DOCUMENT RESUME

ED 077 195 EM 011 077

AUTHOR Brown, John S.; And Others
TITLE A Model Driven Question-Answering System for a CAI Environment. Final Report (July 1970 to May 1972).
INSTITUTION Air Force Human Resources Lab., Lowry AFB, Colo. Technical Training Div.; System Development Corp., Santa Monica, Calif.
REPORT NO AFHRL-TR-72-39
PUB DATE Mar 73
NOTE 63p.

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Artificial Intelligence; *Computer Assisted Instruction; *Computer Programs; Deep Structure; *Information Processing; Information Storage; Man Machine Systems; *Programed Materials; Semantics; Technical Reports
IDENTIFIERS Automata Models

ABSTRACT

A question answering system which permits a computer-assisted instruction (CAI) student greater initiative in the variety of questions he can ask is described. A method is presented to represent the dynamic processes of a subject matter area by augmented finite state automata, which permits efficient inferencing about dynamic processes and provides a satisfactory deep structure for paragraph generation. A CAI system dealing with meteorology is described which uses this automation model to represent the processes in meteorology. Examples of the inferencing techniques using both the automaton model and the semantic network are given. A sample session with the system is included in the appendixes. (Author/RH)

AFHRL-TR-72-39

AIR FORCE HUMAN RESOURCES LABORATORY

A MODEL DRIVEN QUESTION - ANSWERING SYSTEM FOR A CAI ENVIRONMENT

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March 1973

AIR FORCE SYSTEMS COMMAND

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FOREWORD

This research was completed under Project 7907, Conditions of Effective Training and Transfer, Task No. 790700, Research on Demonstration of Natural Language Computer-Aided Instruction. The effort was initiated by the Advanced Systems Division and subsequently transferred to the Technical Training Division under the monitorship of Dr. Marty R. Rockway.

The research was carried out under the provisions of Contract No. F33615-70-C-1726 by System Development Corporation, Santa Monica, California.

This report has been reviewed and is approved.

Harold E. Fischer, Colonel, USAF
Commander

ABSTRACT

This report describes a question-answering system which permits students in a computer assisted instruction (CAI) environment greater initiative in the variety of questions they can ask concerning the subject area being studied. A method of representing processes as augmented finite-state automata is developed and is shown not only to permit efficient inferencing about dynamic processes but also to provide a satisfactory deep structure for paragraph generation. A CAI system dealing with meteorology is described which uses this automaton model to represent the processes in meteorology. Coupled with the dynamic process model is a semantic conceptual network which contains the static information about meteorology. Examples of the inferencing techniques using both the automaton model and the semantic network are given. A sample session with this system is included in the Appendices.

SUMMARY

Brown, J.S., Burton, R.R., & Zdybel, F. *A model driven question-answering system for a CAI environment.* AFHRL-TR-72-39. Lowry AFB, Colo.: Technical Training Division, Air Force Human Resources Laboratory, March 1973.

Problem

A major limitation of frame-oriented CAI is the restriction it places upon the student's ability to explore those areas of the subject which interest him. While it is desirable to allow a student to take initiative and explore the subject in his own way, any system which permits the student to do more than answer its posed questions must have some "knowledge" of the subject. The more initiative the student can take, the more "knowledge" the system must have. This paper describes a prototype system developed from the view that the system should be fluent in the subject area and that the student should be free to ask well-formed questions. This paradigm raises several problems not present in existing question answering systems. Two of these are (1) the representation of dynamic processes, with its related notions of causality, and (2) the generation of explanatory text in quantities greater than a simple sentence.

Approach

A method of representing the dynamic processes of a subject matter area as augmented finite state automata was developed. This automata model was coupled with a semantic conceptual network which contained the static factual data associated with the body of information to be learned. These two subsystems were consolidated in a prototype demonstration CAI system dealing with the facts and processes of meteorology. The potential of the prototype CAI system to permit a relatively free dialogue between a "student" and the subject matter data base was evaluated using a batch processing (*i.e.*, non-interactive) simulation of the system represented.

Results

The approach used appeared to have the potential for permitting a more realistic tutorial dialogue than is possible with conventional CAI systems. Despite its limitations the system provided an improved method for inferencing about dynamic processes as well as a satisfactory capability for generating paragraph-length answers to "student" questions. A computer printout of a simulated student-system interaction is included in the appendices.

Conclusion

The prototype CAI system developed under this basic research effort provides a useful baseline for continuing work on the development of natural language processors for use in computer based instructional systems. The use of automata-like structures appears to be a particularly promising technique for representing process type information and helping to generate complex responses to student questions.

This summary was prepared by Marty R. Rockway, Technical Training Division, Air Force Human Resources Laboratory.

TABLE OF CONTENTS

		Page
I.	Introduction	1
II.	Representation of Processes	4
III.	Representation of Factual Information	8
IV.	Question-Answering	11
V.	A CAI System	24
VI.	Conclusions	26
References		28
Appendix I.	Container Questions	29
Appendix II.	Meteorology Questions	31
Appendix III.	Sample Dialog	34
Appendix IV.	Meteorology Model	45

LIST OF TABLES

Table		Page
1	Transition Table for Automation	6
2	External State Vector	14

I. INTRODUCTION

An intriguing goal for a CAI system is the ability for it to perform as a general purpose question-answering system. Several years ago Jaime Carbonell at M.I.T. commenced an ambitious research project to investigate the feasibility of such a system (1). His goal was to create a Mixed Initiative CAI system which would permit the student to interrupt the tutorial process and pose direct questions. Although Carbonell's system performed quite well with highly structured geographic data, its direct application to less uniformly structured data seemed problematic. The inferencing techniques used were clearly tuned to answering static and simple factual questions. Nevertheless, the philosophy underlying the Mixed Initiative system remains impressive.

Our goal was to design a question-answering system suitable for use in a learning situation to work with dynamic material as well as static. Such a system should allow good representation of processes, their interactions, and through these, be able to deal with causality. The notion of causality is central to the characterization of all physical phenomena. It also underlies much of our common sense knowledge of the world and for this reason, if

no other, deserves close study.

Meteorology provides an ideal body of knowledge for studying these problems. Introductory meteorology is characterized by the study of the processes of evaporation, condensation, cloud formation, precipitation, etc. and their effects upon each other. These processes are amenable to a general representation in a qualitative manner. To explain the processes which cause rain, for example, lengthy logical explanations can be offered which need not be preponderantly quantitative. There do exist, of course, complex numeric treatments of topics in meteorology, but much of the introductory material can be represented with variables and functions which assume a purely directional nature. Thus, it is possible to talk about the relative behavior of meteorological entities without having to solve differential equations in an attempt to determine precise relationships.

In constructing its replies, we expected our system to generate qualitative statements and not simply to regurgitate numeric solutions. We did expect, however, that if the student asked a quantitative question, the response generated by the system would be a qualitative explanation coupled with a sequence of numeric computations. Also, we recognized that if our question-answering system was to be useful in a CAI environment, it would have to respond not

only to "What happens" but also to "Why does it happen" questions. (Examples of questions will be covered in detail in a later section.)

In addition to being able to handle these kinds of questions, we required that our system not only be generalizable to other areas of knowledge, but that it also incorporate a representation of information (inference rules, etc.) that would facilitate the addition of new concepts as well as new facts.

In view of these goals, we rejected the highly popular approach which invokes resolution type strategies which require an axiomatic representation of its knowledge about the world. Although such systems are extremely attractive because of their generality, this benefit is more than offset by:

1) The degree of difficulty in obtaining a complete axiomatic characterization of a body of knowledge as complicated as even the minor subset of meteorology under consideration;

2) The substantial complications involved in the handling of causality which often requires complex considerations of the current "state of the world".

On the other hand, we did not want to construct a system so specialized that it would not be applicable to any other areas of knowledge. The following sections discuss a

question-answering system that satisfies these basic requirements. The system is written in LISP 1.6 for the PDP-10 and occupies approximately sixty-thousand words of core.

II. REPRESENTATION OF PROCESSES

Whereas most question-answering systems excel in their ability to perform fact-retrieval tasks or answer true-false type questions, our system has been designed with broader goals in mind. Central to meteorology is the notion of a "process" (cloud formation, hail formation, evaporation, etc.). We are therefore much concerned with efficient ways of encoding information about processes. Although the structure of processes can be characterized by statements in a predicate calculus, we have sought a representation by which processes could be more naturally "understood" by the computer. An obvious possibility is to represent each process by a procedure - the "meaning" of the process could then be realized by evaluating the procedure. Such a representation of a process has certain advantages but, on the other hand, provides very little structural framework for specifying interactions among processes. (Winograd's (4) use of PLANNER might be an exception.)

Since comprehension of a process often emerges through studying its effects or interactions with other processes, and not by studying the process in isolation, this unconstrained representation was not pursued. Instead, a compromise was sought in which the computer could symbolically execute a process and in which the interactions among various processes could be made perfectly explicit. (These interactions, as will be discussed later, function as the basic set of inference rules for this system.)

Borrowing from automata theory, we decided to represent each process as an automaton where each automaton is itself represented as an augmented state transition table (as shown in TABLE 1 on the following page). Each row in the transition table concerns a particular transition between two states in that automaton. The first column specifies the particular transition between two given states. The second column specifies conditions which must be satisfied over the global or external state of the system before the transition can occur. The column marked "Internal Conditions" specifies constraints concerning which states other automata must be in before this automaton could exercise the given transition. Both the external and internal constraints take the form of LISP predicates which must evaluate to "True" before the transition can occur.

TABLE 1

TRANSITION TABLE FOR AUTOMATON

AUTOMATON	TRANSITION	EXTERNAL * CONDITIONS	INTERNAL * CONDITIONS	* COMPUTATION	ASSOCIATED PHRASE
AIR-WATER PROCESS	B => A	-	[IIB]=A OR [IB]=C	-	NET EVAPORATION
	B => C	-	[IIB]=C OR [IB]=A	-	NET CONDENSATION
	A => B	-	[IIB]=C	-	EQUILIBRIUM
	C => B	-	[IIB]=A	-	EQUILIBRIUM
RATE OF EVAPORATION	B => A	[N]=X => [N]=B (X # B)	[WT]=A	IF NB="TRUE" THEN IB=.85 x TABLE(WT) ELSE IB=TABLE(WT)	DECREASE
	B => C	[N]=B => [N]=X (X # B)	[WT]=C	-	INCREASE

The first line is read: "A state of Equilibrium becomes a state of Net Evaporation if either the Rate of Condensation decreases or the Rate of Evaporation increases". The other symbols used are: [N] for the state of Nuclei(see TABLE 2) and [WT] for the Water Temperature automaton (see Appendix 4).

* These columns are arbitrary LISP predicates.

Usually, these predicates are simple Boolean functions. They can be, however, as complicated as is necessary to capture the subtleties of interactions between two given concepts or processes of the transitional system.

The "Computational Column" specifies how a parameter of t automaton is to be computed if the query requires a numeric answer. This entry is either the name of a table or the name of a computational procedure along with information specifying the binding of arguments for this procedure. The last column, "Text Generation", specifies a fragment of text that can be generated in conjunction with the automaton making this transition. We will later see how these fragments can be synthesized into a paragraph or complex sentence in response to a complex "Why" question:

The cross product of all these automata (one for each process or concept) forms a global automaton which functions as the dynamic model of our meteorology data base. (See Appendix 4 for a synopsis of the sub-automata that currently form the global automaton.) The user can easily augment this global automaton by adding new sub-automata and specifying via the internal and external conditions (columns) how the new automata interface with the old. The user can, in fact, throw out the entire Meteorology global automaton

substituting his own (on say ecology) and thereby redefine the subject matter of the system. In this respect, the system's data base is table-driven.

III: REPRESENTATION OF FACTUAL INFORMATION

Not all "knowledge" can be conveniently encoded in terms of automata. We therefore needed another specialized data structure to represent the kind of information we believed important to meteorology but which was not easily captured by the above methods. In addition, certain information about "processes" (e.g., their definition) is inherently factual, rather than functional, and hence could be best represented external to the transition tables. In light of these considerations, a semantic/conceptual network, similar to those developed by R. Quillian (2) and R. Simmons (3), was designed. Our network possesses three basic kinds of nodes, each with slightly different property list structures. Since any node within a given generic class has the same kind of properties, we can take advantage of this uniformity in writing specialized routines to perform a limited class of inferences. Nevertheless, this network along with its procedures for performing inferences, does not have the flexibility of a general purpose

question-answering system. In order to expand the range of questions that the system can handle, the user must adjoin new inferencing procedures to the executive which processes this network.

The three kinds of nodes in this semantic/conceptual network are:

1) Objects (e.g. Rain, Ice, Snow, ...)

2) Concepts (e.g. Temperature, Pressure, Freezing Point, ...)

3) Processes (e.g. Evaporation, Precipitation, Saturation, ...)

Objects are interrelated by two basic ordering relationships; e.g., x "is a kind of" y, or x "is an example of" y. These relations induce a partial ordering over the set of objects and function in the standard way by allowing the object x to inherit properties of the object y as specified by the given inference procedures. Each object has the following properties (a property can have sub-properties):

1) DEF: an ASCII string giving the object's definition - key words in the string are subject to cross-referencing as described later.

2) PATT: Physical attributes, such as shape, size (bounds), color, weight, etc.

3) BC: Boundary conditions for the object's

a) formation
and b) existence.

4) SUB: What things are examples of this object.

5) EX: What things this object is an example of.

6) LOC: Where the objects are usually found or contained.

7) WAFF: What things the object affects (which process automata this object affects)

8) UF: What things the object is used for. (Which process automata this object is involved in)

9) WAFFT: What affects the object's attributes.

10) TXT: A short exposition (coded simply as text) about this object.

11) SCH: A schema used by the CAI executive to specify an ordering over the other properties for "Tell me something about x" type questions.

12) XREF: Contains cross-reference information

13) SYN: Any synonyms that are also contained in the network

The network structure for processes has various properties in common with the structure for objects. There are, however, important differences as seen by examining the property list for processes:

1) INV: Inverse of this process.

2) XFORM: The given process transforms object (state) x into object (state) y.

3) EX: Examples of the process.

4) BC: Boundary conditions (same as for the objects).

5) DEF: (Same as for the objects.)

6) SYN: Technical synonyms for this process that are not already contained in our lexicon.

7) EXP: (Each process node has a corresponding automaton. This property list contains simple explanations for each possible transition in that automaton. These explanations are at present simply ASCII strings and do not cross-reference any other part of the network.)

8) XREF: contains cross-reference information.

Conceptual nodes have only one additional property which specifies (if applicable) the units of measurement for that concept.

The most important property that all three nodes have in common is the "XREF" property which specifies for every "node" in the semantic/conceptual network which other nodes contain properties which reference (mention) this node and in which property this reference occurred. Therefore, when a procedure commences its search from a particular node, it can selectively pursue certain paths determined by how this particular node is used or referenced by other nodes.

IV. QUESTION-ANSWERING

Having discussed the two basic representations of information in our data base, we are now in a position to

discuss how question-answering is performed. We will draw heavily upon examples to elucidate the inferencing techniques fundamental to our system.

Students using this system invariably formulate questions assuming certain contextual information that they have just been presented. Questions are not formulated in a vacuum, and almost always involve numerous presuppositions even apart from contextual considerations. For example, if a student asks: "What happens when the temperature drops?", he undoubtedly is presupposing that the temperature is already above absolute zero (obviously), that there is some water vapor present or perhaps some other objects whose states might be altered. In certain contexts, it would be clear in what range the temperature was before it "dropped". Or, depending on previous assertions, students may be assuming that temperature means "air temperature" and presupposing that air temperature is always equal to the water temperature (of the water droplets in the clouds). One characteristic of either contextual or presuppositional knowledge is that it is implicit and therefore it would be unreasonable to expect students to make all such assertions explicit. A useful system (in a CAI environment) must somehow keep track of at least some of these underlying assumptions. In other words, a "model" of the student

(albeit simple) must be kept up-to-date with respect to his current assumptions.

Towards this end, an external (or environmental) state vector E is formulated, which reflects the student's current assumptions. In essence, E is a sequence of flags and parameters which are altered in accordance with the kind of material the student is currently exploring. TABLE 2 specifies the parameters included in the vector representing the E state. These parameters are primarily referenced by the predicates in the "External Condition" columns of the transition tables (TABLE 1). In the absence of any information, default conditions are specified which are set to evoke the maximum information from the model. For example, if the student is working with clouds, the clouds are assumed to be deep and condensation nuclei are assumed to be present. These conditions are necessary for the formation of precipitation. When a student lowers the air temperature, the precipation process starts. The response generated explicitly states these assumptions (see Appendix 3). At this point the student sees what assumptions have been made and can ask "Suppose there were no condensation nuclei?".

To best illustrate how the process model performs

TABLE 2

EXTERNAL STATE VECTOR
(* INDICATES DEFAULT VALUE)

```
[S]  (WATER TEMPERATURE ALWAYS EQUALS AIR TEMPERATURE)
* T = "TRUE"(ALWAYS TRUE WHEN DEALING
                WITH WATER IN A CLOUD)
  F = "FALSE"

[N]  (NUCLEI)
  A = "NON-HYGROSCOPIC NUCLEI PRESENT"
* B = "HYGROSCOPIC NUCLEI PRESENT"
  C = "NO SURFACES OR NUCLEI PRESENT"
  D = "SURFACES PRESENT"

[G]  (GRADIENT OF CHANGE)
  A = "GRADUAL"
* B = "SUDDEN"

[C]  (CLOUD DEPTH)
* D = "DEEP"
  S = "SHALLOW"

[E]  (SUFFICIENT ELECTRICAL FIELD PRESENT)
* T = "TRUE"
  F = "FALSE"

[IC]  (ICE CRYSTALS PRESENT)
* T = "TRUE"
  F = "FALSE"(CAN BE MADE TRUE BY THE CLOUD
                                FREEZING PROCESS)

[SCWD]  (SUPER-COOLED WATER DROPLETS PRESENT)
  T = "TRUE"
* F = "FALSE"(IS MADE TRUE BY CONDENSATION
                      OCCURRING BELOW ZERO DEGREES)

[NWD]  (NORMAL WATER DROPLETS PRESENT)
  T = "TRUE"
* F = "FALSE"(IS MADE TRUE BY CONDENSATION
                    OCCURRING ABOVE ZERO DEGREES)

[FN]  (FREEZING NUCLEI PRESENT)
* T = "TRUE"
  F = "FALSE"
```

TABLE 2 (CONTINUED)

EXTERNAL STATE VECTOR

[T] (TURBULENCE EXISTS)
* T = "TRUE"
  F = "FALSE"

[P] (PROCESS TYPE)
* C = "CONTAINER"
  M = "METEOROLOGICAL"

[D] (DUALITY OF PROCESS POSSIBILITY)
  T = "TRUE"
* F = "FALSE"

[ATLA] (AIR TEMPERATURE AT LOWER ALTITUDES)
  H = "GREATER THAN 20 C"
  W = "GREATER THAN 0 C"
  C = "LESS THAN 0 C"
* X = "UNSPECIFIED"

PHYSICAL PARAMETER DEFAULT VALUES

AIR TEMPERATURE = 25 DEGREES CENTIGRADE
WATER TEMPERATURE = 25 DEGREES CENTIGRADE
BAROMETRIC PRESSURE = 760 MM OF MERCURY

question-answering, let us consider the following question:

Q: "What happens when the water temperature decreases?"
(For actual system response see page 20)

The cross product or global automaton is set to its initial state and the E (external) state is likewise set. The question is parsed, interpreted and a command is established to "twitch" the global automaton by forcing changes in the E state or by forcing a particular transition in one of the sub-automata. In this case that automaton representing temperature is forced from the stable state (B) to the decreasing state (C). Once an internal state (a state of one of the automata making up the global automaton) is altered, the relevant predicates (as determined by cross-reference) in the other automata are evaluated to see if their respective automaton can exercise a transition. This process is repeated recursively until no new transitions occur.

What develops is a tree reflecting all possible global state changes where any single transition of the global automaton reflects one and only one transition of a sub-automaton. If a condition is achieved in which more than one sub-automaton could exercise a transition, then from that global state a branch point develops (of the

above-mentioned tree) - one branch for each sub-automaton that could currently effect a transition. At each of these points, there is a problem of which branch to expand first and in fact whether to use a depth first or a breadth first expansion. As long as the various branches are independent (i.e; if no automaton transition requires conditions from both branches), there is no difference in the resulting trees. As soon as one of the transitions requires conditions from more than one branch, it can make a difference how the tree is expanded. To help with this problem, certain timing information is contained in particular transitions. This information is currently of the form "don't expand this node any further until all other nodes have been expanded". It is used to unfold the tree in a way dependent upon the processes involved and avoids the arbitrariness of a breadth or depth first approach.

The resulting tree acts as a "deep structure" for the generation of the explicative sentences or paragraphs which form the response to the query. The timing information is retained in the tree and provides natural break points in this response. At this stage only the crudest text generator is invoked, as can easily be seen by examining the sample output. Nevertheless one can see that enough information is present to permit reasonable text generation.

(The words surrounded by parentheses in these examples are lifted directly from the "text" column in the appropriate transition table.)

If the question had been a true-false type question such as "Does Relative Humidity decrease when the temperature drops?" this tree would be searched for a node (global state) that corresponds to a decrease of the Relative Humidity .omaton. However, a special situation arises when a sing.e non-terminal state is used to verify the correctness of the answer. For example, both of the following questions are answered "True" (in a contained environment):

1) Does the Relative Humidity increase with a drop in temperature?

2) Does the Relative Humidity decrease with a drop in temperature?

A'though our system answers "True" to both questions, this situation is not paradoxical since the contextual information (as generated by a global state transition) is altered between when question 1 gets an affirmative response and when question 2 gets an affirmative response. [For more examples of questions of this form, we refer the reader to Appendix 1.]

Handling "Why" type questions follows directly from the above consideration. In terms of the above example question, suppose we asked:

> "Why does the Rate of Condensation decrease when the water temperature decreases?"

To answer this question we need simply scan the above mentioned tree to find a node which reflects the appropriate transition of the Rate of Evaporation automaton and then construct a response from the chain arising from pursuing a path from the root of the tree to that node.

