36	4.05	1.89	8.70	6.52
Fourth Grade:						
Boys (N=35)	4.20	2.35	2.89	1.43	4.29	4.03
Girls (N=36)	3.86	2.12	3.14	1.72	4.95	3.42
Total (N=71)	4.03	2.08	3.01	1.58	4.62	3.72
Fifth Grade:						
Boys (N=71)	5.79	4.18	3.30	2.54	5.54	4.24
Girls (N=73)	6.28	4.08	3.85	1.78	5.95	5.61
Total (N=144)	6.04	4.12	3.58	2.20	5.75	4.97
Sixth Grade:						
Boys (N=38)	5.21	1.77	3.58	1.37	5.82	3.08
Girls (N=35)	5.11	2.49	3.60	1.46	5.71	3.96
Total (N=73)	5.16	2.14	3.59	1.40	5.77	3.51

Table 12. Means and Standard Deviations by Grade and Sex on the *Product Improvement Test* in the U.S.A. Comparison Group School (42, p. 52)

Sex and Grade	Fluency		Flexibility		Originality	
	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.
First Grade (N=35)	11.21	6.55	4.47	2.04	5.75	4.64
Second Grade (N=38)	10.80	5.56	4.82	2.15	4.64	4.24
Third Grade (N=32)	15.57	7.73	5.58	1.96	7.31	5.67
Fourth Grade:						
Boys (N=35)	7.80	4.59	3.54	1.94	7.31	6.64
Girls (N=36)	7.46	3.80	3.95	1.25	5.70	4.42
Total (N=71)	7.62	4.18	3.75	1.62	6.49	5.63
Fifth Grade:						
Boys (N=71)	8.83	5.39	4.22	1.99	7.87	6.64
Girls (N=73)	9.76	5.06	4.66	1.78	9.39	6.80
Total (N=144)	9.30	5.23	4.45	1.89	8.65	6.79
Sixth Grade:						
Boys (N=38)	9.68	4.06	4.82	1.56	9.18	5.13
Girls (N=35)	11.74	5.68	5.71	1.87	9.03	6.29
Total (N=73)	10.76	4.98	5.25	1.76	9.11	5.76

APPENDIX B

EQUATIONS

Equation Formulation

The equations below are written in the form acceptable to the DYNAMO compiler, which was written by Phyllis Fox and Alexander Pugh in 1959. For a further discussion concerning the DYNAMO language, the reader is referred to Pugh's *Dynamo User's Manual.*

Sector 1, Creative Behavior--Capability and Usage

This sector describes the relationship that exists between creative capability and the utilization of that capability. A child's creative capability is represented by an accumulation equation with the net change represented by net change in capability. Creative capability is an accumulation because it is acquired through time and retains the same value unless changed. Since a measurement for creative capability does not exist, the initial values were obtained by multiplying use of creative talent by the inverse of the comfortable utilization fraction.

CC.K = CC.J + (DT)(NCC.JK + 0)

CC = 10 uncreative child; 24 creative child

NCC.KL = (FCC.K)(CC.K)

The net change in creative capability might have been represented as an

absolute numerical change per month or as a fractional change as indicated in the equation above. Since the change in behavior (UCT) measured by Torrance stayed within a fairly small percentage range, the magnitude of capability probably influenced the effect of usage on capability.

FCC.K = TABHL (TFCC,DAU.K,0,1,.1)

The fraction change in capability is equal to a table function called table of fraction change in capability having as its independent variable the average fraction utilization (DAU) with a range from zero to one incremented by .1. The values of fraction change in capability are:

TFCC* = -.01/0/.005/.01/.015/.02/.035/.05/.06/.065/.07

This equation represents the values fraction change in capability assumes as the average fraction utilization increases from zero to one. At an average fraction utilization of .1, fraction change is zero, i.e. just sufficient to maintain the current level of capability. Any value of utilization above .1 will result in a positive flow rate and hence increase the level of capability. Similarly any value below .1 will cause a negative flow and creative capability will decrease. The values for fraction change in usage were chosen for two reasons:

1. Creative capability, like any other developed skill,

when not used will decrease.

