THE EFFECT OF COGNITIVE STYLE
ON THE ANALYSIS, DESIGN, AND IMPLEMENTATION
OF INFORMATION SYSTEMS

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Abstract

The purpose of the paper is to consider the expansion of the Information Systems Development Methodology to include the cognitive style variable.

The individual differences approach to decision making emphasizes that people exhibit "characteristic, self-consistent ways of functioning," called cognitive styles, when dealing with perceptual and intellectual functions. These preferences are believed to negatively affect decision outcome when data is inconsistent with the decision maker's cognitive style. Additionally, counteraction of style differences is seen to have a positive effect on decision outcome.

Review of the Information Systems Development Methodology reveals that every aspect of the design process, whether it be evaluation of alternatives or the definition of functions, requires some form of intellectual activity and decision making. Because cognitive style affects decision making, and information systems development is dependent on decision making, it is logical to conclude that consideration of the cognitive style variable during the development process will aid in the successful design of an information system.
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I. Introduction

Researchers and practitioners agree that the key to the success of a computer-based information system is to involve the users in the decision making of both the development and operations phases of that system. In relation to other factors (e.g., management support, quality of technical support, quality of system goals) user involvement appears to be the only element that is significantly related to the quality of the final product on a consistent basis.(10).

There are a number of explanations for this relationship between user involvement and information system success. One of these explanations centers around the decision making function as represented by the individual differences perspective. This theory suggests that individuals have personalized strategies and abilities that are effective in some situations, ineffective in others. This "cognitive style" is believed to influence decision outcome and any decision making aid must be compatible with this style as incompatibility is likely to result in the system not being used. Therefore, the successful implementation of an information system is dependent on the "cognitive style" of the personnel intended to use the system. User involvement is then necessary to ensure that cognitive style preferences are defined and are incorporated into the system design.
To better understand the reasoning behind this explanation, consider the function of an information system. An information system can be defined as an integrated man/machine system utilizing computer hardware and software, manual procedures, models, and a data base to provide information to support the operations, management and decision making in an organization.\textsuperscript{(8).} The information system accepts data as representations of people, objects, events, or concepts and through modelling, formatting, and organizing transforms them into information that is intended to increase the recipient's understanding of a situation. This information is then cognitively evaluated by the recipient resulting in some action such as a decision, a question, or possibly a request for additional information. Data are objective, dealing only with facts. Conversely, information is highly subjective, its significance being dependent on the attitudes of the recipient.\textsuperscript{(5).} Cognitive style theory states that an individual’s style influences these attitudes that determine significance. Therefore, if the style of an information system is incompatible with that of the user, the "information" provided by that system will not be used. A compatible system is much more likely to produce information the user perceives as being significant.

The purpose of this paper is to examine the potential effects of cognitive style, or more importantly cognitive style differences, on the design of information systems.
The first step in this procedure is to define different cognitive processing styles and the variables that may be influenced by style. The next step is to define the information systems development methodology so as to determine the functions involved and the areas that may be influenced by cognitive style effects. Based on this analysis, the last section of the paper expands the development methodology to incorporate the cognitive style constraints and identifies generalized information system models to meet the needs of the basic cognitive groups.
II. Cognitive Style

Cognitive style has been defined by Doktor and Hamilton as the "characteristic, self-consistent way of functioning that an individual exhibits across perceptual and intellectual activities." (9, p. 885). A question arises as to the definition of these "characteristic" ways of reasoning. Presented here are a series of models. Each one builds on the basic foundations of the others in an attempt to define cognitive style characteristics. Also included are descriptions and evaluations of several tests used to determine styles and present experimental efforts into the effects of cognitive style on decision making.
A. Jungian Theory of Psychological Types

One of the most common personality typologies used as a basis for the development of cognitive models is the theory of psychological types as developed by C. G. Jung. There are several probable reasons for this selection. First, material from Jung is abundantly available for use in deriving behavioral implications. Second, although the defined personality orientations are in conflict, theoretically, one is not valued as better or worse than the other, only different.\(^{15}\).

In Jungian psychology, personality consists of several separate subsystems including the ego, personal unconscious, basic attitudes, and psychological functions. The ego refers to all conscious activity including feelings, thoughts, perceptions, and memories. The personal unconscious includes experiences which have not reached the conscious level due to suppression or lack of development. The personal unconscious is frequently expressed as a dream or fantasy and can change its content in harmony with the conscious mind. The personal unconscious and the conscious often offset one another allowing for a more balanced personality.\(^{12}\).

According to Jungian theory, there are two basic attitude types in personality, introversion and extroversion, both of which are present in an individual's character. One is dominant and resides in the conscious mind while the other
exists subordinately in the unconscious mind. The extrovert is outgoing, confident, and easily adapted to any situation. The introvert is shy, hesitant, and defensive. Extroversion involves an interest in the external world of people and things while introversion involves the internal world of concepts and ideas. (25).

Extroversion and introversion are each paired with four psychological functions: sensation, intuition, thinking and feeling. Sensation and intuition are ways of perceiving the world. A preference for sensation refers to an individual who experiences things as they are without looking for hidden meanings. Data are received as fact by relying on the five senses. The intuitive type sees the objects in the world as possibilities instead of facts. This type sees visions and have fantasies. Where sensation is a direct form of perception, intuition is an indirect form enriched by the added information of the perceiver. (25, 11).

The thinking and feeling functions represent opposing methods for evaluating the perceived world. A preference for the thinking type refers to an individual whose actions are the result of an "intelligently considered motive." The thinking type likes logic and order and relies primarily on cognitive processes to obtain impersonal judgements of right and wrong. Alternately, the feeling type places a value on the object or phenomenon (pleasant/unpleasant, good/bad). This value then determines what conclusions are
reached. Where thinking types systematize, feeling types are concerned with moral judgements. As is with the two modes of perception, the two evaluation modes tend to be mutually exclusive. (11,16).

Only one of the four psychological functions is likely to be dominant in each individual. However, the dominant function in usually supported by one of the functions from the remaining set of paired opposites. For example, thinking may be backed by sensation or sensation supported by thinking. (12).

Also included in Jung's typology are several structural properties. The first of these properties is stability. There is an inclination to develop certain attitudes. Even though development is continuous, within environmental restrictions, type changes are not likely to occur. Secondly, attitudes, functions, and external influences are interacting. Various combinations of attitudes and functions create modifications and produce unique effects. Therefore, introverted thinking is different from extraverted thinking, and an introvert with intuition is different than an extrovert with intuition. Additionally, a subsystem can be altered by interaction with external influences, especially other individuals. This interaction may cause an individual to exhibit a previously unconscious attitude. Third, the predisposition toward the development of certain functions results in more reliance and increased
effectiveness with them. This reliance determines the pattern of personality characteristics, values, interests, and other surface traits. Finally, ineffective behavior is seen to result when type is indeterminant. Indeterminancy arises when members of a pair of functions are at the same level instead of one member being stronger.(23).
B. Hellriegel-Slocum Model

Hellriegel and Slocum applied the Jungian typology to the manager and developed the following descriptions of the basic attitudes and psychological functions. "The introverted manager needs quiet for concentration, must work without interruptions, has problems communicating with co-workers and usually works best alone. Extroverts like variety and action, are impatient with long, slow jobs, usually communicate well, like to have people around and are good at greeting people." (12, p. 12). Because they determined that the majority of the managerial occupation was of the extrovert type, the researchers concentrated on the psychological functions as evident in the extrovert manager.

The sensation manager is oriented toward realism, external facts and concrete experiences. He may therefore experience anxiety over the uncertainty of some decision making. Sensation types are good performers as bureaucrats whose lives revolve around implementation of rules and regulations. Sensation types dislike unstructured problems which require judgement. (12).

The intuitive manager will not perform well in the structured role the sensation type enjoys. An intuitive type likes new and different problems, is impatient with routine items and dislikes taking time for precision. The intuitive manager relies on hunches, considers and rejects
many alternatives quickly, and continuously redefines the problem. The intuitive manager can be valuable as an initiator and promoter of new ideas.(12).

The feeling type manager tends to be sympathetic and relates well to people. This type tries to accommodate others and will make decisions that gain approval from peers and superiors. The feeling type manager avoids problems that may lead to disagreements and when avoidance is impossible, will change his position to a more acceptable one. Friendly relationships may often supercede effectiveness and good decision making.(12).

The thinking type manager is uninterested in feelings and emphasizes analysis and order. This manager is constantly trying to make decisions dependent on intellectual processes and to standardize problems. Thinking type managers may forget to consider their own welfare when involved in a problem. These type managers are concerned with the problem solving approach, carefully define problem constraints, and perform orderly searches for additional information.(12).

Hellriegel and Slocum carried their analysis one step further and developed a composite model of managerial problem solving styles by combining the two perception functions with the two evaluation functions. This model consists of four types: sensation-feeling, intuition-feeling, sensation-thinking, and intuition-thinking. The sensation-
feeling type managers use sensation for perception and feeling for evaluation. They are interested in facts that can be collected and verified directly by the senses. They approach these facts with personal and humane concern. To the sensation-feeling manager, the ideal organization has a well defined hierarchy, enacts rules for the benefit of members and society, and also allows for open communication between members. (12).

The intuitive-feeling type manager relies on intuition for perception and on feeling for decision making. This type focuses on new developments, approaching them in terms of serving the needs of others. The intuitive-feeling types avoid specifics, concentrating on broad generalities. The ideal organization for these managers would be decentralized with few rules or operating procedures and would emphasize long term goals as well as be adaptive and flexible. (12).

The sensation-thinking type emphasizes external, factual details and problem specifics. This manager's style tends to be very practical, with step by step reasoning leading from cause to effect. The ideal organization is described as highly regulated with a well defined hierarchy, a high degree of specificity and certainty, and concern for limited short term goals. (12).