There is one obvious case where this strategy fails. Suppose the node being sought is adjacent to the root of the tree. In this case, no information is gained from the chain. When this happens, the semantic/conceptual network is accessed for explanatory information on that particular transition. This information may be a simple explanatory note or in special cases, another automaton. This automaton can be used to generate the explanatory note and may be investigated further by the student. For example, if the student wants to know why the Rate of Evaporation increases when the Water Temperature increases (see TABLE 1 for condition), an automaton model of thermo-dynamics and molecular interactions could be called upon to explain this transition. After explanation of the transition, the

molecular model is available if the student wishes to continue his investigation along these lines. In this way hierarchies of automaton models can be created for exploration by the student.

Because the generated tree is preserved until the next question is posed, the following type of dialog is always possible:

Q: Does x cause y to happen?
R: Yes.
Q: Why?
R: Because ...

In addition to these purely qualitative questions, quantitative queries can be likewise handled. Suppose, instead of asking the qualitative question:

Q: What happens when the Water Temperature drops?

We ask the question:

Q: (What happens when the Water Temperature drops to 22 degrees)

R: THE (AIR TEMPERATURE) (DECREASE) FROM 25 TO 22 DEGREES BECAUSE (WATER TEMPERATURE) (DECREASE). THE (HUMIDITY OF SATURATION) (DECREASE) FROM 24 TO 20 MM HG BECAUSE (AIR TEMPERATURE) (DECREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (RELATIVE HUMIDITY) (INCREASE) FROM 100 TO 120 % BECAUSE (HUMIDITY OF SATURATION) (DECREASE). THE (RATE OF EVAPORATION) (DECREASE) FROM 24 TO 20 MM HG BECAUSE (WATER TEMPERATURE) (DECREASE).

THEN THE (AIR CONDITION) (SUPERSATURATED) BECAUSE (RATE OF EVAPORATION) (DECREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (PROCESS) (NET CONDENSATION) BECAUSE (RATE OF EVAPORATION) (DECREASE) AND (NUCLEI) (HYGROSCOPIC NUCLEI ARE PRESENT). THE (ABSOLUTE HUMIDITY) (DECREASE) FROM 24 TO 20 MM HG BECAUSE (PROCESS) (NET CONDENSATION). THE (RELATIVE HUMIDITY) (DECREASE) FROM 120 TO 100 % BECAUSE (ABSOLUTE HUMIDITY) (DECREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (RATE OF CONDENSATION) (DECREASE) FROM 24 TO 20 MM HG BECAUSE (ABSOLUTE HUMIDITY) (DECREASE). THE (AIR CONDITION) (SATURATED) BECAUSE (RATE OF CONDENSATION) (DECREASE).

THEN THE (PROCESS) (EQUILIBRIUM) BECAUSE (RATE OF CONDENSATION) (DECREASE).

Again, the constructed response is open to further interrogation by the student. For example, he might ask how we arrived at the value for the Humidity of Saturation of 20 mm. Hg. For such a request we would access that column of the appropriate transition table and see what technique is used for that particular computation. If it is a table look-up, then the student can request the table to be printed. If it is a procedure, then the student could ask to have the formula displayed, to insert his own values into the procedure or have a graph drawn of the functional values produced by the procedure.

Appendices 1 and 2 contain numerous examples of actual output from our system. The latter appendix contains questions about the more complex processes of meteorology. Since these questions appear in isolation, we have

necessarily set the E state to reflect the appropriate context. Automatic techniques for setting the E vector will be discussed in the CAI section.

Of course, not all questions require the above kind of treatment. Some can be answered directly from the semantic/conceptual network. In fact, the semantic/conceptual network is always consulted first, and only when no responses can be found is the global automaton used. Limited inferences can be obtained directly from the semantic/conceptual network in conjunction with some procedures for processing it. For example, when asked:

Q: What happens to ice when it melts?

it is noted that:

a) Ice is an example of solid water
and b) To melt means by definition to transform solid water into liquid water.

By a simple inferencing procedure which interrelates the SUB relation "is an example of" with XFORM property list we obtain the response:

R: Liquid water.

A slightly more sophisticated example is:

Q: Is it true that fog is a form of precipitation?

Once parsed, a command is set up to access the semantic/conceptual network at the node representing "Precipitation" and a search is made on its value list attached to the property "EX" (examples of). When "Fog" is not encountered, the cross reference list for Fog is searched for a node which references Fog as a value to the property "EX". If such a cross reference exists, that node is processed accordingly. And in this case our system would respond:

R: No, Fog is an example of condensation.

If this cross reference search fails, then a search is made for any object which references it via an "is a kind of" or "is an example of" relation and so on.

Although only "shallow" (with respect to depth of inferencing) inferences are derived from the semantic/conceptual network, it does encode a great deal of information in a sufficiently systematic way that simple inferencing procedures can operate on the network to answer many of the questions that naturally arise in this environment. Again, we stress that our goals are not to build yet another "deep" (with respect to its logical

capabilities) question-answering system, but to explore a pragmatic system carefully tuned to the particular environment of a Mixed Initiative type CAI system. As we encode still more information in the network and expand the set of inferencing procedures that operate on it, we expect to discover better ways to structure this network. Seldom, to our knowledge, have there been attempts to encode "large" amounts of information in any kind of conceptual or semantic network structure, although recently there has been some movement in this direction.

V. A CAI SYSTEM

The prototype CAI system that we have implemented might be viewed more as a non-directed system rather than as a mixed-initiative system. As such, the student is presented with no required lesson plan and is quite free to "wander at will" through the data base, asking questions at random. Of course such behavior is not expected (and can cause certain problems in the correct setting of the E vector). What is more normal is the type of dialog contained in Appendix 3 which reflects a typical session with the system. In particular, the semantic/conceptual network contains a sequence of nodes representing text frames for each

"lesson". The student can request the presentation of any of these frames (currently, these frames are stored as ASCII strings and involve no sentence generation for their presentation). Associated with a frame can be non-displayed information that directly sets the E vector. In addition to selecting a lesson frame, a student can simply request to be told about something, such as:

0: Tell me something about condensation.

To handle such a request the system determines the conceptual node to access ("Condensation") and searches for the SCH ("Schema") property. The value of this property is a list which specifies the order in which properties are to be accessed in synthesizing responses to such queries. In addition, a pointer is advanced along this list so that when the same question is repeated, or a question is encountered such as:

0: Tell me something more about condensation

the student will always receive new information (until the knowledge base is exhausted).

The system was originally designed to accept as input a deep structure parse of the student's query produced by a transformational parser currently under development. A

key-word parser was developed so that experimentation with the question-answering system could proceed independent of the development of the transformational parser. All the examples discussed thus far, and all the output contained in the appendices of this report were parsed by this keyword system. Although successful parses were often obtained, it is, of course, trivial to "fool" this parser.

VI. CONCLUSIONS

We feel that we have just begun to realize the potential of representing process type information in these highly specialized automata-like structures. Of special interest is the use of these automata to help in synthesizing complex natural language responses to questions. In other words, we believe that these structures might provide a semantic representation of "casual" structures that is prerequisite to meaningful discourse generation. Also, this representation is obviously useful for the generation of sentences that involve the logical conjunction "because". We are especially excited by having two drastically divergent ways to represent knowledge (i.e., the semantic/conceptual network and the automata) where each modeling structure is especially well suited to handling

certain kinds of questions. We were surprised by the relative ease of adding new information to the system and by the amount of knowledge that we finally got encoded into it. With hindsight, we realize how fortuitous the decision was to implement the external and internal conditions for each automaton as LISP predicates instead of restricting ourselves to some Boolean calculus. With the flexibility afforded us by being able to write arbitrarily complex conditions on certain transitions, we could easily add to and modify the automata until they behaved as expected. Of course, the end set of conditions is not necessarily as parsimonious as might be hoped, but then we were not after a theory of meteorology but rather a pragmatic question-answering system that could successfully function in a CAI environment.

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APPENDIX I. CONTAINER QUESTIONS

Sample output from questions asked of the system while dealing with the processes of meterology in a closed environment. (Note the first three questions are quanitative while the last is purely qualitative.)

Q: (WHAT HAPPENS WHEN THE WATER TEMPERTURE DROPS TO 22 DEGREES)

THE (AIR TEMPERATURE) (DECREASE) FROM 25 TO 22 DEGREES BECAUSE (WATER TEMPERATURE) (DECREASE). THE (HUMIDITY OF SATURATION) (DECREASE) FROM 24 TO 20 MM HG BECAUSE (AIR TEMPERATURE) (DECREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (RELATIVE HUMIDITY) (INCREASE) FROM 100 TO 120 % BECAUSE (HUMIDITY OF SATURATION) (DECREASE). THE (RATE OF EVAPORATION) (DECREASE) FROM 24 TO 20 MM HG BECAUSE (WATER TEMPERATURE) (DECREASE).

THEN THE (AIR CONDITION) (SUPERSATURATED) BECAUSE (RATE OF EVAPORATION) (DECREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (PROCESS) (NET CONDENSATION) BECAUSE (RATE OF EVAPORATION) (DECREASE) AND (NUCLEI) (HYGROSCOPIC NUCLEI ARE PRESENT). THE (ABSOLUTE HUMIDITY) (DECREASE) FROM 24 TO 20 MM HG BECAUSE (PROCESS) (NET CONDENSATION). THE (RELATIVE HUMIDITY) (DECREASE) FROM 120 TO 100 % BECAUSE (ABSOLUTE HUMIDITY) (DECREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (RATE OF CONDENSATION) (DECREASE) FROM 24 TO 20 MM HG BECAUSE (ABSOLUTE HUMIDITY) (DECREASE). THE (AIR CONDITION) (SATURATED) BECAUSE (RATE OF CONDENSATION) (DECREASE).

THEN THE (PROCESS) (EQUILIBRIUM) BECAUSE (RATE OF CONDENSATION) (DECREASE).

Q: (WHAT HAPPENS IF THE AIR TEMPERTURE DECREASES TO 20 DEGREES AND THERE ARE NO CONDENSATION NUCLEI)

THE (HUMIDITY OF SATURATION) (DECREASE) FROM 24 TO 17 MM HG BECAUSE (AIR TEMPERATURE) (DECREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (RELATIVE HUMIDITY) (INCREASE) FROM 100 TO 180 ≤ BECAUSE (HUMIDITY OF SATURATION) (DECREASE). THE (WATER TEMPERATURE) (DECREASE) FROM 25 TO 20 DEGREES BECAUSE (AIR TEMPERATURE) (DECREASE). THE (RATE OF EVAPORATION) (DECREASE) FROM 24 TO 17 MM HG BECAUSE (WATER

TEMPERATURE) (DECREASE).

THEN THE (AIR CONDITION) (SUPERSATURATED) BECAUSE (RATE OF EVAPORATION) (DECREASE) AND (GRADIENT OF CHANGE) (SUDDEN).

Q: (WHAT HAPPENS WHEN THE TEMPERTURE INCREASES TO 30)

THE (HUMIDITY OF SATURATION) (INCREASE) FROM 24 TO 32 MM HG BECAUSE (AIR TEMPERATURE) (INCREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (RELATIVE HUMIDITY) (DECREASE) FROM 100 TO 75 % BECAUSE (HUMIDITY OF SATURATION) (INCREASE). THE (WATER TEMPERATURE) (INCREASE) FROM 25 TO 30 DEGREES BECAUSE (AIR TEMPERATURE) (INCREASE). THE (RATE OF EVAPORATION) (INCREASE) FROM 24 TO 32 MM HG BECAUSE (WATER TEMPERATURE) (INCREASE).

THEN THE (AIR CONDITION) (UNSATURATED) BECAUSE (RATE OF EVAPORATION) (INCREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (PROCESS) (NET EVAPORATION) BECAUSE (RATE OF EVAPORATION) (INCREASE). THE (ABSOLUTE HUMIDITY) (INCREASE) FROM 24 TO 32 MM HG BECAUSE (PROCESS) (NET EVAPORATION) THE (RELATIVE HUMIDITY) (INCREASE) FROM 75 TO 100 % BECAUSE (ABSOLUTE HUMIDITY) (INCREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (RATE OF CONDENSATION) (INCREASE) FROM 24 TO 32 DEGREES BECAUSE (ABSOLUTE HUMIDITY) (INCREASE). THE (AIR CONDITION) (SATURATED) BECAUSE (RATE OF CONDENSATION) (INCREASE).

THEN THE (PROCESS) (EQUILIBRIUM) BECAUSE (RATE OF CONDENSATION) (INCREASE).

Q: (SUPPOSE THE PRESSURE DECREASES GRADUALLY).

THE (ABSOLUTE HUMIDITY) (DECREASE) BECAUSE (BAROMETRIC PRESSURE) (DECREASE). THE (RATE OF CONDENSATION) (DECREASE) BECAUSE (ABSOLUTE HUMIDITY) (DECREASE).

THEN THE (PROCESS) (NET EVAPORATION) BECAUSE (RATE OF CONDENSATION) (DECREASE). THE (ABSOLUTE HUMIDITY) (INCREASE) BECAUSE (PROCESS) (NET EVAPORATION). THE (RATE OF CONDENSATION) (INCREASE) BECAUSE (ABSOLUTE HUMIDITY) (INCREASE).

THEN THE (PROCESS) (EQUILIBRIUM) BECAUSE (RATE OF CONDENSATION) (INCREASE).

APPENDIX II. METEOROLOGY QUESTIONS

Sample output from the system while exploring the processes of meterology in nature.

Q: (WHAT HAPPENS IF THE AIR TEMPERATURE DROPS TO 22 DEGREES)

THE (WATER TEMPERATURE) (DECREASE) BECAUSE (AIR TEMPERATURE) (DECREASE). THE (RATE OF EVAPORATION) (DECREASE) BECAUSE (WATER TEMPERATURE) (DECREASE) THE (HUMIDITY OF SATURATION) (DECREASE) BECAUSE (AIR TEMPERATURE) (DECREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (RELATIVE HUMIDITY) (INCREASE) BECAUSE (HUMIDITY OF SATURATION) (DECREASE).

THEN THE (AIR CONDITION) (SUPERSATURATED) BECAUSE (RATE OF EVAPORATION) (DECREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (PROCESS) (NET CONDENSATION) BECAUSE (RATE OF EVAPORATION) (DECREASE) AND (NUCLEI) (HYGROSCOPIC NUCLEI ARE PRESENT). THE (NORMAL WATER DROPLETS PRESENT) BECAUSE (PROCESS) (NET CONDENSATION). THE (COALESCENCE PROCESS) (LARGE AND SMALL WATER DROPLETS FORM) BECAUSE (PROCESS) (NET CONDENSATION) AND (GRADIENT OF CHANGE) (SUDDEN). THE (COALESCENCE PROCESS) (LARGE AND SMALL WATER DROPLETS FALL AT DIFFERENT SPEEDS) BECAUSE (THE LARGER THE DROPLET, THE GREATER THE EFFECT OF GRAVITY RELATIVE TO THE EFFECT OF AERODYNAMIC DRAG). THE (COALESCENCE PROCESS) (COLLISIONS OCCUR BETWEEN LARGE AND SMALL WATER DROPLETS) BECAUSE (COALESCENCE PROCESS) (LARGE AND SMALL WATER DROPLETS FALL AT DIFFERENT SPEEDS). THE (COALESCENCE PROCESS) (COALESCENCE OCCURS) BECAUSE (SUFFICIENT ELECTRICAL FIELD PRESENT). THE (NUMBER OF SMALL PARTICLES) (DIMINISHES) BECAUSE (COALESCENCE PROCESS) (COALESCENCE OCCURS).

THEN THE (COALESCENCE PROCESS) (PRECIPITATING DROPLETS RESULT) BECAUSE (CLOUD DEPTH) (DEEP). THE (RAIN) BECAUSE (COALESCENCE PROCESS) (PRECIPITATING DROPLETS RESULT). THE (COALESCENCE PROCESS) (FRACTIONIZATION MAY OCCUR) BECAUSE (THE DROPLETS MAY GROW BEYOND 7 MM IN DIAMETER, AT WHICH POINT AERODYNAMIC DRAG MAY PULL THEM APART). THE (NUMBER OF SMALL PARTICLES) (INCREASES) BECAUSE (COALESCENCE PROCESS) (FRACTIONIZATION MAY OCCUR).

Q: (WHAT HAPPENS WHEN THE TEMPERATURE GRADUALLY DROPS TO -10 DEGREES IN A TURBULENT CLOUD)

THE (WATER TEMPERATURE) (DECREASE) BECAUSE (AIR TEMPERATURE) (DECREASE). THE (RATE OF EVAPORATION) (DECREASE) BECAUSE (WATER TEMPERATURE) (DECREASE).

THEN THE (PROCESS) (NET CONDENSATION) BECAUSE (RATE OF EVAPORATION) (DECREASE) AND (NUCLEI) (HYGROSCOPIC NUCLEI ARE PRESENT). THE (SUPER-COOLED WATER DROPLETS PRESENT) BECAUSE (PROCESS) (NET CONDENSATION). THE (HAIL FORMATION PROCESS BEGINS) BECAUSE (SUPER-COOLED WATER DROPLETS PRESENT), (TURBULENCE EXIST) AND (SMALL ICE CRYSTALS PRESENT). THE (COLLISIONS OCCUR) BECAUSE (THE ICE PARTICLES AND WATER DROPLETS ARE MOVING THROUGH THE CLOUD AT VARIOUS VELOCITIES). THE (SUPER-COOLED WATER DROPLETS FREEZE ONTO THE ICE CRYSTALS WHEN THEY COLLIDE WITH THEM) BECAUSE (SUPER-COOLED WATER WILL FREEZE IMMEDIATELY WHEN IT COMES IN CONTACT WITH SOMETHING FOR IT TO FREEZE AROUND). THE (NUMBER OF SUPER-COOLED WATER DROPLETS) (DIMINISHES) BECAUSE (SUPER-COOLED WATER DROPLETS FREEZE ONTO THE ICE CRYSTALS WHEN THEY COLLIDE WITH THEM). THE (PRECIPITATING HAILSTONES RESULT) BECAUSE (TURBULENCE EXIST) AND (CLOUD DEPTH) (DEEP) AND (THESE TWO FACTORS INSURE THAT THE ICE PARTICLES WILL REMAIN IN THE VININITY OF THE SUPER-COOLED WATER DROPLETS LONG ENOUGH TO BECOME RESPECTABLY SIZED HAILSTONES). THE (HAIL) BECAUSE (PRECIPITATING HAILSTONES RESULT).

Q: (WHAT HAPPENS IF THE TEMPERATURE DROPS TO -10 DEGREES SUDDENLY)

THE (HUMIDITY OF SATURATION) (DECREASE) BECAUSE (AIR TEMPERATURE) (DECREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (RELATIVE HUMIDITY) (INCREASE) BECAUSE (HUMIDITY OF SATURATION) (DECREASE). THE (WATER TEMPERATURE) (DECREASE) BECAUSE (AIR TEMPERATURE) (DECREASE). THE (RATE OF EVAPORATION) (DECREASE) BECAUSE (WATER TEMPERATURE) (DECREASE).

THEN THE (AIR CONDITION) (SUPERSATURATED) BECAUSE (RATE OF EVAPORATION) (DECREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (PROCESS) (NET CONDENSATION) BECAUSE (RATE OF EVAPORATION) (DECREASE) AND (NUCLEI) (HYGROSCOPIC NUCLEI ARE PRESENT). THE (SUPER-COOLED WATER DROPLETS PRESENT) BECAUSE (PROCESS) (NET CONDENSATION). THE (ICE CRYSTAL PROCESS BEGINS) BECAUSE (SUPER-COOLED WATER DROPLETS PRESENT) AND (SMALL ICE CRYSTALS PRESENT). THE (AVERAGE RATE OF CONDENSATION) IS 3.3 MM HG. THE (RATE OF EVAPORATION FROM WATER DROPLETS) IS 4.6 MM HG BECAUSE (THEY ARE IN A LESS STABLE STATE THAN THEIR ACTUAL TEMPERATURE WOULD SEEM TO INDICATE). THE (RATE OF EVAPORATION FROM ICE CRYSTALS) IS 2.1 MM HG THE (ICE PARTICLES GROW AT THE EXPENSE OF THE SUPER-COOLED WATER DROPLETS). THE (PRECIPITATING ICE CRYSTALS RESULT).

APPENDIX III. SAMPLE DIALOG

(This output sample has been run through a typographic/justifying program in order to make it easier to read. the character strings in this appendix are identical to those generated directly by the Q-A system except that extra spaces have been added in order to achieve justification.)

Q: BEGIN LESSON ONE

(IN ORDER TO UNDERSTAND PRECIPITATION, WE MUST FIRST UNDERSTAND ABOUT WATER VAPOR. A SMALL FRACTION (ABOU^ 4 ≤) OF THE ATMOSPHERE IS WATER VAPOR. UNDER NORMAL CONDITIONS, TINY INCREASES IN THIS SMALL PERCENTAGE CAN RESULT IN PRECIPITATION. WATER MOLECULES CAN ASSUME THREE DIFFERENT PHYSICAL STATES: GASEOUS, LIQUID AND SOLID. WATER VAPOR IS WATER WHICH IS IN THE GASEOUS STATE. WHEN WATER IS IN THE SOLID STATE, WE CALL IT ICE . WATER AS WE USUALLY THINK OF IT IS SIMPLY WATER IN THE LIQUID STATE. ALL FORMS OF PRECIPITATION ARE PRIMARILY COMPOSED OF WATER. IN THE COURSE OF THIS LESSON WE WILL DISCUSS HOW WATER VAPOR IN THE ATMOSPHERE IS TRANSFORMED INTO LIQUID OR SOLID STATES AND FALLS TO THE EARTH).

Q: WHAT IS PRECIPITATION

PRECIPITATION IS (WATER IN LIQUID OR SOLID STATE WHICH FALLS FROM THE SKY).

Q: WHAT ARE SOME EXAMPLES OF PRECIPITATION

RAIN, SLEET, HAIL AND SNOW

Q: IS FOG A FORM OF PRECIPITATION

NO

Q: WHAT IS FOG

FOG IS (CLOUDS WHICH ARE FOUND AT VERY LOW ALTITUDES; USUALLY AT LESS THAN A FEW HUNDRED FEET ABOVE GROUND LEVEL).

Q: TELL ME ABOUT WATER VAPOR

WATER VAPOR IS (WATER WHICH IS IN THE GASEOUS OR VAPOR STATE).