2. Based on the scores of Torrance's test represented in Figure 1, the average percentage change in creative capability per month was approximately 1 per cent with a maximum gain of 6 per cent per month. Assuming a child tries to behave within his comfortable range 20-35 per cent utilization, the average percentage change was placed within this region.

AU.K = UCT.K/CC.K

DAU.K = DAU.J + (DT)(1/ATDAU)(AU.J - DAU.J)*

DAU = .2 uncreative child; .333 creative child

ATDAU = 6 months

The above equation represents how the actual and average values of the utilization fraction are calculated. Actual utilization fraction is the ratio of use of creative talent and creative capability. Since actual utilization will fluctuate monthly and hence will not represent a smooth flow of information, it is necessary to average it to obtain a more stable value. This average of actual utilization is called delay of actual utilization. It is represented by a standard exponential smoothing equation. Initially the average value (DAU) is assumed to equal the actual value (AU)--.2 for the uncreative child and .333 for the creative child.

Although the value of the averaging time in delay of actual

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*This is the standard form for a first order exponential smoothing equation and is discussed in Forrester's *Industrial Dynamics* book on pp. 150-152.

utilization may vary, it is assumed an average of around six months is a reasonable figure. Averaging over a longer period of time would not significantly change the value of delay of actual utilization; yet a longer delay might distort the pattern of growth in creative capability; averaging over a shorter period would not allow enough time to smooth out the fluctuations that arise in actual utilization.

UCT.K = UCT.J + (DT)(FCU.JK + 0)

UCT = 2 uncreative child; 8 creative child

A child's use of creative talent is similar to the use of any skill, in that it becomes habitual eventually. This is a behavioral accumulation that persists at its established value unless changed. Since use of creative talent is on a relative scale from zero to ten, it is assumed values less than three would represent uncreative behavior and greater than seven creative behavior. Initial values were therefore chosen within their respective range dismissing the lowest and highest value to allow for growth or decline.

The change in behavior, represented by fraction change in usage, is a weighted sum of total change and capability influence.

FCU.KL = (X)(CAPI.K) + (1)(TC.K) + (-X)(TC.K) + (0)(0)

Although a child's capability to be creative has an influence on his behavior, the pressures placed on him from the environment as well as the internal pressures to satisfy his drive and need for self-fulfillment are so great, they mostly control any change in behavior that occurs.

For this reason, a weight of .9 was attached to total change leaving capability influence with a weight of .1.

Capability influence is the variable that tries to equalize use of creative talent and comfortable behavior.

CAPI.K = (1/ADT)(CB.K - UCT.K)

ADT = 4 months

The adjustment time represents the time it takes to change the current level of behavior to equal comfortable behavior. Since a child is adaptable and quite flexible, if placed in an uncomfortable position he will quickly change his behavior. An adjustment time of four months was therefore chosen, one less than four months would seem unreasonable to assume since behavior patterns are somewhat difficult to change even if a conscious effort is given.

CB.K = (CC.K)(CU)

CU = .2 uncreative child; .33 creative child

This equation represents comfortable behavior as the product of creative capability and the comfortable utilization fraction. In this model, comfortable utilization varies. A creative child might have a comfortable utilization of .333 while an uncreative child's might be .2. It is assumed that like other abilities, people do not often utilize more than half of their capabilities; therefore, values were chosen less than .5.

Sector 2, Environment's Responses

This sector represents the effect the environment has on a change in the child's behavior. Two environments--a permissive and an authoritarian--are assumed. Their standards are imposed on the child and their reaction to the child's deviation from their standards are represented. The child then compares the amount of reinforcement he needs to the amount the environment gives him and based on his comparison, he decides whether it is desirable for him to change his behavior to that desired by the environment.

