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A conceptual instructional model for electronics technology based on the I Ching

Shih, Chun-Hsieh, Ph.D.

The Ohio State University, 1988

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UMI
A CONCEPTUAL INSTRUCTIONAL MODEL FOR ELECTRONICS TECHNOLOGY BASED ON THE I CHING

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

Chun-Hsieh Shih, B. A., M. S.

* * * * *

The Ohio State University 1988

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CHUN HSIEH SHIH

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To : My parents, wife and sons.
ACKNOWLEDGMENTS

During the development of this dissertation, several people have provided valuable assistance and advise. The writer would like to specially thank Dr. E. Keith Blankenbaker, my dissertation adviser, for his expert guidance through the course of this study.

Thanks are extended to Dr. John Belland, Dr. Marjorie Cambre and Dr. Paul E. Post for their critical analysis of the text.

The writer would also like to thank the panel of experts who reviewed the content and provided suggestions. They are Dr. Tsung W. Chien, Mr. Chun. S. Hsu and Mr. Wu. H. Hsu.

The writer wishes to express his sincere appreciation to the faculty, and department staff members of Industrial Technology Education at the Ohio State University who gave assistance at numerous times during this study.
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CHAPTER I

- INTRODUCTION

The purpose of this research was to establish a conceptual instructional model for electronics technology in the Republic of China. This model is based on the concepts of the I Ching. Many studies directly or indirectly have dealt with the issue of the impact of electronics technology on our society. Electronics can change not only our lifestyle but our thinking as well (Daken, 1981). Friedrichs and Schaff (1983) emphasize the relationship between microelectronics and society. Therefore, it has become necessary to create an acceptable system in which to interact with this ever changing and lifestyle altering phenomena.

It is becoming more and more urgent to educate the public about the process and theory behind conventional conveniences. Such an education is necessary to appreciate the tremendous influence of electronics upon our daily lives. In order to implement this goal, it is necessary to establish instructional programs in electronics technology at general and vocational schools.
Taiwan, the Republic of China, is one of the foremost countries exporting electronic products. Leaders in Taiwan educational system are aware of the fact that there is a need to provide electronics technology instruction for both general and vocational education. Currently, electronics technology instruction is provided in junior and senior high schools, technical colleges and teachers' colleges. The importance of electronics technology education in the Republic of China is far reaching. This study attempts to create a conceptual instructional model which incorporates a Chinese cultural background within it.

**Background of the Study**

Electronics technology is complex and is always changing in its nature. Phenix (1962) states that all content of curriculum should be drawn from the disciplines. Taba (1962) also indicates that the area of a subject or a discipline in knowledge has at least two main characteristics. It has its own acquired information and its own specialized method of acquiring that knowledge. Phenix (1962) further explains that:

The disciplines have a life of their own, it is held, and knowledge in theme is not directly available for the purposes of instruction, but to be suitable for education must be translated and transformed so as to become useful and meaningful to ordinary learners. (p. 274)
Therefore, it is essential to identify the concepts of electronics technology for the development of an instructional model.

Technology is part of the human knowledge, and the teaching and learning process involves sociology and behavioral sciences. The research questions and theories created by both sociology and behavioral sciences are normally influenced by the societal and cultural background. The Republic of China has borrowed and applied the technologies from the western world for the last forty years. There is a great need for combining the western technology and Chinese tradition, culture, and knowledge to make the present Chinese educational systems more functional and applicable.

Each era has its own mission to interpret and address the tradition and to keep it vital. Educational systems are the most important tool to carry out this mission. In relation to the Chinese technological aspect, the ultimate goal is to be free from duplicating the western technologies, and to become a self-sufficient and self-confident country.

During development of the model, the concepts drawn from the Chinese culture and philosophy shall be added to the procedure. China has five thousand years of history, it has
gone through a long period of social development and cultural accumulation. The Chinese can definitely benefit from a conceptual instructional model consistent with Chinese culture. The I Ching has been included in this study for this purpose. The following are the reasons for choosing the I Ching from among so many Chinese heritages:

1. **I Ching** influenced the mainstream of Chinese philosophy.

2. **I Ching** presents a system of symbols and codes to represent and simplify the complexity of knowledge.

3. **I Ching** discusses changes, it is suitable to apply the concepts to the instruction of the ever-changing electronics technology.

4. **I Ching** contains the dual concept of Yin and Yang. When dealing with modern technology, one can easily find that the dual concept is an important foundation. For example, electricity and electronics technology rely on two states, open and closed; and a digital computer deals with binary numbers, 0 or 1.

These reasons will be further supported in Chapter IV after introducing the **I Ching**.
Purpose of the Study

The purpose of this research is to establish a conceptual model. This purpose will be fulfilled by answering the following questions:

1. What concepts of the I Ching should be included?
2. What concepts of the electronics technology should be included?
3. What educational goals should be actualized by the electronics technology instruction?
4. How should electronics technology content be organized?
5. How should the conceptual instructional model be developed?

Methodology and Procedures

To answer the major research questions of this study, the systems approach and heuristic problem-solving strategy were utilized. The procedures were shown as follows:

1. To define the research problem.
2. To review the related literature.
3. To select the panel of experts.
4. To identify the major concepts from the I Ching and have the expert panel confirm the selections.
5. To identify the concepts of electronics technology and confirm this section with the panel of experts.
6. To develop a draft conceptual model.
7. To conduct interviews and collect feedback data for revising the draft model.
8. To write summary, conclusions and recommendations.

Assumptions

There are basic assumptions which can be made at the outset of this study. These assumptions are:

1. Electronics technology can be identified within the context of technology and human knowledge.
2. The context of electronics technology can be ordered, codified, and classified for instructional purposes.
3. General concepts of electronics technology can be taught in both general and vocational education programs in the Republic of China.

Definition of Terms

Concept. The name(s) of items or ideas that can be explained. (Romiszowski, 1981, p. 247)

Conceptual Model. The logical form that states the relationship between processes, things, attributes, and events.
Electricity. The study of how electrical charges are produced and used to provide electrical energy to do work.

Electronics. The study of how electrons are controlled to carry intelligent signals for mankind through electronic products.

Electronics Technology. The study of efficient action and practice in the ways electrons are controlled to carry intelligent signals for mankind through electronic products.

Curriculum. A written document which is intended to be used by a teacher as a basis for developing teaching strategies for specific groups of pupils.

Instruction. The process of arranging human, temporal, material, and spatial resources with the intention of facilitating one's own learning or the learning of others.

Discipline. Knowledge organized for instruction (Phenix, 1962, p. 273)

Inherent Tools. A broad term of human using the body's existing functions to perform physical and mental work, such as using the hands to manipulate objects; using the five senses to directly or indirectly contact objects; using the brain to process information.
Statement of Limitations

The following limitations were taken into consideration as the study was conducted.

1. This research was limited to the nature of electronics technology, and was not directly transferable to other subject matter.

2. This model was based on the concepts of the I Ching. It may not be directly useful in other countries.

Delimitation of the Study

This study was focused on the process of conceptual model development. The field testing of developed materials was not conducted.

Organization of the Dissertation

This chapter described the background of the problem, stated the purpose of the study, listed the methodology and the procedures, presented definitions, selected specific assumptions, and identified the limitations and delimitations of the study.

The remaining chapters are arranged as follows:

1. Chapter II reviews the literature related to curriculum and instruction. This literature review will provide
the necessary background information and direction for
decision-making to establish the conceptual model for
this dissertation.

2. Chapter III describes the research methodology used in
this study, and the procedures conducted in this research.

3. Chapter IV identifies important concepts from the I
Ching, for the purpose of identifying the context of
electronics technology and for developing the model.

4. Chapter V identifies the context of electronics
technology from the broader concept of human knowledge.
Part of the concepts used in this chapter to identify
the context of electronics technology were drawn from the
I Ching. After studying electronics in this context,
the body of knowledge for electronics technology is
structured.

5. Chapter VI summarizes the concepts and develops the
conceptual model of electronics technology.

6. Chapter VII presents the summary, conclusions and
recommendations.

The organization of this study can be illustrated as shown
in Figure 1.
Figure 1  The Organization of the Study
A manual and computer assisted search of the literature confirmed that there were no studies specifically establishing electronics technology curriculum from the view of the nature of electronics technology. However, there are a number of previously developed studies relating to general curriculum and instruction. This chapter reflects the review of the literature in the area of curriculum and instruction and is therefore divided into the following subsections:

1. Curriculum and Instruction,
2. Knowledge and Disciplines,
3. Curriculum Design: Objectives, Content, Learning Activities, Resources, and Evaluation,
4. Instructional Models
5. Current Electronics Technology Programs
Curriculum and Instruction

Beauchamp (1981) defines "curriculum" as a written document which contains many ingredients. But basically it is a plan to educate students in the school. It is the overall plan used by teachers for developing teaching strategies for specific classroom groups.

Taba (1967) discusses an interesting concept about curriculum and instruction. She considers a continuum of educational phenomena with curriculum as ultimate-general at one end and instruction as immediate-specific at the other as illustrated in Figure 2.

![Figure 2. Continuum of the Curricular or Instructional Nature of Educational Phenomena (Taba, 1967)]

There is no definitive point on the continuum that divides curriculum and instruction. Taba (1967) emphasizes that curriculum can be viewed as a document or as a group of phenomena in a classroom environment. On the other hand, instruction can be used by the teacher and students on a
daily basis. Reigeluth (1983) asserts that curriculum is what is taught, and instruction is how it is taught. These concepts are used in this research.

Knowledge and Discipline

Knowledge has been frequently indicated as an important foundation of curriculum in western publications. (Tyler, 1950; Taba, 1962; Doll, 1974). Knowledge is central to human life, now and in the future. Even as early as the Chou dynasty of China (400 B.C), Sun Tzu states: "Knowledge is power, and permits the wise sovereign and the benevolent general to attack without risk, conquer without bloodshed, and accomplish deeds surpassing all others"

Bloom (1956) indicates that:

Some knowledge is the result of little more than convention and consensus. Other knowledge is obtained as a result from tests of consistency, which reveals a clearly defined logical relationship. Geometry, mathematical propositions, and mathematical models are examples reflecting this principle. Knowledge is also known as the result of the historical, experimental, or pragmatic tests. Historical knowledge is known as the result of a number of observations which are in agreement or which satisfy particular historical tests of their authenticity. Scientific information is known as a result of the observation, experiment, or test which meets the canons of scientific methodology (pp. 31-32).

A precise definition of acquired and practical knowledge is given by Feigenbaum and McCorduck (1984) in their book, The Fifth
Generation:

Knowledge is of two types. The first one is the facts of the domain - the widely shared knowledge, commonly agreed among practitioners, that is written in textbooks and journals of the field, or that forms the basis of a professor's lectures in a classroom. Equally important to the practice of a field is the second type of knowledge called heuristic knowledge which is the knowledge of good practice and good judgment in a field. It is experiential knowledge, the "art of good guessing" that a human acquires over years of work. (p. 82)

From this point of view, knowledge consists of facts and, perhaps more importantly, heuristic knowledge. Bloom (1956) further asserts why knowledge is justified as learning objective. The most common justification is that with an increase in knowledge there is a development of one's acquaintance. The selection of knowledge assumes some stability in the world, in the culture and in the subject field. If the knowledge learned at one time is not useful at another time, it would be useless for the student learning it. Regarding teaching knowledge, problem solving or thinking cannot be carried on in a vacuum, but must be based upon the reality of the student's world.

Taba (1962) indicates that the question of knowledge is a perennial challenge to sound curriculum development. Each area of knowledge, a subject or a discipline, has at least two main characteristics: it has its own fund of acquired information,
and it has a specialized method of inquiry, or a strategy of acquiring knowledge.

Phenix (1962) states all curriculum content should be drawn from the disciplines, and only knowledge contained in the disciplines is appropriate to the curriculum. He further defines that a discipline is knowledge organized for instruction. There are three fundamental features, all of which contribute to the availability of knowledge for instruction and thus provide measures for degree and quality of a discipline. These three are:

1. analytic simplification,
2. synthetic coordination, and
3. dynamism.

Phenix (1962) explains that the prime essential for effective teaching is analytic simplification. All intelligibility rests upon a radical reduction in the multiplicity of impressions which impinge upon the senses and the imagination. Phenix continues to explain the second feature of a discipline which makes knowledge in it instructive; namely, synthetic coordination. Analysis is not an end in itself; it is the basis of synthesis. Synthesis means the construction of a new whole, the coordination of elements into significant
coherent structures. A discipline is a community of concepts. Just as human beings cannot thrive in isolation, but require the support of other persons in mutual association.

The third quality of knowledge in a discipline Phenix calls dynamism. It is the power for leading on to further understanding. Phenix (1962) concludes that a discipline contains a lure to discovery.