Q: BEGIN LESSON TWO

(EVAPORATION IS THE PROCESS BY WHICH LIQUID WATER IS TRANSFORMED INTO WATER VAPOR. IN DAY-TO-DAY LIFE WE SEE MANY EXAMPLES OF EVAPORATION. FOLLOWING A RAIN, FOR INSTANCE, THE PUDDLES ON THE SIDEWALKS SLOWLY VANISH. THIS IS BECAUSE THE LIQUID WATER IN THE PUDDLES EVAPORATES: IT CHANGES INTO WATER VAPOR WHICH DISSOLVES IN THE AIR. CONDENSATION IS THE OPPOSITE PROCESS OF EVAPORATION. CONDENSATION MEANS THAT WATER VAPOR IS TRANSFORMED INTO LIQUID WATER. IF YOU HAVE EVER POURED YOURSELF AN ICE-COLD DRINK ON A WARM DAY, YOU MAY HAVE NOTICED HOW THE OUTSIDE OF THE GLASS BECOMES COATED WITH A THIN FILM OF TINY WATER DROPLETS. THIS IS BECAUSE WATER VAPOR IN THE AIR CONDENSES ON THE COLD SURFACES OF THE GLASS: IT BECOMES THE TINY WATER DROPLETS THAT YOU SEE. EVAPORATION AND CONDENSATION ARE WHAT WE CALL OPPOSING PROCESSES. WHEREVER THERE IS LIQUID WATER, EVAPORATION OCCURS. WHEREVER THERE IS WATER VAPOR, CONDENSATION OCCURS. WHEREVER THERE IS BOTH LIQUID WATER AND WATER VAPOR, THE TWO PROCESSES OCCUR AT THE SAME TIME).

Q: TELL ME ABOUT EVAPORATION

(IF WE TOOK A VERY CLOSE LOOK AT A PUDDLE OF WATER, WE WOULD SEE A COLLECTION OF WATER MOLECULES MOVING IN ALL DIFFERENT DIRECTIONS AT FAIRLY SLOW SPEEDS. NO WATER MOLECULE STAYS IN ONE PLACE FOR VERY LONG, BUT THE AGGREGATE MASS OF WATER MOLECULES WOULD TEND TO STAY CLUMPED FAIRLY TIGHTLY TOGETHER. REMEMBER THAT THE WATER MOLECULES IN THE PUDDLE ARE CONSTANTLY BUMPING INTO EACH OTHER AND ARE THEREFORE CONSTANTLY CHANGING SPEED AND DIRECTION OF MOTION. ALTHOUGH THE AVERAGE SPEED OF THE WATER MOLECULES IS FAIRLY SLOW, SOME OF THEM ARE MOVING FASTER, AND SOME SLOWER, THAN AVERAGE. IF A WATER MOLECULE NEAR THE SURFACE OF THE PUDDLE WAS BUMPED BY OTHER MOLECULES SO THAT IT GAINED THE CORRECT SPEED AND DIRECTION OF MOTION, IT COULD MOVE RIGHT UP THROUGH THE SURFACE OF THE PUDDLE AND BECOME A VAPOR

MOLECULE. THIS IS HOW EVAPORATION OCCURS).

Q: TELL ME MORE ABOUT EVAPORATION

(PUDDLES DRYING UP) AND (FOG BURNING OFF) ARE EXAMPLES OF EVAPORATION

Q: WHAT CAUSES EVAPORATION

(PROCESS) (NET EVAPORATION)MAY BE CAUSED BY (RATE OF EVAPORATION) (INCREASE) OR (RATE OF CONDENSATION) (DECREASE).

Q: TELL ME SOMETHING ABOUT CONDENSATION

(SUPPOSE WE HAVE SOME WATER VAPOR AND SOME LIQUID WATER IN A CONTAINER. ALL THE WATER MOLECULES WHICH MAKE UP THE VAPOR ARE MOVING VERY FAST AND IN ALL DIFFERENT DIRECTIONS. ALSO, THESE VAPOR MOLECULES ARE CONSTANTLY BUMPING INTO EACH OTHER AND INTO THE WALLS OF THE CONTAINER. WHEN THEY BUMP INTO SOMETHING, THEY BOUNCE - RATHER LIKE BILLIARD BALLS. LIKE BILLIARD BUMPING INTO EACH OTHER, TOO, THEY ARE CONSTANTLY CHANGING THEIR DIRECTIONS AND SPEEDS OF TRAVEL. THE WATER MOLECULES IN THE LIQUID WATER MOVE MUCH MORE SLUGGISHLY, AND TEND TO STAY PRETTY MUCH CLUMPED TOGETHER - RATHER LIKE A MASS OF SWARMING BEES. NO SINGLE BEE IN THE SWARM STAYS IN ONE PLACE FOR LONG, BUT THE MASS OF THE SWARM SORT OF STICKS TOGETHER AND SEEMS TO HAVE A FAIRLY CONSTANT VOLUME. THAT'S HOW IT IS WITH THE WATER MOLECULES IN THE LIQUID. SUPPOSE NOW THAT ONE OF THE WATER MOLECULES IN THE VAPOR JUST HAPPENS TO BE HEADED IN THE RIGHT DIRECTION SO THAT IT SMACKS INTO THE SWARM OF LIQUID WATER MOLECULES INSTEAD OF A FAST MOVING VAPOR MOLECULE OR ONE OF THE WALLS OF THE CONTAINER. THE MASS OF SLOW MOVING WATER MOLECULES SOAK UP ITS MOMENTUM AND DISTRIBUTE IT AMONG THEMSELVES. WHAT WAS ONCE A FAST MOVING VAPOR MOLECULE HAS NOW BECOME A SLOW MOVING LIQUID MOLECULE. A LITTLE BIT OF OUR WATER VAPOR HAS CONDENSED INTO LIQUID WATER).

Q: BEGIN LESSON THREE

(AS WE MENTIONED IN THE PREVIOUS LESSON, WHEREVER WATER VAPOR AND LIQUID WATER EXIST TOGETHER, THE PROCESSES OF EVAPORATION AND CONDENSATION OCCUR SIMULTANEOUSLY. WHAT

WILL ULTIMATELY HAPPEN IN SUCH A SITUATION DEPENDS UPON WHICH PROCESS IS OCCURING THE FASTEST. IF THE RATE OF EVAPORATION IS GREATER THAN THE RATE OF CONDENSATION (THAT IS, IF LIQUID WATER IS EVAPORATING FASTER THAN WATER VAPOR IS CONDENSING) THEN THE AMOUNT OF LIQUID WATER WILL DECREASE AND THE AMOUNT OF WATER VAPOR WILL INCREASE. IF THE RATE OF CONDENSATION IS GREATER THAN THE RATE OF EVAPORATION THEN THE AMOUNT OF LIQUID WATER WILL INCREASE AND THE AMOUNT OF WATER VAPOR WILL DECREASE. IN ANY CASE, OF COURSE, THE AMOUNT OF WATER (VAPOR AND LIQUID) WHICH WE HAVE ON HAND WILL REMAIN THE SAME. IF THE RATE OF CONDENSATION IS JUST EQUAL TO THE RATE OF EVAPORATION, THEN WE SAY THAT THE TWO PROCESSES ARE IN A STATE OF EQUILIBRIUM. SINCE WATER IS CONDENSING OUT OF THE VAPOR STATE AS FAST AS IT IS EVAPORATING INTO IT, THE AIR IS NOW HOLDING AS MUCH WATER VAPOR AS IT IS GOING TO UNDER THE PREVAILING CONDITIONS OF TEMPERATURE AND PRESSURE. WE THEREFOR SAY THAT THE AIR IS SATURATED).

Q: WHAT AFFECTS THE RATE OF EVAPORATION

(WATER TEMPERATURE) AND (NUCLEI).

Q: WHAT CAUSES AN INCREASE IN THE RATE OF CONDENSATION

(RATE OF CONDENSATION) (INCREASE)MAY BE CAUSED BY (ABSOLUTE HUMIDITY) (INCREASE).

Q: WHAT HAPPENS IF THE TEMPERATURE INCREASES

THE (HUMIDITY OF SATURATION) (INCREASE) BECAUSE (AIR TEMPERATURE) (INCREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (RELATIVE HUMIDITY) (DECREASE) BECAUSE (HUMIDITY OF SATURATION) (INCREASE). THE (WATER TEMPERATURE) (INCREASE) BECAUSE (AIR TEMPERATURE) (INCREASE). THE (RATE OF EVAPORATION) (INCREASE) BECAUSE (WATER TEMPERATURE) (INCREASE).

THEN THE (AIR CONDITION) (UNSATURATED) BECAUSE (RATE OF EVAPORATION) (INCREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (PROCESS) (NET EVAPORATION) BECAUSE (RATE OF EVAPORATION) (INCREASE). THE (ABSOLUTE HUMIDITY) (INCREASE) BECAUSE (PROCESS) (NET EVAPORATION). THE (RELATIVE HUMIDITY) (INCREASE) BECAUSE (ABSOLUTE HUMIDITY) (INCREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (RATE OF

CONDENSATION) (INCREASE) BECAUSE (ABSOLUTE HUMIDITY) (INCREASE). THE (AIR CONDITION) (SATURATED) BECAUSE (RATE OF CONDENSATION) (INCREASE).

THEN THE (PROCESS) (EQUILIBRIUM) BECAUSE (RATE OF CONDENSATION) (INCREASE).

Q: WHAT HAPPENS IF THE TEMPERATURE INCREASES GRADUALLY

THE (WATER TEMPERATURE) (INCREASE) BECAUSE (AIR TEMPERATURE) (INCREASE). THE (RATE OF EVAPORATION) (INCREASE) BECAUSE (WATER TEMPERATURE) (INCREASE).

THEN THE (PROCESS) (NET EVAPORATION) BECAUSE (RATE OF EVAPORATION) (INCREASE). THE (ABSOLUTE HUMIDITY) (INCREASE) BECAUSE (PROCESS) (NET EVAPORATION). THE (RATE OF CONDENSATION) (INCREASE) BECAUSE (ABSOLUTE HUMIDITY) (INCREASE).

THEN THE (PROCESS) (EQUILIBRIUM) BECAUSE (RATE OF CONDENSATION) (INCREASE).

Q: BEGIN LESSON FOUR

(BEFORE PROCEEDING INTO A DETAILED STUDY OF THE PHYSICS OF METEOROLOGY, WE WILL HAVE TO DEVOTE SOME ATTENTION TO MEASURING OR QUANTIFYING THE CONCEPTS INTRODUCED IN THE PREVIOUS LESSONS. TO BEGIN WITH, WE WILL DEFINE THE TERM ABSOLUTE HUMIDITY TO MEAN THE AMOUNT OF WATER VAPOR IN THE AIR. SINCE WATER VAPOR IS A GAS, ABSOLUTE HUMIDITY IS MEASURED AS A PRESSURE. ANY UNITS OF PRESSURE ARE SATISFACTORY (ATMOSPHERES, MILLIBARS, INCHES OF MERCURY) BUT, SINCE WE ARE ADVOCATES OF THE METRIC SYSTEM, WE WILL MEASURE PRESSURE THROUGHOUT THIS DISCUSSION IN MILLIMETRES OF MERCURY (ABBREVIATED MM.-HG.) WHEN WE SAY THAT THE AIR IS UNSATURATED (OR NOT SATURATED) WITH WATER VAPOR, WE MEAN THAT THE RATE OF EVAPORATION OF LIQUID WATER INTO THE AIR IS GREATER THAN THE RATE OF CONDENSATION OF WATER VAPOR OUT OF THE AIR. WHEN WE SAY THAT THE AIR IS SUPER-SATURATED WITH WATER VAPOR, WE MEAN THAT THE ABSOLUTE HUMIDITY OR RATE OF CONDENSATION IS GREATER THAN THE RATE OF EVAPORATION. WHEN THESE TWO RATES ARE JUST EQUAL, WE SAY THAT THE AIR IS SATURATED WITH WATER VAPOR. HUMIDITY OF SATURATION WE WILL DEFINE AS THE ABSOLUTE HUMIDITY AT WHICH THE RATE OF CONDENSATION SHOULD EQUAL THE RATE OF EVAPORATION. SINCE THE RATE OF EVAPORATION VARIES AS A FUNCTION OF THE

TEMPERATURE, THE HUMIDITY OF SATURATION DOES ALSO. THE TERM RELATIVE HUMIDITY IS SIMPLY DEFINED AS THE ABSOLUTE HUMIDITY DIVIDED BY THE HUMIDITY OF SATURATION, THE ANSWER BEING EXPRESSED AS A PERCENTAGE BY MULTIPLYING THE QUOTIENT BY ONE HUNDRED. AS WE CAN EASILY SEE FROM ITS DEFINITION, THE RELATIVE HUMIDITY SHOULD IDEALLY BE EQUAL TO 100 ≤ WHENEVER THE AIR IS SATURATED. LATER ON, HOWEVER, WE WILL DEAL WITH CASES IN WHICH THE AIR BECOMES SATURATED AT RELATIVE HUMIDITIES LESS THAN 100 ≤).

Q: WHAT THINGS CAN CAUSE AN INCREASE IN THE RELATIVE HUMIDITY

(RELATIVE HUMIDITY) (INCREASE)MAY BE CAUSED BY (HUMIDITY OF SATURATION) (DECREASE) OR (ABSOLUTE HUMIDITY) (INCREASE) AND (GRADIENT OF CHANGE) (SUDDEN).

Q: WHAT AFFECTS THE RATE OF CONDENSATION

(ABSOLUTE HUMIDITY).

Q: BEGIN LESSON FIVE

(SUPPOSE WE PLACE A SMALL AMOUNT OF WATER ALONG WITH A QUANTITY OF PERFECTLY DRY AIR INTO A LARGE CONTAINER WHICH WE SEAL AND KEEP AT A CONSTANT TEMPERATURE. THE WATER LEVEL INSIDE THE CONTAINER WILL DROP AS THE WATER BEGINS TO EVAPORATE AND, AS MORE AND MORE OF THE WATER TURNS INTO WATER VAPOR, THE ABSOLUTE HUMIDITY WILL INCREASE. SINCE THE RATE OF EVAPORATION IN THIS INSTANCE DEPENDS SOLELY ON THE TEMPERATURE OF THE WATER, WHICH IS BEING KEPT CONSTANT, THE RATE OF EVAPORATION WILL ALWAYS REMAIN AT ITS INITIAL VALUE. THE RATE OF CONDENSATION, HOWEVER, WILL INCREASE AS THE ABSOLUTE HUMIDITY INCREASES: THE MORE WATER MOLECULES THERE ARE IN THE AIR, THE MORE OF THEM THERE WILL BE BUMPING INTO THE SURFACE OF THE WATER (THAT IS, CONDENSING). AFTER A PERIOD OF TIME, THE RATE OF CONDENSATION WILL INCREASE UNTIL IT EXACTLY EQUALS THE RATE OF EVAPORATION AND THE WATER LEVEL INSIDE THE CONTAINER WILL CEASE TO FALL. AT THIS POINT, THE AIR INSIDE THE CONTAINER WILL BE SATURATED AND THE RELATIVE HUMIDITY INSIDE THE CONTAINER WILL BE EXACTLY 100 ≤. SINCE THE WATER LEVEL HAS STOPPED FALLING, WE WOULD NATURALLY SAY THAT THE WATER HAS STOPPED EVAPORATING. FROM A MORE PRECISE POINT OF VIEW, HOWEVER, THE WATER IS STILL EVAPORATING; IT IS SIMPLY THAT WATER VAPOR IS NOW CONDENSING

BACK INTO LIQUID WATER JUST AS QUICKLY, AND, THEREFORE, THE TOTAL AMOUNT OF LIQUID WATER REMAINS THE SAME. IN ORDER TO AVOID AMBIGUITY, WE WILL CALL THE TYPE OF EVAPORATION WHICH MEANS A LOWERING OF THE WATER LEVEL : NET EVAPORATION. SIMILARLY, WHEN THE AMOUNT OF LIQUID WATER INCREASES BECAUSE THE RATE OF CONDENSATION IS GREATER THAN THE RATE OF EVAPORATION, WE WILL SAY THAT A PROCESS OF NET CONDENSATION IS OCCURRING).

Q: TELL ME MORE ABOUT CONDENSATION

(CLOUDS FORMING), (DEW FORMING ON THE GRASS) AND (WINDOWS FOGGING UP) ARE EXAMPLES OF CONDENSATION

Q: WHAT ARE CONDENSATION NUCLEI

CONDENSATION NUCLEI ARE (PARTICLES SO SMALL THAT THEY CAN EASILY BECOME SUSPENDED IN THE AIR. THEY PROVIDE A PLACE OR SURFACE UPON WHICH THE PROCESS OF CONDENSATION CAN BEGIN. THE MOST COMMON TYPE OF CONDENSATION NUCLEI ARE DUST PARTICLES).

Q: TELL ME ABOUT HYGROSCOPIC NUCLEI

HYGROSCOPIC NUCLEI ARE SMALL PARTICLES (USUALLY ONLY A FEW MICRONS IN DIAMETER) WHICH CAN BECOME AIRBORN AND WHICH ATTRACT WATER VAPOR. THE MOST USUAL TYPE OF HYGROSCOPIC NUCLEI ARE SMALL SALT PARTICLES BLOWN UP FROM THE OCEANS.

Q: WHAT HAPPENS IF THE TEMPERATURE DECREASES SUDDENLY AND NO SURFACES OR NUCLEI ARE AVAILABLE

THE (HUMIDITY OF SATURATION) (DECREASE) BECAUSE (AIR TEMPERATURE) (DECREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (RELATIVE HUMIDITY) (INCREASE) BECAUSE (HUMIDITY OF SATURATION) (DECREASE). THE (WATER TEMPERATURE) (DECREASE) BECAUSE (AIR TEMPERATURE) (DECREASE). THE (RATE OF EVAPORATION) (DECREASE) BECAUSE (WATER TEMPERATURE) (DECREASE).

THEN THE (AIR CONDITION) (SUBERSATURATED) BECAUSE (RATE OF EVAPORATION) (DECREASE) AND (GRADIENT OF CHANGE) (SUDDEN).

Q: WHAT HAPPENS IF THE WATER TEMPERATURE INCREASES

THE (AIR TEMPERATURE) (INCREASE) BECAUSE (WATER TEMPERATURE) (INCREASE). THE (HUMIDITY OF SATURATION) (INCREASE) BECAUSE (AIR TEMPERATURE) (INCREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (RELATIVE HUMIDITY) (DECREASE) BECAUSE (HUMIDITY OF SATURATION) (INCREASE). THE (RATE OF EVAPORATION) (INCREASE) BECAUSE (WATER TEMPERATURE) (INCREASE).

THEN THE (AIR CONDITION) (UNSATURATED) BECAUSE (RATE OF EVAPORATION) (INCREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (PROCESS) (NET EVAPORATION) BECAUSE (RATE OF EVAPORATION) (INCREASE). THE (ABSOLUTE HUMIDITY) (INCREASE) BECAUSE (PROCESS) (NET EVAPORATION). THE (RELATIVE HUMIDITY) (INCREASE) BECAUSE (ABSOLUTE HUMIDITY) (INCREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (RATE OF CONDENSATION) (INCREASE) BECAUSE (ABSOLUTE HUMIDITY) (INCREASE). THE (AIR CONDITION) (SATURATED) BECAUSE (RATE OF CONDENSATION) (INCREASE).

THEN THE (PROCESS) (EQUILIBRIUM) BECAUSE (RATE OF CONDENSATION) (INCREASE).

Q: BEGIN LESSON SIX

(ALTHOUGH METEOROLOGISTS HAVE CLASSIFIED MANY DIFFERENT TYPES OF CLOUDS AND ASSIGNED NAMES TO EACH, ALL CLOUDS CONSIST MAINLY OF ONE OR MORE OF THREE TYPES OF WATER PARTICLES. MOST CLOUDS ARE COMPOSED OF NORMAL WATER DROPLETS WHICH ARE TINY ENOUGH TO REMAIN SUSPENDED IN THE AIR. THESE DROPLETS FORM WHEN NET CONDENSATION OCCURS ON TINY DUST OR SALT PARTICLES WHICH ARE CALLED CONDENSATION NUCLEI. CLOUD DROPLETS WHICH FORM THIS WAY ARE PRACTICALLY FREE OF IMPURITIES. ALTHOUGH WATER ORDINARLIY FREEZES WHEN THE TEMPERATURE DROPS BELOW ZERO DEGREES CENTIGRADE, VERY PURE WATER (SUCH AS IS FOUND IN CLOUD DROPLETS) CAN REMAIN IN THE LIQUID STATE UNTIL THE TEMPERATURE DROPS TO ALMOST FORTY DEGREES BELOW ZERO. LIQUID WATER FOUND AT TEMPERATURES BELOW ZERO CENTIGRADE IS SAID TO BE SUPERCOOLED. SUPERCOOLED WATER DROPLETS (THE SECOND OF OUR THREE TYPES OF CLOUD WATER PARTICLES) WILL REMAIN LIQUID UNTIL THE TEMPERATURE DROPS BELOW THE CRITICAL LEVEL OR UNTIL THEY ENCOUNTER FREEZING NUCLEI. ALL FREEZING NUCLEI HAVE CRYSTALLINE STRUCTURES. THESE TINY CRYSTALS PROVIDE A SEED FOR THE LIQUID WATER TO CRYSTALLIZE (FREEZE) AROUND. THE MOST EFFICIENT NATURALLY OCCURRING FREEZING NUCLEI ARE

VERY MINUTE ICE CRYSTALS. THE CLOUD DROPLETS THAT FREEZE IN THIS WAY BECOME THE TINY ICE CRYSTALS WHICH ARE, OF COURSE, OUR THIRD TYPE OF CLOUD PARTICLE).

Q: TELL ME MORE ABOUT CLOUDS

(CLOUDS ARE MASSES OF TINY WATER DROPLETS OR ICE CRYSTALS WHICH HANG SUSPENDED IN THE AIR. GENERALLY A CLOUD WILL CONTAIN ONE HUNDRED MILLION OR SO PARTICLES EACH OF WHICH IS BETWEEN ABOUT TWO AND TWO HUNDRED MICRONS IN DIAMETER).