The child's behavior is represented by the variable use of creative talent. Since behavior fluctuates monthly, it will not represent a smooth flow of information therefore, it is necessary to average behavior over some time period. This average, the environment's perception of behavior, is represented by an exponential smoothing equation.

EPB.K = EPB.J + (DT)(1/ATEPB)(UCT.J - EPB.J)

EPB = 2 uncreative child, 8 creative child

ATEPB = 6 months

Initially, the average value (EPB) is assumed to equal the actual value (UCT). The environment's perception of behavior is averaged over a six-month period. Any shorter time period would not be sufficient to eliminate the monthly fluctuations, while a longer time period would not give significant additional information to warrant the effects resulting from an increase in the delay.

Actual behavior error is the difference between the average

behavior (EPB) and the behavior desired by the environment (BDE).

ABEE.K = BDE.K - EPB.K

BDE.K = TABHL(TBDE,TIME.K,0,240,24)

TBDE* = 5/5/5/4.5/4.5/3/3/2.5/2.5/1/1 Authoritarian

TBDE* = 9/8.8/8.6/8.4/8.2/8/7.8/7.6/7.4/7.2/7 Permissive

The behavior desired by the environment is a function of time and differs with the two environments. The authoritarian environment's standards, represented in Figure 7, abruptly change at the onset of each of the stages of a child's development. By the time a child reaches maturity the authoritarian environment expects a "model citizen," i.e. one that conforms to all of society's rules and customs. This is in contrast to the permissive environment, represented in Figure 4, whose demands gradually change through time and do not emphasize conformity.

NRCE.K = ABEE.K/NADT

NADT = 4 months

The normal rate of change is a ratio of the actual behavior error and the normal adjustment time. This adjustment time of four months represents the amount of time the child normally needs to change his behavior to meet the environment's standards.

PBEE.K = (100)(ABEE.K)/EPB.K

ATCE.K = TABHL(TATC,PBEE.K,-100,200,20)

TATC* = .1/.15/.3/.5/.85/1/.95/.8/.65/.55/.45/.4/.35/.3/.25/.2

The above equations represent the relationship that exists between the percentage of behavior error and the ability to change. The ability to change is one when percentage of behavior error is zero and therefore the normal rate of change (which is later multiplied by the ability to change) remains the same. However, as the percentage of behavior error deviates from zero, the ability to change decreases and so does the normal rate of change.

The next set of equations describes the relationship that exists between the actual behavior error and the desirability to the environment.

```
PDBE.K = (100)(ABEE.K)/BDE.K
DTE.K = TABHL(TDTE*,PDBE.K,-200,100,20)
TDTE* = .5/.8/1.2/1.8/2.5/3.5/5/6.5/8.5/9.5/10/9.5/8/5/1.5/0
```

The first equation represents the actual behavior error as a percentage. This percentage of desired behavior error is the independent variable in the desirability table, which has a range from zero to 10. As explained in conjunction with Figure 13, when the percentage of behavior error deviates from zero the desirability (DTE) decreases. Therefore, the function starts off with a low level of desirability, reaches its maximum value of ten when the percentage of behavior error is zero and then starts decreasing. A behavior error of +100 per cent is more undesirable than a deviation of -100 per cent. The former occurs when there is no creative behavior (EPB)--an unnatural state, while the latter represents a hyperactive child.

Since the level of desirability fluctuates monthly, a smoothing equation is used to eliminate the fluctuations. Initially, the average value (DID) is assumed equal to the actual value (DTE). An averaging period of four months seems to be a reasonable length of time to eliminate the fluctuations and not cause any major distortions.