**Curriculum Design**

Curriculum design refers to the nature and arrangement of the components or elements of a curriculum. Beane, Toepfer, and Alessi (1986) state that there are five components in a curriculum document:

The first component is a statement of learning objectives or proposed outcomes of the plans. The second component is content: the important factors, principles, concepts and understanding related to the organizing center and objectives. The third component involves the many activities that might be used to accomplish the objectives. The fourth component involves possible resources that may be used to address the objectives. The fifth component is measuring devices, or the means to determine whether or to what degree objectives have been accomplished. (p.70)

For the purposes of this study these five components are discussed in the following sections.
Curriculum Design: Objectives

Beane, Toepfer and Alessi (1986) state that instructional objectives serve as major guidelines in curriculum planning. The objectives seek to clarify what is to be accomplished during the teaching. The objectives are to set the outline for selecting meaningful content, activities and measuring instruments.

Taba (1962) asserts that objectives ought to be comprehensive. They should include concepts or ideas to be learned, and attitudes, sensitivities, and feelings to be developed. Furthermore, the objectives should reinforce, strengthen, or initiate the ways of thinking. Finally, the students are expected to master the habits and skills. This process transfers the school goals into specific objectives in order to set the direction for designing the curriculum.

Taba (1962) offers six principles to guide the development of objectives. These principles outline the complexity of the task of developing specific objectives. They are as follows:

1. A statement of objectives should describe both the kind of behavior expected and the content or the context to which that behavior applies.
2. Complex objectives need to be stated analytically and specifically enough so that there is no doubt as to the kind of behavior expected, to what the behavior applies.

3. Objectives should also be so formulated that there are clear distinctions among learning experience required to attain different behaviors.

4. Objectives are developmental, representing roads to travel rather than terminal points.

5. Objectives should be realistic and should include only what can be translated into curriculum and classroom experience.

6. The scope of objectives should be broad enough to encompass all types of outcomes for which the schools are responsible.

Perhaps the formulation of instructional objectives is most extensively classified in the work of Bloom (1956); Krathwohl, Bloom, and Massia (1964); and Simpson (1966). Bloom classifies six major behavior groups in the cognitive domain as:

1. Knowledge simply involves recall of a pattern, structure, or setting.

2. Comprehension refers to understanding or
appreciation.

3. Application refers to the use of abstractions in particular and concrete situations.

4. Analysis relates to the breakdown of a communication into its constituent elements or parts in order to clarify the hierarchy of ideas, and to make explicit relations between ideas.

5. Synthesis refers to the putting together of elements and parts so as to form a whole.

6. Evaluation involves judgments about the value of the material and methods for given purposes. (pp. 201-207)

Krathwohl, Bloom, and Massia (1964) when dealing with the taxonomy of affective domain name five areas to be investigated. These are receiving, responding, valuing, organization, and characterization by a value complex. The students should receive certain phenomena and learning stimulation. They are expected to respond to the learning activities with satisfaction. Yet, the student needs to internalize a set of values to enable him/her to establish a value system. A value system helps students act consistently.
Simpson (1972) studied the psychomotor domain. She summarizes five taxonomy categories which referred to the learning situation. "Perception" is the way of sense organs becoming aware of objectives, qualities or relations; "Set" is to prepare and adjust the action and experience; "Guided response" means the individual's behavior under the instructors' guidance; "Mechanism" refers to responding habits; and "Complex overt response" reflects individual's complex motor act at a higher level when the movement pattern is required. In relation to educational goals, learning objectives can be illustrated in Figure 3 (Brandt and Modrak, 1980).

Educational Goals are justified by Learning Goals are actualized by Objectives

Figure 3. The Relationship Between Educational Goals and Learning Objectives

These objectives further explain the broader goals of education. The goal is for students to become equipped with basic skills, self-conceptualization, understanding others, using accumulated knowledge to interpret the world,
participation in the economic world of production and consumption, responsible societal membership, creativity, and coping with change (Brandt and Modrak, 1980, pp. 9-12).

Curriculum Design: Content

Although the subject matter for this study is electronics technology, there are common criteria which can be used to select and organize any content. The criteria include the important facts, principles, concepts, and understandings associated with the objectives. The content is strongly connected to the accomplishment of the instructional objectives. (Beane, Toepfer, and Alessi, 1986.) Denemark (1963) suggested nine criteria for selecting the content:

1. Content is accurate and up-to-date.
2. Content facilitates understanding of major principles and generalization.
3. Content facilitates understanding the structure and methods of inquiry of a field.
4. Content contributes to the skills and habits basic to independent and disciplined thinking.
5. Content contributes to the development of an essential morality regarding the evaluation and use of knowledge.
6. Content has meaning and purpose for the learners.

7. Content provides both a measure of success and challenge.

8. Content contributes to balanced growth.

9. Content leads to appropriate action.

Selecting content involves picking topics, basic ideas and specific content. Selecting topics is the first step and is crucial. The combinations of significance, validity, learnability, and appropriateness to the content must be taken into considerations. The task of selecting the basic ideas is fundamental to a subject or discipline. Taba (1962) indicated that "These ideas represents the essential knowledge, which all students should master." (p. 354) The final step is to select specific content and to construct a sample for each basic idea.

Organizing content is another important step in curriculum design. The sequences from simple to complex, easy to difficult, from concrete to abstract are ways to the organization of content. Taba (1962) points out the psychological sequence associated with the learning process as following: an inductive logical arrangement emphasizing the content and psychological sequence for learning experiences need to be established to facilitate learning.
According to Taba (1962) each curriculum and instructional unit should contain a method for developing self deduction and reasoning. From this method, the learners can grow in their skills of argument, application and implementation. In order to reach each goal, the relationship between ideas and facts needs to be established. Thus the organization of the content will facilitate these processes, rather than obstruct them.

Taba (1962) points out that organizing content must be flexible enough to handle the different levels of complexity. The flexibility also helps to open up new possibilities for teaching heterogeneous groups in the classroom. "Choices are also open regarding what methods of instruction to pursue." (p. 362) The scheme of organization is open-ended and can be adapted to a variety of conditions. Hopefully, there are many levels of freedom, even though the curriculum and instruction outline appears structured. The idea is for the students to be led step by step to generalization.

Curriculum Design: Learning Activities

Curriculum objectives, need to be implemented by appropriate learning activities. The selecting of activities is one of the important tasks of curriculum planning which
involves student’s everyday experience in the school. Activities should be planned based on their appropriateness to the objectives, and their ability to positively influence attitudes toward school. (Beane, Toepfer, and Allessi, 1986)

The adequate learning experience requires a sequence which allows students continuous and cumulative learning experiences. This involves at least three main stages. The introductory stage includes pre-planning with the students and allowing student interaction: the development, analysis and study stage includes developing the subject and providing the needed factual materials such as reading, research, analysis of data, committee work, and various kinds of study. Generalization is the stage in which students put their own ideas together, reformulate them in their own terms, and form their own conclusions (Taba, 1962).

The purposes of organizing and selecting learning activities are to obtain the educational objectives. Tyler (1950) states that the student must be given opportunities to practice what he or she has learned and the students must obtain satisfaction from such practice. The expectation of students’ achievement in the activities should be within the limit of the students’ capabilities. The activities should not be confined
and rigid but should try to bring several outcomes from the same learning experience. During learning activities, the students' motivation can determine the success of the learning. Motivation comes from the students powerful needs and oriented goal and strong purpose. However, motivation can be controlled to some degree by external variables (Phenix, 1964)

Beane, Toepfer, and Alessi (1986) also indicate that:

The more pertinent content is to the needs and interests of the learner, the greater the likelihood that he or she will perceive its meaning and worth. As a result, there is a greater chance that the content will be learned and used. (p. 236)

Continuity is also a basic factor in planning the sequence of learning activities. Phenix (1964) indicates that each unit should fit into a previous unit and maintain consistency. Maintaining the stability is to ensure the new influence in learning can bring the continuing integrity of the person.

Curriculum Design: Resources

To pursue instructional objectives, the broader resources should not be limited to text books and audiovisual aids. Any materials, places and people can be useful resources allowing possible varieties to support the teaching-learning process. The common curriculum materials can include books and other printed matter, computer software, films and videotapes,
cassette tapes, television and radio programs, interactive 
videodiscs (Beane, Toepfer, and Alessi, 1986).

McNeil (1981) cites that indeed, technology keeps enlarging 
the diversity of the teaching tools. Computer-based 
instruction, self-instructional modules, individualized learning 
systems, and video and audio cassettes are no longer unusual 
terms to the classrooms. These tools have the capacity of 
analysis, implementation and evaluation. They are surprisingly 
improving the effectiveness of the instructions, methods and 
learning activities.

The computer specially stands out among these learning 
tools. There is no doubt that integrating computer systems to 
the instruction can create a new learning dimension. 
However, it is essential to properly teach students about 
high-tech equipment so that students receive the benefits of 
using the equipment.

Curriculum Design: Evaluation

Evaluation is used to establish baselines for learning and 
appraising progress and change. Evaluation in instruction 
covers various areas. Almost anything concerning instruction 
can be evaluated. It can include objectives, scope, quality of 
personnel, the capacities of the students, the importance of the
subjects, the degree to which objectives are implemented, the equipment and materials, and so on. Evaluation can also mean a rendering of a value judgment based on opinion.

Since curriculum is mainly a plan for student's learning, all evaluations provide a means to enhance the effectiveness of learning. Tyler (1951) extended the function of evaluation in educational process to four essential steps. These are: (1) identifying educational objectives, (2) determining activities for attaining objectives, (3) designing activities which suit student's level, and (4) evaluating the degree to which students attain the objective.

**Instructional Models**

Recently, the use of modeling has often been applied in the academic area. A model is intended to be close to the perfect or ideal form of something, or at least an acceptable, satisfactory version. Underlying a good model is some theory, and both are interrelated. Basically, a model can serve two major functions: (1) to describe phenomena in some specified domain of nature; and (2) to offer means for making predictions about those phenomena under specified conditions. That is, the model can represent reality in a simplified and therefore comprehensible form.
Based on the review of literature, there are a number of instructional models. Each model is supported by a solid ground of theories on how students learn, grow, and develop. Each one is designed to promote certain sets of educational goals and objectives. According to Joyce and Weil (1980), there are over eighty distinct models of teaching. Every model has its base in a rational theory and is clearly defined for practical use. One can conclude that most instructional models developed are valid within the context of their intended use.

Joyce (1978) divides present models into four major types. The social interaction models emphasize the relationship of the individual and the other person. The information processing models stress the student's ability to process information, master learning stimuli, organize data, be aware of problems, and generate solutions to solve problems. The personal models deal with the individual and the development of self. Individuals are required to construct and organize their unique reality. The fourth type of model is based on behavior modification and cybernetic theory. These theories are generally associated with educational technology. They emphasize changing the visible behavior of the learner through manipulation of reinforcers.
Current Electronics Technology Programs

In Taiwan, Republic of China, a variety of electronics technology programs have been designed for different levels of schools. In general education, electronics technology is included in industrial arts. The students are taught respectively in ninth grade in junior high school and in eleventh grade in senior high school. On the other hand, electronics technology programs are weighted heavily in vocational high schools and technical colleges in the Republic of China. Unfortunately, the courses are only presented in course outlines. There is no rationale to support them.

In the United States, there are many electronics technology programs. A total of eighty-one are listed in Appendix A. With no exception, they are all designed for a particular level, being either for college, for vocational high school, or for industrial arts programs. The instructions themselves are limited in the special area such as basic electronics, television or other subjects. Only a few of them developed part of the rationale for the instruction.

Summary

The review of literature presented in this chapter included a general review of curriculum design and instructional model.
Taba (1962) indicates a continuum of educational phenomena with curriculum as ultimate-general at one end and instruction as immediate-specific at the other. This research focuses on immediate-specific or instruction. However, the conceptual model for electronics technology instruction should be considered curriculum design. Five curriculum components (learning objectives, content, learning activities, resources, and evaluation) are reviewed in detail in this study.

Review of electronics technology in both Taiwan and the United States reveals that developing a conceptual instructional model for electronics technology based on the nature of electronics technology and Chinese culture will be beneficial to the whole field of electronics technology for the Republic of China. Thus, Chapter IV selects important concepts from the I Ching, for the purpose of identifying the context of electronics technology and Chapter V identifies the context of electronics technology from the broader concept of human knowledge.
CHAPTER III
RESEARCH METHODOLOGY AND PROCEDURES

This chapter presents the research methodology and procedures.

Research Methodology

The research methods chosen for this study were: (1) Systems methodology, and (2) Heuristic strategy.

Systems Methodology

The systems methodology was derived from the field of systems engineering science. It was first applied rigorously to the electronics and mechanical design, military, space systems and so forth, so apparent in our modern world. In education, it began to be used in the early 1960's.

The systems approach yields novel and highly sophisticated models as abstractions of real-world systems. The root idea of the systems approach is to model the integration of real world structure or organization into an orderly whole that functions as an organic unity.