The final type, intuition-thinking, tends to focus on possibilities using an impersonal analysis that is often
technical or theoretical. These managers enjoy loosely defined problems requiring abstract skills. Their ideal organization would be conceptual and impersonal with goals that stress environmental needs as well as member needs, but in an impersonal reference frame. (12).

The Hellriegel-Slocum model characterizes four pure manager types, but allows that in accordance with Jung, individuals tend to move toward a balance of the psychological functions.
C. Mason-Mitroff Model

Along with Hellriegel and Slocum, Mason and Mitroff consider psychological type as a variable in decision making. They based their work on the Jungian Philosophy and as in the previous model, developed a composite model consisting of the thinking-sensation, thinking-intuition, feeling-sensation, and feeling-intuition types. These were characterized in much the same manner as in the Hellriegel-Slocum model. However, Mason and Mitroff went beyond the consideration of the types and proposed that other variable factors such as problem type, type of evidence generated and mode of presentation also affect decision making.(16).

Briefly, the classes of decision problems Mason and Mitroff defined are of two types, structured and unstructured. Structured problems are then subdivided into three categories: decisions under certainty, where all elements and the relationships between them are known, decisions under risk, where the elements are known but the relationships between them are based on probabilities, and decisions under uncertainty, where the elements are known but the relationships between them are not. An unstructured problem is one in which both the elements and the relationships are unknown. The authors proposed that different types of problems require different kinds of information and that this information has an effect on the
manager in accordance with the manager's type. If a manager is a thinking type, information should be entirely symbolic, without empirical content. Sensation types prefer information that will be entirely empirical devoid of any theoretical content. To the intuitive manager, information should be in the form of creative stories or diagrams of future possibilities. Information for feeling types would involve stories with moral or ethical components.(16).

There are also different methods of generating evidence. One method is the Lockeian Information System which builds an empirical, inductive representation of evidence by starting from the raw data and building to a set of facts. The guarantee of validity of such information is the consensus of a group of experts. Examples of Lockeian systems are data bases, accounting principles, and statistics.(16).

Leibnitzian information is derived from models or proven axioms. Problems are solved first by building symbolic representations of them and then applying basic formal truths to develop a solution. The guarantee of this system, which is used mostly in operations research, is the traditional specification of what will be accepted as proof of a derived theorem.(16).

The Kantian system develops two possible alternatives which are complimentary using a combination of the previous
theories. The Kantian system provides interaction between scientific theory and data. (16).

The Hegelian system is the same as the Kantian system except that the proposed alternatives are conflicting. This system proposes that the confrontation between opposing interpretations of the same data will result in a creative synthesis and formation of a solution. The guarantee for this system is that conflict exposes underlying assumptions which may hinder solution development. (16).

The final evidence generation system is the Singerian-Churchmanian system which involves continual learning and adaption through feedback. The learning converts unstructured problems into structured problems and thusly allows for easier evidence generation. (16).

The manager relies on information to provide evidence on which to base his decisions. A manager will place reliance on some methods of generation over others because the mechanisms used are more in line with his psychological type than are those of another system. (16).

A fourth variable in the Nason-Mitroff model is mode of presentation. Information can be presented in many forms other than a hard copy report. It is not clear as to whether all psychological types will accept or use information that is presented to them in a form that is inconsistent with their type. Some types may react negatively to the traditional hard copy presentation. (16).
Mason and Mitroff conclude that managers need to receive information for decision making based on their psychological types. The problem type, type of evidence and presentation mode should all be compatible with the manager's own style.
D. McKenney-Keen Model

McKenney and Keen present a cognitive model which is quite similar to that of Mason and Mitroff. Although dependent on different psychological types, McKenney and Keen do not use the Jungian classifications but instead define their own model in terms applicable to problem solving and decision making. The model is based on the premise that consistent modes of thought develop in an individual and that these modes can be classified along two dimensions, information gathering and information evaluation. "Information gathering relates to the essential perceptual processes by which the mind organizes the diffuse verbal and visual stimuli it encounters. The resulting information is the outcome of a complex coding activity that is heavily dependent on mental state, memory capacity, and strategies."(18,pp.80-81). Information evaluation refers to processes commonly classified under problem solving, such as data analysis.

Information gathering is categorized between preceptive and receptive classifications. Preceptive individuals focus on data relationships and look for deviations from, or conformities with expectations. Receptive individuals are sensitive to the stimulus itself and focus on detail rather than relationships. These categories are similar to the perception functions of intuition and sensation in the Jungian model.(18).
Information evaluation is divided into two areas as well, systematic individuals and intuitive thinkers. These classifications correspond to the Jungian thinking and feeling types. Systematic individuals approach a problem by structuring it in terms of some known method which will likely lead to a solution. Intuitive thinkers avoid commitment and use a trial and error approach, jumping from method to method based on internal cues. (13).

The manager is also faced with problem definitions and recognition. McKenney and Keen include in their model the characteristics of each style in terms of how they would approach data and problems because it is believed that certain styles are better suited to certain types of problems. (A similar indication was presented by Mason and Mitroff). The systematic thinker tends to:

- look for a method and make a plan for solving a problem,
- be very conscious of his approach,
- defend the quality of the solution in terms of the method,
- define constraints early,
- discard alternatives quickly,
- move through a process of increasing refinement of analysis,
- conduct an ordered search for additional information.

As a result, the systematic thinkers are most suited to
planning tasks in which both the data and the analysis operations are known, a decision under certainty in Mason-Mitroff terminology.

The intuitive thinkers tend to:
- keep the overall problem continuously in mind,
- redefine the problem frequently,
- rely on hunches,
- consider a number of options simultaneously,
- jump back and forth between steps,
- explore and abandon alternatives quickly.

Intuitive thinkers are most suited to intelligence search tasks, or decisions with risk, in which the operations, methods and probabilities are known but the exact data is not.

The receptive thinker tends to:
- suspend judgement and avoid preconceptions,
- be attentive to detail and to the exact attributes of data,
- insist on complete examination of a data set before deriving conclusions.

The receptive thinker is most suited to problems in which the data is understood, but the necessary manipulations are not, a decision under uncertainty in the Mason-Mitroff model.

The perceptive thinker tends to:
- look for clues in a data set.
jump from one data set to another, building a set of explanatory precepts,
focus on relationships.
Preceptive thinkers are most suited to problems in which both information and operations are unknown, or unstructured decision making.(18),

As Mason and Mitroff, Mckenney and Keen emphasize that there are multiple variables including psychological type that affect decision making.
E. Churchman-Scheinblatt Model

Churchman and Scheinblatt extend the cognitive style model beyond the categorization of style to the relationships between styles as evidenced by manager-scientist interaction.

The model is based on the theory that managers and scientists have different cognitive styles and that these differences cause problems when the two interact. In order to facilitate a more useful relationship, the authors developed four possible interaction philosophies. The first is the separate function position. In this position the scientist prepares as complete a plan as possible then presents it to the manager whose responsibility it is to either accept or reject the proposal. The manager's acceptance or rejection is not based on an understanding of the scientist's behavior, but more likely on the past record of the scientist or on intuition. Similarly, the scientist's proposal is not specifically designed to correspond with the manager's cognitive preferences.(7)

The second position, the communication position involves getting the manager to understand the scientist by using communication techniques. There are several theories as to how these communication techniques can be established. One theory involves the use of a "social engineer" to bridge the gap between scientist and manager and then develop a method to be used by the manager. Another theory
implies that the necessary communication skills should be obvious to the manager based on his prior education. A third theory suggests that if the manager lives in the environment of the scientist for a time, "eventually" he will understand the scientist. A final theory suggests a universal education program for managers to teach them to understand the scientist. The communication position is an attempt to alleviate any cognitive style differences by training the manager to accept the scientist's type.(7).

The third position, the persuasion position, involves overcoming manager resistance by either being able to "sell" proposals to managers or by tailoring projects to the individual manager. In order to overcome resistance the scientist must understand the cause of the resistance. One theory suggests that resistance results from the dissonance caused by making a decision. In making a decision the manager is forced to reject the good points of the unchosen proposals. This rejection causes dissonance and also creates pressure to relieve the adverse feeling. The scientist must determine if the manager will reduce the dissonance by accepting the recommendation or by rationalizing away the attractiveness of the proposal. Another proposal deals with the primacy and recency effects of order of presentation and still another with the effects of the manager's group associations on decision making. Regardless of the method used, this position emphasizes
the scientist understanding the manager's style. (7)

The final position is the mutual understanding position. The separate function position ignores the manager-scientist relationship, and the communication and persuasion positions advocate one-way understanding. The fourth position supports a complete understanding of both professions. Churchman and Schainblatt admit that though this may be the most appealing position, it is also the most difficult to achieve. Neither profession is willing to reveal its deepest secrets or to admit that these treasures could be mastered by someone else. (7).
F. Measures of Personality

One of the primary assumptions of all cognitive style research is that an individual's style is measureable. The Myers-Briggs Type Indicator (MBTI) is often used to determine style because it was explicitly designed to make the measurements called for by the Jungian typology.

Although differing in some details, the MBTI does follow the broad outlines of Jung's psychology. The Indicator consists of four scales: Extroversion-Introversion, orienting toward the outer world of people and things or the inner world of concepts and ideas, Sensation-Intuition, perceiving directly through the five senses or indirectly by way of the unconscious, Thinking-Feeling, arriving at judgements by impersonal and logical or by subjective processes, and Judging-Perceiving, coming to a conclusion about something or becoming aware of something. Jung had no variable describing judgement versus perception however he did classify functions as rational (using judgement) or irrational (using only perceptions). Items on the test consist of behavior reports, value judgements, and word pairs. All items have at least two alternatives, one reflects a particular attitude and the other reflects the opposite attitude or function. Each alternative is weighed separately to reflect the relationship to the scales zero point (the division between one alternative and the other). The score on the scale is the difference
between the sum of the scores for the two chosen alternatives. The sign of the score indicates the dominant category.(23).

