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THE LIVING CASE: AN INTELLIGENT SYSTEM FOR PROVIDING CASE INSTRUCTION

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ABSTRACT

One of the primary methods of instruction in business education is the case. However, some of the basic learning goals associated with case instruction are compromised by its form of presentation. We have used new forms of media, involving computing and communication, to build a novel learning environment, *the Living Case,* which flexibly and interactively presents cases along with dynamic, on-going feedback to students while they work. Key to providing meaningful assistance during case analysis is the ability to model and interpret student behavior.

Several investigations were conducted in order to understand the process of case analysis. Case analysis is characterized as a problem solving activity driven by *comprehension and reasoning* operators. Twelve hours of protocols are analyzed using "retelling profiles" as an interpretation mechanism for further specifying the operators involved in analyzing a case. Retelling profiles are visual time plots of the activities undertaken in a reading task. Our preliminary results suggest a deeper structure to case analysis which is common across business disciplines, cases, and analysts, and therefore implementable in a system like Living Case. Differences between the analysis strategies of experts and novices are formalized in terms of the experts' use of "templates" of typical company behaviors. This provides the basis for building mechanisms to instruct and re-orient case analysts using the Living Case system.

The Living Case system is described along with some of the insights gained during its construction. Future research directions and instructional uses of the system are also discussed.

1. INTRODUCTION

The case method of instruction is fundamental to teaching in business and other professional disciplines (e.g., law). It is known for the complexity of issues that accompany its design, use, and evaluation — not only does it require specific classroom skills on the part of the instructor and analytic skills on the part of the student, but case construction itself is an art. Many of these complexities are attributed to the diverse range of teaching and learning objectives associated with the case method (Christensen 1981; Argyris 1980; Carson 1954; McNair 1954). One important objective of the method is the development of reasoning in students by teaching them skills of problem identification and diagnosis.

The case method, as implemented currently in classroom settings, requires students to read and analyze a written case prior to the class meeting; prepare, usually, a written analysis of the case; and participate in a group discussion about the case solution and analysis in class, led by the instructor. It is our belief that the present form in which case material is presented to students, that is, as a written, linear case description, constrains some of the potential inherent in this method of instruction. Moreover, although the case method purports to teach business problem identification and solution, the way it is presently implemented makes it, in fact, relatively weak for these purposes. Our vision is that technology could permit the creation of a richer, more interesting learning environment for case instruction.

The pragmatic long term goal of our research is to build this new information technology (IT) supported learning mileau for business case instruction. This research goal supports a more dynamic case analysis environment where (1) the material presented is more flexible in that student actions and decisions determine the content and sequence of case information displayed and (2) the student's analysis and solution is critiqued and corrected, *on-going*, as the analysis proceeds in real time. The key issue to be addressed here is the mechanism for providing feedback to the student that is customized to his or her particular learning needs. Our primary aim in the research presented in this paper is to report on the design elements of the new learning environment and to

formalize a model which will enable an IT based system to recognize and interpret a student's behavior while he or she is analyzing a case in order to provide relevant assistance in solving the case at hand.

As part of this effort to construct a computational model of the case analysis activity, we set out to understand the ***process of case analysis***. Case analysis is an unstructured domain where expertise is not well defined and steps to reach a final solution are not well specified. In such domains, it is useful to explicate the *process* of performing a task, here the process of analyzing a case. Understanding the process of analysis will help in tracing the mental schema and logic that guide a student's case solution. This will permit diagnosing the reasons of shortfalls in analysis. We have studied business case analysis protocols with the aim of gaining insight into the models and strategies used for case analysis. This understanding of the case analysis process has provided the basis for designing components of a more flexible, active case instruction and learning environment.