All living systems are open systems, in which some outside...
forces may be beyond the scope of the system, but they should still be considered in the system. The open-system is descriptive, as it endeavors to describe what will happen if the system is followed. It makes no guarantee as to outcomes.

In this study, the researcher recognized that instructional environment and individuals are very complex. Bronfenbrenner (1975) stated that the difficulties of addressing the complication of real world problems using standard hypothesis-testing research procedures has been well documented by thoughtful researchers in the social sciences. Therefore, the model of an open system was used.

**Heuristic Strategy**

The heuristic strategy can be seen as a problem-solving procedure. It improves the chances of coming up with a solution, but does not guarantee a correct solution. Usually, the heuristic is used in the situation when the variables can not be totally controlled. By utilizing its characteristics, the systems approach was primarily a heuristic procedure during the process of model development. The effective use of heuristic strategy depends on (1) understanding the heuristics, (2) creating a model of what the probable solutions will be like, and (3) modifying the model as necessary in the light of
experience as the problem-solving process continues (Romiszowski, 1981). Step 3 begins after steps 1 and 2 are completed. Through this continuing process, the model will become sound.

**Procedures**

The basic plan for conducting the study was to:

1. conduct an extensive review of the related literature,
2. select a panel of experts,
3. select concepts from the Chinese culture which are significantly related to the teaching and learning of electronics,
4. have experts review the selected concepts,
5. identify the concepts of electronics technology,
6. develop a draft conceptual model,
7. conduct interviews with the panel of experts,
8. review by the research committee, and
9. present conclusions and recommendations for the study.

The following are the description of each step.

**Conduct an Extensive Review of the Related Literature.**

In Chapter II, literature was reviewed relating to curriculum and instruction, knowledge and discipline, curriculum
design, instructional models, and instruction of electronics technology. An extensive review of literature in Chinese culture was included to enable a better instructional model to be developed for the Republic of China. The I Ching was selected because it represents the mainstream of Chinese philosophy and heritage. Electronics technology was reviewed from the viewpoint of human function.

Select a Panel of Experts

There are three members of the panel: Dr. Tsung W. Chien, Professor Chun S. Hsu, and Mr. Wu H. Hsu.

Dr. T. W. Chien received his doctoral degree from the Department of Chinese Literature at the National Cheng-Chi University in 1975. He currently teaches at the same university and is known as an I Ching expert in the Republic of China.

Professor C. S. Hsu graduated from the Department of physics at the Tokyo Teacher's University in Tokyo, Japan. He also studied in the Department of Industrial Education at the Pennsylvania State University. He has thirty-five years of teaching experience in electronics technology. During those years, he served as the Chairman of the Department for seven years and as the Graduate Program Director for three years at the National Taiwan Normal University.
Mr. W. H. Hsu is a vice-president of the Sampo Electronics Company, one of the largest companies in Taiwan. He has twenty years of work experience in electronics technology.

Identify the Major Concepts from the I Ching

To further study the I Ching for the use of this research, the writer joined the I Ching Research Association in Taiwan. He had attended seminars sponsored by the association to acquire the related knowledge about the I Ching during the period of September, 1985 to March, 1986. The seminars were beneficial, especially the discussions with the members after each seminar. After that time, the writer's paper about the Concepts of Knowledge Processing and the I Ching was published in December, 1985 (Shih, 1985). The concepts selected for this study were outlined during this period of time. The selected concepts later were reviewed by Dr. T. W. Chien, one of the panel members.

Develop a Draft Conceptual Model

Applying the concepts selected from the I Ching, electronics technology, and the review of literature in instruction, the draft model was crystallized. The feedback system of electronics technology provided the guideline for the development of the model. For validation of the model, the
writer presented the model in some formal and informal situations. In January, 1986 it was presented to the Seminar of Electronic Technology Instructional Research in Taipei City. In March, 1986, it was presented to Symposium on Technical and Vocational Education (Shih, 1986). The model thus closely related to the theme of the study.

Conduct Interviews with the Panel of Experts.

Interviews were conducted with the panel and suggestions for revising the model were extremely beneficial and were taken into consideration.

Reviewed by the Research Committee

The draft of this paper was reviewed by the research committee. Committee members include experts in technology education, instructional design and electronics technology. This paper was benefited by their valuable suggestions, especially the model.

Present Conclusions and Recommendations.

Conclusions and recommendations are a major part of this study and are presented in Chapter VII.
CHAPTER IV

CONCEPTS FROM THE I CHING

The I Ching is unquestionably one of the most important books in the Chinese literature. The word "I" means the changes, and "Ching" is the book written by the sage. The I Ching is usually translated as "the Book of Changes." Of the five Confucian classics, the I Ching is most important; its influence has reached even the most commonplace of everyday life in China for more than two thousand five hundred years.

This chapter introduced the I Ching and identified concepts useful to this study. This chapter was divided into the following sections:

1. Background of the I Ching,
2. Basic Elements of the I Ching,
3. Yin and Yang, and Zero and One,
4. Selected Concepts from the I Ching: the trinity of primary powers, ease and simplicity, change and transformation, invariability, symbols and images, and judgments,
5. Applications of the I Ching and Epistemology, and
Background of the I Ching

Because the I Ching has years of history, identifying the real author of the book seems impossible. However, in Chinese literature, four sages are cited as the authors of the I Ching, namely Fu-Hsi, King Wen, the Duke of Chou, and Confucius. Fu-Hsi is a legendary figure representing the era of hunting and fishing and of the invention of cooking. The old time legend stated that the eight trigrams were invented by the mythological Emperor Fu-Hsi. The sixty-four Hexagrams which developed from the eight trigrams were formulated by either Fu-Hsi, or King Wen, one of the founders of the Chou Dynasty (1150-249 B.C.). King Wen extended the meanings for each hexagram. His son, Chou Kung (Duke of Chou), the "consolidator and legislator" of the dynasty further make the Yao-Tz'u, Appended Judgment. It is believed that the supplementary commentaries and appendices, known as the Ten Wings were later added to the I Ching by Confucius or by his scholar students.

Chin Shih Huang Ti, the first Universal Emperor of China reigned 221-209 B.C. had a policy to keep the people in ignorance. He ordered books which contained human wisdom to be burned. The I Ching was believed to be a book of the divine god's intention, and was fortunatly preserved.

After the I Ching had become firmly established as a book
of divination and magic during the reign of Chin Shih Huang Ti, the entire school of magicians (Fang Shih) of the Chin and Han dynasties made it their prey. Wang Pi, (226-249 A.D.) wrote about the meaning of the I Ching as a book of wisdom, not as a book of divination. He soon found emulation, and the teaching of the Yin-Yang school of magic were displaced, in relation to the book, by a philosophy of statecraft that was gradually developing. Indeed, not only the philosophy of China but its science and statecraft as well have never ceased to draw from the spring of wisdom in the I Ching. Even the commonplace of everyday life in China are saturated with its influence.

Basic Elements of the I Ching

The core of the I Ching is the eight trigrams (Figure 4). Each trigram consists of three strokes called Yao. These strokes consist of two primary forms: a continuous undivided line called Yang-Yao (—), the symbol of the masculine or positive principle; and a divided line called Yin-Yao (—), the symbol of the feminine or negative principle. The two basic symbols used originate from and represent the dualism of the universe. Putting together the Yin-Yao and Yang-Yao forms the eight trigrams.
Figure 4 Eight Trigrams

The trigrams represent the eight constituent parts of the whole, namely, the whole of heaven and the whole of the earth, the whole cosmos, and anything within its bounds, either physical or intellectual. At beginning, these combinations of lines did not have specific meaning until certain significance were assigned to each symbol.

Based on the book of the I Ching, Table 1 lists the summary of the meaning of each trigram associated with the attributes, symbolic animals, parts of body, family member, and natural objects.
<table>
<thead>
<tr>
<th>Trigrams</th>
<th>Symbols</th>
<th>Attributes</th>
<th>Symbolic Animals</th>
<th>Parts of Body</th>
<th>Family</th>
<th>Natural Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ch'ien</td>
<td>Ch'ien</td>
<td>strenth</td>
<td>horse</td>
<td>head</td>
<td>father</td>
<td>Heaven</td>
</tr>
<tr>
<td>K'un</td>
<td>K'un</td>
<td>docility</td>
<td>ox</td>
<td>belly</td>
<td>mother</td>
<td>Earth</td>
</tr>
<tr>
<td>Chen</td>
<td>Chen</td>
<td>movement</td>
<td>dragon</td>
<td>foot</td>
<td>eldest son</td>
<td>thunder</td>
</tr>
<tr>
<td>Sun</td>
<td>Sun</td>
<td>penetration</td>
<td>fowl</td>
<td>thigh</td>
<td>eldest daughter</td>
<td>wood and wind</td>
</tr>
<tr>
<td>K'an</td>
<td>K'an</td>
<td>danger</td>
<td>pig</td>
<td>ear</td>
<td>second son</td>
<td>water and moon</td>
</tr>
<tr>
<td>Li</td>
<td>Li</td>
<td>brightness</td>
<td>pheasant</td>
<td>eye</td>
<td>second daughter</td>
<td>fire and SUN</td>
</tr>
<tr>
<td>Ken</td>
<td>Ken</td>
<td>standstill</td>
<td>dog</td>
<td>hand</td>
<td>youngest son</td>
<td>mountain</td>
</tr>
<tr>
<td>Tui</td>
<td>Tui</td>
<td>pleasure</td>
<td>sheep</td>
<td>mouth</td>
<td>youngest daughter</td>
<td>marsh</td>
</tr>
</tbody>
</table>
Putting together any two of the eight trigrams forms sixty-four hexagrams. The hexagrams are arranged in the I Ching in accordance with a definite order. Figure 5 demonstrates that these hexagrams can be arranged either in a circle as shown in the outer part of Figure 5, or a block as shown in the inner part. It clearly shows that these hexagrams are a combinations of the eight groups of three lines, or trigrams.
The I Ching consists of the symbols - Yao (lines) and Kua (trigrams and hexagrams) - along with their statements and commentaries. The brief statement accompanying each different hexagram is known as the Kua-Tz'u or T'uan, which has been translated as "Judgment" or "Decision". The commentary on each of the six lines of the hexagram is known as the Yao Tz'u, which has been translated as "Appended Judgments".

The supplementary commentaries and appendices, known as the Ten Wings are:

1 and 2. T'uan Chuan, the Treatise on the T'uan.
3 and 4. Hsiang Chuan, the Treaties on the Symbols.
5 and 6. Hsi Tz'u Chuan, the Commentary on Appended Judgments.
7. Wen Yen, the Explanation of the Words and Sentence.
8. Shuo Kua, the Discoures on the Trigrams.
9. Hsu Kua, the Treatise on the Sequence of the Hexagrams.
10. Tsa Kua, the Miscellaneous Remarks on the Hexagrams.

Yin ( — ) and Yang ( — ) and Zero (0) and One (1)

The key to the relationships between I Ching and science lies in its logic system of symbols. This logic system is based on the symbols Yin ( — ) and Yang ( — ). It is identical to the use of zero (0) and one (1) in computers. The binary number system
uses a base of 2 with each place assigned with the following values: one, two, four, eight, sixteen, thirty two and so on. The eight trigrams then are accorded a natural sequence of numbers.

<table>
<thead>
<tr>
<th>Decimal Numbers</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binary Numbers</td>
<td>000</td>
<td>001</td>
<td>010</td>
<td>011</td>
<td>100</td>
<td>101</td>
<td>110</td>
<td>111</td>
</tr>
<tr>
<td>Eight Trigrams</td>
<td>≡≡≡</td>
<td>≡≡≡</td>
<td>≡≡≡</td>
<td>≡≡≡</td>
<td>≡≡≡</td>
<td>≡≡≡</td>
<td>≡≡≡</td>
<td>≡≡≡</td>
</tr>
</tbody>
</table>

Figure 6. The comparison of Yin and Yang and Binary Number System

In Figure 6, the relationships of these three systems are summarized. Viewing the figure from the top to the bottom in each column, one can find that the first column is "0", "000", and "≡≡≡". It simply indicates each " " weights 0. Three ""s arranged from top to bottom, interprets three 0's from left to right. On the other hand, each "—" weights 1. Therefore, "111" indicates in trigram. In relating to the decimal numbers, as the number goes up, the numbers of "—" lines increases in the trigram. The bottom lines of the four trigrams numbered from 0 to 3 are Yin Yao (0). The bottom lines of the subsequent four trigrams, 4 to 7, are Yang Yao. The first lines determining the position of trigrams are exhibited circularly. From this
constant permutation of position, the eight trigrams as shown in Figure 7 are formed.

Figure 7. The Order of Eight Trigrams

The circle which is considered as a whole can be divided into two halves - right and left. The first lines of the right half Yin Yao lines draw back counter (counter - clockwise upward), while the left half of the first Yang lines advance forward (clockwise upward).