When evaluating the Myers-Briggs Type Indicator it is important to differentiate between its usefulness as a personality measure, and its usefulness as a measure of the Jungian typology. When considering the MBTI in relation to overall personality measurement, the consensus of reviewers is that the indicator has some utility. Research findings indicate that the type scores do relate significantly to several variables including personality, ability, and interest. Additionally, though there are better predictors for some tasks, the MBTI is believed to be an efficient mechanism for deriving a great deal of information because it is easily administered and easily scored.(6).

Evaluation of the Indicator's ability to support the Jungian typology has been less positive. When considering the Jungian structural properties of stability and interaction of functions, the MBTI offers little support. Test-retest reliability scores showed correlations between scores as low as forty-eight percent for the thinking-feeling assessment. The highest correlation (seventy-three percent) was found with the extrovert-introvert scales. These values do not support Jung's stability property. Additionally, results showed little or no

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intercorrelation between scales, thusly negating the interaction property. Another major criticism is that the scales presented do not measure the characteristics in the Jungian sense, but in the popular sense. For example, where Jung defined introversion and extroversion in terms of the individual's interest in the conceptual internal world versus the material external world, the MBTI items deal primarily with the person's liking for interpersonal contact. The conceptual interests are not represented. Although evaluators conclude that the Myers Briggs Type indicator does not support the Jungian framework, they do not present this as proof that the Jungian typology is invalid. Instead, the results merely indicate that the Indicator does not define the typology.(25).

Another set of tests used to determine personality are those developed by H. A. Witkin. The purpose of Witkin's studies was to determine the ways in which individual differences in perception are related to personality. Witkin distinguished between field-dependent and field-independent subjects on the basis of their ability to separate an object from its context. These characteristics were measured by using such tests as the "Body Adjustment Test," the "Rod and Frame Test," and the "Embedded Figures Test," in which the subject is asked to place physical objects in positions independent of their surroundings. Field independence or dependence is then
measured in terms of the observed influence of the field on the subject's perceptions of the object within it. For example, the "Embedded Figures Test" requires the subject to identify a predefined figure that is embedded in a complex design. A field independent individual is able to identify the hidden object in much less time than the field dependent subject. Other Witkin tests then demonstrate that the style of perceptual functioning is related to intellectual activity.(9).

Witkin describes the field dependence-independence perception as follows, "at one extreme is the tendency for experience to be global; the organization of a field as a whole dictates the way in which its parts are experienced. At the other extreme the tendency is for experience to be delineated and structured; parts of a field are experienced as discrete and the field as a whole is structured". (25,p.469). Based on these concepts, individuals can be classified as high analytic (field independent) or low analytic (field dependent) using the results of their tests. These categories can then be expanded to encompass the sensation (high analytic) and intuition (low analytic) types of the Jungian typology.

Evaluators accept the validity of the Witkin relationships between perception and personality. However, the series of tests used to develop these relationships and classifications are highly complex and extensive. It is
questionable as to whether the use of just a sample of tests provides an adequate means of determining the analytic style of an individual, while use of the entire battery of tests would be unwieldy.
G. Research - Cognitive Style and Decision Making

Investigation into the effect of cognitive style on problem solving has been a long, slow process. Part of the difficulty stemmed from the fact that initially, researchers concentrated on the problem solution, instead of the process used to arrive at that solution. The success or failure to derive a problem solution may be a direct result of the problem-solving technique used. As scientists began to develop methodologies for associating different styles with different individuals, emphasis turned to investigation of the effect of style on problem-solving.

Among the first experiments relating the process to the product was an "Electronically Operated Logical Test" conducted by Erwin John and James Miller. The researchers felt that problems could be resolved into elements and relationships between the elements. They designed a Problem Solving with Information (PSI) apparatus consisting of a set of lights representing the elements, and a series of arrows between the lights representing the relationships between elements. Through a series of actions, various combinations of lights could be lit, eventually leading to the lighting of the board's central light, the objective of the exercise.(14).

Subjects from varying backgrounds were presented with a series of problems to be solved. Measurements were made
as to the rate of work and the number of trials necessary to determine the sequence required to light the central light. Results showed marked differences in performance between subjects in the natural sciences and subjects in other areas. These differences, John and Miller concluded, were not caused by educational factors, but instead resulted from different approaches to the problems. Findings also indicated that it was possible, by structuring the problems in a certain way, to change the subject's performance. (14).

Ralph Kilmann and Vern Taylor expanded the investigation. The subjects for their experiment, a group of graduate students, were first classified as to type through use of the Myers-Briggs Type Indicator. The students were all enrolled in a graduate course, Behavioral Science for Management, in which they participated in exercises designed to help class members get acquainted, practice giving feedback, and develop trust. At the end of the term students were given a sociometric measure of their acceptance or rejection of the laboratory situation. (15).

The researchers theorized that students who were oriented toward functions compatible with the laboratory situation would accept it, while those who were incompatible would reject the experience. Additionally, subjects whose type allowed them to experience both orientations were hypothesized to learn more than either of the other
two groups. The results of the experiment presented strong evidence to support the acceptance/rejection hypothesis, but data to validate the third hypothesis was less prevalent. From these results Kilmann and Taylor concluded that in order to promote successful learning, individual types must be considered and appropriate consideration given. (15).

The final research effort to be discussed here represents the current experimentation into the relationship between individual style and problem solving. The experiments described were conducted by McKenney and Keen in an effort to validate their cognitive style model described earlier. The researchers first administered twelve standard reference tests for cognitive factors which were developed by the Educational Testing Service. Each test was chosen to fit a particular style defined by the McKenney-Keen model. Results indicated distinct performance differences, confirming most of the style characteristics defined.

A sub sample consisting of those who scores indicated the most distinction between styles was chosen from the original sample of MBA students. These subjects were presented sixteen problems of varying style and difficulty, and were asked to select and solve five of them. Distinct differences were observed between types in both the problem solving method used and the effectiveness of the
method in solving the different types of problems. Additionally, the reported enjoyment of the problem types was consistent within groups, the systematic group preferring program type problems while the intuitive group preferred open ended problems, especially those requiring creativity or opinion. (18).

A final investigation by McKenney and Keen involved examination of the relationship between style and career choice. The career preferences of a group of students were compared to their test scores. Systematic individuals were more attracted to occupations involving production, planning, and control while intuitive individuals were more attracted to open ended professions such as psychology and advertising. (18).
H. Summary

The basis for the individual differences approach to decision making rests in the Jungian Theory of Psychological Types. Jung defined a set of opposing attitude types and a pair of psychological dimensions, perception and evaluation. Hellriegel and Slocum created a composite model of these dimensions, defining the characteristics of each possible type as applied to individuals in management positions. Mason and Mitroff, using a similar composite model, went beyond the consideration of style and proposed that other variables such as problem type, information generation method, and presentation mode also affect decision making. McKenney and Keen then developed a Jungian based cognitive model, incorporating the Mason and Mitroff variables, and characterizing each type in terms of the process by which an individual of that type would approach decision making. Finally, Churchman and Schainblatt added yet another dimension by proposing alternative philosophies regarding the interaction of people with different psychological types.

In order to experimentally validate these models, a mechanism for classifying individuals by type is needed. Two instruments, the Myers-Briggs Type Indicator and the Witkin tests, are among those available for this purpose. Though each is believed to accurately distinguish cognitive styles, both have deficiencies. The MBTI, designed to
measure the Jungian typology, it is not a valid measure of the psychological types as defined by Jung. The Witkin tests, though effective are often difficult to administer. In spite of these measurement difficulties, experimentation has progressed from a determination that cognitive style affects decision making, as shown by John and Miller, to Mckinney and Keen's attempt to relate problem solving methods to psychological types.

Although there are similarities between models, attempts to combine the frameworks into a single composite model have been unsuccessful due to the uncertainty in the number of style dimensions and the relationships between them.(26). However, for use in studying information systems a simplified model can be defined containing two basic cognitive styles, systematic and intuitive, that are concerned with an individual's perceptions of what is information and the cognitive processes used in evaluating this information. Systematic individuals prefer factual, detailed information, models, and deductive reasoning where intuitives prefer generalizations, trial and error, and intuitive insight. As in other models, this model views cognitive style as a constraint in interactive processes based on the idea that individuals tend to reject data that are inconsistent with their own style.
III. Information Systems Development Methodology

The Information Systems Development Methodology can best be portrayed by the systems development life cycle. This cycle consists of five phases: systems analysis, general design, evaluation and justification, detail design, and implementation. Although these phases can be discussed individually, in practice they are related to each other by the dependence of each one the successful completion of the preceding one. On completion of a phase, decisions are made as to whether the results should be accepted and the project continue, the phase should be repeated and modifications made, or the project should be terminated.

Presented here are descriptions of each of the cycle's five phases as seen from the viewpoint of the systems analyst, a person who designs information handling procedures. These descriptions are not intended to provide a thorough analysis of the development of each system component, but instead to describe each phase in terms of the perceptions, interactions, and evaluations required.

A. Systems Analysis

A systems analysis is defined as "the analysis of an activity to determine exactly what must be done in order that it be carried on in optimum fashion". (21, p.109). The basic reasons for undertaking an analysis are:

- to correct a malfunction in the current system,
- to accommodate a new requirement or regulation,
- to implement a new technology or technique, or
- to provide a more effective, more efficient means of conducting current operations.