DID.K = DID.J = (DT)(1/ATDID)(DTE.J - DID.J)

DID = 5.0*

ATDID = 4 months

The kind of reinforcement (positive or negative) given the child is based on the average desirability (DID) his behavior gives to the environment. The amount of reinforcement varies with the environments and degree of desirability; and is represented on a relative scale with zero representing maximum negative reinforcement (punishment), and ten maximum positive reinforcement (reward). Comparing the two environments, the different amounts of reinforcement given the child can easily be noticed.

ERE.K = TABHL(TDPE,DID.K,0,10,1)

TDPE* = 1/1.2/2/3.6/4.8/5/5.2/6.4/8/8.9/9 Authoritarian

TDPE* = 4/4.1/4.4/4.8/5/5/5/5.2/5.6/5.9/6 Permissive

The authoritarian environment not only reacts more quickly to any deviation from the norm (an average desirability score of five), but the

---

*Initial values differ depending on the type of child, and his environment. All initial values will represent the uncreative child in an authoritarian environment unless otherwise stated.

amount of reinforcement given the child, both positive and negative, is much greater than that of the permissive environment.

Since the amount of reinforcement fluctuates, an exponential smoothing equation is used to obtain the average reinforcement over a four-month period. Initially the average value (OERE) is assumed to equal the actual value (ERE).

```
OERE.K = OERE.J + (DT)(1/ATOERE)(ERE.J - OERE.J)
OERE = 5.0
ATOERE = 4 months

NER = TABHL(TNER,TIME.K,0,240,24)
TNER* = 10/8.8/8/7.4/7/6.4/5.8/5.6/5.4/5.2/5
```

The above table function represents the child's need for external reinforcement. During the early childhood and juvenile period, the child is dependent on his environment and looks to it for encouragement, fulfillment, etc. As the child matures his need for external reinforcement decreases; however, in almost all cases, it never drops below five, since this represents a need for punishment.

```
DNER.K = (1/NER.K)(OERE.K - NER.K)
PDNER.K = (100)(DNER.K)
DTCE.K = TABHL(TDES,PDNR.K,-100,100,10)
TDES* = .1/.75/1.3/1.75/1.9/2/1.75/1.5/1.25/1.1/1/.95/.9/.8/
        .75/.6/.5/.4/.25/.1/.05
```

This set of equations represents the comparison between the

average reinforcement (OERE) and the reinforcement needed (NER). Based on this comparison, the child decides if it is desirable for him to change his behavior to satisfy the environment. This desire to satisfy the environment, represented in the above table function, is later multiplied by the normal rate of change. When the child is receiving more reinforcement than needed his desire to change his behavior is less than one and the normal rate of change decreases. On the other hand, when the child is not getting the amount of reinforcement he needs, his desire to change his behavior is greater than one and the normal rate of change increases. However, if the child becomes discouraged and feels he is getting unduly punished, he no longer tries to change his behavior to satisfy the environment, and the normal rate of change decreases again. This is assumed to occur when the deviation from needed reinforcement is less than -50 per cent.

The last equation in this sector combines the normal rate of change with the child's ability and desirability to change. This variable is called the behavior change influenced by the environment.

BCIE.K = (NRCE.K)(ATCE.K)(DTCE.K)

In summary when the percentage of behavior error (PBEE) and the percentage deviation from needed external reinforcement (PDNER) are zero, the child's ability and desirability to change his behavior are one and the normal rate of change remains the same. Any deviation from these points results in a behavior change per month less than or greater than the normal rate of change.

Sector 3, Individual's Internal Responses

This sector represents the effect the individual's internal forces have on a change in his behavior. The child compares his innate need to create to his actual behavior and based on his comparison a feeling of self-acceptance or self-rejection arises. This is then compared to the child's need for self-fulfillment and based on the percentage deviation from needed self-fulfillment his desirability to change his behavior is determined.