Figure 8 exhibits how the eight trigrams expanded to sixty four hexagrams. Starting from the bottom of the right half, there are eight hexagrams with the same outer value "[]" which are assigned to the "0" group (# 0-7). Following in the counter
- clockwise direction the next eight hexagrams with same value "££" are assigned to the "8" group (# 8-15). For the next eight, a group of "££" belongs to "16" group (# 16-23). Following this group are the "24" group (# 24-31).

The same method is applied to the left half circle. Beginning from the bottom of the circle and moving clockwise. These are:

A group of eight "££" belong to "32" group (# 32-39).
A group of eight "££" belong to "40" group (# 40-47).
A group of eight "££" belong to "48" group (# 48-55).
A group of eight "££" belong to "56" group (# 56-63).

![Figure 8 The Order of Sixty Four Hexagrams](image-url)
In summary the basic ideas presenting in this subsection suggests that Yin and Yang can be used as the same concepts as "0" and "1". Furthermore, trigrams and hexagrams in the I Ching represent both numbers and symbols.

Selected Concepts from the I Ching

Of far greater significance than the use of the I Ching as an oracle is its other use, namely, as a book of wisdom. Some of Lao Tse's profoundest aphorisms were inspired by it. Confucius also studied the I Ching. The I Ching was once edited and annotated by Confucius. This version is still used today. Many scholars in China stated that the most profound and intricate philosophies are included in the I Ching. The following selected concepts from the I Ching are notable:

1. The trinity of primary powers,
2. Ease and simplicity,
3. Change and transformation,
4. Invariability,
5. Symbols and images, and
6. Judgments.

Selected Concepts: the Trinity of the Primal Powers

The I Ching was originally divided into two sections: One
deals with heaven and earth or the universe; and the other
deals with "all creatures under the sky" or the world of man.
In the I Ching, the Hsu Kua (sequence of the hexagrams), one
of the Ten Wings, interprets the order of the hexagrams, and
represents the natural process of the evolution of the
universe. In the Hsu Kua, it states that:

When there were heaven and earth, then afterwards
all things were produced. What fills up the space
between heaven and earth are all these
things. (Section 1, Ch.1)

Thus, man is linked with heaven, the suprasensible world
of ideas, and with earth, the material world of visible
things, to form with these a trinity of the primal powers.
Hsu Tzu studied this trinity of heaven, earth, and man as
following:

The I Ching is a book vast and great, in which
everything is completely contained. The Tao of
heaven is in it, the Tao of the earth is in it,
and the Tao of man is in it. It combines three
primal powers and doubles them; that is why there
are six lines. The six lines are nothing other
than the ways (Tao) of the three primal powers.

The way has changes and movements. Therefore the
lines are called changing lines. The lines have
gradations, therefore they represent things.
Things are diverse; this gives rise to line
characteristics. The line characteristics do not
always correspond. From this arise good fortune
and misfortune. (Sec. II, Ch. 10)

Figure 9 shows the places where heaven, man and earth are
represented in each hexagram. The first and the second lines
are the places of the earth, the third and the fourth those of man, and the fifth and the top line those of heaven. The different gradations of the lines include good fortune or misfortune. The Chinese character of Yao, when written in different form may also mean "to imitate". The regular writing of Yao (¥) is two sets of crossing lines which indicates the interaction of Yang and Yin. Since the original Yao case from the pattern of Tao, Yao also means changing lines. The Yin and Yang then combined with three primal powers and became cosmic phenomena.

Figure 9 The Trinity of A Hexagram
The book presents a complete image of heaven and earth, a microcosm of all possible relationships, it enables people to monitor each others movements in different situations. The I Ching contains the methodology which provides the tools to investigate the universe.

Looking upward, we contemplate with its help the brilliant phenomena of the heavens, and looking down, we examine the definite arrangements of the earth. Thus, we come to know the circumstances of the dark and the light. Going back to the beginnings of things and pursuing them to the end, we come to know the lessons of death and life. The union of seed and power produces all things; the escape of the soul brings about change. Through this we come to know the conditions of outgoing and returning spirits.

Since in this way man comes to resemble heaven and earth, he is not in conflict with them. His wisdom embraces all things, and his tao brings order into whole world; therefore he does not err. He acts according to the exigency of circumstances without being carried away by their current. He rejoices in heaven and knows its ordinations; and hence he has no anxieties. Therefore he is free of care. He is content with his circumstances and genuine in his kindness, therefor he can practice love. (Sec. I, Ch. 4)

With the help of the fundamental methodology of the I Ching it is possible to arrive at a complete realization of man's innate capacities. It believes that man has innate capacities that resembles heaven and earth, that he is a microcosm. With the laws of heaven and earth are discribed in the I Ching, man
is provided with the means of shaping its own nature. He became to realize his potentialities. In this process man is consistent with his circumstances and in harmony with the universe. In applying the concepts of the trinity of the primal powers, human function is to be emphasized in this study.

Selected Concepts: Ease and Simplicity

In the I Ching, the complex phenomena of the universe originated from the Tai-Chi, Supreme Ultimate. The Tai-Chi generates the two primary forces which eventually separated into the four images. The four images then developed eight trigrams. (Hsi Tz'u, Sec. I, Ch 11) The process of transforming simple and easy into complex and difficult is demonstrated in Figure 10.

Figure 10 Tai-Chi and eight trigrams.
The eight trigrams, together with the sixty four hexagrams formed by their combinations represent all the possible situations and mutations of creation, a miniature universe. This process indicates the pathway of transforming from simplicity to complexity.

The "I" makes Ch'ien, (Creative ☰) and K'un (Receptive ☦) represent what is easy and simple. There are two main principles of the I Ching. Only from what is easy and simple can there be "complex phenomena" and "great movement". As the Hsu Tzu says:

The creative is known through the easy. The receptive can do things through the simple. What is easy, is easy to know; what is simple, is easy to follow. He who is easy to know attains fealty. He who is easy to follow attains works. He who possesses attachment can endure for long; he who possesses works can become great. To endure is the disposition of the sage; greatness is the field of the sage. By means of the easy and the simple we grasp the laws of the whole world. When the laws of the whole world are grasped, therein lies perfection. (Sec. I. CH. 1)

The creative (☰) is the strongest of all things in the world. The expression of its nature is invariably the easy, in order thus to master the dangerous. The receptive (☷) is the most devoted of all things in the world. The expression of its nature is invariably simple, in order thus to master the obstructive. (Sec. II, CH. 12)

The creative is decided and therefore shows to men the easy. The receptive is yielding and therefore shows to men the simple. The Yao imitate this. The images reproduce this. (Sec. II, Ch. 1)
These paragraphs also demonstrate how the easy and simple principles affect human life. The Creative, (☰) is always represented as strong, decided, to which everything is easy. Thus it confronts no difficulties. It always remains true to itself, and it is effortless. Difficulties being caused by vacillation. On the other hand, the Receptive (☷), represent devotion, which reflects simplicity. The Receptive has its nature to be consistently yielding, to follow the direction of least resistance. Complications occur only when the inner motives conflict.

Therefore, from "easy and simple" to "enduring for long" and "becoming great" is an important logic sequence in the I Ching. For instruction, how to make things easy and reduce complexity to simplicity becomes a crucial point.

**Selected Concepts: Change and Transformation**

In the I Ching, the word "I" is used interchangeably with the Tao. And Tao is simply defined as "the alternation of Yin (the shade/soft) and the Yang (the light/firm). Interaction of these two primal forces produces all kinds of movements and changes. The Hsi Tz'u, states that as the firm and the yielding lines displace one another, change and transformation arise. (Sec.I, CH.2) It specifically indicates the degree to which
events in the world are represented in the I Ching. The
hexagrams are made up of firm and yielding lines. Under certain
condition the firm and yielding lines change: the firm lines
are transformed and softened, the yielding lines convert and
become firm. This reveals it is a reproduction of the
alternation in the world phenomena as follows.

One Yin and one Yang constitute what is called Tao.
That which is perpetuated by it is good. That
which is completed by it is the essence. It
possesses everything in complete abundance. This
is its great field of action. It renews everything
daily: this is its glorious power. (Sec. I, CH. 5)

The terms Yin and Yang are gradually extended to include
the positive and the negative forces of the universe. Between
the two primal powers there arise again and again a state of
tension, a potential that keeps the powers in motion and causes
them to unite, thus they are constantly regenerated. The Tao
is the result of the ceaseless movement of the Yin and the Yang.
Therefore, the Tao achieves a great field of action in daily
renewal. Just as the Hsi Tz'u says: "It is the great virtue of
heaven and earth to bestow life." (Sec II, CH. 1) And as
begetter of all begetting it is called change." (Sec. I, CH. 5)

The union of the Creative and Receptive, all things
generate with all possible changes and transformations. Of
these two primal forces, Yang and Yin, one is vivid, the other
docile, one gives forth, the other receives; to one all things owe their beginning, and to the other they owe their birth.

Thus, in the Hsi Tz'u, it states:

There is Creative. In a state of rest the creative is one, and in a state of motion it is straight; therefore it creates that which is great. The Receptive is closed in a state of rest, and in a state of motion it opens; therefore it creates that which is vast. (Sec. I, Ch. 6)

Thus, the Creative and the Receptive complement each other and all things in the universe therefore change and transform.

In summary, there are two forms of transformation in the I Ching: the transformation of things through the self transformation of the creative source, the Tai-Chi; and the transformation of the interaction of things via their relative relationships in the totality of things, the production and reproduction. The I Ching has the following statements:

Therefore they called the closing of the gates the Receptive, and the opening of the gates the Creative. The alternation between closing and opening they called change. The going forward and backward without ceasing they called penetration. What manifests itself visibly they called an image; what has bodily form they called a tool. What is established in usage they called a pattern. (Sec. I, Ch. 11)
Production and reproduction is what is called "I". As that which completes the primal images, it is called the creative; as that which imitates them, it is called the Receptive. (Sec. I, Ch. 5)

These statements show that, following the principle of the creative, conceiving the unity of opposites produces all creatures in nature including man. Specifically, the I Ching refers to this principle as "Tai-Chi" or "production and reproduction." Based on this principle, the I Ching explains the difference of things. When all differences of things are oriented and positioned, they become mutually supported and complement one another. The primary unity of creativity which manifests the alternation of the opposites is also called the tao in the I Ching. Thus, the tao is simply defined as "the alternation of Yin (the shade /soft/ rest) and the Yang (the light /firm/ motion)." It is implied that the tao is what makes the alternation of the opposites Yin and Yang possible. This process leads to the creation of the world as an ordered structure and specifies the world in terms of the spatial complementary to each other. It is also supported in terms of temporal relationships of winter and summer which are again opposite and complementary to each other.

These relationships unite the totality of a whole world (Tai-Chi). This process is referred to as "production and
reproduction" or "creativity of creativity " (sheng-sheng). The Tai-Chi gives rise to the polarity of Yin and Yang; the unity of Yin and Yang create a second level polarity then which multiply and become eight trigrams. Eventually, the sixty four hexagrams can be explained. This transformation indicates that the tao is unlimited in creating new unities and re-affirmed actions. The following illustration exhibits the unbounded nature of creativity in unity and creativity of the Tao. (Figure 11)

Figure 11 An Unbounded Structure of the I Ching
Creativity takes two directions to accomplish and to perpetuate. In both downward or forward direction, the creative divide of opposites, while in the upward or backward direction creativity changes and penetrates. By concepts of change and transformation, expanding knowledge is possible.

Selected Concepts: Invariability

The third meaning of "I" is invariability. Because the word of I is in midst of variability, it reveals an element of invariability. For example, changes in all natural phenomena follow a constant order, due to the consistency of the Tao.

The sun and the moon, pertaining to Heaven, shine forever. The four seasons keep rotating. The thirty second hexagram describes these phenomena clearly as: "When we see how they are constant, the nature of Heaven, Earth, and all things can be seen." (Hsi Tz'u, Sec.II , Ch.1)

It is found in the Analects that Confucius stood by a river and said that all God's creature grow just like the river flowing without pause through day and night. He expressed the idea of change. But he looked beyond all changes and formed eternal law of the Tao at work.

In the midst of any change there shall be the consistency
to which the change can be grasped so that will not be dissolved in chaos. This point of law must be established, and this always requires a choice and a decision. It makes possible a system of co-ordination to which everything can be fit in appropriately. It is clear that all God's creations in the universe follow a definite order, while they are constantly changing and transforming. This is the quality of the invariability. It is clear that the invariability is the concept drawn from the eternal law which causes man to seek the commonality among many things.