However, in many cases the decision to begin an analysis is based on vague, undefined reasoning. Therefore, the first step in any project is to ascertain the specific objectives of the project. Objectives are defined by conducting interviews with the persons requesting the analysis. During this interview process any constraints imposed by management philosophy, such as cost or time constraints, may also be defined. Project definition is a vital element in the design process. Improper definition of project scope can result in failure to meet objectives and in surpassing cost and time constraints. It is important that the analyst not overextend the project scope. Statements such as "I want to know what yesterday's sales were by 8:00 A.M. today," should not immediately be converted to "Develop a new sales reporting system." (5, p.249). At the same time, by defining too narrow a scope the analyst severely limits the number
of potential solutions.

To aid in ensuring that the true nature of the project is understood, a formal report outlining the project goals and a general approach toward achieving those goals is presented to management. This provides the requestor an opportunity to evaluate the analyst's understanding of the project and to make any necessary changes. Additionally, management should be informed that the project scope and constraints defined, though accurate now, are subject to redefinition based on the findings of later analysis.

Once the overall project has been defined, in depth data collection begins. Data are available from a variety of sources both internal and external. One internal source of information is the existing system. Examination of the current system provides a basis for determining whether objectives can be met by that system, either as is or with modifications, or whether a new design is needed. If a new system is indicated, knowledge of the old system provides a common communications point between manager and analyst, serves as a basis for determining conversion requirements, and may also instigate design ideas for the new system. However, this type of investigation may also have disadvantages. It can be a time consuming and therefore expensive process which may be difficult to justify, especially if findings indicate a new system is needed. An other potential problem is that in examining the old system
the analyst may become overly involved in old methods and old problems, thereby reducing his/her effectiveness in designing a new system. In this sense, evaluation of the old system may result in additional, possibly unnecessary constraints to the new one.

People, both those in management and those in support level positions, are another important information source as they are the primary provider of system requirements. Again there are potential hazards however. The analyst is often forced to make judgements as to whether a stated requirement is necessary or just desired. It is also important to remember that people tend to define their needs in relation to what they now receive. Unless users are educated as to the system's potential, requirements will again be based on the current system, not on what is really necessary.

Additional sources of internal information are existing documentation and the interrelationships between people and functions. When examining these sources, the analyst must realize that discrepancies may exist between the reported information and the actual processing. For example, documentation is intended to describe current operations. However, procedures often change and the documentation is not updated. Additionally, documented procedures though current may not be followed in actual operations. The same is true of relationships. Existing affiliations may not be
those intended by management, and also may not be those most beneficial to the organization.

External information provides the analyst a source of new ideas as well as the opportunity to observe a system in operation. Exchanges of information through textbooks, journals, seminars, and on-site visits are common in the information processing environment. Observing similar information systems in other organizations can often provide the analyst a new approach toward designing his/her own system.

Upon completion of the fact gathering process, analysis of the data begins. There are potential hazards in this process as well. The first is the utilization of inaccurate facts. During the data collection phase the analyst may have been given some well meaning, yet invalid data. Another concern involves the use of prior knowledge in making assumptions. Often an analyst familiar with the organizational function being evaluated, may consciously or unconsciously substitute prior knowledge for fact gathering resulting in erroneous information. By using many different sources of information and comparing results, the analyst can aid in eliminating these problems. However, too much verification can result in a time consuming, extremely expensive process.

Throughout the analysis phase, the analyst must maintain an intelligent, open-minded approach. He/she will
come in contact with many people and will have to record and evaluate a great deal of information. When the analysis is complete, the analyst should organize the information into a report stating:

- the user performance requirements (information input, output, and processing),
- the systems performance requirements (costs, reliability, installation time), and
- a list of major problems identified.

This report, in conjunction with preliminary design recommendations, and the technical and economic feasibility of continuing the project is communicated to management. As a result of this communication, management will decide to either stop work on the project, postpone further activity, modify the current project, or continue the project as is. If modifications are indicated the systems analysis cycle advances to the next phase, the general design phase.
B. General Design

The main purpose of the general design phase is to develop specifications for the proposed new system, or system modification, which adhere to the requirements established during the system analysis phase. The design phase addresses "how" processing should be done whereas the analysis phase deals with "what" processing should be done.

The ability to design a system involves combining individual reasoning and creativity with specific knowledge in seven fundamental areas. Several of these areas, organizational resources, user requirements, and systems requirements, were defined during the analysis phase. However, each requirement serves not only as an objective, but also as a potential constraint to other procedures. Therefore, the analyst must continually evaluate each requirement in terms of its effect on resource utilization and its compatibility with other requirements. The analyst should also be alert for potential uses of new or additional resources not previously considered.

Other required knowledge relates to operational considerations such as the data processing method (manual, electromechanical, computer) and the data handling operations (collection, verification, classification, storage, retrieval). Typically, a given system will incorporate multiple processing methods, each method requiring a different number and sequence of data operations. Therefore, although many
of the data operations required can be identified from the user information requirements, these requirements can change based on the processing method used. Again, an evaluation of need versus resource utilization is required.

Another key area to consider is the "human factor." Most users are not technically oriented, yet they are the ones who must interact with the system on a day to day basis. Therefore, the portions of the system accessible by the user (inputs, outputs, screen displays) must be designed to be as flexible as possible so as to meet the user's changing needs. Often efficiency must be sacrificed in order to provide human understanding and satisfaction.

The final area of analyst knowledge is knowledge of design tools and techniques. Different types of requirements can be evaluated through utilization of different tools. Flowcharting is an effective means of illustrating information flow requirements while decision tables are useful for charting strategic processing requirements. Yet another technique, modelling, provides the analyst a means of experimenting with and evaluating different design alternatives. These and other tools assist the analyst in organizing the vast amount of information required in making a design.

The application of this knowledge to system design is a repetitive process. As each new requirement is introduced, reexamination and modification of previously developed
structures is usually required. As a starting point, an overall system goal is defined by reviewing and evaluating the requirements formulated in the analysis. The systems goal, unlike the user requirements, does not change. Where the input, output, and processing requirements of a system are subject to change as user needs change, the overall purpose (goal) of the system remains constant. A system designed to meet a goal provides some flexibility with regard to the way in which that goal is reached, allowing the system to be modified as user needs change. Alternately, a system designed to produce specific outputs is likely to require extensive redesign when changes are necessary.

The next step is to construct a generalized conceptual model of the proposed system by making use of the similarities between systems designed to perform the same type of functions. For example, all accounts payable systems require information from purchase orders, invoices, and receiving reports, and outputs of checks, purchase reports, and outstanding purchase order reports. Similarly, accounts receivable systems require the input of charges and payments, and the output of aged receivable reports, bills, and account trial balances. The conceptual model illustrates these fundamental inputs and outputs without concern for the specific requirements.

Once the conceptual model is defined, the customizing process begins by applying the organization's user and
systems requirements, and by considering the available resources. Information systems must compete with other systems and activities for a share of the finite organizational resources. As a rule, resources are allocated to activities which provide the greatest benefit to the organization. On the other hand, user requirements mandate that the system be flexible and responsive to user needs. When applying constraints to the conceptual model, the analyst must weigh the importance of each requirement against the resources utilized in an attempt to obtain an optimum system (an optimum system is one in which available resources exceed requirements by some predefined margin so as to allow for future expansion and modification). As a result of this process, the analyst develops definitions for feasible alternative systems, each of which appear to meet the defined system objectives and performance requirements.

The possible alternatives are communicated to management and user personnel in a report that includes a restatement of objectives, a thorough model of each alternative, and an explanation of resources required for each alternative. Management must then decide whether to eliminate an alternative from consideration, to accept an alternative for further evaluation, or to propose modifications to certain alternatives before making a final decision. If modifications are indicated, the general design cycle is reinitiated. Otherwise, in depth evaluation begins.
C. Evaluation and Justification

The purpose of this phase of development is to provide the information management will use in deciding which of the proposed system alternatives should be selected. The two primary considerations for management when making this decision are the results of a cost/benefit analysis and the impact of the proposed system on employees. Therefore, for each alternative, the analyst determines the associated costs, including equipment costs, programming or software cost, implementation costs, and operating costs, and also the benefits, both direct and indirect. Additionally, an analysis of each alternative with respect to its effect on personnel staffing and training is performed.

When defining the costs associated with acquisition of hardware and/or software a decision must be made as to whether the systems should be purchased from outside vendors, or should be developed by personnel within the organization. The variables investigated include personnel availability, required implementation dates, and the "uniqueness" of the systems requirements. Generally, in-house development allows for: a system that precisely matches requirements, optimum use of available resources, and state of the art technology. Alternatively, a purchased system provides: a proven product, reduced development and installation time, a reduced burden on development personnel, and typically, reduced overall costs. Each
advantage and disadvantage must be weighed when evaluating the make-or-buy decision.

If the system is to be purchased, an additional phase is required. First a proposal is requested from a vendor or group of vendors. This can be a request for a specific equipment configuration or processing method, a more general request based on performance objectives, or simply a request for a single vendor to propose several alternatives for meeting the system requirements. Once proposals have been received, the analyst determines if the proposal meets the general mandatory requirements outlined by the organizational philosophy. Next, each proposal is evaluated in terms of its ability to meet the design requirements of the alternatives under consideration. Consideration is also given to the reliability and maintainability of each proposed system as well as the support provided by the vendor both before and after implementation. Once this evaluation is complete, the analyst can rate each system. This rating is used as an element in the cost/benefit analysis for choosing a system.