SPB.K = SPB.J + (DT)(1/ATSPB)(UCT.J - SPB.J)

SPB = 2 uncreative child, 8 creative child

ATSPB = 6 months

INC = 3 uncreative child, 9 creative child

ABEI.K = INC - SPB.K

NRCI.K = ABEI.K/NADT

NADT = 4 months

The above equations are similar to those in sector 2. Self-perceived behavior is identical to the environment's perception of behavior. Both are smoothing equations to eliminate the fluctuations that occur in the child's behavior (UCT). Their averaging period and initial values are the same. The child's need to be creative (INC) is represented by a constant. It is assumed this need varies from the uncreative child to the creative one. Thus on a relative scale from zero to ten, the value nine will represent the creative child's need and three that of an uncreative child. The next equation represents the

comparison between the average behavior (SPB) and the child's need to be creative (INC). Based on this comparison (ABEI) and the normal adjustment time, the normal rate of change is calculated.

```
PBEI.K = (100)(ABEI.K)/SPB.K
ATCI.K = TABHL(TATC,PBEI.K.-100,200,20)
```

The first equation above converts actual behavior error to a percentage. This percentage of behavior error is then used as the independent variable in the table function representing the child's ability to change. The table is the same one used in the environmental sector with the ability to change decreasing as the percentage of behavior error deviates from zero.

```
PIBE.K = (100)(ABEI.K)/INC
DTI.K = TABHL(TDTI,PIBE.K,-200,100,20)
TDTI* = .5/.8/1.2/1.8/2.5/3.5/5/6.5/8.5/9.5/10/9.5/8/5/1.5/0
SRE.K = TABHL(TDPI,DTI.K,0,10,1)
TDPI* = 2.5/2.6/3/3.5/4/5/6/6.5/7/7.4/7.5
```

This series of equations describes the effect the child's behavior has on his self-esteem. The first equation represents the percentage of behavior error, this time, in reference to the child's innate need to create. The desirability to the individual of his own actions is represented by a table function, having as its independent variable the percentage of behavior error. When the percentage of behavior is zero desirability is at its maximum value of ten, as the percentage of

behavior error deviates from zero desirability decreases. The curve is not symmetrical since a behavior error of +100 per cent, representing no behavioral activity, is less desirable than a behavior error of -100 per cent, representing hyperactivity. The degree of self-fulfillment (SRE) is affected by the magnitude of desirability. These variables are positively correlated with values less than five representing a feeling of self-rejection and greater than five self-acceptance.

Since feelings change with behavior, they must be averaged to eliminate the fluctuations that occur. A smoothing equation with an averaging period of four months, similar to the average reinforcement (OERE) in sector 2, is used. Initially the average value (OSRE) is assumed to equal the actual value (SRE).

OSRE.K = OSRE.J + (DT)(1/ATOSRE)(SRE.J - OSRE.J)

OSRE = 7.2

ATOSRE = 4 months

This average of self-fulfillment (OSRE) is compared with the child's need for self-fulfillment, represented on a relative scale from zero to ten. Values less than five represent a need for self-rejection, greater than five a need for self-acceptance. Since this model does not take into consideration the varying need for self-acceptance among children, an average value of seven was assumed.

NSR = 7

DNSR = (1/NSR)(OSRE.K - NSR)

PDNSR.K = (100)(DNSR.K)

DTCI.K = TABHL(TDES,PDNSR.K,-100,200,20)

Based on this comparison (DNSR), a percentage deviation from needed self-fulfillment (PDNSR) was calculated. It was used as the independent variable in the table function representing the child's desire to change his behavior to satisfy his internal needs. Since the same table was used to represent the child's desire to satisfy the environment, a discussion can be found in sector 2.

BCII.K = (NRCI.K)(ATCI.K)(DTCI.K)

The last equation in this sector combines the normal rate of change with the child's ability and desirability to change. When the percentage of behavior error (PBEI) and the percentage deviation from needed self-fulfillment (PDNSR) are zero, the child's ability and desirability to change are one and the normal rate of change remains the same. Any deviation of these percentages from zero will result in a behavior change (BCII) per month less than or greater than the normal rate of change.