Selected Concepts: Symbols and Images

The book of I Ching uses a logic system of symbols. The symbols represent the different images in their proper order. As the hexagrams developed from the trigrams, the images remained and contained in each of sixty four hexagrams. The sages investigated all phenomena and symbolized their characteristics. The symbols are also self explanatory. For example, heaven is placed in higher lines and means superior, while earth is located in the lower position and keeps an inferior profile. Affairs are arranged according to their tendencies and things are divided to their respective classes (Hsi Tz'u, Sec I, Ch 1). Thus, the symbols themselves tell the
good fortune and misfortune.

The eight trigrams devised by the Sage were the symbols representing the basic constituents of the universe and the associated attributes with them. This rule also applies to the invention of the hexagrams:

He made knotted cords and used them for nets and baskets in hunting and fishing. The idea of this was taken, probably, from Li (the third trigram,☰, and the thirtieth hexagram,☷☳). This paragraph explains that a net has many meshes. The hexagram Li, the clinging, represents a composition of meshes. Furthermore, the written character means "to cling" or "to be caught on something". This image can be illustrated by Figure 12.

Figure 12 Hexagram Li and Its Image
It was believed the forty second hexagram, Yi, gave Shan Nang an idea of making a plow. Shan Nang fashioned wood to form the plow, and bent wood to make the plough handle. He taught his people using the plow on the field. The hexagram Yi, consists of the two trigrams Sun and Chen. Both trigrams associate with wood. This lead to an idea of designing a wooden tool that penetrates the soil.

There are countles examples of applying the image presented by the hexagrams and turning it into practical use in the I Ching (Sec II, Ch. 2). In comparison of technology, the idea brings out the product. But it is the image which stimulates the idea. The concept of symbol and image is useful for further study.

Selected Concepts: Judgments

In the I Ching, each hexagram and each Yao has a symbol, representing a certain object or idea. However, symbols (image) alone cannot describe the total meaning and significance of the I, The Hsi Tz'u state the role of judgments as follows:

In the I, there are four symbols, so as to give information; there are judgments (Tz'u) appended, so as to give interpretation; and a determination either fortunate or the reverse, so as to resolve the doubts. (Sec. I, Ch. 11)
The sages set up the symbols in order to express fully their ideas; they devised hexagrams in order to show fully truth and falsehood; they appended judgments in order to give the full expression of their words. (Sec. I, Ch. 12)

The Sages devised hexagrams, so that symbols might be perceived therein; they appended judgments, so that good fortune and misfortune might be made clear. (Sec. I, Ch. 2)

Symbol can be substituted by objects or ideas. But it is tz'u (judgment) to a hexagram or a Yao to determining good fortune and misfortune. For instance, Figure 13 illustrates the judgment. It represents modesty or humbly. It means that "within the earth, there is a mountain." But it does not indicate the directions. Therefore the Kua Tz'u (Judgment on the Hexagram) defines modesty, modesty leads to "progress and success, and the superior man will carry his work through." Additionally, supplements with the Tz'u on the Yao explain: "The great stream must be crossed with this, and there will be good fortune." A dangerous mission crossing of a great stream, will turn to a good fortune, if behaving modesty and humbly. Thus, the judgment together with the symbol completely present the full meaning of the hexagram.
The Ch'ien Hexagrams (15)

above, K'un (Earth)

below, Ken (Mountain)

Figure 13 An Example of Judgments

Application of the I Ching and Epistemology

There is much literature discussing the I Ching in China. Kao Huai Min (1978) describes the concepts drawn from the I Ching so they are not ambiguous or difficult to understand. It contains the concrete thoughts and is considered as a part of formal knowledge. Formal knowledge is easier to be explained from the perspective of formal theory. Formal theory is that whenever the content is abstracted from a certain system and fails to give any explanation the system can not be valid. (Cheng, 1981) The theory consists three levels of meanings:

1. The system of the theory has the related content.
2. The explanation is needed to keep the theory valid when the content is removed.
3. When the content is removed, the system of the theory can be applied universally.

The I Ching originated from Yin and Yang as the abstract concepts. The basic concepts of the I Ching can be employed in different situations. The following is an attempt to relate the I Ching and epistemology.

Wang Shih (1984) connects the I Ching to epistemology and discusses this relationship from the aspects of the characteristics and application aspects. In Figure 14 A, starting from Ch'ien (☰) counter clockwisely to Chen (☱), every trigram is symbolized with a base line of — (Yang). On the other half circle begining with Kun (☷) and ended Sun (☳), each trigram has — (Yin) as a base line. In translating to the epistemology rational, inference, proof and motivation are rather voluntary and subjective. Conversely, knowledge, judgment, assumption, and sense are in objective and conditional areas. These areas state the characteristics of the I Ching in relations to the epistemology.

The Figure 14 B demonstrates the general learning process which describes the viewpoint of epistemology. The I Ching emphasizes that motivation is the origin of all behavior. Without motivation, there is no stimulation to the senses: one
can not see, one can not hear, and the body can not move. Senses have to depend on motivation to carry out the act. On the other hand, experience and knowledge do not directly develop from the senses. Lacking of proof, experience and knowledge can not be established. When complex experience and knowledge occur, inference comes in to the next step. Inference categorizes and sorts out the experiences. It produces an end result of a rational which provides humans the tools of understanding. Only through understanding, one can develop ability of making assumptions under certain conditions. According to Figure 14 B assumption comes between rational and judgment and has an important role in transaction. Finally, judgment is the last element of the cycle.
A. Illustration of the Nature

B. Illustration of the Process

Figure 14  Illustration of I Ching and Epistemology
Summary

In summary, this chapter discussed the trinity of the primal powers. Man is joined in heaven, the suprasensible world of the ideas. At the same time, man is joined in earth, the material world of visible things. In this chapter, three folds of meanings of the word "I": ease and simplicity, change and transformation and invariability were interpreted. The symbols and the image were clearly illustrated throughout the chapter. At last, this chapter revealed the linkage between epistemology and the I Ching.
CHAPTER V

THE CONTEXT OF ELECTRONICS TECHNOLOGY

Technology is a part of human knowledge. The teaching and learning process involves sociology and behavioral sciences. Each era has its own mission to interpret and address tradition and to keep it vital. The Republic of China has borrowed and applied technologies from the western world for the last forty years. This chapter combines western technology and Chinese tradition and culture to provide the context of electronics technology for this study.

This chapter is divided into the following sections:

1. General Systems Theory,
2. Domains of Man's Knowledge,
3. Technology and the Other Knowledge,
4. Technology Evolution,
5. Electronics Technology, and
General Systems Theory

The I Ching emphasizes that all things in the universe are ever in a process of changing, and that all changes of things conform to the basic laws of nature. Electronics technology is a subset of technology. It is important to illustrate in this study that technology is one of the domains of human knowledge. DeVore (1980) points out that:

The study of technology has been approached too frequently by studying the parts without reference to the whole. However, as is the case with human beings, the sum is greater than the parts. (1980, p.243)

First, it is necessary to investigate what technology represents in today's society. Technology is usually associated with machinery. According to Bertalanffy (1972), technology should be thought in terms of systems.

Technology in terms of an automobile, or radio receiver was within the competence of the engineer trained in the respective specially. But when it comes to ballistic missiles or space vehicles, they have to be assembled from components originating in heterogeneous technologies, mechanical, electronics, chemical, etc.; the relation of man and machine comes into play; and innumerable financial, economic, social and political problems are thrown into bargain. Again, air or even automobile traffic are not just a matter of the number of vehicles in operation, but are systems to be planned or arranged. So innumerable problems are arising in production, commerce, and armaments. (pp.3-4)

To go further from this point of view, selected concepts from the General Systems Theory will be applied in this study.
The field of General Systems Theory came from several different disciplines, perhaps most significantly from engineering science. The theory was the natural product of the complex systems in modern technology, man-machine relations, programming, automation, and control mechanisms. The General Systems Theory mathematically deals with novel or highly sophisticated models and techniques to abstract from the real world. One of the major aims of the General Systems Theory is to unify the sciences, nature and society. The creator of the theory was Ludwig Von Bertalanffy. In 1954 the Society for General Systems Research was organized. It served four major functions:

1. Investigating the isomorphic concepts, laws, and models in useful transfers from one field to another.

2. Encouraging the development of adequate theoretical models in fields which lack them.

3. Minimizing the duplication of theoretical efforts in different fields.

4. Promoting the unity of science through improving communication among specialists. (Bertalanffy, 1974, p.15)
These functions show the similarities of the characteristics and the concepts of the *I Ching* which were discussed in Chapter IV. In the *I Ching*, all hexagrams conform to the principles of the Yin and Yang; the soft and the hard; and the benevolence and righteousness. The principles are useful in transforming to a different situation. The *I Ching* is a book vast and great, in which everything is completely contained. The concept of the *I Ching* is able to reach all depths, penetrate all wills, and complete all affairs (*Hsi Tz'u* Sec. I, Ch.10). The concepts similar to the General Systems Theory in the way of relating capacity of covering vast fields.

Additionally, in the General Systems Theory all living systems are adaptive in some way. In other words, all organisms worth examining display characteristics of adaptation. The comparisons between two concepts can be displayed as follows:

1. The progression of electronics technology starts from easy and simple stage. When one understands the first stage one can predict the effects of the complex and the difficult.

2. Electronics technology is ever changing and changeable. The underlying principles in the *I Ching* can be applied to electronics technology in
demonstrating its invariable concepts.

3. In electronics technology, where mechanisms are complex and keep changing, simplicity can be rooted. One can always search for circuits during changing. With the comprehension on the I Ching, it is valuable in developing conceptual models for electronics technology.

Domains of Man's Knowledge

Man's knowledge has been created and accumulated from generation to generation. In order to obtain efficiency in education, classifying man's knowledge is essential. Towers, Lux, and Ray (1966) describe the need to structure knowledge into different domains:

Man's accumulated knowledge, increasing at an accelerating rate, is vast in scope and heterogeneous in nature. It is not economically feasible to deal with this amorphous mass without structuring it into logical divisions. Thus, for various reasons, knowledge has been subdivided into more manageable divisions which are functional, for one reason or another. (P. 1)

In reviewing Towers, Lux, and Ray's study (1966), they attempt to structure man's knowledge in four different domains of knowledge for Industrial Arts Curriculum Project (IACP). These four domains are descriptive, prescriptive, praxiological, and formal knowledge which is shown in Figure 15. (Towers, Lux, and Ray, 1966)
Each domain of knowledge reflects human experiences and culture with its own interpretations. The domain of descriptive knowledge is science which seeks and establishes facts about phenomena and events. It also describes their interrelations. The main divisions of science are physical, biological and social. The second domain, prescriptive knowledge, includes the fine arts and the humanities. It reflects human's experience on values and judgments. The third domain relates to praxiological knowledge which helps people to take efficient action on what is valued. The fourth one is formal knowledge. The disciplines within formal knowledge serve as tools to abstract the above three categories in the right order. Mathematics and logic are considered in this domain.

![Domains of Man's Knowledge in Hierarchical Structure](image)
Another effort to identify the nature of knowledge based on technological education is the Jackson's Mill Industrial Arts Curriculum Theory (Snyder & Hales, 1981). The theory recognizes human adaptation of knowledge in the cognitive domain. There are four domains of knowledge identified as sciences, humanities, technologies and formal knowledge. The first three are equivalent to descriptive, prescriptive and praxiological knowledge respectively. These four domains of knowledge are intrinsically linked together and overlap each other, Figure 16.

![Figure 16 Domains of Man's knowledge in Overlapping Structure]
In conclusion, man's civilization began with technology which will be further explained in the next section. Secondly, without such knowledge, the world would be chaotic. Thirdly, the *I Ching* is scientifically oriented when dealing with formal knowledge. Fourthly, people are aware of the importance of technology through their daily contact.

**Technology and the Other Knowledge**

This study emphasized the knowledge of technology and its relationship to the sciences of describing and understanding human experience. If the relationship between technology and the science is clarified, an adequate position of technology may be identified. Lindsay in his book, *The Role of Science in Civilization* (1963), describes that science is a method for the description, creation, and understanding of human experience, and technology should be defined as human activity toward the satisfaction of human needs by using the environment. For instance, food and shelter comes as part of fundamental technology by primitive people. Unlike science, technology is not essentially a contemplative activity. It is obvious that technology came long before science, simply because man had to overcome the problems of his environment before he had the leisure to indulge his curiosity about the world in an
intellectual sense. In a word, technology possesses characteristics of practice or action.

From the history of science, mathematics plays a role as the language in technology. The symbols in mathematics initially have no meaning by themselves. However, when these symbols obey a small number of rules, humans use them to represent a wide range of phenomena. Today, mathematical and logical symbols are increasingly providing technology with a more efficient means of communication. Therefore, the I Ching which uses a system of mathematical and logical symbols can be thought as a formal knowledge.