Q: WHAT ARE SOME TYPES OF CLOUDS

CUMULUS, CIRRUS, NIMBUS, AND CUMULO-NIMBUS

Q: WHAT ARE SOME EXAMPLES OF FREEZING NUCLEI

SALT, ICE CRYSTALS AND SILVER IODIDE

Q: BEGIN LESSON SEVEN

(CLOUD PARTICLES ARE TINY ENOUGH TO REMAIN SUSPENDED IN THE ATMOSPHERE. WHEN CLOUD PARTICLES BECOME TOO LARGE TO REMAIN IN SUSPENSION, THEY BECOME PRECIPITATION AND FALL TO THE EARTH. THERE ARE TWO KNOWN PROCESSES BY WHICH PRECIPITATING PARTICLES OTHER THAN HAIL MAY BE GROWN INSIDE OF CLOUDS. THE FIRST OF THESE IS CALLED THE COALESCENCE PROCESS. THIS PROCESS OCCURS IN CLOUDS COMPOSED OF WATER DROPLETS OF VARYING SIZES. THE LARGER DROPLETS FALL TO THE BOTTOM OF THE CLOUD MORE QUICKLY THAN THE SMALLER ONES AND COLLIDE AND MERGE WITH THEM. IF THE CLOUD IS DEEP ENOUGH, DROPLETS CAN GROW IN THIS MANNER TO BECOME QUITE SUBSTANTIAL RAINDROPS. THE SECOND PROCESS IS CALLED THE ICE CRYSTAL PROCESS. THIS PROCESS OCCURS IN CLOUDS COMPOSED OF SUPERCOOLED WATER DROPLETS AND SMALL ICE CRYSTALS. SINCE SUPERCOOLED WATER EVAPORATES MORE QUICKLY THAN DO THE ICE CRYSTALS, THE ICE CRYSTALS GROW WHILE THE DROPLETS SHRINK. IN THIS MANNER, PRECIPITATING ICE CRYSTALS (SNOW) ARE FORMED IN CLOUDS. IF THERE IS A STRONG UPDRAFT OR TURBULENCE INSIDE THE CLOUD, THESE LARGER ICE CRYSTALS MAY REMAIN NEAR THE SUPERCOOLED WATER DROPLETS LONGER THAN THEY OTHERWISE WOULD. WHEN COLLISIONS OCCUR BETWEEN THESE ICE CRYSTALS AND THE WATER DROPLETS, THE SUPERCOOLED LIQUID WATER FREEZES ONTO THE CRYSTALS ALMOST INSTANTANEOUSLY. THE ICE PARTICLES BECOME

LARGER AND LARGER. IF THE PROCESS CONTINUES FOR LONG ENOUGH, THEY CAN BECOME LARGE HAILSTONES WHICH WILL EVENTUALLY FALL OUT OF THE CLOUD).

Q: WHAT HAPPENS IF THE AIR TEMPERATURE DECREASES

THE (HUMIDITY OF SATURATION) (DECREASE) BECAUSE (AIR TEMPERATURE) (DECREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (RELATIVE HUMIDITY) (INCREASE) BECAUSE (HUMIDITY OF SATURATION) (DECREASE). THE (WATER TEMPERATURE) (DECREASE) BECAUSE (AIR TEMPERATURE) (DECREASE). THE (RATE OF EVAPORATION) (DECREASE) BECAUSE (WATER TEMPERATURE) (DECREASE).

THEN THE (AIR CONDITION) (SUPERSATURATED) BECAUSE (RATE OF EVAPORATION) (DECREASE) AND (GRADIENT OF CHANGE) (SUDDEN). THE (PROCESS) (NET CONDENSATION) BECAUSE (RATE OF EVAPORATION) (DECREASE) AND (NUCLEI ARE PRESENT). THE (NORMAL WATER DROPLETS PRESENT) BECAUSE (PROCESS) (NET CONDENSATION). THE (COALESCENCE PROCESS) (LARGE AND SMALL WATER DROPLETS FORM) BECAUSE (PROCESS) (NET CONDENSATION) AND (GRADIENT OF CHANGE) (SUDDEN). THE (COALESCENCE PROCESS) (LARGE AND SMALL WATER DROPLETS FALL AT DIFFERENT SPEEDS) BECAUSE (THE LARGER THE DROPLET, THE GREATER THE EFFECT OF GRAVITY RELATIVE TO THE EFFECT OF AERODYNAMIC DRAG). THE (COALESCENCE PROCESS) (COLLISIONS OCCUR BETWEEN LARGE AND SMALL WATER DROPLETS) BECAUSE (COALESCENCE PROCESS) (LARGE AND SMALL WATER DROPLETS FALL AT DIFFERENT SPEEDS). THE (COALESCENCE PROCESS) (COALESCENCE OCCURS) BECAUSE (SUFFICIENT ELECTRICAL FIELD PRESENT). THE (NUMBER OF SMALL PARTICLES) (DIMINISHES) BECAUSE (COALESCENCE PROCESS) (COALESCENCE OCCURS).

THEN THE (COALESCENCE PROCESS) (PRECIPITATING DROPLETS RESULT) BECAUSE (CLOUD DEPTH) (DEEP). THE (RAIN) BECAUSE (COALESCENCE PROCESS) (PRECIPITATING DROPLETS RESULT). THE (COALESCENCE PROCESS) (FRACTIONIZATION MAY OCCUR) BECAUSE (THE DROPLETS MAY GROW BEYOND 7 MM IN DIAMETER, AT WHICH POINT AERODYNAMIC DRAG MAY PULL THEM APART). THE (NUMBER OF SMALL PARTICLES) (INCREASES) BECAUSE (COALESCENCE PROCESS) (FRACTIONIZATION MAY OCCUR). THE (COALESCENCE PROCESS) (COALESCENCE OCCURS). THE (NUMBER OF SMALL PARTICLES) (DIMINISHES) BECAUSE (COALESCENCE PROCESS) (COALESCENCE OCCURS).

THEN THE (COALESCENCE PROCESS) (PRECIPITATING DROPLETS RESULT) BECAUSE (CLOUD DEPTH) (DEEP). THE (RAIN) BECAUSE

(COALESCENCE PROCESS) (PRECIPITATING DROPLETS RESULT).

Q: ARE TYPHOON THUNDERSTORM AND DRIZZLE EXAMPLES OF STORM

THUNDERSTORM AND TYPHOON ARE BUT DRIZZLE IS NOT.

APPENDIX IV. METEOROLOGY MODEL

This is a description of the automaton model for meterological processes. The automatom is made up of a collection of sub-automata. The state of the global automaton is defined by the collection of the states of the sub-automata. The interaction between the sub-automata determine the transition of the global automaton.

These are the sub-automata currently incorporated in the system. Following the description of each automaton is a list of its states and the possible transitions which may occur between these states. The computation and default value are given for those sub-automata which have quanitative parts associated with them.

(Notational notes: Interpret square brackets ([]) to mean "state of"; thus, read [IA] as "the state of the Humidity of Saturation". Interpret opposed double angle brackets (<<>>) to mean "the value of"; thus read <<A.T.>> as "the value of the Air Temperature", meaning the numerical value of this variable rather than the state of the automaton which represents changes in this value. Terms or disjuncts of transition conditions which are flagged with an "*" are to be suppressed from output generated by the model in order to eliminate redundant or pedagogically irrelevant process requirements from reaching the student. Due to typographic limitations, take "#" to mean "not equal to", "V" to mean "inclusive or" and "/" to mean "logical 'and'".)

PHYSICAL PARAMETRIC AUTOMATA

Parametric automata are those which describe values of physical parameters, such as Air Temperature, Barometric Pressure, etc.

AIR TEMPERATURE - Ambient air temperature obtained at the site of the described processes.

[A.T.] (AIR TEMPERATURE)

```
  A = "DECREASES"
  B = "STABLE"
  C = "INCREASES"

  B=>A  (SPEC)* V (([W.T.]=A)/([S]=T))
  B=>C  (SPEC)* V (([W.T.]=C)/([S]=T))

COMPUTATIONAL NOTE:
UNITS = DEGREES CENTIGRADE (C)
DEFAULT VALUE = 25 C
```

WATER TEMPERATURE - Average temperature of masses of water participating in described processes. In the case of meteorological processes, the participating masses of water are assumed to be water droplets which are at essentially the same temperature as the air.

```
[W.T.]  (WATER TEMPERATURE)
  A = "DECREASES"
  B = "STABLE"
  C = "INCREASES"

  B=>A  (SPEC)* V (([A.T.]=A)/([S]=T))
  B=>C  (SPEC)* V (([A.T.]=A)/([S]=T))

COMPUTATIONAL NOTE:
UNITS = DEGREES CENTIGRADE
DEFAULT VALUE ([S]=T) = 25 C
              ([S]=F) = 18 C
```

BAROMETRIC PRESSURE - Average barometric pressure at the site of the described processes.

```
[B.P.]  (BAROMETRIC PRESSURE)
  A = "DECREASES"
  B = "STABLE"
  C = "INCREASES"

  B=>A  (SPEC)*
  B=>C  (SPEC)*

COMPUTATIONAL NOTE:
UNITS = MILLIMETRES OF MERCURY (MM HG)
DEFAULT VALUE = 760 MM HG
```

CENTRAL AUTOMATA

Central automata are those which are employed in the solution of container problems and in the preliminary considerations of the formation of airborn particles (clouds).

HUMIDITY OF SATURATION - The absolute humidity at which the rate of condensation should just equal the rate of evaporation, assuming the air temperature to be equal to the water temperature and the absence of hygroscopic nuclei or other mechanisms which would interfere with the rate of evaporation. This value is a dependent variable of the air temperature.

```
[IA]  (HUMIDITY OF SATURATION)
  A = "DECREASES"
  B = "STABLE"
  C = "INCREASES"

  B=>A  ([A.T.]=A)
  B=>C  ([A.T.]=C)
```

COMPUTATIONAL NOTE:

```
<<IA>> = TABLE(<<A.T.>>)
```

RATE OF EVAPORATION - The rate at which liquid water is being converted into water vapor, measured at the boundary between the liquid water and the air, expressed as a pressure. This quantity is essentially the same as the vapor pressure of water measured over the same boundary.

```
[IB]  (RATE OF EVAPORATION)
  A = "DECREASES"
  B = "STABLE"
  C = "INCREASES"

  B=>A  ([W.T.]=A) V ([N] X=>B (X#B))
  B=>C  ([W.T.]=C) V ([N] B=>X (X#B))
```

COMPUTATIONAL NOTE:

```
<<Q>>=1 IF ([N]=B)
<<Q>>=0 IF ([N]#B)
<<IB>> = TABLE(<<W.T.>>)-<<Q>>*1.5*TABLE(<<W.T.>>)
```

ABSOLUTE HUMIDITY - The partial pressure of water vapor in the atmosphere at the site of the described process.

```
[IIA]  (ABSOLUTE HUMIDITY)
  A = "DECREASES"
  B = "STABLE"
  C = "INCREASES"

  B=>A  ([B.P.]=A) V (([III]=C)/([P]=C)*)
  B=>C  ([B.P.]=C) V (([III]=A)/([P]=C)*)

COMPUTATIONAL NOTE:
<<IIA>> = <<IB>> IF [IIA] TRIGGERED BY [III]
<<IIA>>' = (<<B.P.>>'/<<B.P.>>)*<<IIA>>
                IF [IIA] TRIGGERED BY [B.P.]
                     (' MEANS NEW VALUE)
```

RATE OF CONDENSATION - The rate at which water vapor is returning to the liquid state measured as a pressure upon the air-water boundary. The value is essentially equal to the partial pressure of water vapor in the air.

```
[IIB]  (RATE OF CONDENSATION)
  A = "DECREASES"
  B = "STABLE"
  C = "INCREASES"

  B=>A  ([IIA]=A)
  B=>C  ([IIA]=C)

COMPUTATIONAL NOTE:
<<IIB>> = <<IIA>>
```

PROCESS - This graph describes the imbalance between the rates of evaporation and condensation as net evaporation, net condensation or equilibrium.

```
[III]  (PROCESS)
  A = "NET EVAPORATION"
  B = "EQUILIBRIUM"
  C = "NET CONDENSATION"

  B=>A  ([IB]=C) V ([IIB]=A)
  B=>C  ([IB]=A) V ([IIB]=C)
  A=>B  ([IIB]=C)
```

```
C=>B  ([IIB]=A)
```

RELATIVE HUMIDITY - The absolute humidity divided by the humidity of saturation, the quotient being expressed as a percentage.

```
[IV]  (RELATIVE HUMIDITY)
  A = "DECREASES"
  B = "STABLE"
  C = "INCREASES"

  B=>A  ([IA]=C) V ([IIA]=A)
  B=>C  ([IA]=A) V ([IIA]=C)
```

COMPUTATIONAL NOTE:
<<IV>> = (<<IIA>>/<<IA>>)*100

AIR BECOMES - This graph describes the air as being either saturated, unsaturated or super-saturated, depending on how the rates of condensation and evaporation compare.

```
[V]  (AIR BECOMES)
  A = "UNSATURATED"
  B = "SATURATED"
  C = "SUPER-SATURATED"

  B=>A  (([IB]=C) V ([IIB]=A))/([G]=B)
  B=>C  (([IB]=A) V ([IIB]=C))/([G]=B)
  A=>B  ([III]=A)*/([IIB]=C)
  C=>B  ([III]=C)*/([IIB]=A)
```

PROCESS CHAIN AUTOMATA

ICPROG - This graph describes the various conceptual stages of the ice crystal process. Various states in this process chain are individually devoted to examinations of the physical forces which drive the Ice Crystal Process and of certain requirements which must be satisfied in order for this process to occur.

```
[ICPROG]  (PROGRESS OF ICE CRYSTAL PROCESS)
  A = "PROCESS DOES NOT OCCUR"
```

```
  B = "THE ICE CRYSTAL PROCESS BEGINS"
  C = "AVERAGE RATE OF CONDENSATION = <<ARCD>>"
  D = "RATE OF EVAPORATION FROM WATER DROPLETS = <<REWD>>"
  E = "RATE OF EVAPORATION FROM ICE CRYSTALS = <<REIC>>"
  F = "ICE PARTICLES GROW AT THE EXPENSE OF THE SUPER-COOLED
       WATER DROPLETS"
  G = "PRECIPITATING ICE CRYSTALS RESULT"

  A=>B  ([SCWD]=T)/([IC]=T)
  B=>C    (FORCED)*
  C=>D  (FORCED)*:  "THEY ARE IN A LESS STABLE STATE THAN
                THEIR ACTUAL TEMPERATURE WOULD SEEM TO INDICATE."
  D=>E  (FORCED)*
  E=>F  ([SSC]=A)/([SIC]=C)
  F=>G  ([D]=F)*: "IF THE PROCESS CONTINUES FOR LONG ENOUGH,
        THE PARTICLES WILL GROW LARGE ENOUGH TO FALL FROM THE
        CLOUD."

COMPUTATIONAL NOTE:
<<REIC>> = TABLE(<<A,T,>>)
<<REWD>> = TABLE( 0 )
<<ARCD>> = (<<REIC>>+<<REWD>>)/2
```

HFPROG - This graph describes the various conceptual stages of the Hail Formation Process in the above manner.

```
[HFPROG]  (PROGRESS OF HAIL FORMATION PROCESS)
  A = "PROCESS DOES NOT OCCUR"
  B = "THE HAIL FORMATION PROCESS BEGINS"
  C = "COLLISIONS OCCUR"
  D = "SUPER-COOLED WATER DROPLETS FREEZE ONTO THE ICE
       CRYSTALS WHEN THEY COLLIDE WITH THEM"
  E = "PRECIPITATING HAILSTONES RESULT"

  A=>B  ([SCWD]=T)/([IC]=T)/([T]=T)*/([C]=D)
  B=>C  (FORCED)*:  "THE ICE PARTICLES AND WATER DROPLETS
            ARE MOVING THROUGH THE CLOUD AT RANDOM VELOCITIES."
  C=>D  (FORCED)*:  "SUPER-COOLED WATER WILL FREEZE
        IMMEDIATELY WHEN IT COMES IN CONTACT WITH SOMETHING
        FOR IT TO FREEZE AROUND."
  D=>E  ([T]=T)/([C]=D):  "THESE TWO FACTORS INSURE THAT
        THE ICE PARTICLES WILL REMAIN IN THE VICINITY OF THE
        SUPER-COOLED WATER DROPLETS LONG ENOUGH TO BECOME
        RESPECTABLY SIZED HAILSTONES."
```

FRPROG - This graph details the "cloud freezing" process

which occurs when clouds of super-cooled water droplets encounter freezing nuclei.

```
[FRPROG]  (PROGRESS OF THE CLOUD FREEZING PROCESS)
  A = "PROCESS DOES NOT OCCUR"
  B = "A CLOUD CAN BEGIN TO FREEZE"
  C = "COLLISIONS OCCUR"
  D = "WHEN DROPLETS COLLIDE WITH FREEZING NUCLEI, THEY
       BECOME SMALL ICE CRYSTALS"

  A=>B  ([SCWD]=T)/([FN]=T)/([IC]=F)*
  B=>C  (FORCED)*:  "ALL THE PARTICLES IN THE CLOUD ARE
                MOVING WITH RANDOM VELOCITIES."
  C=>D  (FORCED)*:  "THE CRYSTALLINE FREEZING NUCLEI CAN
               PROVIDE SOMETHING FOR THE SUPER-COOLED WATER TO
                  CRYSTALLIZE (FREEZE) AROUND."
```

COPROG - This graph describes the various conceptual stages of the coalescence process in a manner identical to the foregoing.

```
[COPROG]  (PROGRESS OF COALESCENCE PROCESS)
  A = "PROCESS DOES NOT OCCUR"
  B = "LARGE AND SMALL WATER DROPLETS FORM"
  C = "LARGE AND SMALL WATER DROPLETS FALL AT DIFFERENT
                        SPEEDS"
  D = "COLLISIONS OCCUR BETWEEN DIFFERENT SIZE WATER
                        DROPLETS"
  E = "COALESCENCE OCCURS"
  F = "PRECIPITATING DROPLETS RESULT"
  G = "FRACTIONATION MAY OCCUR"

  A=>B  ([NWD]=T)*/([G]=B)/([E]=T)*/([C]=D)*
  B=>C  (FORCED)*:  "THE LARGER THE DROPLET, THE GREATER
        THE EFFECT OF GRAVITY RELATIVE TO THE EFFECT OF
        AERODYNAMIC DRAG."
  C=>D  ([COPROG]=C)
  D=>E  ([E]=T)
  E=>F  ([C]=D)
  F=>G    (FORCED ON FIRST ENCOUNTER OF STATE "F")*:
        "THE DROPLETS MAY GROW BEYOND 7 MM. IN DIAMETER,
     AT WHICH POINT AERODYNAMIC DRAG MAY PULL THEM APART."
```

AUTOMATON FOR PRECIPITATION FORMS

PRECIPIFORM - This graph describes changes in the attributes or types of forms of precipitation which occur due to other changes in the model. The transition structure for this graph describes, for instance, how it is possible for snow to melt before reaching the ground.

```
[PRECIPIFORM]  (FORM OF PRECIPITATION)
  A = "RAIN"
  B = "SNOW"
  C = "HAIL"
  D = "SLEET"
  E = "NO PRECIPITATION"

  E=>A  ([COPROG]=F)
  E=>B  ([ICPROG]=G)
  E=>C  ([HFPROG]=E)
  A=>E  ([ATLA]=H)
  A=>D  ([ATLA]=C)
  B=>A  ([ATLA]=W)
  C=>A  ([ATLA]=W)
```

SUBSIDIARY PROCESS AUTOMATA

Subsidairy automata form small sub-models which are triggered and controlled by the main process chains. Their purpose is to help in explaining the individual discrete processes which compose those complex processes (e.g., Ice Crystal process).

NET - This graph delineates net processes which occur during and which embody the Ice Crystal process.

```
[NET]  (PROCESS)
  A = "NET EVAPORATION"
  B = "EQUILIBRIUM"
  C = "NET CONDENSATION"

  B=>A  (<<REIC>> > <<ARCD>>) V (<<REWD>> > <<ARCD>>)
  B=>C  (<<REIC>> < <<ARCD>>) V (<<REWD>> < <<ARCD>>)
```

SSC - Describes the average size of super-cooled water droplets in an attempt to flesh out the descriptions

generated by the ICPROG process chain.

```
[SSC]  (SIZE OF SUPER-COOLED WATER DROPLETS)
  A = "DIMINISHES"
  B = "REMAINS CONSTANT"
  C = "INCREASES"

  B=>A  ([ICPROG]=D)*/([NET]=A)
  B=>C    ([ICPROG]=D)*/([NET]=C)
```

SIC - Augments the ICPROG and HFPROG process chains by describing the average size of ice crystals present in the clouds in which these processes occur.

```
[SIC]  (SIZE OF ICE CRYSTALS)
  A = "DIMINISHES"
  B = "REMAINS CONSTANT"
  C = "INCREASES"

  B=>A  ([ICPROG]=E)*/([NET]=A)
  B=>C  ([ICPROG]=E)*/([NET]=C) V ([HFPROG]=D)
```

NSC - Developed for the benefit of the HFPROG process chain, this graph describes the number of super-cooled water droplets present in a hail-forming cloud. By means of this graph, changes in the composition of the cloud can be broadly indicated.

```
[NSC]  (NUMBER OF SUPER-COOLED WATER DROPLETS)
  A = "DIMINISHES"
  B = "REMAINS CONSTANT"
  C = "INCREASES"

  B=>A  ([HFPROG]=D)
```

NIC - Describes changes in the amounts of ice crystals present in the cloud.

```
[NIC]  (NUMBER OF ICE CRYSTALS)
  A = "DIMINISHES"
  B = "REMAINS CONSTANT"
  C = "INCREASES"

  B=>C  ([FRPROG]=D)
```

SPI - Acts similarly to describe the number of water droplets present in the cloud which are below the average size (according to the statistical distribution obtained before the process begins).

```
[SPI]  (NUMBER OF SMALL DROPLETS)
  A = "DIMINISHES"
  B = "REMAINS CONSTANT"
  C = "INCREASES"

  B=>A  ([COPROG]=E)
  B=>C  ([COPROG]=G)
```

LPI - Describes similarly droplets above average size.

```
[LPI]  (NUMBER OF LARGE DROPLETS]
  A = "DIMINISHES"
  B = "REMAINS CONSTANT"
  C = "INCREASES"

  B=>A  ([COPROG]=G)
  B=>C  ([COPROG]=E)
```

LPII - DESCRIBES CHANGES IN THE AVERAGE SIZE OF LARGE CLOUD PARTICLES AS COALESCENCE OCCURS.

```
[LPII]  (SIZE OF LARGE DROPLETS)
  A = "DIMINISHES"
  B = "REMAINS CONSTANT"
  C = "INCREASES"

  B=>A  ([COPROG]=G)
  B=>C  ([COPROG]=E)
```

Unclassified

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* System Development Corporation Santa Monica, California 90406	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

A MODEL DRIVEN QUESTION - ANSWERING SYSTEM FOR A CAI ENVIRONMENT

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Final Report (July 1970 to May 1972)

5. AUTHOR(S) *(First name, middle initial, last name)*
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6. REPORT DATE March 1973	7a. TOTAL NO. OF PAGES 54	7b. NO. OF REFS 4
8a. CONTRACT OR GRANT NO. F33615-70-C-1726 b. PROJECT NO. 7907 c. Task No. 790700 d. Work Unit No. 79070004	9a. ORIGINATOR'S REPORT NUMBER(S) AFHRL-TR-72-39 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*	

10. DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Technical Training Division Air Force Human Resources Laboratory Lowry Air Force Base, Colorado 80230

13. ABSTRACT

This report describes a question-answering system which permits students in a computer assisted instruction (CAI) environment greater initiative in the variety of questions they can ask concerning the subject area being studied. A method of representing processes as augmented finite-state automata is developed and is shown not only to permit efficient inferencing about dynamic processes but also to provide a satisfactory deep structure for paragraph generation. A CAI system dealing with meteorology is described which uses this automaton model to represent the processes in meteorology. Coupled with the dynamic process model is a semantic conceptual network which contains the static information about meteorology. Examples of the inferencing techniques using both the automaton model and the semantic network are given. A sample session with this system is included in the Appendices.