The next step is to identify all of the costs associated with each alternative system. These costs include not only the cost of development (or purchase), but also the setup costs such as installation, testing, conversion of old data into new formats, and employee training, and the annual operating costs such as personnel, supplies and maintenance.
The effectiveness of a system is more difficult to express in monetary terms. There are two types of benefits, direct (tangible) and indirect (intangible), which measure the effectiveness of a system. Direct benefits result from increased efficiency or elimination of an operation. These cost savings are relatively easy to measure because they can be traced directly to a change introduced by the new system and can then be valued based on costs incurred with the old system. Indirect benefits are not so easily measured and are therefore based primarily on the analyst's perceptions of the organization's objectives. Examples of intangible benefits include improved customer service, improved cash control, and reduced number of stockouts.

The dollar values given to costs and benefits may sometimes be derived from price lists or records of past performance. However, due to the fact that a proposal is oriented toward future events some items will be based on estimates. Care must be taken during this estimation process so as not to follow a tendency to overestimate benefits and underestimate costs.

The second area to be considered when evaluating system alternatives is the impact of each alternative on the organization's employees. The analyst determines the number of employees required, the job classifications, and the required skill levels of those employees for each alternative presented. Consideration is also given to the amount and
type of training that will be required of existing personnel when a new system is implemented.

When all of the evaluation data has been collected, the analyst compares the alternatives and formulates a recommendation as to which alternative should be selected for further design and implementation. This recommendation along with the results of the cost/benefit analysis and the employee impact analysis is then presented to management for consideration and a decision.
D. Detail Design

In the detail design phase, the general design alternative selected for implementation is expanded to include exact specifications. This provides the activity necessary to "transform a general or conceptual design into a unified system of people and machine that collects and processes data and produces information." (S, p. 349).

The basis for all information flows has been defined in the general design. In the detail phase, this flow is broken down into greater detail showing the layout of all information to be input, the layouts and organization of the files where the information will be stored, the program specifications, clerical procedures, error recycling procedures, and the number, frequency, retention, and layouts for all outputs. From the program specifications, programmers will write computer code. From the clerical procedures, processing manuals for employees will be prepared.

As an example of the logical processing which takes place during detail design, consider the selection of system controls. Controls are designed to aid in ensuring that a system is performing as required and that its operation is protected from misuse. These protections include input controls to prevent errors from entering later processing, programming controls to help detect input errors and errors resulting from the processing of input, data base controls to guard against complete loss or destruction of data, output
controls to verify the accuracy and completeness of processed information, and hardware controls which aid in detecting errors resulting from faulty transmission of data in the computer itself. Additionally, there are security controls designed to protect against failure of hardware or software. The analyst must examine these control areas and implement those controls necessary to protect the given environment. As with other requirements, there is a cost and a benefit associated with each control procedure. These values play a key role in determining which control mechanisms are utilized.

The end result of this process is a document detailing system functions, flowcharts, component relationships, and program specifications, as well as a revised estimate of project costs. This document is a culmination of the analyst's evaluation of each system component both in terms of costs and requirements. If the design is approved by management, the project advances to the implementation phase.
F. Implementation

The purpose of the final phase in the systems development life cycle, the implementation phase, is to obtain an operational system. The areas to be considered here are personnel training, system testing, and system conversion.

Ensuring that personnel are properly educated with regard to the new system is the responsibility of the analyst. Users of the information (management, salesmen, accountants, etc.) must be instructed as to how the requirements they defined in earlier phases are being met by the new system. Operations personnel, those preparing input and operating the physical components of the system, must be trained to run the new system. This educational process can be accomplished through group instruction, individual instruction, procedure manuals, simulation, or on the job training. Because different educational objectives require different approaches, the analyst must evaluate and utilize many different educational methods. When selecting a technique, consideration should also be given to the usefulness of the program at a later date when new employees must be trained.

Another area that requires careful analyst planning is systems testing. Tests are performed on various levels progressing from the program module, to the entire program, to a series of sequential programs, to all programs in the system, and finally to a test of the entire system including
both manual and automated processes. Again there are tradeoffs between the cost of the testing and the reliability of the test results. Simulated logical testing in which a programmer mentally traces a transaction through the system has a low cost, but also low reliability. As the complexity of the test transactions increases, so does the preparation cost and the test reliability. The analyst must decide what type of testing is appropriate in light of the system complexity. Effective testing can reduce the maintenance needed at a later date to correct errors.

The conversion process is one in which the equipment, data, and procedures used in the old system are changed into those to be used in the new system. Conversion can be accomplished by immediate discontinuance of the old system and initialization of the new, by operating both systems simultaneously for a time so that operating comparisons can be made, or by converting different sections of the system based on either organizational divisions or system segments. The decision as to which method to use is made by the analyst based again on the complexity of the new system as well as the usefulness and compatibility of the old system. Generally, the analyst prepares a detailed conversion plan before any portion of the implementation takes place.

The analyst's involvement does not end with completion of the implementation phase. He/she must monitor and evaluate system performance, making minor changes when ne-
cessary. Additionally, the analyst must respond to user suggestions for changes by determining that they are either problems and responding immediately, or just luxuries that can be handled at a later date. When the analyst is satisfied with the system's operations, an acceptance meeting will be held with management and user personnel. At this time a final approval is requested and if received, the project is considered completed.
F. Summary

As evidenced by the preceding narration, the information systems development methodology is a standardized procedure for designing an information system to both automate day to day transaction processing and provide information to assist managers in making operational as well as strategic decisions. In relation to the defined purposes of an information system, the system analysis, general design, and evaluation and justification phases are concerned with identifying the data inputs, information outputs, and processing that are significant to the organization based on both requirements and cost effectiveness. The remaining phases, detail design and implementation are intended to construct and operationalize a system capable of transforming the data into information and automating some of the cognitive processing used in the current operation.

If one were to simplify the information systems development methodology into its basic functional activities, they would be perception, evaluation, and interaction. During the cycle itself perceptions are used in collecting data, evaluation is used in converting that data into requirements and in formulating designs, and interactions are present throughout the cycle as designers question users and present results to managers. Once the new system is operational, these activities are transferred to the utilization of the system as users interact with the system.
to produce information for decision making and transaction processing.
IV. Cognitive Style and Information Systems Success

Comparison of the simplified cognitive style model and the basic information systems development functions reveals that both models are concerned with the same activities: perceptions, evaluations, and interaction. Cognitive style theory suggests that cognitive style influences an individual's perceptions of information significance, methods of evaluating or processing information and may also be a constraint to effective interaction. The information systems development methodology and the utilization of the completed system involve these same functions. The next logical step in the evaluation is to determine if cognitive style influences these factors as they relate to the information systems development cycle and the utilization of the product system. Presented in this section are the results of some experimentation into this area and the implications of these results for system design.
A. Research

The success of an information system development project is based on the completion of the development cycle and the utilization of the system by the user. Development cycle completion is dependent on the user's decision to accept the product of each phase of the cycle, including implementation. Although the acceptance is necessary for success, acceptance is not sufficient for measuring system success, as the acceptance of outputs does not ensure their usage. The outputs of the product must be "organized and/or manipulated and/or integrated by the decision making process" before the project can be considered successful. (3, p. 36).

Research has been conducted in an attempt to determine the effect of cognitive style differences on the acceptance and utilization of information. Herbert Moskowitz and Richard Mason investigated this area by determining how the order of presentation and the "degree of informativeness" of data affect individual information processing behavior. The degree of informativeness of a data item was defined as the change in the perceived likelihood that a given event would occur based on consideration of the subject data element. In the experiment, subjects were provided a loan application and were asked to assess the probability that the loan applicant would become delinquent during the coming year. Next, based on his/her experimental group, subjects were given one of three additional pieces of information. This
information was in the form of objective conditional probabilities such as: "Ninety percent of those people who have never been delinquent met condition X. The applicant meets condition X." The facts were derived from three sources: the bank's internal records, a credit scoring system based on the borrower's attributes, and a retail credit information service. After considering each new data item, the subject was asked to reassess his/her delinquency estimate. At the end of the processing task, the subjects evaluated the credibility of each information source, the results to be used in studying the informativeness variable.(19).

Analysis of the experimental data was undertaken by using the Bayesian model to compute the objective standard probability of the applicant becoming delinquent. This model specifies internally consistent relationships among probabilities to derive optimal probability estimates. Comparisons between the optimal solution and the experimental solution were made with respect to the control factors, order of presentation and informativeness. Statistical results showed that the first piece of information received had a greater effect on outcome than did the last piece (primacy effect) and that the greater the degree of informativeness, the greater the use of the data. Therefore, both order of presentation and informativeness were concluded to affect decision maker probability estimates and consequen-
tly the type and validity of the decisions made.(19).

Study of the data selection process was expanded by Stephen Barkin and Gary Dickson to include a cognitive style variable. Subjects were classified as either heuristic (using trial and error and intuition) or analytic (using quantitative modelling) based on a seventeen item psychological test developed specifically for the experiment. Each subject was given a manufacturing case in which they were required to make several decisions related to hiring/firing, ordering of raw materials, and production scheduling, each of which covered a week of computer simulated activity. To aid in this process, subjects were given a Production Summary Report reflecting the impact of the prior week's decisions. The report contained 198 data elements, 87 of which were judged by experts as being critical to the decisions.(3, pp. 39-41). The subjects were instructed to "highlight" any report information they considered important to the decision making process. Subjects were required to make decisions covering five weeks of production.

Data selection was measured by counting the number of report data elements highlighted within each of the critical and non-critical classifications. Heuristics were found to have selected more data items than did analytic subjects. Additionally, both the number of non-critical items and the ratio of non-critical data selected to total data selected were higher for heuristic decision
makers. These results, combined with those of Mason and Moskowitz, show that not only do different individuals utilize different information, but also that the differences can be related to cognitive style classifications. (3).