Technology usually is concerned with using tools and other machines. The history of technology is the story of man's countless strivings to improve the standard of living. It is necessary to take the humanities into considerations when evaluating technology. The humanities relate to various sets of beliefs, values, norms, and cultural background, as well. Today, technology tends to make human's lives more materialistic. Therefore, humanities shall be considered. Since the trinity of primal powers in the I Ching advocate man and universe stand in a relation of harmony, it is best for this consideration to be made.
This section is summarized to the following points.

1. Technology is one of the domains of human knowledge. It should not be separated from formal knowledge, science, and humanity. Its overlapping part of human knowledge is important.

2. The characteristics of technology such as its practice and action should be emphasized in technology instruction.

3. The I Ching is part of the domain of formal knowledge. It can be used to identify the context of electronics technology.

4. I Ching is considered to help relate technology and humanities.

Technology Evolution

There are various approaches in studying technological development. Alvin Toffler (1981) describes three waves of change in civilization. Thousands of years ago, the invention of agricultural tools and simple machines brought in the first wave of changes. The second wave occurred approximately two hundreded years ago when industrial revolution came on the stage. During this period machine tools were invented which could produce things and with greater accuracy and precision than
human beings. The third wave civilization began as computers were introduced to every field starting 1950's. This is a new info-sphere, where mankind imparts to the environment not life but intelligence.

Toffler states that human intelligence, imagination, and intuition are far more important than machines. But he also points to the tremendous contribution of the computer to the human lives: Computers can be expected to deepen the entire cultures' view of causality, heightening our understanding of the interrelatedness of things, and help us to synthesize a meaningful "whole" out of the disconnected data whirling around us.

From the historical point of view, one can easily find that through doing things humans have sought new knowledge and efficient ways of living. Work itself has special meaning to human beings. Through making tools, changing environments, developing power machines and developing control machines has come the central core of the human history. This history of civilization separates humans from the animals. It can be described as civilization through tools.

Figure 17 illustrated the various tools used in different time frames. Increased use of power tools began in the nineteen
century while the use of control tools expanded rapidly during 1950's. The curved line representing tools reflects technology's important role in human life. It is necessary to point out that the use of inherent tools also continues to increase.

Although the tools have been created in rapid rate, the inventors must acquire the fundamental knowledge which follows the constant principles. For example, the electronics products such as FAX machine and radar can be complicated, but they are created based on the rule of open and close.

The scope of this study focuses on the development of electronics instructional model based on the concepts from the I Ching. The simple principle of Yin and Yang is the base of complexity and the variety of the hexagrams. It concludes that the knowledge which includes I Ching can be represented by simple symbols. Through the combinations of symbols, expansion of imagination, and by following the judgment and reasoning, the knowledge can be more vital. Thus, the new inventions become more sophisticated and more complex.
In this section the evolution of technology is further discussed from two aspects. The first aspect is to define the complexity of technology for education. The second is to identify a learning process for technological instruction. These two aspects are closely related.
The complexity of technology is progressing along with evolution of technology. The progression began with simple hand or muscle driven tools building into human functions. It gradually developed to sensory tools, then to intellectual tools. Developing a good teaching model for electronics technology shall reveal this progress. All instruction shall be with a certain sequence which is illustrated in Figure 18.

![Complexity of Technology in Terms of Human Functions](Figure 18 Complexity of Technology in Terms of Human Functions)
DeVore (1980) explains that the nature and characteristics of technology are directly and closely related in the on-going process of human life.

Instruction is the process of arranging human, temporal, material, and spatial resources with the intention of facilitating one’s own learning or the learning of others. From this definition it is obvious that instruction involves man, and is concerned with the environment. The relationship of instruction to the curriculum is also very important to the I Ching.

Man's physical and mental characteristics related to technology is defined in this study as "inherent tools" which include hands, senses, and brain. Because hand tools and power machines were invented to extend the abilities of the human hands, it is important to indicate that human hands both transform energy/matter and utilize control information. Control machines were invented to extend man's senses, brain, and mental capability.

Figure 19 attempts to exhibit that the use of hand tools has dominated the other tools throughout the human civilization. This concept can be elaborated upon by saying that, even in a complex technological instruction unit, the use of hand tools
is continually required.

Figure 19 An Alternative Way to Express the Evolution of Technology.

**Electronics Technology**

According to the definitions in Chapter I, the term electronics technology refers to using electrons, and "carrying intelligent signals". This definition relates to communication and information. Communication technology governs
electronics technology in today's world. It covers telecommunications, radio waves and radio telegraphies which increasingly affected human life.

A communication system which applies the General Systems Theory conveys information from its source to a destination. Figure 20 shows a basic model of a communication system.

Few message sources are inherently electrical, consequently, most communication systems have input and output transducers. The input transducer converts the message to an electrical signal, say a voltage or current, and another transducer at the destination converts the output signal to the desired message form.

![Figure 20 A Model of a Simple and Basic Communication System](image-url)
The communication system block in Figure 20 is explained in detail in the block diagram illustrated in Figure 21.

Figure 21 A Communication System.
The transmitter processes the input signal to produce a transmitted signal which suits the type of transmission channel. The channel is the medium that bridges the distance from source to destination. The receiver operates on the output signal received from the channel and prepares it to be delivered to the transducer at the destination.

There are many studies exploring the relationship between language symbol and human thinking in the field of communication. (Shannon, 1949; Bevan, 1938, Hill, 1971; Berlo, 1960).

In electronic communication, signal processing for transmission always involves modulation or encoding. The transmitter performs these operations for efficient and reliable information transmission. On the other hand, receiver operations include demodulation and decoding to reverse the signal-processing performed by the transmitter. The advanced model involves a feedback connection. Figure 22 shows a feedback connection frequently found in electronic circuits.

Starting from simple communication system (Figure 20, 21), feedback is added to develop a the more complicated system, Figure 22. The method of feedback is commonly used in many fields. In electronics, feedback is indicated by two existing
channels. Channel A carrying information transmits through basic amplifier and reaches Channel B. Channel A serves the function of input, and the Channel B is output. The selected portion of the output is sent to the feedback network and returned to input. The cycle will stop when the adjustments are made.

The same situation can be applied to human beings. The human being is a self-regulating being. Receiving feedback enables humans to change their behavior. The changes help human being to adapt to their environment. (Miller, 1978; Asimov, 1972; and Phenix, 1964).

Figure 22  An Electronic Feedback Circuit
This feedback used in human beings is reflected in the development of cybernetics (Ashby, 1961; Parkman, 1972; Gulshkov, 1966; Bell, 1964). Feedback has been increasingly used in the field of curriculum. The Jackson's Mill used a feedback to express an industrial arts curriculum construct (Figure 23). Feedback is not only located in the loop of input and output, but also serves a process control functions.

Computing is a technology derived from all other technologies (Feigenbaum and McCorduck, 1984). The use of the computer in electronics technology to solve problems is great. Four generations of computers, are categorized based on the progression as follows:
1. electronic-vacuum tubes computers,
2. transistorized computers,
3. integrated circuit computers, and
4. very large-scale integrated (VLSI) computers.

The new fifth generation of computers involves artificial intelligence and are conceptually and functionally different from the first four. Artificial intelligence is the science of making machines do things that would require intelligence if done by man (Yazdani, 1984). The new machines are known as Knowledge Information Processing Systems (KIPS). The KIPS shifts from data processing to an intelligent processing of knowledge. It is specially designed to do symbolic manipulation and symbolic reasoning (Feigenbaum, 1984).

Before the computer was invented, humans handled symbols and numbers by themselves, with or without the abacus or calculators. The first four generations of computers handled just numbers and the fifth generation will handle both symbols and numbers. Research has focused on developing a machine that can perform functions that are normally done by human intelligence, including learning, adapting, reasoning, self-correction, automatic improvement. (Yazdani, 1984; Albus, 1981; VonNeumann, 1958)
Asimov (1972) has an interesting observation on man and machine. He pointed out that as science and technology advance, it is becoming more and more difficult to distinguish man and machine. The study of computers and related techniques is to extend man's intellectual capabilities. As a result, man has increased his physical powers by inventing tools and now increases intellectual powers by using artificial intelligence. Nevertheless, using inherent tools should occupy a great portion of instruction in electronics technology.

Figure 24 displays the overlaps of electronics technology, computers and communication technology. They are closely related to the functioning of the human as a whole. Therefore, electronics technology affects the very essence of social cohesion.

Figure 24 The Relationship of Electronics, Communication, Computer Technology and Human Functions
Summary

Electronics technology is one of the important divisions of technology. Studying electronics, the students shall learn elements of the entire development of the human technologies. The earliest stage of technology took place when human beings tried to survive the natural environment. The second stage began with replacing simple manpower tools by machines. The technology of mass production grew rapidly. The third stage is the information revolution which began in 1950's. Rapid expansion of the use of computers in business and industry has provided tremendous efficiency to humans.

In studying technology, the human knowledge should be emphasized as well, since human being are constantly seeking new knowledge. The four domain of human knowledge were reviewed. They are science, technology, humanities and formal knowledge. In technology the researcher stresses the importance of practice and action.

Concerning the instructional purpose, the evolution of technology should be emphasized rather than the revolution of technology. The roots of technological development came from the humanity of seeking survival, comfort and achievement. Therefore, technology can not be separated from the human's
daily life. Although technology developed prior to science, it stimulated the progress of the sciences. In return, the sciences vitalized the technology and helped it accumulate knowledge to a suprisingly abundant level.

The progress of technology can be traced from the evolution of tools. The tools evolved from the muscle activity, to the sensory activity, and to the brain power operation. From simple to complex, they present the accumulation of tool inventions.
CHAPTER VI

THE CONCEPTUAL INSTRUCTIONAL MODEL DEVELOPMENT

The major purpose of this chapter is to report the development of a conceptual electronics technology instructional model. The model construction process is reported including the review by the panel of experts. As a result, the final model is attained. The following aspects relating to the model development are discussed as follows:

1. Concepts of Electronics Technology Instruction,
2. Attainment of the Educational Goals,
3. Content Organization,
4. Development of the Draft Conceptual Instructional Model, and
5. Refinement of the Draft Conceptual Instructional Model.

**Concepts of Electronics Technology Instruction**

1. Electronics technology is a subset of technology. Therefore, the common concepts of technology should be emphasized. The characteristics included are summarized in the following statements:
   a. Human beings and technology co-exist.
b. The traits of practice and action in technology are far more important than others.

c. Technology is evolutionary not revolutionary, in terms of human functions.

d. Technology has a close relationship with science, humanities and formal knowledge. Their overlapping functions should be noticed.

2. The quality of electronics technology which are changing, complex, and comprehensive are obvious to observe:

a. The rapid increase in the use of electronics technology can not replace all tools which include inherent, hand, and sensory tools.

b. Even with its complex structure, electronics technology can be classified, ordered, and coded in a flexible framework which is adequate for different levels and purposes of electronics technology instruction.

c. The definition of electronics, computer, and communication technologies are largely overlapping.

3. Electronics technology is the study of efficient action
and practice in the ways electrons are controlled to carry intelligent signals for mankind through electronic products.

4. Due to the extensive coverage of electronics technology, the instruction in this field can assist in reaching part of the goals in general education.

**Attainment of Educational Goals**

The goals in total education, according to the Association for Supervision and Curriculum Development, are geared to the changing world. The goals include (Brandt & Modrak, 1980):

1. continuing learning throughout life,
2. understanding society's changing nature,
3. setting a goals for the future,
4. accepting new perceptions of the world,
5. coping with change throughout life,
6. Acting as a self-reliant learner,
7. Acting flexible and adapting to a changing world,
8. Selecting viable alternatives in a changing world.

Because of the changing nature of electronics technology, the above goals should provide the same direction when establishing the goals for electronics technology instruction.

By careful analysis of ASCD, it reveals that electronics
technology instruction can contribute to the goals of total education.

Content Organization

The following are the bases derived from previous chapters for organizing the curriculum content:

In Chapter II, the literature related to organizing curriculum content was reviewed in great detail. However, the content in electronics technology must contain the concepts of the technology. The curriculum should follow the progression of the technology from simple and easy step-by-step to the complex and difficult applications. The electronics curriculum content must reflect the constant changing nature of the technology. The curriculum content should include the learning process of finding simple laws from the complex facts.

The concepts of the I Ching can be applied to the organizing of the electronics technology content.

Electronics technology progresses and expands through simplicity to complexity. Resistors, capacitors, inductors, and mechanical switches are defined as passive elements, and vacuum tubes, transistors, and integrated circuits are defined as active elements. These basic elements are assembled as basic circuits, such as rectifiers, amplifiers, oscillators,
and switching circuits. In addition, these basic circuits can be further arranged to become practical devices, such as power supplies, radios, audios, signal generators, oscilloscopes, and televisions. Process is both a form of knowledge and a method of procuring knowledge. (Parker, 1966) The concept of change and transformation can be applied in the process of expanding electronics technology instruction. The different levels of complexity extend upward unboundedly. The interaction of basic circuits blocks expands in a horizontal directions. The expanding processes are open-ended in both vertical and horizontal ways. There are fewer basic elements than basic circuits. Similarly, the basic circuits are less in number than devices which can be created from them. Few types of devices can create a large number of systems. This process can be called "production and reproduction."