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Unclassified

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Computer Assisted Instruction finite-state automata meteorology automaton model						

one-room standardized schools - 1919
mining camp schools - 1919
public junior colleges - 1927
school transportation - 1945
special education - 1955
supplemental or equalization aid - 1945
general aid - 1947[1]

The most far-reaching attempt to establish standards was the program initiated under Mr. J. C. Wright in 1958. This program is more fully discussed under the sub-topic "Reorganization of Local School Districts."

The Department's Changing Role and Growth of Legal Authority

At the turn of the century, the State Superintendent was elected in the statewide partisan political elections. His staff consisted of one deputy and one secretary. His salary was $2,200. The same amount was received by the Secretary of State, the State Auditor and the State Treasurer. The Attorney General received $4,000.[2]

The Better Iowa Schools Commission was an appointed commission of 22 members, eleven professionals and eleven laymen. Working over 1911-1912 and presenting their recommendations to the General Assembly, they had the honor of seeing all their major recommendations passed into law. One of the bills enacted, the Savage bill, abolished the elective position of State Superintendent and reorganized the agency by creating the Department of Public Instruction. The State Superintendent of Public Instruction who would head the reorganized agency was to be appointed by the Governor with the consent of two-thirds of the Senate. The Savage bill passed the

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[1]Smith, Department of Public Instruction, pp. 66-94.

[2]Ibid., pp. 81-82, 88.

Senate 38 to one with eleven absent or not voting and passed the House 60 to 31 with seventeen absent or not voting.[1]

Under the bill the superintendent's salary was set at $4,000, the deputy's at $2,500 and three school inspector positions at $2,000. Positions within the Department were written into various laws. This procedure greatly hampered the State Superintendent in organizing and utilizing his staff in light of changing departmental goals. He was also often faced with the need for additional departmental activities such as the supervising of public junior colleges. If the legislature failed to create new positions in the Department, new responsibilities were assigned to existing personnel.[2]

The passage of the federal Smith-Hughes Vocational Act led to the founding of the State Board for Vocational Education in 1917. The State Superintendent became permanent chairman of the Board but the Board was not an official part of the Department of Public Instruction until 1953.

It is interesting to note the rather substantial margins by which the Savage bill passed both houses. In an attempt to prevent an unpopular governor from appointing a successor to a retiring superintendent, the legislature returned the position to the popular electorate in 1918. Fortunately, the remaining organization of the department was ignored.[3]

With the enactment of state aid for standardized schools in 1919, the department's legal authority grew. The State Superintendent was assigned the duty to "prescribe and promulgate the requirements he shall deem necessary" for the standard schools.[4] The legislature asked the

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[1] Ibid., pp. 12-13. [2] Ibid., p. 17. [3] Ibid., p. 13.

[4] Laws of the 38th General Assembly, 1919, Chapter 373, cited by Smith, Department of Public Instruction, p. 14.

Department to develop standards in the areas of teaching, general equipment, heating and ventilation, lighting, seating, water supply, library, care of grounds, safety against fire and others.

The power to set standards for various schools and programs increased through the years. The Department found it necessary to be realistic concerning goals while exerting professional leadership.

The mining camp schools were of major concern to the department. The problem was the location of the schools in areas of low property value. In 1919, the General Assembly voted aid for the mining camp schools. Unlike aid for standardized consolidated schools, this aid was in reality an attempt to equalize educational conditions in extremely poor districts. The Department was given wide discretion in dispensing the aid. Although coal mining has not been a major activity in Iowa for many years, this categorical aid was not discontinued until 1964. Mining camp aid was important in the Department's history, since it established the principle of state aid to extremely poor districts.[1]

In 1927 the Department was instructed by the General Assembly to establish standards and inspect all public junior colleges. No additional staff positions were created.[2]

A director of research was authorized for the department in 1931. In the same year, the General Assembly directed the Department to establish and enforce a uniform finance and attendance accounting procedure.[3]

In 1937, the General Assembly designated the State Superintendent as the chief educational authority of the state. As such, he was to

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[1]Smith, Department of Public Instruction, pp. 15-16.

[2]Ibid., p. 18.

[3]Ibid.

adopt rules and regulations involving the receipt and use of federal educational funds.[1]

Under the leadership of Miss Jessie M. Parker, elected State Superintendent from 1939 to 1955, a commission created for the purpose of revising the state's school laws met and issued a series of proposed bills for consideration by the 1945 General Assembly. Several bills were passed into law. One provided state transportation funds for children and created a transportation division in the Department for administration. The Division of Special Education was also created at this time. Other recommendations that became law dealt with county school administration, school district reorganization, teacher qualifications and contracts, school finance and the closing of schools.

Several recommendations were not accepted. One was that the State Board of Vocational Education be disbanded and its duties assigned to the Department. Another recommended the establishment of a seven-man State Board of Public Instruction which would appoint the State Superintendent.[2]

From 1917 on, the profession had worked to remove the State Superintendent's Office from partisan elections. Members were supported by other groups including two government reorganization commissions.

The 1945 General Assembly also passed an appropriations bill for state aid for transportation costs. This was done to remove one of the obstacles to school reorganization. It also provided "supplementary aid" to the schools. This resulted in the establishment of the Administration and Finance Division in the Department. Financial and attendance reports grew in importance.

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[1] Ibid. [2] Ibid., pp. 19-20.

In 1947, supplementary aid was over-shadowed by the passage of general aid. A partial text of the appropriation act shows the climate of the times.

> Whereas, as a result of World War II and the unbalanced economic conditions arising therefrom, an inflation has occurred throughout the United States, and the State of Iowa, and
> Whereas, the cost of education for the local public school districts of the State of Iowa has been increased together with the cost of city, county, and state government because of such inflation, and
> Whereas, the present inflation seems now to be at or near its peak, and a recession is generally accepted as the resulting consequence of such inflation, and
> Whereas, an emergency is now declared to exist and it seems proper to grant emergency aid to the public schools of Iowa.[1]

On April 23, 1953 the State Board of Public Instruction and the State Superintendent of Public Instruction received extensive and broad powers from the General Assembly. The State Board of Vocational Education and the State Board of Educational Examiners were dissolved and their duties assigned to DPI.[2]

The new State Board of Public Instruction met on January 2, 1954. Under the law, Miss Parker finished out her elected term of office. On June 4, 1954, J. C. Wright was chosen as the first appointed superintendent. He assumed office January 1, 1955.

The Office of the State Personnel Director attempted to assert authority over the newly enlarged agency. This would have opened the Department to political appointments and greatly reduced its independence. Fortunately, the new Board received an Attorney General's opinion that DPI did not come under the authority of the State Personnel Director.[3]

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[1] Laws of the 52nd General Assembly, 1947, Chapter 1, cited by Smith, Department of Public Instruction, p. 21.

[2] Ibid., pp. 20-22, 52, 111-112.

[3] Smith, Department of Public Instruction, p. 22.

Mr. Wright served as State Superintendent from 1955 to 1961. He will be best remembered for his vigorous pursuit of school district reorganization. He also oversaw a substantial increase in the size of the DPI staff in 1959 as a direct result of the passage of the federal National Defense Education Act (NDEA) of 1958. Eleven professionals were added to an existing staff of 51.[1] Mr. Wright left the department for a Washington position at the end of 1960.

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[1] Ibid., p. 23.

The County School System in Iowa

1858-1960

A great distance was felt to exist between the statehouse and the local one-room school. The legislature expected the state agency to enforce the regulations that existed and to provide educational leadership. The local school, while perhaps not welcoming regulation, at least recognized the need for advice and encouragement. Neither regulation nor good council flowed freely between the two levels.

The legislature turned to the county level agency for the solution. The "county approach" was the "regional approach" of the nineteenth century. The county area was considered close enough to the people to be effective and large enough to be efficient. Iowa contains 99 counties.

Dr. Wayne P. Truesdell believes that Horace Mann may have had considerable influence upon the development of the county school system in Iowa.

> . . . In 1856 the Iowa General Assembly created a commission to study Iowa school laws. Horace Mann was the chairman. It is most likely that the report submitted to the Iowa legislature in 1856 was the work of Horace Mann alone. This report became the basis of Iowa's first comprehensive school law, in 1858.[1]

Horace Mann said of the county unit:

> 'In regards to county organizations, your commissioners have centered in one individual, the county superintendent, subject to some slight modifications by the superintendent of public instruction, all the actual power exercised for school purposes over the whole county.' (Iowa Legislative Documents, 1856, p. 196)[2]

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[1]Iowa Association of School Administrators, Fifth Annual Report (Cedar Falls, Iowa: Iowa Association of School Administrators, 1966), pp. 77-79.

[2]Ibid.

The early laws gave the county superintendent three essential functions. They were:

1. Supervision of all teachers in the county in the improvement of instruction;
2. Examination and certification of teachers; and
3. The conducting of institutes for professional training of teachers.

Supervision--The county superintendent was to visit each school no less than twice a year. He was to consult with the teachers regarding methods of instruction, discipline and curriculum. He was also to call an annual meeting of all township school presidents to "discuss curriculum, instruction, discipline, qualifications of teachers, books and libraries, and other matters pertaining to the 'common school system.'"

Certification--From 1849 to 1858, the certification of teachers was the responsibility of the local school board. In 1858, certification became a duty of the county superintendent.[1] After 1861, qualified teachers could write examinations for the State Board of Examiners and receive life certificates. Few teachers did. The majority continued to work under county certification. In 1862 a law was enacted that stated no person could collect salary for teaching until properly certified. The county superintendent issued certificates on the basis of examinations devised by him and administered one Saturday each month in his office. As late as 1910, sixty percent of the applicants (6,944) for county certificates had not completed high school.

After 1907, county superintendents no longer certified teachers, but they did administer the examination of the candidates for the State Board

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[1]Smith, Department of Public Instruction, p. 38.

of Educational Examiners in the county offices. The preparation and grading of the examination papers and the issuing of certificates was the function of the State Board. In 1945 the county office lost its last involvement in the certification process. The State Board of Educational Examiners was given sole right to certify teachers based on their college records.[1]

County Institutes--In 1858 school law instructed the State Superintendent to provide for a six-day institute in any county where thirty teachers requested it. In 1864 the responsibility was given to the office of county superintendent. These institutes eventually ran in length from four to six weeks and operated often in a four-year sequence. Many county superintendents came to insist upon institute attendance for annual renewal of certificates. County institutes were reduced to two days under the school reform laws of 1913 and to one day in 1931.

All three original functions of the county superintendent were to be eliminated or seriously curtailed by 1945.[2]

The county superintendent of schools in 1858, took his place beside the county recorder and supervisor. No special education credentials were required and he held office in the courthouse for a period of two years. He was an active member of a political party, usually the Republican Party, the historically dominate party in Iowa. He received $2 per day for his work.

The leaders of the profession in Iowa worked to change the situation. They worked to promote better qualified people for the position, better

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[1] Ibid., p. 39.

[2] This short history of the three basic functions of the original office of the county superintendent of schools is based on the above cited article in the I.A.S.A. Fifth Annual Report, which in turn is based on Wayne P. Truesdell, "A History of School Organization and Superintendence in Iowa" (unpublished Ph.D. dissertation, University of Iowa, 1965).

salaries, longer office tenure and appointment by a lay board rather than political election.

The first major change in the office occurred in 1913. As the result of a recommendation of the Iowa Better Schools Commission, the legislature enacted a reform law requiring superintendents to be certified. The term of office was lengthened to three years and the superintendent was appointed by the presidents of all the school boards located in the county. The 1913 law also clearly established the county office as the intermediary between the state and local level.

At this same time the State Superintendent's office was made appointive. The state reform failed to survive beyond a four-year period. The county school reform survived.[1]

The county superintendent's role was still considered to be primarily that of supervising and guiding the small, one-room schools. As late as 1950, there were 4,960 one-room rural schools in Iowa. Eighty-six counties had more than twenty. The average for the 99 counties was fifty.[2] Unfortunately, this image of the office's duties still exists in many taxpayers' minds.

In the 1945-46 school year, the State Department of Public Instruction employed its first professional staff member in the area of special education. In 1955 the Special Education Division of the Department was formed. The growth of interest in special education programs had special significance for the county school systems. Increasingly, the local school districts turned to the county system for assistance in connection with

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[1]Smith, Department of Public Instruction, p. 104.

[2]Ibid., p. 105.

educational programs that were needed by a relatively small student population, for example, the visually handicapped; programs that were very expensive to provide, such as those for the trainable mentally retarded; or programs of a brief duration, the testing of student hearing.[1]

During this period of time, the interest in reorganization of school districts was growing. A major change in the county system occurred in 1947 which bore a relationship to this. The legislature established a five-man elected board of education to administer each county school system. Four were elected from districts and one was elected at large. They, in turn, appointed the county superintendent of schools. The qualifications for the office became the same as those for the office of the largest city school system superintendency in the state.

One of the most important aspects of the new law, however, was concerned with a new relationship with the rural schools. The county superintendent was given the official task of promoting local school district reorganization. He was to gather information and project plans that would further this goal.

Here again, however, when reorganization of local districts had been accomplished, the county superintendent's duties were, by law, fulfilled. Dr. Truesdell states:

> It was then that creative and energetic superintendents conceived the idea of the county unit as a service unit, to provide types of educational instruction and materials which the local unit could not provide. The administration of special education over several counties provided a concept of a multi-county unit.[2]

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[1] Ibid., pp. 18, 44.

[2] Iowa Association of School Administrators, Sixth Annual Report (Cedar Falls, Iowa: Iowa Association of School Administrators, 1967), p. 85.

The year 1960 found the county superintendents still located in the courthouses. Although a few of the most progressive and usually the largest county systems had hired professional speech therapists and occasionally a school psychologist, the staffs of most county systems in Iowa consisted of the superintendent, perhaps an administrative assistant and a secretary. One-room schools still existed although their days were numbered.

In the summer of 1957, the Iowa Association of County School Superintendents was instrumental in establishing the Iowa Research Committee for the Study of the Intermediate Unit of School Administration in Iowa.

In April 1960 the Committee published its report entitled Effective Intermediate Units in Iowa. The idea of a natural geographic, economic and cultural area approach to intermediate level school government officially appeared in print.

A Period of Rapid and Extensive Change

1960-1972

Mr. Paul F. Johnston took office as the State Superintendent of Public Instruction on January 1, 1961. He was well qualified for the position. Born in Hopkinton, Iowa, he received his B.A. degree at the University of Dubuque and his M.A. from the University of Iowa. He worked as a teacher and administrator in Iowa before joining the Department of Public Instruction in 1946 as Supervisor of Finance. He later held the titles of Director of Administration and Finance and Assistant Superintendent of Administration.[1] He had also served as chairman of a major state school finance study.

The Continuing Fight for School District Reorganization

Mr. Johnston immediately changed the procedure for placing schools on the disapproved list. A school in danger of being placed on the list was to be warned as soon as possible. Mr. Johnston also announced he would personally visit each school accompanied by the regional consultant involved. After inspecting the school during the day, they would visit with the board in the evening. This was to be done at least one full year in advance of the school's being placed on the disapproved list. If the school was to be disapproved, Mr. Johnston would again return to visit with the board.[2]

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[1] Iowa Association of School Administrators, Ninth Annual Report (Cedar Falls, Iowa: Iowa Association of School Administrators, 1970), p. 15.

[2] Smith, Department of Public Instruction, p. 117.

This policy was probably adopted in an effort to allay the distrust and anger of the legislature. It had little effect. As early as January 12, 1961, a bill was introduced in the Senate which would have resulted in the Governor gaining the power of appointment over the State Board of Education.

In February, the House of Representatives debated a different bill which also provided for the appointment of the state board members. For three days the small school supporters visited the statehouse. The Des Moines Register estimated their number to be between 200 and 300.[1]

In a series of moves that came as a complete surprise, the House rejected an attempt to oust all incumbent state board members as of June 30, 1961, 64-40; rejected the idea that state board members should be elected at large during local school district elections, 60-47; and, finally, rejected the bill to allow the Governor to appoint the state board members, 71-35.

George Mills, writing for the Des Moines Register, termed this a crushing defeat for the small school forces. The attitude of the rather liberal-oriented paper is portrayed in Appendix IV.[2]

Many small county representatives voted against the bill. Republican Senator David Stanley of Muscatine said:

> Why was the state board criticized? Because it has raised educational standards to meet the challenge of the space age. Because in the last five years, Iowa has made more progress in school reorganization than any other state. No group of human beings could do these difficult tasks without making enemies.[3]

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[1] Des Moines Register, February 9, 1961, p. 3, cited by Smith, Department of Public Instruction, p. 119.

[2] Des Moines Register, February 10, 1961, p. 1, cited by Smith, Department of Public Instruction, p. 119.

[3] Ibid.

Forty-three school districts had been disapproved in November and December of 1960 as Mr. Wright prepared to leave for Washington. These schools asked for a review of their status.

Most districts were inadequate in their secondary school offerings. At that time 27 units were required of a high school program. The state board adopted a new minimum standard of 36 units. At the same time, however, they stated a new policy of judging each potentially disapproved school on the amount of progress they were making to meet existing standards. In a new strategy the state board would grant waivers to schools showing progress while at the same time publishing their weaknesses. This naturally led to new protests.[1]

Under Mr. Johnston's administration, the number of officially disapproved schools sharply fell. Only seven districts were disapproved in 1961, three in 1962 and nine in 1963. During the same period, 249 districts applied for waivers in 1962 and 239 received them.[2]

At that time, the Iowa Legislature met biennially. In 1963 the State Department of Public Instruction was again an object of controversy. Senate File 18 would have allowed the Governor to appoint the members of the State Board of Education subject to confirmation by the Senate. Senate File 37 would have returned the position of State Superintendent to election on a partisan ballot.

The latter bill passed the Senate 26 to 24 and was sent to the House. Two former elected state superintendents, Miss Agnes Samuelson and Miss Jessie Parker, both made public statements in opposition to the bill. After two days of bitter debate, the House defeated the bill 57 to 46.

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[1]Smith, Department of Public Instruction, p. 119-121.

[2]Ibid., p. 121.

Mr. Johnston was up for reappointment by the State Board. His name was submitted by the Board on the first day of the session, but confirmation was delayed. The leadership assured Mr. Johnston that the delay was designed to show sympathy for the small schools and that he would eventually be confirmed. Confirmation was given on May 14, 1963.[1]

The small schools took their fight to the courts. On March 10, 1964, the Supreme Court of Iowa ruled that the power of the State Board of Public Instruction to withhold payment of state aid to non-approved schools and to adopt standards, regulations and rules formulated by the State Superintendent was unconstitutional. The court held that the General Assembly had not set forth sufficient guidelines for the drafting of the standards.

At the suggestion of Mr. Johnston, Governor Harold Hughes called an emergency meeting of Department representatives and legislative leaders. A compromise was worked into bill form. The Attorney General wrote a legalizing bill that gave state approval to the school districts of the state for the 1963-64 and 1964-65 school years. This was then presented to the General Assembly which was meeting in special session. Blanket approval was given to all districts.[2]

The 1965 session of the General Assembly faced the difficult task of providing legislative standards by which schools could be evaluated. Senate File 553 was enacted into law. It was a compromise bill that gave the State Board considerable enforcement power but did not grant the State Board their full recommendation as to standards. Standards were considerably lowered in the areas of practical arts and vocational education.

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[1] Ibid., p. 121-122.

[2] Ibid., p. 122.

In the face of the opposition, Mr. Johnston recommended raising the minimum enrollment required for a school district from 300 to 1,500. This led to the introduction in the House of a resolution calling for a complete investigation of the Department. It was never called up to the floor. In spite of the atmosphere, reorganization legislation was passed. All school districts in the state were required to be in a high school district by July 1, 1966.[1]

Local school reorganization would slowly continue throughout the state after 1966, but the concept gained more acceptance. School mergers lost the flavor of small towns and rural areas struggling to maintain a separate identity. More often, they were based on purely economic efficiency. A flurry of controversy and concern arose with the publication of the findings of the Great Plains School District Organization Project in June 1968. It recommended considerable reorganization of local districts into larger units.

As 1970 approached, reorganization as a controversial policy seemed to be waning. Other educational problems grew to at least equal importance.

The Development of the Area Concept-- for Regional Education Service Agencies for Community Colleges and Vocational Technical Schools

The development of the area concept for the intermediate level of school government has a considerable history of research, special reports and specific recommendations. Add to this the struggle to establish a state-wide system of community colleges or vocational technical schools and the 1960's emerge as a time of change and commitment.

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[1] Ibid., pp. 122-123.

1960 - Effective Intermediate Units in Iowa Report

The publication in April 1960 of a report by the Iowa Research Committee on the Intermediate Administrative Unit, was the first concerted effort to inform the profession and the public that multi-county or intermediate units were now preferable to single-county units in school government.