The Coupling Equations

The three sectors discussed above are coupled together by several equations. The total change variable is a weighted summation of the behavior change influenced by the internal and external pressures imposed on the child. This summation is then used as one of the factors in determining the fraction change in usage discussed in sector 1.

TC.K = (CHO.K)(BCII.K) + (2)(BCIE.K) + (-CHO.K)
(BCIE.K) + (0)(0)

The weights attached to each of the sectors are determined by a choice mechanism; a table function with the average measure of conflict as its independent variable. Since the measure of conflict (the difference between the internal (BCII) and external (BCIE) pressures) fluctuates monthly, it would not represent a smooth flow of information; therefore, it is averageed over a six-month period. Initially, the average value (AMOC) is assumed to equal the actual value (MOC).

MOC.K = BCII.K - BCIE.K

AMOC.K = AMOC.J + (DT)(1/ATAMOC)(MOC.J - AMOC.J)

AMOC = -.36

ATAMOC = 6 months

CHO.K = TABHL(TCHO,AMOC.K,-1,1,.2)

TCHO* = 2/1.9/1.6/1.4/1.3/1.25/1.3/1.4/1.6/1.9/2 Internal

TCHO = .05/.1/.3/.5/.7/.75/.7/.5/.3/.1/.05 External

The choice mechanism is represented by two table functions. The first, represents the child's determination to be creative despite the pressures imposed on him by his environment. The second, represents the child's decision to satisfy his environment even though his creativity might suffer. As the average measure of conflict deviates from zero, the child places a greater weight on his decision to satisfy his innate need or the desires of his environment.

Glossary of Terms

ABEE	Actual Behavior Error in the Environmental sector (creative behavior units)
ABEI	Actual Behavior Error in the Individual sector (creative behavior units)
ADT	ADjustment Time (months)
AMOC	Average Measure Of Conflict (creative behavior units/mo.)
ATAMOC	Average Time in Averaging Measure Of Conflict (months)
ATCE	Ability To Change in the Environmental sector
ATCI	Ability To Change in the Individual sector
ATDAU	Average Time in the Delay of Actual Utilization (months)
ATDID	Average Time in the Delay In Desirability (months)
ATEPB	Average Time for the Environment to Perceive Behavior (months)
ATOERE	Average Time to Observe Environment's REinforcement (months)
ATOSRE	Average Time to Observe Self REinforcement (months)
ATSPB	Average Time for Self to Perceive Behavior (months)
AU	Actual Utilization
BCIE	Behavior Change Influenced by the Environment (creative behavior units/mo.)
BCII	Behavior Change Influenced by the Individual (creative behavior units/mo.)
BDE	Behavior Desired by the Environment (creative behavior units)
CAPI	CAPability Influence (creative behavior units/mo.)
CB	Comfortable Behavior (creative behavior units)
CC	Creative Capability (creative behavior units)
CHO	CHOice function
CU	Comfortable Utilization

DAU	Delay of Actual Utilization
DID	Delay In Desirability (desirability units)
DNER	Deviation from Needed External Reinforcement
DNSR	Deviation from Needed Self-Reinforcement
DTCE	Desirability To Change influenced by the Environment
DTCI	Desirability To Change influenced by the Individual
DTE	Desirability To the Environment (desirability units)
DTI	Desirability To the Individual (desirability units)
EPB	Environment's Perception of Behavior (creative behavior units)
ERE	Environment's REinforcement (reinforcement units)
FCC	Fraction Change in Capability (1/mos)
FCU	Fraction Change in Usage (creative behavior units/mo.)
INC	Innate Need to Create (creative behavior units)
MOC	Measure of Conflict (creative behavior units/mo.)
NADT	Normal ADjustment Time (months)
NCC	Net Change in Capability (creative behavior units/mo.)
NER	Need for External Reinforcement (reinforcement units)
NRCE	Normal Rate of Change in the Environmental sector (creative behavior units/mo.)
NRCI	Normal Rate of Change in the Individual sector (creative behavior units/mo.)
NSR	Need for Self-Reinforcement (reinforcement units)
OERE	Observed Environment's REinforcement (reinforcement units)
OSRE	Observed Self-REinforcement (reinforcement units)
PBEE	Percentage of Behavior Error in the Environmental sector
PBEI	Percentage of Behavior Error in the Individual sector