The research presented thus far utilizes the cognitive style model as defined by Mason and Mitroff or McKenney and Keen. These models examine the different individual preferences that are a result of cognitive style characteristics. In each experiment subjects were given a complete set of data and then selected the information they wished to apply to the task. The next research to be discussed incorporates the additional cognitive style dimension introduced by Churchman and Schainblatt, the interaction between styles, and attempts to evaluate how individuals with different styles react to each other. Robert Doktor and William Hamilton based their study on the idea that the written report is the primary mode of interaction between managers and researchers. The objective of the research was to determine how cognitive style affects the acceptance rate of written reports with contrasting presentation styles. A secondary objective was to compare the acceptance behavior of practicing managers and graduate business students. (9).

The experiment was conducted in three separate sessions. In each case, subject groups were first divided into cognitive style classifications, high analytic or low analytic, based on the median score of a modified Witkin Embedded
Figures Test for that group. Subjects were asked to assume the role of a manager. They were then given one of two versions of a report and were asked to record whether or not he/she would accept the recommendations described in that report. The two reports contained an identical analysis of a case problem and offered the same solution, but differed in organization and in the presentation style. Based on these differences, one report was classified as analytic, as it contained technical information in the main body, while the other was classified as general because it presented the technical information only in the appendices. (9).

Results were calculated for the three subject groups, students, managers, and a matched sample from the student group. Using the group median Witkin test score of 14 as the dividing point, the results showed that low analytic students were far more likely to accept a report and tended to accept the analytic report over the general one. Conversely, high analytic students tended to accept the general report, if any report was accepted. The manager group, whose median Witkin score was 8, showed no apparent differences in acceptance behavior. For the third test, a sample of student subjects whose test scores most closely matched the manager group was selected. When compared to the manager group, these students showed a much greater tendency to accept a report and also tended to accept the analytic
report over the general one.(9, pp. 889-891).

The researchers concluded that although no explicit relationships could be developed between a given style and acceptance behavior, cognitive style does influence the acceptance/rejection decision. Additionally, cognitive style characteristics are influenced by experience. Students who are subjected to highly structured activities in their educational programs demonstrated stronger analytic capacities than did managers who tend to be involved in fewer structured tasks.(9).

Where Doktor and Hamilton limited themselves to measuring only acceptance, Huysman expanded the experiment to include implementation as well. Subjects were classified as being analytic, reducing problems to a core set of relationships and then working toward optimal solutions, or heuristic, developing workable solutions by observing the total problem and emphasizing consistency with the total environment. The format used was that of a business game in which one "president" (the subject) and four "managers" (simulated) made financial, pricing, production, and purchasing decisions for a hypothetical firm. Six very similar problems were presented to the president, each of which was unrelated to the others except for the financial function. Two of the simulated managers (production and purchasing) were given heuristic arguments representing their viewpoints. The simulated marketing and accounting managers
both used analytic arguments but where the marketing manager confined his arguments strictly to his own area, the accounting manager was interested in the overall optimal operation of the firm. Two different implementation strategies were used by the accounting manager. One strategy incorporated formulas and was intended to gain explicit understanding, the other omitted the formulas intending to gain integral understanding. In order to allow measurement of both acceptance and implementation, optimal solutions were proposed to the president for only four of the six problems. Adoption of these proposals indicated acceptance. Implementation could then be measured by observing how the subject utilized the "optimal reasoning" in reaching decisions concerning the other two problems. (15).

The results of the study showed that analytic subjects responded positively to the proposals when the explicit understanding approach was used, whereas heuristic subjects rejected these proposals. Analytic subjects receiving the explicit arguments were as likely to accept and more likely to implement proposals than were heuristic subjects receiving the same approach. Additionally, all subjects receiving the general approach were as likely to accept and more likely to implement proposals than were heuristic subjects receiving the explicit approach. The acceptance behavior of all but the heuristic-explicit group was approximately equal, but the implementation behavior differed.
indicating that acceptance of a proposal does not guarantee implementation. From these results the researchers concluded that cognitive style is a constraint in implementation because when cognitive style differences exist between manager and researchers (the accounting manager), the manager may ignore the researcher as a source of information. However, the researchers also concluded that consideration of this constraint in the research strategy can result in successful implementation. (13).
B. Summary of Implications

A great deal of research similar to that described here has been conducted in an effort to analyze the influence of cognitive style and cognitive style differences on human information utilization. Due to differences in classification techniques and a general inability to control all of the variables that may affect decision making, the specific results of this research have been inconsistent. However, general conclusions can be drawn. Cognitive style differences are concluded to affect the utilization of information systems. Information presented in a style inconsistent with that of the recipient was ignored during later cognitive processing. Order of presentation, type of information, and quantity of information were also observed to affect cognitive behavior.
V. Cognitive Style Considerations in the Information Systems Development Methodology

Research has emphasized the effect of cognitive style on what information systems are designed and how those systems are used once they are operational. Little or no consideration has been given to the role of cognitive style and cognitive style differences may play in the system development methodology itself. However, general conclusions drawn from the results of those experiments can be applied to the interaction and decision making processes of the systems development cycle.

Before beginning this new extrapolation it is important to review the basic foundations of cognitive style theory. These conclusions are as follows:

1 - Individuals exhibit different, self consistent ways of functioning (cognitive styles) during perceptual and intellectual activities.

2 - Cognitive style affects information processing in that individuals tend to reject information that is inconsistent with their own style.

3 - Negative cognitive style effects can be overcome with appropriate consideration and counteraction.

4 - Variables that are affected by cognitive style preferences include problem definition, information selection, mode of presentation, and communication between individuals.
In a previous section, the procedures used by the analyst in meeting the objectives of each development phase were defined. After considering the potential effects of cognitive style, it is necessary to expand these procedures to include style considerations.
A. Systems Analysis

For the analyst, the purpose of the systems analysis phase of development is to define the general system requirements, the functions to be performed by the new system. Effective user involvement is a key variable in this process. Studies by Edstrom showed a high correlation between system success and user involvement in the system analysis phase. Additionally, the direct influence of the analyst was found to be counter-productive in defining user needs.(10).

These results can be explained by considering cognitive style theory. If a new system is intended to support the information needs of the manager, it must produce data in a manner consistent with that manager's style. Systems analysts are not in a position to accurately evaluate all of these cognitive style needs, therefore, left on their own, analysts tend to design the system in accordance with their own perceptions of what is needed. Unfortunately, these perceptions are often inaccurate.

Ackoff identified several assumptions commonly made by systems designers. Among them were that managers lack sufficient relevant information and that managers need all of the information they request.(1). Barkin and Dickson demonstrated that information needs vary between individuals. Therefore, by assuming that all managers require additional information, the analyst is ignoring the manager types that
have minimal information requirements. For these types of managers, the current problem may be that there is an overload, not a shortage, of information in which case the new system should be designed to condense the current information into a summarized form and to filter out unnecessary information.

Although it is vital to define system requirements based on user needs, this does not imply that all user requests are necessary. For example, cognitive research suggests that when report formats are inconsistent with user style, the user tends to request additional information.\(^{(26)}\). The problem that prompts a request for more information may be the result of information that is not being used in its current form, not a lack of sufficient information. In this case, providing additional information is a costly alternative that still may not solve the problem. It has been generally accepted that humans do not understand their own information needs and tend to request more information than will be used in decision making.\(^{(26)}\). Again, the analyst must recognize this phenomena and design the system to selectively filter information.

Another factor influencing manager requests is that, based on their own cognition and experience, managers have preconceived attitudes about the usefulness of an information system. Often a user will request data based on what
he/she believes can be provided instead of what is actually needed. The role of the analyst is to educate the potential users as to the capabilities of an information system and the development process through which those capabilities are realized. Based on this knowledge, users will be better able to defined requirements independent of current operations and prior misconceptions. The education process will also increase the probability that management will define realistic system cost, reliability, and installation constraints because they will have more information on which to base these evaluations.

Another key area in the analysis phase, as in every phase of the development cycle is effective communication. The analyst must be able to interact with the users in order to enhance user involvement and thereby gather the information with which to define system requirements. As described earlier, research by Doktor, Hamilton, Huysman and others has shown that interactions are effected by cognitive style differences. The analyst must communicate with the users in a manner consistent with the users' cognitive style.

The mechanism used to avoid these hazards of systems analysis can best be described as the "behavioral" component of systems analysis. Using the Churchman-Scheinblatt terminology, the interactions between analyst and users can best be portrayed by the persuader position in which the
"burden" of dual understanding is placed on the analyst. This means that the analyst must be able to understand both his/her own way of reasoning and that of the manager. Additionally, the analyst must be aware of the potential problems resulting from cognitive style differences and be able to compensate for those differences, reducing if not eliminating the cognitive conflict. In some instances the analyst may encounter a manager who is equally aware of cognitive style effects, resulting in a "mutual understanding" position. Cognitive style remains a concern, but this position allows for the "burden" of understanding to be shared by both parties.

Because only the user can effectively define requirements the interview has traditionally been an integral part of the analysis phase of development. Incorporation of the "persuasion position" does not change the use of this tool, only the manner in which it is applied. For example, instead of questioning the user as to what information is needed, the analyst should ask what type of decisions are required. As mentioned earlier, information requirements are dependent upon cognitive style. Decision making requirements, however, are based on the organizational functions and must be made whether the decision maker is analytic or heuristic, introverted or extroverted. Another similar element of the analysis is to determine the flow of information between organization departments.
Again this information should not be collected by asking individuals what information must be received from other departments, but instead by asking what information they transfer to other departments. The objective of the interview process is to collect data that is independent of cognitive style influences. Questions such as "what problems exist in the current system" should continue to be asked. Information of this type may also be valuable. However, the analyst must be careful not to accept these responses as requirements without further evaluation.