The study began on June 4, 1957, when the county superintendents of Iowa, holding their annual meeting, voted unanimously to request the State Department of Public Instruction to organize a study of the changes that might be needed or desired at the county level. The steering committee was chosen at a meeting held July 23, 1957, and the work began. Steering committee members are listed in Appendix V.[1]

The committee began their work accepting six basic assumptions. They were:

> First Assumption: Some type of intermediate unit of school administration betweer the local level and the state level snould be continued.
>
> Second Assumption: The Intermediate Unit should have a well qualified superintendent and a Board of Education.
>
> Third Assumption: The Intermediate Unit should be fiscally independent.
>
> Fourth Assumption: The Intermediate Unit should not in the long run perform services and functions which can be as effectively discharged by the local unit.
>
> Fifth Assumption: All of the territory of the state should be included in the intermediate units established.
>
> Sixth Assumption: The area of the intermediate unit should, as much as possible, be based on the larger territory community concept, combining contiguous areas which share many services together.[2]

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[1]H. C. DeKock and Virgil Lagomarcino, Report of the Iowa Research Committee for the Study of the Intermediate Unit of School Administration in Iowa (Des Moines: State of Iowa, Department of Public Instruction, 1960), pp. 1-3. (Hereinafter referred to as Effective Intermediate Units in Iowa.)

[2]Ibid., pp. 7-11.

From existing literature and research, the committee cites several previous studies in Iowa that related in some manner to their study. For further information see Appendix VI.

To determine the existing and potential service role of the intermediate unit, a questionnaire was distributed to all 97 county superintendents attending the annual meeting in June, 1958. By October, 1958, 100 percent of the questionnaires had been returned.

The questions asked had covered the following:

Square miles of territory and number of enrolled students served
Adequacy of tax base
Instructional and curriculum services offered (curriculum re ision, adult education, curriculum laboratories, etc.)
Special services offered (accounting, auditing, school lunch, etc.)
Professional personnel services (teacher placement, substitute teacher pool, etc.)
In-service education programs
Pupil personnel services (attendance accounting, testing, census, etc.)
Services for exceptional children

The existing four top-ranking functions, as determined by the study using the frequency of mention, were:

Service	Frequency of Mention
Specialized Education	80
Instructional and Curriculum	65
Consultive	48
General Administrative	47[1]

During the 1958-59 school year, a questionnaire was sent to all 694 local high school districts in Iowa. Five hundred were returned. The study was conducted to see if the local districts felt a need for services from the intermediate unit. Specifically, it asked:

1. What are the current responsibilities of the intermediate (county) unit?
2. How well have these responsibilities been fulfilled?
3. What will its role be in the future?

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[1] Ibid., pp. 18-34.

The findings were presented in four categories: schools under 300 enrollment (K-12), schools with between 300 and 600 enrollment (K-12), schools over 600 enrollment (K-12) and total responses.

For a summary of the most interesting results, see Appendix VII.

In answer to the question, "Is an intermediate unit needed to provide services to the local district?"

Response	Percentage
Not needed	17.4
Moderate need	45.4
Great need	27.0
Indispensable	9.0

The highest percentage category to the response of not needed was, paradoxically, the schools with an enrollment of less than 300 (K-12).[1]

A large segment of the study dealt with the very real problem of actually drawing proposed boundary lines for varying numbers of intermediate units. The planners were looking for the "natural community." They explained their problem by stating:

> Although definitions of a natural community vary they all tend to have a two-fold aspect--a geographical locus and a psychological consensus. In other words, a collection of people in an area with a sufficiency of commonality in beliefs, language, interests, traditions, manners to facilitate communications and social interaction . . . . Obviously mutual understanding and cooperation is augmented in areas or regions involving communities with the highest degree of commonality in natural-socio-economic community characteristics. This, too, is important for Intermediate Units.[2]

Although the planners would have preferred to combine local districts into areas rather than counties, they did not use local districts for two reasons. Sufficient statistical information was not available concerning local districts and the data dividing land by miles would have been overwhelming and unwieldy for the purposes of the study. The second reason

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[1] Ibid., p. 45.

[2] Ibid., p. 55.

pertains to the possibility that the study, upon publication, would have been attacked by local school district reorganization opponents. This, in 1958, was to be avoided at all cost.

The criteria used in developing the plans were as follows:

1. Total K-12 enrollment ranging from 9,000 to 12,000 (city school districts with enrollments over 5,000 are not included in these totals since several large city districts could have met this standard as a single district).

2. Travel distance within the intermediate unit not to exceed 40 miles from a possible administrative center.

3. The intermediate unit should include from six to twelve defensible local school administrative units.

4. The grouping of counties should be guided by a plan which permits location of an intermediate unit administrative center which is logical in terms of the directional flow and pattern of the main highways and roads.[1]

State maps of Iowa were then divided into 36, 34, 30, 28 and 26 areas. This section of their report also includes a table that lists all counties in alphabetical order. The table then lists the code numbers for all local school districts located within the county, the K-12 enrollment by school and the assessed valuation of each district. The planners felt assessed valuation had to be sufficient to support a program adequately. They also were concerned that it be relatively equal among the areas.[2]

In the study's conclusions and recommendations, it recommended that a strengthened intermediate unit in Iowa should consider offering the following services:

Adult education
Audio-visual services including television
Building planning services
Centralized and cooperative purchasing
Curriculum laboratory and instructional materials center

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[1] Ibid., p. 57.

[2] Ibid., pp. 52-82.

Curriculum evaluation and revision leadership
Exceptional children (services) including regular and itinerant teachers as needed for the--gifted, retarded, crippled, partially sighted, speech defectives, hard of hearing, homebound
Financial services including--accounting, counseling, reporting, salary policy and schedule development
Information services
Inservice education programs for the--administrators, teachers, bus drivers, clerical personnel, custodians, lunch personnel
Legal services
Library services--consultative, exhibits, professional materials
Professional personnel services including--teacher recruitment, substitute teacher pool
Pupil health services including--school nurse, school doctor, dental health and hygiene
Pupil personnel services including--attendance supervision, guidance and counseling, testing, psychological, psychiatric
Post-high school education
Recreation and school camping programs
Research services
Trade and industrial education[1]

Specific recommendations of the study are available in Appendix VIII.

1962 - Education Beyond High-School Age - The Community College Report

The work of the previously discussed study was available to a second research committee designed to solve a different problem. On April 25, 1961, the Iowa House of Representatives passed House Resolution 6 as introduced by the Committee on Institutions of Higher Learning. The resolution is contained in full in Appendix IX.[2]

In November, 1959, Raymond C. Gibson, Professor of Higher Education at Indiana University, was retained to conduct the Iowa survey. The contract required that he produce:

1. A prediction of Iowa college enrollments to 1970.

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[1]Ibid., p. 84.

[2]Iowa State Department of Public Instruction, Education Beyond High-School Age--The Community College (Des Moines: State of Iowa, 1962), p. 114. (Hereinafter referred to as Education Beyond High-School.)

2. An analysis of the educational program, facilities and costs; a general analysis of manpower needs in Iowa in occupations requiring education beyond the high school, particularly terminal education and whether Iowa's present educational system met these needs; and an analysis of the Iowa junior colleges.

Professor Gibson and his staff produced the following reports:

1. Projection of Enrollment for Fifty-one Public and Private Junior and Senior Colleges and Universities in Iowa, 1960-1970

2. Manpower Problems and Higher Education in Iowa: A New Alliance

3. An Appraisal of Iowa Colleges: Faculties, Costs, Scholarships and Administration

4. The Junior Colleges of Iowa

They also produced Resources and Needs for Higher Education in Iowa, 1960-1970: A Summary Report.[1]

The reports did not completely satisfy the Committee on Institutions of Higher Learning. The explanation section of the resolution reads:

> The Gibson Report, authorized by the study committee last session, was not received in full until the middle of this session. It points out the problems but does not specifically give us the answers that we can use and the bills to implement them at this session. This resolution directs the Department of Public Instruction to research this problem relating to vocational and terminal education and have the bills ready to be considered in the next session of the legislature. It also directs the department to examine the problem of vocational education in the high schools.[2]

The State Committee on Public Area Community Colleges was established with David H. Bechtel from the Department staff serving as chairman. In all, eight members from the State Department served on the committee. Two members are of special interest because of their eventual relationship to this paper--Dr. Wayland W. Osborn, Director, Division of Advanced Education and Instructional Services, who was to become the compiler and editor of the state plan

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[1] Ibid., pp. 64-70.

[2] Ibid., p. 114.

written for Title II of the Elementary and Secondary Education Act of 1965 and Dr. Richard N. Smith, Director, Division of Administration and Finance who would produce in 1969 the most recently published history of the State Department of Public Instruction. In addition, twenty-one various state agencies were invited to appoint representatives.

The study began with the appointment of Department staff members in August of 1961. Each member was expected to devote one and a half days a week to the study. The official philosophy adopted by the committee was that they would maintain the flow of suggestions, advice and recommendations between all interested groups and themselves.[1]

The final report of the committee was published on December 1, 1962. It was entitled Education Beyond High-School Age--The Community College and consisted of 115 pages.

The report contained three parts:

Part One - Recommendations
Part Two - Supporting Evidence for Recommendations
Part Three - Study of the Availability of Vocational and Technical Education in Iowa Public Educational Institutions

In all, seventeen specific recommendations were made by the report. They are listed in Appendix X.

The two recommendations of most interest are:

> Recommendation 1. The State of Iowa should provide a legal framework for the establishment of a statewide system of area-controlled public community colleges.
>
> Recommendation 2. The State of Iowa should establish area education districts whose elected lay boards would replace existing county school boards and assume educational functions intermediate between the state and local school districts and, when authorized by vote of the people in such districts, would establish and operate public area community colleges.[2]

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[1] Ibid., pp. 3-5.

[2] Ibid., pp. 7-10.

How did a resolution directing the conduct of a study of post high school education lead to a recommendation that the county school system be radically reformed and given new responsibilities?

When asked this question in May of 1971, Mr. Bechtel's answering letter stated in part:

> On your first question, I would first make a slight correction in your statement that H. R. 6 was "clearly directed at post-high-school education." The last portion of this resolution gave some directive for a look at vocational education. A more direct reply to your question, however, I would refer you to item five of the resolution which reads as follows:
>
> 5. Relationship of such community colleges with other parts of the educational system in the state.
>
> In considering this and also the request of the Association of County Superintendents to the State Board to draw boundary lines for intermediate districts the study committee came up with the first two "assumptions" on page two of the final report. These were:
>
> 1. Public area community colleges should be developed in such a manner that they fit into the pattern for the administrative structure of public schools in the state.
>
> 2. A regional education district authorized to establish a public area community college should be sufficient size to provide the human and financial resources needed for an adequate educational and service program, but each such district should be formed without the creation of any additional legal taxing units. (Underlining added by Mr. Bechtel.)
>
> It should also be kept in mind the various "area" proposals, some with legislation, that had been made since the late 40's for restructuring the county office. Whether the decision was right or wrong, it was concluded that both the area school and intermediate unit problems needed to be solved. They both required basically the same type of resources--people and money. It was also felt, very strongly I might add, by some members of the committee that an additional educational taxing unit could not be proposed. The result was that we put the two general problems together in one proposal. I might add a personal observation at this point. Even after ten years and many other things happening I still feel that this was and still is the

best proposal for this state. I wouldn't put these two functions together in some other states but I think it is the most workable alternative for Iowa.[1]

Several years later, in the fall of 1967, Mr. Bechtel authored an article for the Journal on State School Systems Development. In it he states:

> . . . While proposing the legal framework for the development of area community colleges was recognized as the main intent of the legislature, the report was not limited only to this phase of Iowa's public education system. The Department was concerned also with the additional problem of restructuring the state's county intermediate districts. The Iowa Association of County Superintendents requested the Department to establish boundary lines to be incorporated into legislation for redistricting Iowa's 99 counties into fewer yet more effective intermediate units of school administration.
>
> In researching the problems associated with establishing the area community colleges and in attempting to redistrict the boundary lines of the present county school system so as to provide more effective intermediate units, the Department found that both proposals had certain basic elements in common relating to organization. Each required defining specific areas or regions of the state from which financial support could be obtained. Each required that in defining such areas, basic criteria be established to insure that each area had the potential human and financial capacity to fulfill its educational intent. Each required that the area elect a lay board with responsibility for and control of the educational program. Each required that this board appoint an administrative officer to carry out the desired educational functions. In studying these similarities, the Department concluded that both these educational functions be performed within the same area unit, with one elected board, and that one executive officer be responsible for both programs. It was recognized that to combine these two programs could bring about considerable dissatisfaction within the lay and educational leadership, but the Department had the obligation to keep all aspects of public education in perspective and not promote one phase or level of the system to the neglect of the other. There was no evidence also to indicate that the people of Iowa were willing to create a separate tax base for each of these proposals and thus introduce an additional educational taxing unit into the state.
>
> To provide both these functions, the Department proposed that the legislature create 16 areas encompassing the state . . .[2]

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[1]Letter from David H. Bechtel, Administrative Assistant, State Department of Public Instruction, Des Moines, May 7, 1971.

[2]David H. Bechtel, "Iowa's Pattern for Area Vocational and Community

The 1962 report, did indeed, contain the recommendation that the state be divided into sixteen districts to serve as community college and intermediate units. The map is presented in Appendix XI. Anyone familiar with Iowa's educational areas in 1971 would have no difficulty in recognizing or locating any of the sixteen areas as then recommended. This does not mean, however, that the General Assembly eagerly adopted the study they had asked be prepared. On the contrary, Mr. Bechtel writes:

> This tremendous effort was doomed. The reasons for legislature inaction, upon reflection, seem obvious. First, the proposal called for a significant restructuring of many provisions in the existing Iowa Code. Such major changes seldom are achieved in a single session. Second, the proposal affected many existing educational structures--structures for county intermediate district services, for junior colleges, and for vocational education programs. Its most unappealing aspect, however, was the call for mandated redistricting throughout the state which would have established a new educational structure. Because the proposal did not suggest a permissive approach to solving the problem, it would have required the General Assembly to make decisions on specific boundaries and areas, and this has little appeal for any legislator.
>
> It was not surprising therefore, that though a bill had been drafted, and copies provided for each member of the legislature, no legislator introduced the bill into the General Assembly and no member of the study committee was requested to appear before any legislative committee or subcommittee to review the proposal. It died a silent death.[1]

1963 - State Plan for Improvement of Education in Iowa

While the legislature was meeting in 1963, the State Department launched a new program entitled "the State Plan for Improvement of Education in Iowa." Sixteen meetings of school administrators were held around the state during the week of May 13, 1963.[2]

College Education," Journal on State School Systems Development, Vol. 1, No. 3 (Fall 1967), pp. 149-150. (Hereinafter referred to as "Iowa's Pattern for Education.")

[1] Ibid., p. 152. [2] Smith, Department of Public Instruction, pp. 123-124.

The purpose of the state plan was:

1. To provide a method and framework whereby local school districts, county systems, institutions of higher education and the Department could identify and research educational problems.

2. To bring about closer liaison between the various levels of school government and improve the quality of education in Iowa.

Using the sixteen areas defined in 1962, the local and county superintendents were asked to meet as a group. Each group elected a chairman and a recording secretary. The sixteen chairmen in turn were asked to serve as an Advisory Council. The Council has met monthly during the school year since that time. It has served the Department as a communications tool and has also provided feedback from the majority of school superintendents monthly.

A Coordinating Committee was established at the same time. It consisted of the Planning Committee of the Iowa Association of School Administrators, State Department staff and representatives of the four institutions that have graduate programs in education in Iowa.[1]

Mr. Arthur C. Anderson, a Consultant in the Division of Planning and Development for the Department, served as the secretary of the Advisory Council from its founding in 1962-63 until 1968-69. Mr. Don D. Dunlavy, DPI Division of Planning and Research Development took over as secretary in 1969-70.[2]

Dr. Richard N. Smith feels the program was successful because it encouraged the free exchange of ideas and led to a better understanding of

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[1]Iowa. State Department of Public Instruction, "Outline of State Plan for Educational Change in Iowa," internal working paper dated November 2, 1962. This edition was revised and published in 1963 under the title "Outline of a State Plan for the Improvement of Education in Iowa."

[2]Iowa Association of School Administrators, Ninth Annual Report (Cedar Falls, Iowa: Iowa Association of School Administrators, 1970), p. 112.

the various problems encountered at different levels of school government. He cites the 1966 Annual Report of the Iowa Association of School Administrators.

> Never have all organizations for education in Iowa worked together as closely as under Paul Johnston's administration. The sixteen area meetings have discussed problems at the grass roots. The Coordinating Committee has attempted to translate these suggestions into workable programs. It is not a case of handing down decisions from the top, it is a process of trapping the creative ability of all Iowa superintendents and school staffs.[1]

The "Plan" organization was also a very effective way to begin to build the area concept. It was part of a process designed to build loyalty and interest in a larger, less provincial geographical concept. It was the beginning of building an "in-feeling" among sixteen groups of educational leaders. It was an attempt to interest the smallest school's superintendent in the problems of the entire educational structure of the state.[2]

In an article in 1969, Paul Stuart, Chairman of the DPI Area Organization, reports that at the initial organizational meeting in 1963, Superintendent Johnston said,

> Our motive is only to insure that all superintendents in the state have an opportunity to participate in the policies, rules and regulations necessary for the improvement of the instructional program in the schools in the state of Iowa. We would like to see this kind of cooperative approach for it. We have no ulterior motives. [Italics not in the original.] We want only a framework through which we can all approach and solve the problems involved with the improvement of education in this state.[3]

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[1]Iowa Association of School Administrators, Fifth Annual Report (October 20, 1966), p. 73, cited by Smith, Department of Public Instruction, p. 124.

[2]For a more complete history of this project, consult the annual reports of the Iowa Association of School Administrators for the years 1965-1971.

[3]Iowa Association of School Administrators, Eighth Annual Report (Cedar Falls, Iowa: Iowa Association of School Administrators, 1969), p. 63.

Superintendent Francis Peterson of Northwood, Iowa, served as Chairman of the Coordinating Committee during 1969-70. He states:

> Whatever the function or the purpose that might have been [Italics not in the original.] the basic reason for our State Superintendent, Paul Johnston, to create the Advisory Council and Coordinating Committee, one goal has been reached. That goal is a more informed, a more unified, and a more cooperating group of public school administrators.[1]

1965 - Iowa Area Schools Become a Reality

The federal 1963 Vocational Education Act was passed. This gave added thrust to the movement for post high-school education and an interim committee of legislators was established. They reached the following conclusions:

1. The area vocational education schools and the two-year community colleges should be joined in a single comprehensive institution.
2. An area approach was necessary to obtain sufficient enrollment and adequate fiscal support.
3. The post high school program should not be state operated but should have its own area board with the authority to appoint an administrative officer. Significant state funds should be made available for operation and capital outlay.
4. Methods should be devised to encourage permissive development of these institutions.
5. Problems associated with the development of the comprehensive area schools should remain separate from problems of merging the county intermediate districts.

. . . . . .

> As anticipated, the legislature kept separate the establishment of the area schools from the concept of the multicounty intermediate unit and in doing so, passed a separate bill to permit counties to merge in order to create enlarged intermediate units. The legislature also withstood pressure to permit the establishment of a state operated system for the area vocational and community colleges which would have fallen under the direction of a separate state board created for that purpose.[2]

In 1965 both houses of the General Assembly were in the control of the Democratic Party, a rare happening in Iowa. The party members were

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[1]Iowa Association of School Administrators, Ninth Annual Report (Cedar Falls, Iowa: Iowa Association of School Administrators, 1970), p. 19.

[2]Bechtel, "Iowa's Pattern for Education," p. 153.

eager to prove that when given the chance they would "move Iowa forward" as they had been promising for years. They were a receptive audience for the new proposal.

The new law went into effect July 4, 1965. See Appendix XII. By July, 1966, all counties had participated in planning studies and thirteen area schools had been formed--four vocational schools and nine community colleges.

During the legislative session of 1967, there was much criticism of the rapid development of the schools and some of the fiscal problems this brought, but the vocational schools and community colleges were to stay. The following years would see the remaining uncommitted territory attach itself to various existing schools.[1]

The growth of the area schools had its effect on the existing county school systems. Although the State Department of Public Instruction and to a lesser extent, the local and county school systems continued to use the merged area boundaries for other programming purposes, the county school systems developed a specific relationship to the area schools.

The relationship tended to take on many features of the relationship between the universities and the county systems. Cooperation was paid lip-service and certain formalities would be maintained but it became primarily a relationship involving the finished product of one system becoming the raw material of the other. By 1970, the role of the area school was set and it had no direction to give Iowa's county school systems.

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[1] Ibid., pp. 160-162.

1965 - Joint County Mergers Allowed

The General Assembly, in 1945, authorized the cooperative sharing of the services of a superintendent by two or more counties. This permissive legislation was not used until 1957-58. After this time a trend developed. The number of county superintendents in Iowa steadily fell. See Appendix XIII.

It is possible that the trend also developed as a result of the ages of the people occupying the position. County superintendents tend to be older as a group than local district superintendents. See Appendix XIV.

House File 553 was enacted by the General Assembly in 1965. This was permissive legislation which allowed two or more county school systems to merge either by joint resolution of the boards involved or by petition. A new seven-man board would be elected to serve the multicounty unit.

In many ways this simply acknowledged an existing situation. During the 1966-67 school year, only forty-six of the original ninety-nine counties continued to employ a full-time superintendent. The remaining fifty-three county units employed twenty-three superintendents. One superintendent served four separate counties, but the majority served two. This meant working with two or more sets of personnel policies, budgets, programs and board philosophies. It was understandable that most county superintendents supported the legislation.[1]

The Code of Iowa, 1966, Section 273.22 authorized the State Board of Public Instruction to adopt criteria in addition to those set forth in the statute as conditions precedent for the approval of proposed mergers.

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[1]E. Robert Stephens and others, The Multi-County Regional Educational Service Agency in Iowa (Iowa City: Iowa Center for Research in School Administration, 1967), p. 1. (Hereinafter referred to as Regional Educational Service Agency.)

In a 1969 attorney general's opinion, the guidelines established were outlined as follows:

> . . . the state board established six guidelines without submitting them to the legislative departmental rules review committee and . . . such guidelines deny approval to all statutorily proper applications and agreements unless all six of the guidelines are met . . .
>
> > "These guidelines provide that all joint county systems shall be created within the boundary of one or more existing area vocational schools or community colleges; that not more than one 'regional educational service agency' unit will be approved within the boundary of any existing area of a vocational school or community college; that a 'regional education service agency' may be formed by a combination of contiguous county school systems and local districts not presently assigned to an area vocational school or community college providing all guidelines can be met; that in instances where a combination of an unassigned county school system or school districts fail to meet all guidelines herein specified they should be attached to a presently organized contiguous area vocational school or community college area; that an optimum of 30,000 students, preschool through grade 12, shall be enrolled in public schools of the area; 'that an optimum assessed valuation of $300,000.00 shall be available in the area'."[1]

The criteria clearly show that Paul F. Johnston's administration and the State Board of Public Instruction were strongly supporting the concept of sixteen regional education service agencies for the State of Iowa.