All electronics technology changes follow a constant law. In consistency with a law of open and close, the "changes" in electronics technology can be grasped. The concept of symbols and images is an effective vehicle of instruction (Langer, 1963; Marshack, 1972; Standley, 1971.) The symbols and circuit diagrams are necessarily organized in the curriculum content.
Figure 25 An unbounded Electronics Technology Structure

Development of the Draft Conceptual Instructional Model

The conceptual model developed in this study should be flexible and adequate for different levels and purposes of the electronics technology instruction. However, the concepts previously researched in this study should be included in designing the model. They are summarized as following:

1. Man can adjust his behavior regarding various sets of beliefs, values, and norms.

2. The selected concepts drawn from the I Ching which included ease and simplicity, change and transformation, invariability, etc. are valuable in
developing an instructional model appropriate to the R.O.C.

3. The feedback system learned from electronics technology shown in Figure 22 can be adapted in instruction to reinforce student learning.

The structural concepts of each discipline can be identified and taught to students (Bruner, 1966; Ausubel, 1968). Qualitative and quantitative analysis of electronics technology creates two levels of information processing in the electronics technology instruction learning model. Level one requires inherent tools or formal knowledge. Level two includes higher levels of formal knowledge for more complex electronics technology. Figure 26 shows the learning levels of electronics.
In this study, a cubic curriculum model which was adapted from Snyder and Hales, 1981; Towers, Lux, and Ray, 1966, is developed. Figure 27 illustrates the relationship of the three major elements: complexity level of learning, the content of electronics technology instruction, and learning process through feedback system in electronics technology programs. The complexity of electronics technology is viewed from the aspect of human functions. It follows from hand tools, to sensory tools and to brain tools. This study also involves the formal knowledge as learning levels.
Figure 27 A Cubic Structure of Electronics Technology Curriculum
The cubic structure of electronics technology curriculum played a key role in the development of the conceptual model. Before applying the model to the electronics technology program, the learner's educational background shall be assessed to determine the learner's learning level. The assessment is an important reference to the teacher.

The next step is to carefully divide the content of electronics technology into smaller units depending upon the instructional needs. During this process, the concepts selected from the I Ching can be employed as a guideline. The model developed in this study can therefore be used in each unit.

Applying the idea of the electronics feedback circuits (Figure 22) the model is established as shown in Figure 28.

![Feedback Diagram](image)

Figure 28 The Block Diagram of The Model
During the learning situation, teachers and students input information by using the inherent tools: doing, listing, reading or observing. The students use natural language, electronics symbols or mathematics to encode information for further processing. The processing unit is the core of this model and will be discussed in detail in the next section. Through the processing students then decode the acquired knowledge by using natural language, electronics symbols or mathematics. Finally, outcomes (output) will be demonstrated by using speaking, writing or doing as shown on Figure 29.

![Figure 29 Encoding and Decoding of the Model](image)

The processor is the core of the model including motivation, doing, expanding, concepting and feedback (Figure 30).

Motivation. During learning activities, student motivation can determine the success of the learning. Confucius' advocation "to learn with indefatigable zeal and to be diligent
in teaching" has deeply influenced Chinese philosophy. The concepts of the trinity of the primal powers, asserts that man is linked with heaven and earth. If intellect and will are correctly centered, emotional life will be in harmony. The I Ching also emphasizes that motivation is the origin of all behavior. Without motivation, there is no stimulation to the senses. Motivation is a crucial factor in this step of processing.

Doing. The hands-on learning experiences are the valuable part of studying in the field of electronics technology. According to the concept of production and reproduction, doing in this model is different from conducting an experiment. It is used to learn simple skills, knowledge, or concepts which can further expand to other skills, knowledge, and concepts. The doing is for learning.

Expanding. From the concept of change and transformation, adequate learning activities allow students continuous and cumulative learning experiences. The hands on learning experiences in electronics technology should not be limited in obtaining knowledge. They can be expanded to learn more electronics technology and to other domains of human knowledge. According to the concepts of transformation and change, it has
no end in expanding experience in both the vertical and horizontal directions. The related fields under the major disciplines should interact with the content. The degree of the interaction is determined by their relationship. The instruction should contain a lure to discovery.

**Concepting.** During the process of expanding the eight trigrams to sixty-four hexagrams, the arrangement is logical and is completed through the conceptual methods. This method follows the concept of the symbols, images, and judgments. It can be also applied in electronics technology in conceptualizing the output into the input to any learning blocks. This stage requires students to put their own ideas together. Only when the blocks appear to be the same type of logical form between input and output, can it be connected to the next block. This is shown as Figure 30.

**Feedback.** Feedback is commonly used in electronics technology. Man is a living system and feedback is psychological phenomena. A living system is self-regulating because input affects output, and output often adjusts input. The result is that the system adapts homostatically to its environment.
Blocks assembling. The model can be viewed as a single block. By assembling the simple blocks, a complex concept can be built as shown in Figure 30.

Figure 30 The Core of the Model: The Processor

Conducting Interviews with the Panel of Experts

A panel of experts from Taipei City was invited to participate in a formal face-to-face interview. The intention of this interview was to collect qualitative data and then propose some required revisions. Before the interviews were conducted, the experts had an opportunity to study copies of the proposed model. During the interviews, the researcher followed the structured open-ended questionnaire
Summary of the Expert's Review

The panel of expert's reviews were tabulated and recorded in Appendix D. This summary is based on each question and is presented as follows:

Model Theory

Question #1 Is it appropriate to develop an electronics technology instructional model based upon the Chinese culture?

All three of the experts stated the importance of culture in instruction. This is because culture influences people's thinking. The different aspects of the Chinese culture were mentioned. They included Chinese symbolic characters, the creativity of the people, and the historical viewpoint. The experts all emphasized the important role of Chinese culture in designing the instructional model.

Question #2 Is it appropriate to select the I Ching as the primary concept to develop the model?

The experts unanimously agreed with selecting the I Ching as the primary concept to develop a framework for
the Chinese instructional model for electronics technology. The experts stated that the concepts of the Ying and Yang are clearly related to the binary system of electronics technology.

**Question #3** Is it appropriate to apply the selected concepts from the *I Ching* to develop the model?

The experts offered their viewpoints according to their expertise. Generally, they agreed on the selected concepts from the *I Ching*. The concept of the Trinity of Primary Powers should be weighted the most according to Dr. T. W. Chien. Mr. W. H. Hsu thought the concepts of the *I Ching* fit into the Chinese people's way of thinking.

**Question #4** Is it appropriate to include the characteristics of electronics technology in the research?

The characteristics of electronics technology including simplicity, change and transformation, and invariability were approved by the experts. The overlapping relationship of electronics, communication, computer technology and human functions were of interest to the experts. The suggestion was made by Mr. W. H. Hsu.
to revise Figure 24 to make it a better illustration.

**Model Contents**

Question #1 Is each block in the model clearly defined?

The experts specially reacted to the aspect of the feedback system. Basically, the block and feedback systems were logically joined to the electronics.

Question #2 Are the blocks in the model interrelated?

The experts described that the relationships between blocks can be easily understood.

Question #3 Are some general educational goals actualized by the electronics technology instruction?

The panel of experts all agreed that the ever-changing nature of electronics technology contributed to the goal of general education. Mr. W. H. Hsu stated after he became involved with electronics technology, he had a strong tendency toward life-long learning.

Question #4 Is the electronics technology content organized appropriately?

The content of electronics technology raised more questions by the experts. Professor C. S. Hsu complained that the content of electronics technology was only slightly touched and suggested the revision of Figure 27.
Mr. W. H. Hsu suggested that comparisons be made between the concepts of the I Ching and the learning theories when adapting them to the model.

Question #5 Is the process of the model appropriate?

Dr. T. W. Chien related the model to the concept of I Ching. He stated that the concepts of easy and simplicity, change and transformation, and invariability are appropriate to apply to any learning process. Professor C. S. Hsu remarked about the appropriateness of the process of the model. But, he advised the combination of Figures 28, 29, and 30 to provide a better explanation.

Mr. W. H. Hsu would like to see the model applied in his company's training program. He also offered feedback when the training is complete. Relating to the further study of this research, Mr. Hsu urged the need to analyze the design of the content of electronics technology based on the model.

Based upon the data gathered, the researcher summarized and presented the following three major revisions proposed by experts:

1. To understand the model easily, all related diagrams should be merged in one.
2. The overlapped section among electronics, computer, and communication should be drawn larger than before.

Conducting Reviewing With the Research Committee

The research committee members were asked to review the model. The following revisions are proposed by the committee members:

1. The model is important in harmony with Chinese Culture both in content and the shape of the diagram.
2. It is necessary to describe the model in detail.
3. It is necessary to have an example of application.
a very complex instructional processes

Figure 31 An Electronics Technology Instructional Model
The Final Model

As a result of the above validation process, a conceptual electronics technology model was finalized, Figure 31. The final model contains five major steps (1) Input, (2) Encoding, (3) Processing, (4) Decoding, and (5) Output. They constantly adjust themselves through the feedback system. Each step has its own special function and is explained as follows:

(1) **Input.** Before teaching the content, the teacher should decide whether the content of the instruction can fit the learner's background. For example, if the learner has no electronics technology background, the teacher can only use the instruction starting with inherent tools, daily-used language, or body language to explain to the learner. The knowledge received from the instruction is in the input step.

(2) **Encoding.** During encoding step, the learner converts information from the input into familiar information. For instance, when the teacher uses the concept of 0 and 1 to explain bits in electronics, the learner's thinking will follow the concept of 0 and 1. If the learner had not learned the concept before, he or she will have difficulty at this point of encoding. Most Chinese students are
aware of the system of Ying and Yang. If the teacher in Taiwan uses Yao instead, the students can naturally encode the concept of the Ying and Yang into this binary number system. Therefore, Input and Encoding are closely related. If the teacher understands the learner's learning process, he can match the instructional input and the learner's encoding.

(3) **Processing.** The Processing step is the core of the model. Motivation can stimulate the learner's interest in studying. After the learner receives input information and has gone through the encoding process, the teacher needs to stimulate the learner's motivation and to promote the efficiency of learning. Motivation is the key to the Processing step.

The learner should be allowed to practice what he or she learned through doing, since electronics technology has its emphasis in practice and action. The purpose of doing is to help the learner learn better.

However, expanding the content after doing can extend the area of the subject. Expanding has to depend on the learner's learning background and progression. The proper expansion of content is an important element of the
processing. The teacher can apply the concept of the I Ching, Change and Transformation, to expand the content either horizontally or vertically.

Expanding brings in various aspects of the learning content. The learner might become confused by the added dimensions. Concepting is placed after the Expanding in order to synthesize learning in the simplest way. Only by using the concepting process, the learner can truly learn well.

(4) Decoding. Decoding follows the Processing. Decoding is opposite to Encoding in processing information. The learner can use general methods to organize information instead of using his own way. The process can help the learner communicate with people in different ways, which is very useful in future work situations. Encoding and Decoding compliment each other.

(5) Output. Output determines the outcome of the instruction, i.e. how much the learner received. The methods of determining the output should not be limited to the paper and pencil test. Any form, such as verbal investigation and mathematical expression are also valid. Input and Output compliment each other.
(6) Feedback. There are two major loops of the feedback system used in the model. One loop is from Output to Input. The Processing has a loop in itself. However, each step also receives feedback from itself. The purpose of the feedback system is to promote teaching effectiveness.

(7) Enlarging the instructional processes. Each learning process, according to the model, can be a complete instructional processes. The Output of the processes becomes the input of another processes. The more flexible the output, the more opportunity it can be received as the input to a different learning unit. An experienced teacher needs to be flexible in adjusting each learning unit. The concepts of production and reproduction is used in the model to expand an instructional unit in both horizontal and vertical direction and becoming a very complex instructional unit.

Application of the Model - An Example

The model emphasizes practice and action in electronics technology. The design of the content of each instructional unit must reflect these characteristics. The unit of Ohm's Law in electronics is used as an example to demonstrate the application of the model. According to the learner's
background, the teacher designs the content of the unit to a
three sub units.

1. First Sub Unit - Measuring Resistor

(1) Input. The teacher begins with a demonstration of
measuring resistance in various ways.

(2) Encoding. To reach the goal of the learner's encoding
information, the teacher provides a simulation or
graphic instruction for the learner to operate the
multi-meter.

(3) Processing.

(a) Motivation. The teacher can use several
instructional aids, such as interesting cartoon
drawings or videotapes. The teacher reminds the
learner of the advantages of learning resistor
measurement.