PDBE	Percentage Desired Behavior Error
PDNER	Percentage Deviation from Needed External Reinforcement
PDNSR	Percentage Deviation from Needed Self-Reinforcement
PIBE	Percentage Innate Behavior Error
SPB	Self-Perceived Behavior (creative behavior units)
SRE	Self-REinforcement (reinforcement units)
TATC	Table of Ability To Change
TBDE	Table Behavior Desired by the Environment
TC	Total Change (creative behavior units/mo.)
TCHO	Table of CHOice
TDES	Table of DESirability (desirability units)
TDPE	Table of Degree of Permissiveness of the Environment (reinforcement units)
TDPI	Table of the Degree of Permissiveness of the Individual (reinforcement units)
TDTE	Table of Desirability To the Environment
TDTI	Table of Desirability To the Individual
TFCC	Table of Fraction Change in Capability (1/months)
TNER	Table of Need of External Reinforcement (reinforcement units)
UCT	Use of Creative Talent (creative behavior units/month)

```
RUN    TRIAL1
3L     EPB.K=EPB.J+(DT)(1/ATEPB)(UCT.J-EPB.J)
6N     EPB=EPBI
C      EPBI=2
C      ATEPB=6  MONTHS
58A    BDE.K=TABHL(TBDE,TIME.K,0,240,24)
C      TBDE*=5/5/5/4.5/4.5/3/3/2.5/2.5/1/1                    AUTHORITIAN
7A     ABEE.K=BDE.K-EPB.K
44A    PDBE.K=(100)(ABEE.K)/BDE.K
58A    DTE.K=TABHL(TDTE,PDBE.K,-200,100,20)
C      TDTE*=.5/.8/1.2/1.8/2.5/3.5/5/6.5/8.5/9.5/10/9.5/8/5/1.5/0
3L     DID.K=DID.J+(DT)(1/ATDID)(DTE.J-DID.J)
6N     DID=DIDI
C      DIDI=5.
C      ATDID=4  MONTHS
58A    ERE.K=TABHL(TDPE,DID.K,0,10,1)
C      TDPE*=1/1.2/2/3.6/4.8/5/5.2/6.4/8/8.8/9                AUTHORITIAN
3L     OERE.K=OERE.J+(DT)(1/ATOERE)(ERE.J-OERE.J)
6N     OERE=OEREI
C      OEREI=5.0
C      ATOERE=4  MONTHS
58A    NER.K=TABHL(TNER,TIME.K,0,240,24)
C      TNER*=10/8.8/8/7.4/7/6.4/5.8/5.6/5.4/5.2/5
21A    DNER.K=(1/NER.K)(OERE.K-NER.K)
12A    PDNER.K=(100)(DNER.K)
58A    DTCE.K=TABHL(TDES,PDNER.K,-100,100,10)
C      TDES*=.1/.75/1.3/1.75/1.9/2/1.75/1.5/1.25/1.1/1/.95/.9/.8/.75/.6/.
X1     5/.4/.25/.1/.05
44A    PBEE.K=(100)(ABEE.K)/EPB.K
58A    ATCE.K=TABHL(TATC,PBEE.K,-100,200,20)
C      TATC*=.4/.15/.3/.5/.85/1/.95/.8/.65/.55/.45/.4/.35/.3/.25/.2
C      NADT=4 MONTHS
20A    NRCE.K=ABEE.K/NADT
13A    BCIE.K=(NRCE.K)(ATCE.K)(DTCE.K)
7A     MOC.K=BCII.K-BCIE.K
3L     AMOC.K=AMOC.J+(DT)(1/ATAMOC)(MOC.J-AMOC.J)
6N     AMOC=AMOCI
C      AMOCI=-.36
C      ATAMOC=6  MONTHS
58A    CHO.K=TABHL(TCHO,AMOC.K,-1,1,.2)
C      TCHO*=2/1.9/1.6/1.4/1.3/1.25/1.3/1.4/1.6/1.9/2         INTERNAL
16A    TC.K=(CHO.K)(BCII.K)+(2)(BCIE.K)+(-CHO.K)(BCIE.K)+(0)(0)
3L     SPB.K=SPB.J+(DT)(1/ATSPB)(UCT.J-SPB.J)
6N     SPB=SPBI
C      SPBI=2
C      ATSPB=6  MONTHS
```