Using the interview data, along with information collected from other sources (documentation, the current system, external sources) the analyst can define the system requirements and prepare a report summarizing the results of the analysis phase. During the interview process the analyst should also begin to develop an indication of the cognitive preferences of the users (i.e. likes detailed explanations as opposed to generalized statements). Consideration should be given to these factors when preparing the analysis report. Based on this report, management will decide whether or not to continue the project. This aspect of analyst-management interaction will be considered in greater depth during later phases of the development cycle.
B. General Design

The general design phase is the process through which the information needs of the user are matched to the technical capabilities of the computer and the economic constraints of the organization. Studies by Edstrom show that as the technical nature of the task increases, the importance of user influence decreases. (16). Because this phase is concerned with technical constraints as well as user constraints, the direct influence of the user is not as critical as in the analysis phase. This does not imply that user considerations are totally unnecessary, only that when compared to the systems analysis phase, the degree of direct interaction between user and analyst is significantly decreased during the general design phase.

The analysis phase defined "what" decisions must be made by the organization. The general design phase defines "how" the system will aid in making those decisions. To accomplish this each decision must first be categorized. One classification scheme used for this purpose is that defined in the Mason-Mitroff model. In Mason-Mitroff terminology, decisions under certainty are those for which optimal or near optimal solutions can be derived by supplying the variable information to a predefined model. Examples of this kind of decision are break-even analysis, make-or-buy decisions, and return-on-investment analysis. In each of these cases, standard models are available for
deriving optimal solutions. For these decisions the entire decision making process should be built into the information system itself. This eliminates one category of decision from direct management consideration, thereby easing the quantity of information to be evaluated. A second category of decisions, decisions under risk, are those in which models are available, but an optimal solution cannot be derived due to some uncertainty. Decisions of this kind include selection of a new product line and the new equipment versus maintenance of old equipment decision. In this case, the information system should be designed to provide the information that will allow the users to compare the costs and benefits of each alternative. With decisions under risk, as with the decisions under certainty, the models used define the information requirements. This is not the case in the next type, decisions under uncertainty, in which the problem elements are known but the relationships between them are not. Because the relationships are unknown, explicit models cannot be defined. For these decisions the analyst may either conduct research to determine what information is relevant, determine the relevant information based on his/her own evaluation, or determine the decision making process used by the manager and make this an explicit model to be used as with decisions under risk. The hire/non-hire decision is of this type. The final decision type is unstructured decisions for which
neither elements or relationships are defined. The information needed for making this type of decision cannot be defined because the required decision is not explicitly defined. Therefore, these decisions cannot be incorporated into an information system. However, depending upon the decision to be made, the relevant information may be available due to its use in another decision making process. (16,1).

As the uncertainty of a decision increases, the cognitive style characteristics of the decision maker become more important. In cases where optimal solutions are readily available, cognitive style has little effect. However, for decisions under risk and uncertainty, where decision maker evaluation is necessary, cognitive style must be considered in the format, presentation, and generation of the information. Mason and Mitroff identified five different methods of generating evidence that ranged from a strictly empirical method (Lockean) to a highly adaptive method (Singerian-Churchmanian). Managers were found to place more reliance on information generated in a manner consistent with their own cognitive processes. (16). Additionally, managers were more likely to utilize information presented in a style that matched their own. The magnitude of these considerations surfaces during the general design phase in which the number of each type of decision is determined.

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After the analysis of the information requirements is completed, alternative system models that will meet these requirements are developed. The ideal system would be capable of supporting all of the decisions defined, but due to organization constraints, the ideal situation is unlikely. The analyst must design alternative systems, each of which satisfies different combinations of requirements. One strategy for designing systems is prototyping. Using this method, simple working models of the potential systems are constructed. These models are then presented to the potential users giving them an opportunity to understand and evaluate the basic system before committing the organization to the total development effort. The greater the users' understanding the better their ability to evaluate alternatives and consequently the more likely the final system will meet user needs. Prototyping is especially helpful in situations where cognitive preferences are unclear. By constructing models representative of different processing techniques, the user will select, consciously or unconsciously, the system most compatible with his/her own style. This procedure is also helpful in ensuring that the user requirements have been defined correctly and that they are complete.

Another important consideration in the general design phase is the flexibility of the proposed systems. The system design should be flexible, as most users are more
satisfied with systems that may be modified in accordance with their changing needs. (26). Flexibility is important to another aspect of information systems as well. Often in organizations information is not required on a regular basis. Therefore, it is highly inefficient to regularly produce this information as it may never be used. The information system must be able to respond to user requests for information as well as provide information on a pre-defined basis. Use of the "report generator" concept is helpful in providing the user needed information as requirements fluctuate. This approach involves the design of a set of generalized programs that allow the user to select the data elements to be reported and to a degree, the format of the report itself. Providing this capability reduces the probability that users will over-burden the system with unnecessary production just to ensure availability on demand. In general, the system should be designed to adapt to the user's changing needs. Though this flexibility may not directly effect the general design, it must be considered as a constraint in the general design process because flexibility often affects technical efficiency and resource utilization.

After design completion the alternative systems must be presented to management for consideration. Cognitive style plays a key role in this process. Again, information must be presented in a style consistent with that of the
manager. If the cognitive style of the manager is unknown, it is best to use a general (heuristic) approach, but to also be prepared to present analytic information if necessary. If a manager wants additional information, studies indicate that he/she will request it. However, presentation of analytic information to a non-analytic manager could result in immediate rejection. (15,9).

Consideration should also be given to the order of presentation of alternatives. As indicated by Mason and Moskowitz, humans tend to place the most emphasis on the first alternative heard. (26). The analyst should alert the managers to the potential problems and suggest that they reevaluate each alternative before making a decision. This reevaluation, combined with user awareness is intended to counteract the impact of presentation order. However, care must also be taken not to overemphasize the problem and thereby cause management to reject the first alternative based on a fear of accepting it due to the primacy effect.
C. Evaluation and Justification

In the evaluation and justification phase, the analyst collects and organizes all of the information pertaining to the costs and benefits of each system alternative. Direct user involvement in this phase is limited to the final presentation of results. Consideration of user influence, however, is important to ensuring a useful evaluation.

The major emphasis of a system proposal evaluation is on the cost/benefit analysis. As described earlier, this analysis involves the estimation of acquisition, set-up, and operating costs, as well as valuation of tangible and intangible benefits. The costs and tangible benefits are relatively easy to measure. Estimation of intangible benefits requires individual interpretation of exactly what items should be considered benefits. Due to this required interpretation, cognitive style becomes a factor to be considered. What the analyst perceives as a benefit may in fact be a problem for management. For example, analysts tend to assume that organizational performance is improved through increased interdepartmental communication. Often new systems can provide this increased communication through use of on-line system terminals. From a management perspective, some interdepartmental communications are detrimental to performance. Consider the situation in which the purchasing department controls how much of an item is bought and is rewarded on turnover rate, while the sales
department controls the selling price and is rewarded on gross sales. Both departments are given access to price and demand information for the optimistic, the expected, and the pessimistic sales levels of a product. The sales department selects a price and wants to order the optimistic demand quantity because stock-outs reduce their performance rating. Conversely, the purchasing department, after reviewing the same information and the selected price, wants to purchase only the expected demand quantity so as not to be left with excess inventory. This situation is avoided when these two departments do not share information and are forced to estimate each others activity. Although the real problem in this organization is the use of inappropriate performance measures, the difficulties do not surface until the additional information is provided. If the analyst includes interdepartmental communication as a benefit of a given proposal, the manager is likely to reject that proposal because in his/her organization such communication is not a benefit. Information concerning the intangible benefits to be included in the evaluation should be derived during the systems analysis phase when the manager is defining his/her expectations for the system. If unsure of what the user perceives as a benefit, the analyst should question the user, on an informal basis, before preparing the cost/benefit analysis so as not to make inaccurate assumptions that could bias the decision maker. The same is
true of any area of the development cycle in which data requires interpretation by both users and analysts. Information on user preferences should be collected and analyzed before any assumptions are made.

Upon completion of the evaluation and justification phase, as with all of the other phases, the results must be communicated to the manager. Again, effective interaction between analyst and management is essential to development success. Studies show that as the development cycle progresses and the information to be transferred becomes more technical, effective communication becomes more difficult to achieve (10). To counteract this effect, the analyst must utilize the same techniques that will be incorporated into the system he/she is designing: separating decisions into those requiring evaluation and those that are represented by optimization models, condensing and filtering information, and presenting information in formats most consistent with manager preferences. As the project design becomes customized to user needs, this same customization can be applied to the analyst's presentations.
D. Detail Design

In the detail design phase, the conceptual model is transformed into a sequence of inputs, processing algorithms and outputs. User involvement in this phase is expanded to include not only the managers who will be utilizing the final system outputs, but also the operations personnel who will be responsible for supplying system input. The analyst's own ideas are also incorporated into the system design to promote efficiency and effective operation.

The ease of use of the information system is positively associated with system satisfaction. When designing input forms and establishing procedures, the analyst must remember that the system users are not technically oriented. Forms should be designed so that the user is explicitly directed as to where information should be written. This can be accomplished through use of coding blocks and color shading. Procedure manuals should be written in non-technical language. Copies of each form should be included in the manual along with verbal explanations of the form's use and how it should be completed. Diagrams and other visual aids should be used whenever possible. System success is dependent on system utilization and utilization depends on user understanding.