1967 - The Multi-County Regional Educational Service Agency in Iowa Report

The next extensive study supporting this concept was published in September of 1967. It was prepared by the Iowa Center for Research in

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[1]Nolan to Grassley, State Representative (Des Moines: Iowa Attorney General's Office, December 5, 1969), letter format.

School Administration at the University of Iowa for the Linn County Board of Education under a grant from the United States Office of Education - Grant No. OEG-3-6-000980-1701. Linn County surrounds Cedar Rapids, Iowa and is located in Area X. Entitled The Multi-County Regional Educational Service Agencies in Iowa, the report consisted of four chapters,

I. Background of the Study
II. The Major Needs of Public Elementary and Secondary Education in Iowa and the Need for a New Type of Educational Service Agency
III. Major Recommendations of the Study
IV. Major Benefits Resulting from the Establishment of a Network of Multi-County Regional Educational Service Agencies in the State of Iowa

Under Chapter II, four alternative approaches to revamping the county systems were discussed. They were:

1. Encourage the development of larger local school districts
2. Encourage cooperation between local units
3. Decentralize the state education agency
4. Provide services through post high school institutions.[1]

It is interesting that the suggestion to tie intermediate services to the community colleges, vocational schools or universities goes on to state:

> Although these agencies do have important roles to perform for public elementary and secondary education in the state, they are essentially consultative in nature. The primary role of post high school institutions is the provision of education programs for the post high school age population of the state. For them to dissipate their human and financial resources and undertake still another vital role would tend to weaken their existing commitments. Further, it is questionable whether or not personnel and policy-making boards can reasonably be expected to be competent in such diverse planes as would be required.[2]

Chapter III is by far the best presented and most thorough statement of what a regional educational service agency should be and do.[3]

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[1]Stephens, Regional Educational Service Agency, p. 10.

[2]Ibid., p. 11.

[3]Ibid., pp. 12-35.

Chapter IV lists the major benefits as follows:

1. Protect and promote local control and local determination in public education.
2. Equalize and extend educational opportunities.
3. Assure economical and efficient operation of many educational programs.
4. Improve the quality of many educational programs.
5. Provide a needed change agent in education.
6. Promote the restructuring of school government consistent with development in the public and private sectors.
7. Improve the coordination of local, regional, and statewide educational planning.[1]

If the study's findings are valid, one would anticipate that the more rural areas of the state would readily see the advantages as presented. Time would prove, however, that the more urban areas would show more interest in the allowed mergers. The study found that Iowa, which has been considered largely a rural state, will have by 1980 over 50 percent of its people concentrated in approximately ten standard metropolitan statistical areas.[2]

The study set five criteria, three considered to be major and two considered to be minor, for the establishment of area boundaries. They were:

Major Criteria

1. A minimum public school enrollment in grades K-12 of 30,000 students.
2. A minimum assessed valuation of $300,000,000.
3. A maximum of one-hour driving time from the service center(s) to local public school districts in the area served.

Minor Criteria

4. A minimum total population of 100,000.
5. A minimum number of 1,200 professional personnel in the local public school districts in the area served.[3]

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[1] Ibid., p. 36.

[2] Ibid., p. 38.

[3] Ibid., p. 14.

With the exception of the criteria that merged area boundaries could not be crossed, the criteria matched those adopted by the State Department of Public Instruction later.

In the 1969 yearbook of the Iowa Association of School Administrators, Dr. E. Robert Stephens, Assistant Professor of Educational Administration at the University of Iowa, urges that the term RESA (Regional Educational Service Agencies) be used rather than Intermediate Units.

He believes the term RESA better indicates the predominant function of special services that are better provided by a larger unit to the local schools. Dr. Stephens was in charge of the Linn County study.[1]

1968 - The Great Plains Project Report

The next and most recent study of Iowa's educational structure was entitled A Design for Educational Organization in Iowa. Published in June, 1968, by the Great Plains School District Organization Project, it was the result of an ESEA Title V project that involved the state educational agencies of Iowa, Missouri, Nebraska, and South Dakota. The study progressed from March 18, 1966 to June 30, 1968.

The purposes of the Great Plains School District Organization Project were identified as follows:

> 1. To improve the State Department of Education (Title V, and the primary basis for the entire grant).
> 2. To assist in resolving some of the major problems of State Departments of Education, including, but not limited to the following:
> --bringing about an increased awareness on the part of professional and lay groups of the need for adequate school district organization.
> --analyzing and clarifying the role of professional and lay organizations in school district organization.
> --developing guidelines to be used to implement programs

[1] Iowa Association of School Administrators, Eighth Annual Report (Cedar Falls, Iowa: Iowa Association of School Administrators, 1969), p. 122.

(a) for school district organization
(b) as a part of developed state plans
--providing comprehensive programs of quality education to meet the needs of all youth in all parts of the state.
--clarifying the role, function and need for intermediate districts.
--planning for adequate and appropriate follow-up services to those districts which have been reorganized.
--developing an awareness within each state of the relationships between tax structure, and rates and school district organization.
--providing data, information, understanding and insights essential for the introduction and passage of adequate legislation for school district organization.
--pooling the resources of the several states in making a joint attack on a common problem.[1]

Under the heading "Implication of Demographic Change for Educational Planning," the study suggested six specific implications for educational planning.

1. The criteria of a local community or a group of interrelated local communities as the basis for a school district is obsolete and indefensible.
2. Local school districts should be organized around city centers with populations of at least 2,500 to 5,000.
3. All area of each state should be in K-12 district.
4. Emerging demographic changes necessitate future school district reorganization be based upon comprehensive state-wide planning.
5. An enlarged and strengthened middle eschelon of school government should be developed in the four Midwest states.
6. Increasing attention must be directed to the problems of urban education in the Midwest.[2]

Many people read the report this far and stopped. The "Great Plains Report," as it was popularly referred to, caused a rebirth of concern regarding school district reorganization among the supporters of the small

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[1]Ellis G. Hanson and Ralph D. Purdy, A Design for Educational Organization in Iowa (Des Moines: State of Iowa, Department of Public Instruction, 1968), pp. 7-8. (Hereinafter referred to as Design for Organization.)

[2]Ibid., pp. 32-35.

schools. They interpreted it as a power grab by both the State Department and the urban or large school district supporters.

The area educational service agency was to have a sufficient pupil base and financial resources to permit development in at least the following areas:

--Administrative and staff personnel programs and services, including:
  Administrative and business management consultant services
  In-service programs for members of boards of education, school board secretaries and treasurers
  School building consultant services
  School district reorganization consultant services
  Electronic data processing services
  Public information services
  Cooperative purchasing programs
  In-service programs for classroom teachers, specialists, supervisors, consultants, and administrators
  In-service programs for non-certified personnel including transportation, food service, maintenance, custodial, secretarial and clerical
  Substitute teacher services
  Services for the state education agency
  Coordinative activities with other health, welfare, and social agencies in the public and private sectors, and other governmental subdivisions
--Instructional programs and services
  Educational media center
  Elementary and secondary curriculum consultant services
  Outdoor education programs
  Remedial instruction programs and services
  Health consultant programs and services
  Testing programs and services
  Institutionalized childrens' education programs
--Student Personnel Programs and Services
  Consultant services for student personnel programs
  In-service programs for guidance counselors and other professional personnel
  Other student personnel programs and services including graduate follow-up studies and drop-out studies
--Special Education Programs and Services
  Programs for trainable retarded children
  Work-study programs
  Programs for emotionally disturbed children
  Psychological and psychiatric services
  Programs for physically handicapped children and children with special health problems
  Programs for exceptional children of pre-school age
  Homebound instruction programs
  Programs for gifted children
  Programs for partially-sighted and blind children

Programs for hard-of-hearing and deaf children
Programs for speech handicapped children
School social work services
Programs for children with specific learning disabilities
Providing coordinative and cooperative efforts for the many health, welfare, and social agencies in the public and private sectors

--Research and Development Programs and Services:
Budget analysis and cost studies
Long-range financial planning
Community surveys
Enrollment studies
Pilot projects in various curricular areas
Evaluation of instructional materials
Development of local school district and regional norms for standardized tests
Evaluation of various types of organizational and grouping practices[1]

The tasks listed in the Great Plains Report are very similar to those listed in the previous studies. Although there seems to be general agreement among the professionals who recommend the tasks of the intermediate unit, in reality only two types of services have been extensively developed. They are special education programs and services and, to a lesser extent, instructional programs and services.

Two specific recommendations concerning the intermediate unit were presented.

> 8. A statewide network of area educational service agencies should be created to supplement and complement the efforts of local school districts.
>
> 10. The desirability of merging all area education programs and services (those provided by area vocational schools and community colleges and those provided by area educational service agencies) into one administrative organization should be assessed and appropriate action taken by the State Board of Public Instruction within the next 10 years.[2]

This was the last large-scale public relations effort to combine the functions of the regional educational service agency and the vocational school or community college function as it was presented in the 1963 study.

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[1] Ibid., pp. 139-140.

[2] Ibid., pp. 177-178.

In conclusion, the study found the organization of school government in Iowa in 1968:

1. Fails to provide equitable educational opportunity to all youth and adults.
2. Inhibits the development of comprehensive sequential educational programs and provision for services to meet the needs, interests and abilities of all youth and adults.
3. Encourages citizens to accept lower levels of quality than one deemed necessary and desirable.
4. Prevents realizing the maximum return from the tax dollars invested in education.
5. Does not encourage or permit the ready implementation of educational innovations in organization, curriculum, or technology.
6. Is not flexible enough to permit adaptation to changing social, cultural and economic conditions emerging within the state.
7. There is an absence of formalized coordination between various segments of the state system of education.[1]

The study itself was a thorough research project. It deserved a less emotional appraisal by the public than it received.

In an attractive twenty-four page booklet also entitled "A Design for Educational Organization in Iowa," the basic outline of the completed report was presented to the public. The inside cover of the booklet contained the following quotation:

> 275.1 Code of Iowa--It is hereby declared to be the policy of the state to encourage the reorganization of school districts into such units as are necessary, economical and efficient and which will insure an equal opportunity to all children of the state . . .[2]

No significant legislation arose from the study.

1970 - The RESA Compaign Continued

In the November, 1970, issue of Educational Bulletin, the newsletter published by the State Department of Public Instruction, there appears an

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[1] Ibid., p. 173.

[2] "A Design for Educational Organization in Iowa" - booklet (Des Moines: State of Iowa, Department of Public Instruction, 1968), inside cover.

article entitled "State Board Considers Legislative Recommendations." Among the recommendations is found:

> Regional Educational Service Agencies (RESA)
>
> Chapter 273 should be amended to require the merging of county school systems so that all areas of the state will be in a merged county school system by July 1, 1973. It is further recommended that the following criteria be adopted:
>
> 1. Any merged county school system should be created within the boundary of one or more existing area school corporations.
> 2. Not more than one merged county school system should exist within the boundary of any existing school corporation.
> 3. An enrollment, preschool through grade 12, should approach, as nearly as possible, 30,000 students.
> 4. Assessed valuation of an area should approach, as nearly as possible, $300 million.
>
> It is further recommended that provision be made in Chapter 273 to make it possible to adjust the boundary lines of a county school system, to permit a school district or school districts to become a part of an adjoining merged county school system.[1]

Within a ten year period an idea had taken several giant steps toward reality. Most educators felt it was only a matter of time until RESAs became a reality in Iowa.

1970 - An Educational Challenge for the 70's

The Iowa Official Register for 1969-70 states:

> Educational leadership is the major purpose served by the State Department of Public Instruction. Although the department provides other services, they are all subservient to and intermeshed with the guidance of educational endeavors in the state of Iowa. Through its leadership, the state department helps to mobilize, unify, and coordinate all the positive forces concerned with education for the dedicated purpose of its improvement--and to give common direction to the efforts of all.[2]

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[1] "State Board Considers Legislative Recommendations," Educational Bulletin, Nov. 1970, p. 4.

[2] Iowa. Iowa Official Register (Des Moines: Superintendent of Printing, 1969-70), p. 200.

In line with this philosophy the Department and the State Board attempted to identify educational goals for Iowa for the period 1970-75.

Mr. Johnston first presented ten broad areas of educational need in a speech given in September, 1969. Subsequently, another need was identified and added to the total. The State Board adopted them as official service goals for the period 1970-75.[1]

The "eleven imperatives," as they came to be called, were first published in the December issue of the Educational Bulletin. During 1970, an attractive pamphlet was printed and distributed. The exhibit of the Department at the 1970 fall meeting of ISEA was built around the eleven imperatives theme. The covers of both the October and November, 1970, Educational Bulletin were devoted to them. Large white, blue and green buttons advertising the goals were distributed among the profession.

The eleven imperatives in education for Iowa--as identified by the Department of Public Instruction and the State Board--are:

1. Strong programs of education and services for children of pre-kindergarten and early childhood age.
2. Strong programs of education and services for children and adults requiring special kinds of instruction.
3. Strong programs of education for people desiring to develop their skills in vocational pursuits and technical training.
4. Extension of vocational rehabilitation services to all persons who can benefit from such services.
5. Strong programs of teacher education in all areas, with special emphasis on the preparation of teachers for work with disadvantaged and handicapped pupils.
6. Continuing emphasis on equal educational opportunity for all of Iowa's children through organization of school districts into effective and efficient units.
7. Development of a statewide system of Regional Educational Service Agencies to supplement and support the instructional program of local school districts.

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[1]Iowa Association of School Administrators, Ninth Annual Report (Cedar Falls, Iowa: Iowa Association of School Administrators, 1970), p. 113.

8. Public understanding of the comprehensive programs offered by area schools as a service to individuals, agencies, businesses, and professionals.
9. Procedures for assessing and measuring the effectiveness of educational programs at local, state, and regional levels.
10. Continuing study and improvement of the financing of education from pre-school through community college.
11. Expanded programs of educational research and evaluation.[1]

The Search for a New State Superintendent of Public Instruction

In November 1970 Paul F. Johnston was unanimously reappointed to the position of State Superintendent of Public Instruction by the State Board of Public Instruction for a new four-year term after having served in the position for ten years. The appointment was subject to confirmation by the Iowa Senate, but Mr. Johnston announced a desire to have the nomination withdrawn in January 1971. This was reportedly due to pressure brought to bear by Iowa Governor Robert D. Ray.[2]

The press reported:

> Johnston has been the recipient of strong criticism over the years from rural legislators who contended his policies forced needless school district reorganization in the early 1960's and that his insistence on enforcing school standards has caused educational costs to rise sharply.
>
> His confirmation in 1967 came only after a stormy debate centering around a charge that Johnston was guilty of faulty planning which had left Iowa's new area vocational-technical schools and community colleges in the red.
>
> The board in withdrawing Johnston's nomination this year expressed regret but said it feared another confirmation battle "might damage the whole cause of education in the state."[3]

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[1] "Needs of Education in Iowa," Educational Bulletin, December 1969, pp. 4-6.

[2] Des Moines Register, March 20, 1971.

[3] Waterloo Daily Courier, February 28, 1971.

Various segments of the profession and the legislature expressed the desire that a large-city superintendent be appointed, that the new man stress development of the vocational-technical schools and that he allow the State Board to set policy and be content to carry out policy. Although many people were suggested as possibilities, the Board was unable to gain an appointee for over a year.

The biggest stumbling block was the salary Mr. Johnston was receiving--$23,000.00. Most large-district superintendents in Iowa made more than this and were reluctant to accept the job if it meant a cut in salary. The board urged the legislature to raise the salary, but the legislature felt it had to hold the line. The Iowa Association of School Administrators, on April 2, 1971, urged that the post receive a salary equal to that of a president of a state university. This would have placed it in the range of $36,500.00 to $40,000.00.[1]

The State Board of Public Instruction did not escape the consequences of their action. House File 293 would have returned the memberships on the Board to elective rather than appointive positions, but was never brought to the floor. It was also proposed that the Governor be given the direct power to appoint anyone, including people outside the education profession, by-passing the Board completely.[2]

In December 1971, Dr. James Walter, President of the State Board of Public Instruction, sent his resignation to Governor Ray. He announced that he felt his position "was in jeopardy" and that Governor Ray did not intend to reappoint him. He also said the Governor's influence on the

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[1] Des Moines Register, April 2, 1971.

[2] Des Moines Register, February 20, 1971.

actions of the board members was too strong. Mrs. Virgil Shepard was elected as his successor.[1]

In the spring of 1972, the State Board announced it had found a successor. He was Dr. Robert D. Benton, Superintendent of the Council Bluffs Schools. He had been educated in a one-room school near Guthrie Center, Iowa, received his B.A. and M.A. degrees from the University of Northern Iowa and his Ed.D. degree at Colorado State College. Dr. Benton's attitude toward the intermediate unit of education government and the sixteen regional media centers is unknown.[2]

Legislative Action in 1970, 1971 and 1972

The Legislative Session of 1970

President Nixon set the stage for debating school legislation in 1970 when he vetoed the entire national education bill on January 26, 1970. A wave of negativism seemed to settle in the state.

For the first time in its history, the House branch of the Iowa Legislature voted to place a limit on school spending. Acting on March 19, 1970:

> The major proposal passed 76-28 by the House and sent to the Senate, would clamp a 3-mill lid on the amount of property tax that can be levied for support of county school systems.
>
> It would also limit administrative expenses of a county school system to no more than 10 per cent of the amount raised by property tax levies.[3]

The bill later passed the Senate.

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[1] Waterloo Daily Courier, December 13, 1971.

[2] Iowa State Education Association. ISEA Communique, "Benton Becomes State Superintendent July 1," May 1972, p. 1.

[3] Waterloo Daily Courier, March 20, 1970.

The Senate saved the local school districts from the same fate when it voted 37-16 to reject a proposal to limit local spending to an increase of $50.00 per pupil over the 1970-71 budgets.[1]

On March 26, 1970, Paul F. Johnston, State Superintendent, announced that the State Board had agreed not to penalize schools that did not meet state approval standards which were to have taken effect in the fall.

> Gov. Robert Ray also singled out school standards in a speech to a joint session of the Legislature Wednesday on state financial problems.
>
> Ray drew his biggest applause of the speech when he announced he had asked the Department of Public Instruction to modify "any unncessary staff requirement regulations."
>
> The governor also asked for a moratorium on any new standards requiring additional staff.
>
> Among the standards involved is one which would require at least one principal for every two schools, effective this fall.[2]

Another standard that was weakened by a special bill passed by the legislature pertained to guidance counselors and librarians. It stated that they could be employed on a part-time or full-time basis, "as determined by the local board."[3]

In 1965 the Catholic schools in Iowa enrolled 92,757 students. By 1970 the figure was around 70,000. On the last day of the 95-day session, the legislature voted to help the parochial schools. The House passed it 110 to 5 and then the Senate voted for it, 37 to 14.

> The law permits county school systems to provide "ancillary" services to private and parochial school pupils on the same basis as to public school children.
>
> The county school systems provide special education services to youngsters with problems of speech, vision, hearing, reading and mental health.

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[1] Waterloo Daily Courier, April 15, 1970.

[2] Des Moines Register, March 26, 1970.

[3] Waterloo Daily Courier, April 13, 1970.

> Ray said the law "will be of great help to our private schools in meeting the serious problems of rising costs affecting both public and private education in our state.
>
> "The private schools fulfill a vital role in Iowa's educational structure, and I have long advocated assistance to prevent their passage into oblivion," . . .[1]

The Legislative Session of 1971

With the adoption of a conference committee report by a vote of 30 to 16 in the Senate and 63 to 27 in the House, the Legislature approved the "freezing" of tax support for Iowa's 453 local school districts.

> The measure would forbid Iowa's 453 local school districts to raise more operating money from property taxes for 1971-72 than they are collecting this year.
>
> It would also freeze the two major categories of state school aid at this year's levels, equilization aid at $115 million and the share of income tax collections earmarked for schools at $40 million.
>
> Each school district would get the same amount of equalization aid and income tax money in 1971-72 as it received this year. The only new money provided would be additional state aid of $45 per pupil based on next fall's enrollment.
>
> The extra $45 per pupil would allow local school spending to go up by 5.2 per cent next year over this year's $875 per pupil statewide average.
>
> County boards of education would be limited to a 1 1/2 per cent budget increase next year for everything except special education program costs - and under a Senate Amendment approved Tuesday, the program costs of special services provided by county systems.[2]

The attitude held by many educators toward the "freeze" was expressed by the editors of the Des Moines Register:

> If Iowa were one big school district with an adequate education program and a static enrollment, 1971-72 school spending freeze bill now before the Iowa House would not result in inequity or deprivation.[3]

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[1] Waterloo Daily Courier, April 30, 1970.

[2] Waterloo Daily Courier, February 24, 1971.

[3] Des Moines Register, February 4, 1971.

Most educators and several legislators were concerned with the worsening financial situation.

In a speech at Marshalltown, Lt. Governor Roger Jepsen predicted that the bill:

> will put a permanent freeze on the maximum tax that a school district may levy on property.
> . . . . . .
> "And then we say that from here on any increase in school budgets has to be directly related to the growth of the state's economy, . . ."[1]

This comment and the fact that four separate plans for school aid distribution were defeated in the House led the ISEA (Iowa State Education Association) to dramatically vote "public censure sanctions" against Governor Robert D. Ray, Lt. Governor Roger W. Jepsen and the Iowa General Assembly. Ironically, the announcement came during the Governor's Conference on Libraries held on April 30-May 1, 1971.

Rey Satory, President of the Iowa State Education Association said:

> This action was taken because these elected leaders have failed to exert positive leadership in developing the kind of educational program we feel parents and other concerned citizens expect the schools to provide, . . .
> Our censure should be viewed as an expression by Iowa teachers that unsatisfactory educational conditions exist in this state . .

The editorial board of The Des Moines Register commented on the reactions of Governor Ray and Lt. Governor Roger Jepsen:

> Ray called the statement a "pompous pronouncement," and Jepsen called it "impulsive negativism." It's the closest the two have com to agreement in several weeks.
> . . . . . .
> The statement censures some specific actions dating back to 1969: (1) Holding the line on state school aid for 1969 and 1970, forcing property taxes up to meet the cost of inflation and rising enrollment and creating the present

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[1] Des Moines Register, April 16, 1971.

[2] Des Moines Register, May 1, 1971.