This paper is exploratory in that it reports on our investigations into the process of business case analysis and instruction as well as the status of our attempt to construct an active, less linear learning environment. The paper is organized as follows: Section 2 is a description and critique of the current method of presenting information in case instruction. Shortcomings of the present implementation of case instruction provide the rationale to introduce a novel approach to the delivery of cases, which we call ***the Living Case***. Section 3 presents a conceptual model of case analysis based upon conclusions from secondary data analysis and expert interviews. The domain of case analysis is cast as a *comprehension and reasoning activity* which suggests an overall strategy for system implementation. Section 4 summarizes interpretations from twelve hours of case analysis protocols. Cognitive activities are inferred from *retelling profiles*, which are aggregate representations constructed from observing the sequence of reading activities. Experts appear to use *analogical strategies* to analyze a case efficiently. Early in the process, experts match case facts to a *template of typical company behaviors* which they have constructed from experience in their memory. Subsequent analysis is guided by a desire to verify the applicability of the template to the current case scenario. Section 5 builds on the understanding gained of the case analysis process and provides a detailed description of various components of the Living Case system. Finally, section 6 describes the difficulties we have encountered in designing the system, the issues that remain to be resolved, what we have learned so far, and the future direction we expect our research to take.

2. THE CASE TEACHING ENVIRONMENT

A major portion of the pedagogy for case instruction was developed at the Harvard Business School and they are the largest publishers of business cases. A teacher either evaluates written case solutions submitted by students and/or leads a class discussion involving the groups' analysis. The varied perspectives and approaches taken by different members of the group in identifying and diagnosing a problem from the same case material is a major contributor in building each student's repertoire of analysis skills. A case is a description of a business decision or problem normally written from the point of view of a decision maker. More precisely a business case is

> a record of a business issue which actually has been faced by business executives, together with surrounding facts, opinions, and prejudices upon which executive decisions had to depend. These real and particularized cases are presented to students for considered analysis, open discussion and final decision as to the type of action which should be taken (Gragg 1954).

In the case method of instruction, students are not given general theories or hypotheses to criticize. Rather, they are given specific *facts*, the raw material out of which decisions have to be reached in life and from which they can realistically and usefully draw conclusions (Gragg 1954). They are provided with an opportunity to solve problems in real situations and to obtain feedback on their answers. Each participant starts with the same information from which different solutions are suggested. In cases, as in real business situations, many solutions are possible; recognizing this is an important part of learning.

In their current form, case material is presented as a written document, varying in length from a few to several tens of pages, often with tables, charts and other forms of data. In comparison to real business situations, written cases have the following shortcomings:

- *Sequential presentation of material:* Case documentation tends to be linear in structure, often following a time or simple story line. The linear presentation does not facilitate making rapid associations or comparisons among the details of the situation. This hampers an intuitive assimilation of facts and patterns and does not support opportunistic recognition of atypical and uncommon activities that often trigger insights in good organizational diagnoses.

- *Organized exposure to information relevant to the business situation:* The case material presented is selective, focused and reasonably consistent — an artifact of the written medium. Reality is chaotic, complex, dispersed and inconsistent; order in this situation must be imposed by the observer.

- *Static representation of case materials:* In the current format, case material is static - it does not change based on actions the student takes during reading and analysis. There are no revelations, and the student cannot discover new information beyond those insights provided by colleagues and the instructor during class discussion. No feedback is provided dynamically as the analysis proceeds; this would be valuable in reorienting the *process* of analysis as opposed to merely the final solution. The student analyst can therefore not learn from analysis mistakes in a what-if kind of exercise.

- *Information is presented in a single, print medium:* Real situations make use of a variety of information sources: observations, written material, telephone calls, chance encounters, meetings, pictures, people's expressions, triggers from prior experience, etc. Although one's imagination can create great richness out of words, narrative fades in comparison to actual experience. There is a great difference between reading *about* something and experiencing it more directly using more than one sense.

In short, current methods for presenting and teaching business cases have limitations. The selection of material to be included in a case and the structure imposed on it by the case author prompt students in problem identification and diagnosis. The student is essentially led through the material with conclusions often following naturally from the material presented. Working with this ordered and relatively consistent set of material is far different than the type of information gathering and sense-making skills one needs in order to investigate *real* organizational problems. In real situations, the challenge is to recognize what information is important and to understand what it means in context.