Figure 33. Example of Computer Output Listing

```
C       INC=3
7A      ABEI.K=INC-SPB.K
44A     PIBE.K=(100)(ABEI.K)/INC
58A     DTI.K=TABHL(TDTI,PIBE.K,-200,100,20)
C       TDTI*=.5/.8/1.2/1.8/2.5/3.5/5/6.5/8.5/9.5/10/9.5/8/5/1.5/0
58A     SRE.K=TABHL(TDPI,DTI.K,0,10,1)
C       TDPI*=2.5/2.6/3/3.5/4/5/6/6.5/7/7.4/7.5
3L      OSRE.K=OSRE.J+(DT)(1/ATOSRE)(SRE.J-OSRE.J)
6N      OSRE=OSREI
C       OSREI=7.2
C       ATOSRE=4  MONTHS
C       NSR=5
21A     DNSR.K=(1/NSR)(DSRE.K-NSR)
12A     PDNSR.K=(100)(DNSR.K)
58A     DTCI.K=TABHL(TDCS,PDNSR.K,-100,100,10)
44A     PBEI.K=(100)(ABEI.K)/SPB.K
58A     ATCI.K=TABHL(TATC,PBEI.K,-100,200,20)
20A     NRCI.K=ABEI.K/NWDT
13A     BCII.K=(NRCI.K)(ATCI.K)(DTCI.K)
20A     AU.K=UCT.K/CC.K
3L      DAU.K=DAU.J+(DT)(1/ATDAU)(AU.J-DAU.J)
6N      DAU=DAUI
C       DAUI=.2
C       ATDAU=6  MONTHS
58A     FCC.K=TABHL(TFCC,DAU.K,0,1.00,.10)
C       TFCC*=-.01/0/.005/.01/.015/.02/.035/.05/.06/.065/.07
12R     NCC.KL=(FCC.K)(CC.K)
1L      CC.K=CC.J+(DT)(NCC.J-0)
6N      CC=10
1L      UCT.K=UCT.J+(DT)(FCU.JK+0)
6N      UCT=2                                                   UNCREATIVE
15R     FCU.KL=(.1)(CAPT.K)+(.9)(TC.K)
C       CU=.2
12A     CB.K=(CC.K)(CU)
C       ADT=4 MONTHS
21A     CAPI.K=(1/ADT)(CB.K-UCT.K)
PRINT   1)EPB,BDS,DTE/2,ERE,BCIE,PDNER/3)DTCE,ATCE,NRCE/4)SRE,BCII,PDNSR,/
X1      5)DTCI,ATCI,NRCI/6)MOC,AMOC,CHO/7)CAPI,TC/8)DAU,FCC/9)FCU,UCT,CC
PLOT    UCT=U,SRE=S,ERE=R(0,10)/FCU=P,TC=T,BCIE=A,BCII=B(-2,2)/CAPI=I(-4,4
X1      )
SPEC    DT=2/LENGTH=240/PRTPER=4/PLTPER=4
RUN     TRIAL2
```

Figure 33. Continued

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