Report formatting is another detail design procedure. Reports, whether on paper or terminals, are the primary mechanism through which information is passed from the
system to the manager. Through these reports the manager evaluates how effectively the system is meeting his/her information requirements; an estimation that affects overall satisfaction with the system. The objectives of the report designing process is then to match report content, format, and presentation with the user’s cognitive structure, thereby providing the necessary information in an acceptable form. Irrelevant information should not be included in a report because it detracts from the decision making process. However, a certain degree of information redundancy in the form of descriptive information is useful in helping the user remember important facts. (26). The designer must consider these two items and develop reports that provide an effective balance between the two. The decision classifications identified during the general design phase provide much of the report content requirements. Format requirements can then be determined based on either the designers understanding of manager style, or by requesting format specifications from the user. The later method may be the more costly approach, requiring many redesign phases due to the manager’s inability to express his/her own needs. Conversely, the designer’s understanding of the appropriate formats may be inaccurate, causing poor report design. The optimal approach incorporates both of these procedures, beginning with a design the analyst believes most closely represents the user’s needs, followed by any
necessary modifications based on user comments.

Flexibility is another important element to be incorporated into the system design. No system can be defined perfectly. After installation, system performance is monitored by comparing actual results with those predicted by the system. Deviations in performance are reviewed and may result in the definition of required system adjustments. These adjustments could be the result of changes in procedure, changes in the components of an internal decision model, or simply inaccuracies in the original design. In either case, the system must be able to adapt to these necessary changes. Without this flexibility, the manager's perceptions of the system's ability to meet his/her needs will decrease, followed by a reduction in system usage, and eventually, a totally outdated system.

The technical functions performed during the detail design phase are under the influence of the analyst. In this area the organizational constraints (computer resources, available process time) are the greatest concern. User cognitive influence has little effect on the actual programming tasks.
E. Implementation

The remainder of the development cycle, the implementa-
tion phase is concerned with testing the system, training personnel, and initiating operations.

System testing is the process by which programs are evaluated in terms of whether or not they meet the detail design requirements. There are many different testing methods, the one used is dependent on the analyst's perceptions of the associated costs and benefits. Evaluation of results with respect to organizational constraints should be conducted by the analysts and programmers as they are the people with the required technical knowledge. However, the users should be involved in evaluating those areas related to user constraints including report formats and data editing. By reviewing system outputs the user becomes more familiar with operations, has an opportunity to make evaluations, and can suggest necessary changes. These activities tend to make the user feel greater control over his/her environment, reducing the potential resistance to change, and increasing satisfaction.

Personnel training is also related to user satisfaction and system success. Again, favorable attitudes toward system usage are dependent upon user knowledge of the system. For each system, the training techniques used will be different due to the differences in the user personnel. Various groups of individuals may require different lengths
of time for training and may respond differently to each training technique. As with all other analyst-user interactions, the cognitive style factor should be considered when selecting the programs to be used.

Once all testing and training is completed, the new system is installed. However, the analyst's involvement is not yet completed. Following installation, the analyst must be available to monitor system performance, answer questions, and evaluate requests for changes. When both parties are satisfied with the system's operations, an acceptance document is signed and the project is officially complete. Continued interface with the analyst has been useful in increasing user confidence and system satisfaction.
F. Summary

The purpose of the systems development methodology is to design and construct an information system that aids managers in making decisions. Because cognitive style affects decision making, it also affects the information needed to make decisions (systems analysis), the methods used in generating that information (general design), the perceived value of an information handling system (evaluation and justification), the presentation of the information (detail design), and the understanding and utilization of the completed system (implementation). Each phase of the development cycle can be affected by cognitive style and specifically, cognitive style differences. If users and analysts exhibited exactly the same cognitive preferences, style would not be a design constraint. However, due to the unlikelihood of this condition, cognitive style differences do exist and they do have a negative effect on the design process. Fortunately, by considering these negative effects and counteracting them, the cognitive style constraint can be overcome.
VI. Conclusion

There are many different factors that are believed to influence the success of information system development projects. Cognitive style is only one of these factors. Therefore it is unwise to assume that by considering cognitive style influence the success of a project is assured. However, based on research results and model comparisons, it is safe to assume that not considering cognitive style effects decreases the probability of achieving a successful information system. Gone are the days when analysts and programmers could assume all users were the same and proceed to single handedly create functional systems. Users are no longer awed by the processing power of the computer. Functions that were once deemed "miraculous" are now commonplace. The computer scientists have gone on to tackle new, more unstructured problems and the users are expecting all of their needs to be met.

This does not mean that designers must be able to identify each and every trait affecting a user's information requirements and design a system tailored precisely to that user. The costs of such a strategy would be tremendous as there would be as many information systems as there are information system users, each one unique. The approach taken by the analyst should be that individuals are not all alike, but certain groups do exhibit common cognitive style characteristics. Systems should then be designed to meet
the needs of each group based on these common characteristics.

The simplified cognitive model defined earlier can be used to identify the common cognitive characteristics. This model proposes two types, systematic and intuitive, based on preferences for selecting and processing data. Systematic individuals use models and quantitative, logical processing while intuitives base their approach on experience, common sense, and trial and error. The information system designed for each group should match these cognitive needs.

Traditionally, information systems have been designed using systematic reasoning. This is due in part to the fact that most designers are of the systematic type. Another explanation rests with the idea that until recently, information systems have been intended to support only the routine decision making that involves determining optimal solutions based on problem algorithms. These logical, model oriented functions are well suited to the systematic approach. Additionally, research indicates that individuals tend to be attracted to occupations that incorporate their own approach to problem solving.(18) Therefore, systematic individuals were attracted to systematic occupations, and these occupational areas were applicable to utilization of systematic information systems. As a result, no cognitive conflicts were evidenced and the
published, models was successful.

However, as information systems expanded to include other types of decisions, with fewer guidelines and less structure, designers encountered applications that were not easily systematized and consequently, occupations that attracted intuitive individuals. In these situations, such as product development or marketing, the uncertainty, lack of structure and volume of information may prohibit the planned, programmable approach. The model used in these areas must conform with the manager's trial and error approach. Systems for intuitive managers should be highly flexible and adaptive. J. W. Botkin identified several necessary features for this type of system. The information system should not force the manager into a logical step by step sequence of data processing but should allow an arbitrary selection of information. The user should be able to control the system in terms of the form of output and level of detail. Additionally, information systems for intuitive managers should provide an interactive mechanism through which managers can define test situations and generate alternatives.(18). Unlike systematic individuals who make decisions based on a single optimal model, intuitive managers must be able to generate a number of solutions and then make decisions based on their own insights.

From this analysis it can be concluded that the design of an information system is dependent on the cognitive style
of user personnel, and the functional application of the system. The designer can determine these factors by talking with organization personnel and observing working environments. However, just as it is inconceivable to design an information system to meet the precise needs of individuals, organizational resource constraints make it impractical to customize systems to individual applications. Information on the same subject is often required by two different operations, one systematic, the other intuitive. For example, consider an inventory system. While control personnel are systematically determining reorder quantities, forecasting personnel are making an intuitive analysis of historical trends in order to establish future sales levels. In this case, the options are either to design a separate system for each application, using separate but identical data bases, or to incorporate the needs of both areas into one system. The latter is obviously the more efficient utilization of technical and economic resources, but is also the most complex for the designer. The situation is further compounded when consideration is given to employee turnover. Although occupations and styles are usually compatible, it is possible to find an intuitive manager in a traditionally systematic position or a systematic in an intuitive position. Therefore, a system designed to meet the needs of current personnel may be totally inappropriate for replacement personnel.
In the final analysis the implications of cognitive style for information systems design are twofold. First, designers must be aware of the differences between styles and the relative needs of each style. Secondly, a given system must be flexible enough to meet the needs of multiple styles. In general, the level of detail required decreases as the hierarchic level increases. Additionally, the structure of the task decreases as the hierarchic level increases. Therefore, lower level tasks tend to be more appropriate for systematic models while upper level decisions are more intuitive in nature. By recognizing these differences and working with users throughout the organization, designers can establish a series of distinct levels for information detail and processing structure. This allows individuals to utilize the information most appropriate to their needs. Ideally, future information systems will allow each user to select the precise level of detail and structure from a continuum of information. Until that time, however, analyst and manager awareness of cognitive differences, combined with increased system flexibility will provide a significant impact of information systems development.
VII. Implications

The individual differences perspective is but one of many approaches to the study of decision making. Other theories have investigated the effects of variables such as organizational roles, political bargaining, problem complexity, perceived risks, costs, timeliness, creativity, and other factors on decision behavior. No one variable has been shown to successfully predict decision outcome. In fact no combinations of variables has been able to duplicate the human decision making process. Within the cognitive style research itself models, classifications techniques, and experimental results differ to such an extent that no single representation can be developed. Compounding the problem is the fact that most cognitive style/decision making research has centered around "face valid" descriptions of decision styles or untested propositions that style affects decision making. Little research has been conducted that relates decision style to actual decision behavior. One limited experiment of this nature produced findings that contradict the theory that styles have inherent preferences for information and that they will reject information from sources incompatible with that style. Although these theories can be logically deduced from the literature, they are as yet unproven, and are therefore subject to uncertainties.

Even if one accepts the cognitive style literature as
valid, there are other problems, mainly the lack of a simple device for measuring an individual's style. Although the Myers-Briggs Type Indicator has been valuable in many of the research efforts, application of this mechanism in the everyday working environment is much more restrictive. If administration of the MBTI or a similar instrument to every potential system user were to be required before the development task could begin, one can foresee a significant, unwelcome change in the development methodology, the systems personnel, and managements' reaction to both. This approach does not appear to be a viable one at this time.

Although cognitive style theory is not fully supported and the type classifications are uncertain, this approach does provide a valuable piece of information. The most important aspect of the theory is not the model labels or the measurement techniques, but is instead the concept that designers must look at how decision makers actually function, not how they "should" function. Individuals function differently and these differences must be considered when designing systems. Future research may establish predictable relationships between decision variables and decision behavior. Until such prescriptive guidelines are available, simple awareness must suffice.
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