Chi and Greeno (1987) have described the current approach used for presenting business cases as *directive and guided techniques* for teaching. We believe that this method does not adequately support the learning objectives of case instruction, which has a major goal of teaching problem identification, diagnosis and solution. Students should conduct a realistic analysis in the simulated world of a business case. Learning is expected to take place when students apply their procedural knowledge, processing logic, and inferencing skills to massage case facts into a solution. When students independently analyze a situation by applying prior skills, they appreciate the process and intricacies of problem identification and diagnosis in a decision situation (Tuma and Reif 1980; Arlin 1977). However, we maintain that the current form of written case presentation directs and guides the student toward which data to consider important in analysis, and leads the student through the inferencing sequence in-built in the case narrative. The cuing and prompting inherent in the rigid structure of the written case detract from developing the student's independent analytic skills, thereby compromising one of the objectives of case analysis.

Learning by discovery is an alternative often advocated in the teaching literature as an effective approach for domains where inference and induction skills are important (Eysenck 1984; Carroll, Paine and Ivancevich 1972; Taba 1966). In this method, students are allowed to gather their own data, form hypotheses about problems and solutions, and then accumulate additional confirming or refuting information. Advantages of the independent discovery approach in the long term development of a student's conceptual thinking and processing logic have been stressed by many researchers in the education area (Bruner, Oliver and Greenfield 1956; Norman 1984; Johnson-Laird 1983). We maintain that a more flexible, active and interactive approach to the presentation of business cases is needed. The original philosophy of case education will be well supported by such an approach. Our goal is to create an environment that is more conducive to learning by discovery than is the present method of case presentation and to investigate the consequences for learning of such an environment. The *Living Case* is a concept that provides for such flexible and active case presentation, thereby promoting the discovery approach to case education.

2.1 The Living Case: A New Environment for Case Instruction

We believe that new technologies present an opportunity to implement some of the improvements suggested by the above pedagogical discussion. For example, a personal computer could be used as a delivery vehicle for cases permitting great flexibility in the sequence and structure of material presented to students. In a manner similar to some computer games, a student could explore an organization by following information leads in a non-directed manner and independently uncover new data while investigating a problem. Such a system need not be static. The student could actively run analyses on prepared data using a standard set of analytical tools (e.g., spreadsheet, database system). In addition, the system could monitor student activity and provide appropriate

feedback, for example, hints and suggestions to a student that was lost in analysis. This would accomplish one of the primary goals in education: customized instruction for each student. Color, graphics, video, and sound all can be used to make a business case more interesting and, through the use of multiple senses, more vivid. Case instruction now takes place in large classrooms requiring all students and the instructor to be present together. We see no reason why technology cannot be used to permit synchronous, multi-location case discussions, both for case preparation and instruction. In fact, this may be one of the promising applications of "groupware" for instruction. We have called this vision of an active, flexible, "multi-media" case presentation environment the ***Living Case*** to signify its life-like and realistic features.

The *Living Case* is a case instructional system that has been designed to explore some of the notions of learning by discovery by making use of computer and communications technology. It consists of three subsystems:

- Case Authoring
- Case Delivery
- Student Tutoring

The *Case Authoring* subsystem provides facilities for the design and construction of business cases. It permits creating, editing and linking text, graphics, video and audio material into a form that is compatible with the other two subsystems, including the construction of data structures and databases. The system contains knowledge about case construction, organizations, case instruction, and manipulation of various media.

The *Case Delivery* subsystem is the interface between the student and a set of materials and data structures which comprise a case. It permits manipulation of the case materials and provides a set of features to assist the student in his/her analytical activities. Section 5 contains a detailed description of the user interfaces and special features that have been developed for the case delivery subsystem.

The *Student Tutoring* subsystem monitors the student using the Case Delivery subsystem during case analysis. It records the student's behavior, attempts to interpret this behavior, and forms messages for student feedback based upon both a model of expert analysis for this particular case and student behavior. The Student Tutoring subsystem is the mechanism that makes the system adaptive and permits it to be customized to the instructional needs of each student. It is a central element of the system and one of the primary foci of this paper. In section 4, we investigate a concept for the design of this portion of the system.