> "crisis." (2) The 1971-72 school spending freeze passed by the Legislature which the ISEA says will force cutbacks in staff and materials to the detriment of education. ISEA survey [sic] schools to determine how budgets were being trimmed. (3) Failure to provide funds to "maintain quality" at state universities. (4) Failure to finance area community colleges "in proportion to their growth." (5) Failure to set a "realistic" (that means "high enough") salary for state superintendent.
>
> The emphasis of the censure statement is on the tone and temper of current discussion of school finance plans, not the plans themselves. A spokesman for the ISEA explained it as a reaction to Capitol Hill debate which seems more concerned with who is going to pay and how much than with school quality.[1]

Governor Ray warned the ISEA that the action would "backfire" and the Association did come under heavy attack from the conservative press. For example:

> One of the primary reasons why all local and state taxes have reached staggering levels in recent years is the fact that many local school boards along with the State Board of Public Instruction and State Board of Regents, have allowed professional educators to take over the policy-making responsibilities that properly belong with the lay boards.
>
> Now officials of the Iowa State Education Association, sated with their new power, have the unmitigated gall to publicly censure the elected representatives of the people.[2]

Part of the furor was due to an attempt to eliminate the County School Systems. The Governor's Educational Advisory Committee had recommended reorganization of Iowa's 453 school districts into about 100 county-size units and the total elimination of the intermediate unit. This approach had little public support.[3]

Representatives Michael Blouin of Dubuque and Keith Dunton of Thornburg, both Democrats, sponsored a bill to incorporate the county systems

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[1] Des Moines Register, May 5, 1971.

[2] Bill Severin, Waterloo Daily Courier, May 3, 1971, p. 1.

[3] Des Moines Register, March 6, 1971.

within the framework of the area community colleges. Rep. Dale Cochran, Democrat from Eagle Grove, sponsored the RESA or Regional Education Service Agencies bill which was the approach most favored by the county superintendent's group. On February 18, 1971 Rep. Laverne W. Schroeder, Republican from McClelland, filed a bill designed to destroy the intermediate unit and transfer its function to:

> . . . the superintendent and board of the local school district nearest the county seat.
> "The power of self-government resides with the individual (local) school corporation," the bill states. "There shall be no immediate education unit established to function between the State Board of Public Instruction and the school corporation."[1]

These bills did not receive serious consideration.[2]

Political columnist Bill Severin explained the bill that received th most attention:

> Three members of the Iowa House were to file a bill Thursday that would abolish single county and multiple county school districts and replace them with what is described as a cooperative educational service agency.
> The agency would be governed by a board of directors composed of one member of each school board in the district it served.
> The board would have no independent taxing powers, but would finance its programs by assessing the costs against each participating school corporation, with the costs assessed based on the extent or participation.
> Sponsors of the bill are Charles Grassley, R-New Hartford, chairman of the House schools committee, Harold Fischer, R-Wellsburg, and Charles Knoblauch, Sr., R-Carroll.
> Rep. Grassley says that the goal of the bill is to hopefully reduce the number of special service programs offered and give each school district the opportunity to determine to what extent it wants to participate in each.[3]

The bill was House File 592. Critics attacked it for four reasons:

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[1]Waterloo Daily Courier, February 18, 1971.

[2]Bill Severin, Waterloo Daily Courier, April 20, 1971, p. 1.

[3]Bill Severin, Waterloo Daily Courier, April 8, 1971, p. 1.

1. It ignored the concept of "one man - one vote" completely. Rep. Grassley answered that this need not apply since the body in question was not a tax levying body.

2. It did not guarantee that every child in the state would have access to equal special education programs. Entire geographic areas could stay out of the cooperatives on the basis of the local school board's decision.

3. The fact that local districts could make yearly decisions on buying separate services made long-term planning impossible.

4. The newly-designed system ignored the private schools.

The bill failed to reach the floor of the House. Rep. Grassley lacked two votes of sending the bill out for debate, but it had forced many educators to think seriously about the problem.

Bill Severin summed up the situation at the end of April:

> For at least the last 10 years everyone at each legislative session seems to have been agreed that the county systems are outdated and outlived their usefulness with the passing of the one-room country school. Yet no one seems to have been willing to come to grips with the problem - up to now.
>
> With three concrete proposals now in bill form, it appears that the legislator is finally getting ready to tackle this problem. It is probably too late in this session to get the job done.
>
> But the revamping of the county school system should be made one of the first orders of business for the 1972 session.[1]

It was.

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[1]Bill Severin, Waterloo Daily Courier, April 20, 1971, p. 1.

The Legislative Session of 1972

The 1971 session ended with the establishment of an interim committee charged with the study of School District Structure and Educational Standards. The committee was composed of five senators and five representatives. It was co-chaired by Senator Charlene Conklin and Representative Charles Grassley. Experts in various fields were invited to serve in an advisory capacity on the committee, but they were not allowed to vote.

In December 1971, the committee made its recommendation to the Iowa Legislative Council. Under the plan, the Department of Public Instruction would assume all regulatory and data processing control held by the county school boards. The "area schools," fifteen community colleges and vocational schools, would control the special education programs and operation of media centers. The new system would eliminate one tax-levying body since it would be financed by a complicated formula involving assessments to the local school districts and reimbursement from the state.[1]

The House acted on the bill early in the session. It was successfully amended in the Schools Committee to establish an independent, elected, area-wide, lay board which would control policies, programs and budgets without tax-levying powers. This amendment to the bill made it unacceptable to the Schools Committee Chairman Charles Grassley. He voted against bringing the bill out for floor debate, but was defeated.

As soon as the amended bill was filed as House File 291, Rep. Grassley filed an amendment that reestablished the original concept. The bill was debated and passed in three hours on one day. Rep. Grassley's amendment was scheduled for first debate. Rep. Vernon Ewell, Democrat-Waterloo,

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[1]Waterloo Daily Courier, December 13, 197-

filed a substitute amendment to the Grassley amendment. The Ewell Amendment would have mandated that by July 1974 all existing county school systems join a joint county system under the law of 1965 that allowed this. It required that three counties merge or if the student population exceeded 30,000, it allowed two counties to merge. The amendment froze the tax levy at a rate of 3.5 mills. It had the approval of several county superintendents, but it was quickly defeated 55-27. The Grassley Amendment passed 60-29 and the final bill passed 63-28. The day of passage was February 29, 1972.[1]

On March 2, Rep. Grassley and Senator Conklin spoke with the media center group for two hours. This was a period of extensive lobbying by educators and parents and on March 10, 1972, Senator Conklin announced that the Senate Schools Committee would not send the bill out for floor debate.

> Mrs. Conklin told the Senate Friday that there had been a lot of "misinformation" from local areas about the purpose of the bill.
>
> She said more time is needed to study the matter before it is finally passed.
>
> Gov. Robert Ray Thursday signed a bill to make contracts of county school superintendents effective for only one year instead of the usual three so that if a bill is passed to eliminate the county systems, there wouldn't be several superintendents with two years left on their contracts and no systems to administrate.
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> Mrs. Conklin said the decision to defer the matter was made Thursday night.[2]

Rep. Grassley, however, decided not to give up easily. He asked to meet with the State Board of Public Instruction at their regular meeting March 16, 1972.

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[1] Statements by Rep. Vernon Ewell, personal interview, May 28, 1972.

[2] Waterloo Daily Courier, March 10, 1972.

> . . . In his opening comments Representative Grassley indicated he had asked for the opportunity to meet with the Board since in previous discussion with the Board by members of the House Schools Committee, interest had been expressed in the provisions of H. F. 291. He stated it had been his hope that this bill would have complete discussion in the Senate but apparently it had no chance of coming out of the Senate Schools Committee for further consideration . . . He felt many misconceptions had been conveyed by various individuals and groups as to the actual provisions of the bill and the possible effects it might have in the general education program of the state.[1]

An exchange of questions and answers concerning the proposal then followed. The Board gradually moved to Rep. Grassley's position.

> Mr. van der Linden . . . asked Representative Grassley if he felt there was any possibility of the Senate discussing this legislation before the close of the session. Representative Grassley responded that from statements he had seen attributed to Senator Conklin, it appeared that the Senate Schools Committee was not going to give consideration to this bill.
>
> He felt that considerable damage had been done to possible consideration of this legislation by the large city superintendents when representatives of this group had met with the Senate Schools Committee on March 9. He indicated it was his understanding that they had expressed concern for administration of this program by area boards of directors and had recommended that the bill not be considered by the Senate.[2]

The Board continued to debate the possible actions they could take.

> President Shepard asked Superintendent Johnston what his position was in regard to H. F. 291. He responded he had only had one contact from a member of the Senate in regard to his position on this legislation. He responded he would give the same reply to the Board as he had given to the Senator on the request. His reply had been that H. F. 291 was a vehicle by which a change could be made in the current apparent impasse in regard to resolving the problems of the county school system. He felt there were some areas of the bill that were not adequately written in regard to assuring the continuance of certain programs and services but that it was definitely a vehicle that provided an opportunity

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[1] Iowa State Board of Public Instruction, Official Minutes, Meeting of March 16-17, 1972, p. 7.

[2] Ibid., pp. 8-9.

> for change in the current status of the county school system. He further pointed out that he had indicated to the superintendents of the state that he felt they collectively would not be able to resolve the problem and present a common position on modification of the current county school system. He felt the legislature would, by necessity, need to make this change. H. F. 291 was a framework to obtain a start toward such change in this structure and to get something done. He also pointed out that the original position of the State Board several years ago was the concept of one board administering services and programs for the intermediate unit as well as for the community college and area school.[1]

The Board decided to invite the 22 large city superintendents in the state and the officers of the Iowa Association of School Administrators to meet with them at 10:30 a.m. on March 17. It was decided that they would not contact Senator Conklin until the meeting had been held.

The following day, the Board met with the President and Executive Secretary of IASA, thirteen of the twenty-two largest city superintendents and two county superintendents. Although they had not been invited the Board allowed the Director of Special Education for Polk County (Des Moines), the Executive Director of the Iowa Council for Area School Boards and the Executive Secretary of the Iowa Association for Retarded Children to attend.

> President Shepard read the motion passed by the Board at the previous day's meeting in regard to the request of contact with Senator Conklin in regard to the position of the Board requesting that the concepts of H. F. 291 be considered at the current session of the General Assembly. She stated that because of the priority for needed change in the current provisions for the county school system the Board had felt an input from the large city superintendents and the officers of the IASA would be of assistance on this matter.[2]

Thirteen superintendents then presented their reasons for not supporting H. F. 291. Only Mr. William Dabb, Superintendent of Ottumwa Community

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[1] Ibid., pp. 9-10.

[2] Ibid., p. 16.

Schools spoke in its favor. "He reported that of the 28 local superintendents in Area XV, 26 indicated full support for this legislation."[1]

> President Shepard asked Superintendent Johnston if he had any comments to make concerning the various presentations. He responded that the problems associated with the county school system were not new or unexpected. He stated that the staff and the Board had worked toward some revision of this level of school administration for many years. He also pointed out that the general reaction through the years of school administrators had been one of apathy to supporting change in this system . . . He stated he hoped that the administrators would be able to reach a common solution to this problem. He stated that education did not need anything to further divide the various factions concerned with the profession. He reviewed attempts he had made through the years to obtain some legislation in this area and the very limited success that had been experienced. He indicated there apparently was nothing like a crisis to obtain some solution to the problem. He felt the Board had a commitment from the new State Superintendent to continue to work toward a solution in this area. It was his opinion that any comments he would make at this time would have little impact on this the total situation. He did feel that the request from local administrators for an additional year of study was reasonable but he was not highly optimistic that they would be able to reach a common solution to this problem.[2]

The conversation moved on to the possible consequences of acting during this session. Federal funds, personnel contracts, and the financing structure were discussed. During this time President Shepard left the room to telephone Senator Conklin informing her of the Board's action.

> President Shepard reported she had been in phone communication with Senator Conklin and she had expressed grave concern over the action taken by the Board in regard to proposing support for the concepts of H. F. 291 Senator Conklin had indicated she felt this action was both irresponsible and unpardonable on the part of the Board. President Shepard reported she would attempt further contact with Senator Conklin on this matter.[3]

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[1] Ibid., p. 20.

[2] Ibid., p. 22.

[3] Ibid., p. 23.

Up to this time, only two area schools, Area X - Cedar Rapids and Area XV - Ottumwa, had openly worked to acquire the K-12 service programs. However, Mr. Ray Stephens, Executive Secretary of the Iowa Council of Area School Boards indicated how the majority of the area schools felt by his statements. He said he would

> . . . like to clarify the position of his organization in regard to some of the comments made during the discussion of the morning . . . It was his opinion that if given a chance to study the specific legislation presently in the schools committee in the Senate, many administrators that had expressed opposition would have some of their concerns alleviated . . . He suggested that it might be possible for representatives of the IASA and the city superintendents to meet with representatives from the Iowa Council of Area Boards over the weekend to resolve some of these problems. It was his feelings that a compromise could be reached and this could be conveyed to the Senate by Monday morning. He indicated that he and the boards he represented were willing to work at any time or any place with the local school administrators in regard to adjustments in this legislation . . .[1]

Superintendent Johnston spoke in opposition to a weekend meeting and the suggestion was dropped. President Shepard thanked everyone for attending and the last threat of passage of the bill in the 1972 session passed.

During the spring of 1972, the Iowa Supreme Court ruled unconstitutional the 1971 session's reapportionment plan. The Court then remapped the entire state on a "one man - one vote" principle. Representative Grassley announced he would seek reelection. Senator Conklin announced she would not run again. The Interim Legislative Committee on School District Structure and Educational Standards continued to meet with the restructuring of Iowa's intermediate school systems as the priority item.

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[1] Ibid., pp. 24-25.

Summary

The establishment of Iowa's sixteen regional educational media centers has depended on the strong support of two levels of educational government; namely, the Department of Public Instruction and Iowa's county school systems. Both agencies were willing to provide support because they saw the establishment of the centers as an opportunity to further their service goals.

The Department of Public Instruction had been concerned with three basic problems: providing equality of educational opportunity for all children, reorganization of local school districts into larger and more efficie units and providing educational leadership to a changing profession.

The county school system had been established in 1858 to provide regulation, leadership and direct services to the thousands of small schools existing in the ninety-nine counties. At the time of their establishment they had served as the "regional concept" of service. As a century passed, however, they became inefficient and uneffective in providing new educational services that contemporary educators viewed as indispensable.

In April 1960 a report entitled Effective Intermediate Units in Iowa was published. This marked the beginning of twelve turbulant years of both DPI and county school personnel actively working for a reformed intermediate level of educational government in Iowa.

In May 1963 Superintendent Johnston called sixteen meetings of local school superintendents under a program entitled "the State Plan for Improvement of Education in Iowa." This was the first attempt to establish "regional concepts" with local school people.

In 1965 the Iowa General Assembly allowed two or more county school systems to legally merge their service areas. They allowed the establishment

of a system of regional community colleges and vocational schools, and county school and local school people were involved in establishing boundaries.

At this same time DPI submitted a state plan to the federal office for ESEA Title II monies that used the boundaries of the newly-established community colleges and vocational schools to establish a system of regional educational media centers to receive all federal monies under the program. The county school systems were asked to cooperate by supplying monies for physical facilities and personnel.

Mr. Paul F. Johnston served in the office of State Superintendent of Public Instruction from January 1961 to June 1972. While serving, he exerted as much influence as he could to modernize and strengthen the Iowa school government structure. He was particularly committed to the concept of strong regional educational services agencies and saw the sixteen media centers as an auxiliary to them. Mr. Johnston was succeeded in office by Dr. Robert D. Benton in June 1972. Dr. Benton had committed himself to support the State Board of Public Instruction's expressed desire to see the county school systems replaced with regional educational service agencies.

During the 1971 and 1972 sessions of the Iowa General Assembly the House Schools Committee was active in attempting to reform the structure of the county schools. There is general agreement in Iowa that the county school structure needs to be changed. The problem is lack of general agreement among educators and legislators on the structure needed to continue current services, including the operation of the media centers. It is expected that the problem will be debated in both houses of the Assembly in 1973.

PART II

IOWA'S PLAN FOR ESTABLISHING SIXTEEN REGIONAL EDUCATIONAL MEDIA CENTERS AND THE PROGRAM'S HISTORY

Any person studying Iowa's ESEA Title II plan should become aware of the controversy that has surrounded it since its inception. A knowledge of the points of contention lead to a greater appreciation of the subtilties and nuances of the program's history.

The basic objection to the Iowa plan was simply that the law had been intended to aid local school districts develop building media centers. Many people, particularly media specialists, feared that regional centers would supplant local effort.

The remaining objections fall into three categories.

1. Criticism of the Department of Public Instruction--Administrators wrote the plan with little or no advice from media specialists or classroom teachers. It was claimed that the sixteen regional media centers were designed as a political tool which could be used by DPI to further the cause of their proposed regional educational service agency (RESA). No provisions were made for continuation of the program at the end of its five-year life. No financial support was provided by the state for the administrative support of the centers. There was a lack of leadership exhibited by the Department of Public Instruction and all sixteen centers moved in sixteen different directions.

2. Criticism of the Regional Administration of the Program--Sub-agency chairmen were slow to recognize the importance of providing media specialists to develop the regional programs. Too many centers began operation with minimal local support for operation. The methods of material selection used were inadequate for building useful collections. The centers were really depositories. Lack of catalogs and delivery systems left the materials unused. Personalities and differences in regional program offerings greatly affected the centers.

3. Criticism and In-Fighting Among Education Professionals--School administrators favored any media program that was easy to administer. They also wanted to replace rental films from the universities with free films. Audio-visual specialists argued that the bulk of regional monies should be spent on non-print materials with books kept in the local buildings. School librarians agreed that the books should be kept in the buildings and opposed the entire concept of regional centers supported by ESEA Title II.

The above criticisms are mentioned to provide a setting for the history that follows. Several arguments favoring the centers will be offered. All the factors involved will be discussed further in the sections entitled "The Controversy that Raged Over the Iowa Program in 1966-67" and "A Subjective Evaluation of the ESEA Title II Plan in Iowa."

The Writing of the Plan

The Elementary and Secondary Education Act of 1965 (ESEA) was enacted as Public Law 89-10 on April 11, 1965 and was funded in October, 1965. The writing procedure of the Iowa Plan, in many ways, increased the controversy surrounding it. It is necessary to understand how the plan was conceived in order to appreciate many of the objections raised by its opponents.

Placing the Plan in Its Departmental Context

The Iowa ESEA Title II Plan must be discussed in context. It must also be seen in proportion to the surrounding issues. Public Law 89-10 had many sections or titles included in it. Most of these were of interest to DPI and several required that state plans be written. The writing alone was a heavy burden for a rather small staff.

Dr. Richard N. Smith comments on the problems faced:

> A review of the state board minutes of April 16, 1964 discloses one of the major problems connected with federal legislation dealing with new educational programs. Congress enacts new legislation which requires the drafting of a state plan. However, the Congress fails to appropriate funds to be used by the state department of education of the respective states to hire additional personnel so that the state plan can be written. This results in adding more responsibilities to an already overloaded staff and the concomitant inadequate preparation of the state plans. To this must be added the effect the passage of the new legislation has on the school districts. The minutes point up this problem as follows:
>
> "Mr. Graeber stated the problems associated with a state plan were almost overwhelming. He indicated the office had been deluged by letters and communications from schools requesting how they could make application for funds and that it was more than a full-time job of the present staff in trying to maintain some semblance of communication with the schools on current problems. This left no time for the solution of the major problem which was to write the state plan itself."[1]

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[1]Richard N. Smith, Development of the Iowa Department of Public Instruction 1900-1965 (Des Moines: State of Iowa, Department of Public Instruction, 1969), pp. 58-60.

These comments were made one year before the massive ESEA bill was enacted.

The years 1963 to 1965 were years of change and rapid growth for the Department. The Department foresaw increases and changes in the staff caused by ESEA. The April and May state board meetings in 1965 were spent on a proposed long-range plan for the organizational structure of the Department. There had been two staffing problems in the past. There was more work to be done than there were people available to do it. Because the staff was overloaded there was no one with the time to plan and review the Department's operation.

Effective July 1, 1965, the Department experienced a major reorganization. There were to be seven branches each headed by an associate superintendent not responsible for day-to-day operations. These men were to sit as a total group, referred to as "the cabinet," and coordinate the entire operation. A new planning and development staff was to work with the associate superintendents in the initiation of programs.[1] Within this atmosphere, the Iowa plan was produced.

The Writing Procedure

In 1967, DPI published nine mimeographed sheets of paper entitled "Steps Followed in the Development of the Iowa State Plan for Making Available School Library Resources and Other Instructional Materials, Under Sections 201-207 of Title II and Sections 601-605 of Title VI of the Elementary and Secondary Education Act of 1965 P.L. 89-10." This document traces the writing procedure. It does not, however, use the names of individuals and in this way falls short of being satisfactory as a complete record. Hereinafter, it shall be referred to as "the official document."

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[1] Ibid., pp. 60-61.

The official document states that four members of the staff were appointed to develop the Title II plan in May, 1965. They were to represent the areas of audio-visual education, librarianship, and supervision and curriculum (elementary and secondary).[1]

In actuality, the members were chosen by their supervisors in May. On June 3, 1965, William J. Edgar, the Director of the Curriculum Division, sent a memo to four staff members setting the first committee meeting for June 9th. The meeting was not held, however, until June 14th. The four members of the committee were Clifton L. Kessler, Audiovisual Consultant; Max Morrison, Regional Consultant; Gladys Horgen, Elementary Consultant; and Betty Jo Buckingham, Library Consultant.[2]

In addition to the meeting on the 14th, the committee also met on the 16th and 17th of June. The work of this committee, which was primarily advisory in nature, was finished shortly after this time. This committee did not actually write the plan.[3]

At the committee's first meeting the members were told that Iowa's allotment for fiscal 1966 was $1,483,765.00 of which 5% or $74,188.00 could be used by the state for administrative purposes. This left $1,409,577.00 available for distribution.

The provisions of Title II were summarized for the committee as follows:

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[1]Educational Media Section, "Steps Followed in the Development of the Iowa State Plan for Making Available School Library Resources and Other Instructional Materials, Under Sections 201-207 of Title II and Sections 601-605 of Title VI of the Elementary and Secondary Education Act of 1965 P.L. 89-10" (Des Moines: State of Iowa, Department of Public Instruction, 1967), p. 1. (Hereinafter referred to as "Development of the State Plan.").

[2]Letter from Betty Jo Buckingham, Library Consultant, State Department of Public Instruction, Des Moines, May 25, 1971.

[3]Ibid.