(b) Doing. The teacher sets up a multimeter and color
coded resistor in the laboratory for the learner to
measure.

(c) Expanding. After the learner's hands-on
experience, the teacher can mention the rules of color
coded resistors. Additionally, the size of the
resistor reflects different power capacity. The
learner expands his knowledge to a related subject after understanding resistance measurement.

(d) Conpecting. The teacher helps the learner organize information received in the unit. It can include the sizes of the resistor, color coded resistor and resistance, their relationships, and the steps of measuring resistance.

(4) Decoding. The teacher reviews the general methods of measuring resistance for the learner so that the learner can adjust the information received.

(5) Output. In the last step, the learner understands the methods of measuring resistance and can demonstrate these methods.

2. Second Sub Unit - Measuring Voltage.

(1) Input. The teacher demonstrates to the learner various ways of measuring voltage.

(2) Encoding. The learner receives information from the teacher with his own ways of thinking.

(3) Processor.

(a) Motivation. The teacher motivates the learner so that the learner is interested in measuring voltage.
(b) Doing. The learner is given the opportunity to measure the voltage of batteries.

(c) Expanding. After the doing process, the teacher extends information to the difference between the units of resistance and voltage and the various methods of measurement.

(4) Decoding. The teacher reviews the general methods to help the learner readjust his information on voltage.

(5) Output. Consequently, the learner comprehends the information and can demonstrate the measurement of voltage.

3. Third Sub Unit - Measuring Current.

(1) Input. The teacher prepares the instructional unit and demonstrates the ways of measuring current.

(2) Encoding. The learner receives instruction and progresses in his own pathway of thinking.

(3) Processing.

(a) Motivation. The teacher uses effective teaching techniques to promote the learner's learning interest in measuring current.

(b) Doing. The laboratory exercise allows the learner to practice measuring current.
(c) Expanding. The teacher thus expands the related information and adds:

(i) Resistor, voltage, and current each have different units,

(ii) Measuring current should be in series,

(iii) The relationship with Ohm's Law is explained,

(iv) A measuring of a resistor, voltage and current should be conducted in a circuit,

(v) Ohm's law can be used to verify the values of resistor, voltage and current measured in the circuits.

(4) Decoding. The learner learns general methods of applying the methods of measurement by adjusting his own way of thinking.

(5) Output. Finally, the learner understands the instructional unit and is able to demonstrate measuring current and to apply Ohm's law.

Summary

This chapter is to report the development of the conceptual electronics technology instructional model. First, it reported the aspects relating the model development. Second, the model
development was described. Third, the conducting of interviews of the panel of experts and the research committee review were reported. Fourth, the final model was described. Finally, an application example was described.
CHAPTER VII

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to develop a conceptual electronics technology instructional model based upon the concepts of the I Ching. Five research questions were developed to direct the study:

1. What concepts of the I Ching should be included?
2. What concepts of the electronics technology should be included?
3. What educational goals should be actualized by the electronics technology instruction?
4. How should electronics technology content be organized?
5. How should the conceptual instructional model be developed?

The systems approach and heuristic strategy were chosen. And, a panel of experts from Taipei were requested to review the draft model. Once the required revisions had been made, the final model was established.
Conclusions

1. Research studies have shown that language symbols have strong influences on human thinking patterns. One of the major cultural differences existing between the West and China is the language symbols. Thus, to study the electronics technology originally developed by the West, some concepts regarding the instructional process should be adjusted in order to match Chinese thinking patterns.

2. The I Ching, whose primary characteristic is utilizing Yin and Yang symbols to present its content. It explores the change principles of the natural phenomena and humanities. Therefore, to develop the electronics technology instructional model, it should be based on the familiar concepts of the I Ching known by Chinese.

3. The meaning of the "I" is three fold: ease and simplicity, change and transformation, and invariability. In the I Ching, those meanings are the major concepts dealing with the principles of changes. Yin and Yang are the primary categories of all existence. The interplay of Yin and Yang is a
categorizing process of an inner reality. In the instructional process of the electronics technology, those concepts of the "I" can be applied. That is, complicated and difficult electronics technology can be converted into easy and simplistic patterns. The simple and easy patterns then can expand into complex concepts. This process can produce a hierarchy of interrelated knowledge. Moreover, general laws can be built from relationships among concepts. Thus, a model applied to other fields can be created from the learning outcomes.

4. The trinity of primary powers is the major concept of the *I Ching*. It advocates that man and universe stand in a relation of harmony. From this viewpoint, learners should be involved in electronics technology. This would make the learning more effective and efficient.

5. The major concepts of electronics technology were summarized in the following: (1) electronics technology is a subset of technology; (2) the quality of electronics technology contains changing, complexity, and comprehensiveness; (3) electronics technology is the science of studying efficient action and practicing the way electrons are controlled to
carry intelligent signals for mankind through electronics products; and (4) the electronics technology instruction can assist in reaching some goals of general education.

6. Due to the changing nature of electronics technology, electronics technology instruction should pay much attention to this specific characteristic—inevitability of change. Via the electronics technology instruction, the following major general educational goals can be achieved: (1) understanding society's changing nature, (2) continuing learning through life, (3) setting a goal for the future, (4) accepting new perception of the world, (5) coping with change through life, (6) acting as a self-reliant learner, (7) acting flexibly and adapting in a changing world, and (8) selecting viable alternatives in changing world.

7. Based upon the context of electronics technology derived from the concepts of the I Ching and instructional theories of the West, a conceptual electronics technology instructional model was constructed as shown in Figure 31.
Recommendations

1. There are numerous research studies investigating the relationship between the language symbol and the human thinking pattern of people in many countries. But, there is a paucity of study in Taiwan, further research should be encouraged.

2. The conceptual electronics technology instructional model based upon Chinese culture can serve as a referenced framework for those who intend to develop similar model in other fields.

3. The I Ching has been widely known in people's life. But, people usually do not clearly understand its concepts. Thus, they use the I Ching in divination. It is imperative to explore the theories of the I Ching and extend its concepts to more fields.

4. The knowledge of the I Ching is very extensive. But only a part of the knowledge was utilized in the model development of this study: In order to increase the validity of the model, other concepts of the I Ching should be analyzed to see if any enhance instruction.

5. The model developed in this study is presented in a conceptual form. It will be necessary to conduct
further study in electronics curriculum development, which has the characteristics of continuity and coordination. Thus the curriculum applications will have to be developed and evaluated in actual instructional situations. Knowledge from the evaluation can be used to revise or elaborate the model.

It will be difficult to measure the impact of a curriculum for electronics technology until engineers, scientists, and technicians have graduated from schooling and have begun to fill roles in the electronics industry and electronics research laboratories. Perhaps the ultimate indication of the success of this model will be the invention of sophisticated electronic devices and the development of new electronic theory by Chinese people taught electronics technology from the Chinese, I Ching viewpoint.
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Appendix A

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Appendix B

Panel of Experts
B. Panel of Experts

Dr. T. W. Chien
Professor
Department of Chinese Literature
National Cheng-Chi University

Mr. C. S. Hsu
Professor
Department of Industrial Education
National Taiwan Normal University

Mr. W. H. Hsu
Vice President
Division of Audio and Communication Systems
SAMPO Electronics Company
Appendix C

Interview Questionnaire
C. Interview Questionnaire

**Model Theory**

1. Is it appropriate to develop an electronics technology instructional model based upon the Chinese culture?

2. Is it appropriate to select the I Ching as the primary concept to develop the model?

3. Is it appropriate to apply the selected concepts from the I Ching to develop the model?

4. Is it appropriate to include the characteristics of electronics technology in this research.

**Model contents**

1. Is each block in the model defined clearly?

2. Are the blocks in the model interrelated?

3. Are some educational goals achieved by the electronics technology instruction?

4. Is the electronics technology content organized appropriately?

5. Is the process of the model appropriate?
Appendix D

Response of the Panel of Experts
Response of the Panel of Experts

1. Dr. Tsung W. Chien

Model Theory

Question #1

People's thinking patterns are influenced by their cultural background in many ways. For instance, many Chinese characters are created by the shapes of the objects. When looking at the character, one begins to think how the character was created. This element of the thinking pattern influenced by culture should always be included in all teaching subjects.

Question #2

The Ying and Yang concept from the I Ching and the 0 and 1 of the electronics technology are certainly identical. After reviewing your study, I am familiar with the concept of binary numbers. I agree with your choice of the I Ching as selected from the broad choice of cultural heritages.

Question #3

I think that your selected concepts from the I Ching were appropriate for your study. The concept of the Trinity of Primary Powers is surely the most important concept of all. It can help people overcome materialism which is usually the result of the development of technology.
Question #4

I am not familiar with the electronics technology. However, the characteristics of ever-changing electronics should definitely be included. Additionally, approaching this subject from the concept of simplicity, change, transformation and invariability in the I Ching is an excellent idea.

Model Content

Question #1 and #2

I am not familiar with these two topics. However, the block of expanding in the model can be applied by the concept of symbol and image and judgement in the I Ching.

Question #3

One of the characteristics of electronics technology is the ever-changing. If the students understand the characteristics, it will help them to have a goal of life-long learning.

Question #4

This is not in my expertise.

Question #5

A Chinese person should be able to use the concepts of easy and simplicity, change and transformation, and invariability as a tool in the learning process.

Response of the Panel of Experts
2. Professor Chun S. Hsu

Model Theory

Question #1

Chinese people emphasize the importance of one's history, which, I think, is influenced by culture. If a Chinese mentions his work, he usually starts from his past work experience first before he talks about his current work. The verbal expression is especially different. Therefore, wherever instruction is concerned, culture must be included.

Question #2

As I become more apprehensive to the I Ching, I can easily and Yang can present the concept better than that of the system of 0 and 1.

Question #3

I am very interested in the concepts you have selected for the study. I am handicapped in this field and can not offer you more appropriate concepts.

Question #4

I agreed with your emphasis on the nature of electronics. From the view of an educator, I also agree with the concepts of overlapping in knowledge and evolution. Because of the
overlapping. One can see the relationships of computer, communication and electronics technology. Because of evolution, there is value in education. Anything without cumulative character will be hard to learn.

Model Content

Question #1

The blocks in the model developed from the concepts from the I Ching, as well as the feedback and communication systems can be easily understood.

Question #2

Because these blocks are rooted strongly, the relationships between the blocks can be seen.

Question #3

With the appropriate guidance, the education of electronics shall be able to help students reach the goals of understanding society's changing nature, learning through life time and general education as well.

Question #4

The organized principles in the content of electronics technology were properly mentioned. But the content of electronics technology was only slightly touched. I also have a suggestion on the revision of Figure 27. The analytic geometry
The process of developing the model is appropriate approach. If you can combine Figure 28, 29 and 30 and give an explanation, it will better demonstrate their relationships.

Response of the Panel of Experts

3. Mr. Wen H. Hsu
Model Theory

Question #1

Chinese characters are a system of symbols and were created with tremendous imagination. The Chinese people are accustomed to this system and often use this ability of imagination in different creativities. It is very important that the teacher emphasizes this aspect of culture in the teaching situation.

Question #2

I have known the concept of the Ying and Yang from the I Ching for a long time. Not until your recent discussion in your dissertation have I started to link the concepts to electronics technology. Using the Ying and Yang as the base to teaching assembly line workers in electronics manufacturers can help them further understand the theories of electronics and keep them
interested in their work.

Question #3

Although I have a basic understanding of the I Ching, I have never read a paper approaching the concepts of the I Ching with the system presented in your dissertation. The system fits into the Chinese peoples' traditional thinking logic very well.

Question #4

I can appreciate your use of the figure illustrating the relationship of electronics, communication, computer technology and human functions. There are advantages of understanding their relationships in teaching situations, such as:

(1) concerning human functions during teaching can help learners greatly apply their potential of manipulation, sensation and thinking.

(2) adapting human functions to electronics technology shall help in keeping harmony between man and technology. However, I have one suggestion on your illustration of overlapping relationships among electronics, computer, and communications. Figure 24 should be drawn larger and the overlapping section should be shaded.
MODEL CONTENTS

Question #1

This is an excellent approach of using the concepts of the I Ching and applying them to the feedback system of electronics technology. Because I am familiar with the block system, it seems to be logical to me. But I am not sure that it can be applied to the learners who do not have a similar background.

Question #2

Based on the same reasoning that I have answered in the last question, I can easily associate with the relationships between any of two blocks.

Question #3

Based on my own experience, ever since I got involved in electronics, I have a strong tendency toward life-long learning.

Question #4

It is necessary to compare the concepts of the I Ching with the learning theories. I would like to know if these two concepts can be simultaneously adapted in instruction.

Question #5

I urge you to analyze and design the content of electronics technology based on the results of your study. I would like to see the model applied in the context of electronics. I will be
very interested in using it to train my employees. The result of the training will be surely sent to you and could be a part of the feedback cycle.