Prior to constructing the Living Case, it was important to learn more about the process of case instruction. We now report our findings of this investigation.

3. THE CHALLENGE OF DESIGNING THE LIVING CASE: A DEEPER, CONCEPTUAL STRUCTURE

The first phase of our research was primarily directed at understanding the factors that define and identify "good" case analysis. Intuitively we felt there should be a deeper structure for case analyses that was common across disciplines. Only if such a common, deeper structure existed would it be possible to model the case analysis process in terms of the tasks, procedures and strategies it involves. The design of various components of the Living Case could then be based on a representation and delivery of this shared, abstract conceptual model of the case analysis process.

In order to explore the existence of commonality in the case analysis process at a useful level of abstraction, we distilled material from an analysis of teaching notes that accompany business cases and semi-structured interviews with experts using business cases for teaching their courses. We interviewed seven faculty members in the areas of Accounting, Business Policy and Operations Management from the business school at New York University (NYU). The faculty experts were asked to describe their views of a good case analysis. Each of the interviews lasted between twenty minutes and forty-five minutes.

In our view, the major difficulty in specifying common primitives for the case analysis process originates from the numerous degrees of freedom allotted to a "good" analysis. Responses of the experts and reviews of teaching notes suggest that case analysis does not have an algorithmic procedure that can be reduced to a step by step routine guaranteed to provide a correct solution. Additionally, our interviewees supported the prevalent view that quantitative and qualitative case analyses had very different flavors and processes, i.e., they did not share common case analysis strategies and procedures. However, faculty member descriptions of distinguishing factors that contributed to the indeterminism of the case analysis process were *consistently* in *consensus*. The major factors cited were

- *Multiple correct answers:* Most teachers spend 75% of class time discussing issues and "painting a picture" and only 25% of the time discussing the case solution. Different students could have radically different solutions to the same case; yet their analysis could be judged at par if logically supported with relevant

facts. It is the *process* of arriving at a solution that is important, not so much the solution itself.

- *Centrality of context and semantics:* The issues and facts in a case lead to an inference only as a group, not in isolation. The significance and implication of a case fact can be judged only in the context of other situational facts.[1] This means that domain knowledge is not in the form of time invariant logical implications from facts, but instead it is contextual, combinational, and probabilistic. A system like Living Case cannot be equipped with a cookbook of answers for the case analysis domain.

- *Story understanding kind of comprehension:* Teachers are more interested in developing the students' ability to sketch a cohesive account of case events, richly embellished by both past knowledge and experience of the student, and the unfolding of relevant facts in the current case. They stress skills of comprehension and integration of evidence in students to combat the natural limits of human memory.

The result is that case analysis is classified in terms of generalities, rather than as a precise, predictable procedure amenable to formal specification. In the absence of narrowly restricted do's and don'ts, right and wrong paths to a solution, and indeed, one correct answer to the analysis, it would be difficult to model case analysis in a precise manner. As a result, we found it more useful to cast case analysis at a more general and abstract level. Our interviews and analysis of teaching notes (Matejka and Cosse 1981; Ronstadt 1977) had indicated that the most frequently described procedure for case analysis consisted of

(1) read the case,

(2) extract significant highlights from the business situation,

(3) identify the problem not explicitly stated in the case,

(4) generate alternate courses of action (solutions), and

(5) evaluate alternate decision solutions.

The objectives behind these steps can be interpreted in terms of a deeper structure to the case analysis procedure. We characterize the above process description as a generalized *problem solving* method. In this perspective, case analysis can be modelled along the lines of Newell and Simon's (1972) characterization of human problem solving. Problem solving is described as beginning with an *initial state* of problem facts and ending at a predefined *desired goal-state* of solution facts. *Operators* are applied to the initial state to produce intermediate states (Figure 1). Operators are selected based on their ability to reduce the difference between initial state and goal state. Each new intermediate state has a reduced difference from the desired goal state and is treated as the initial state for the next iteration of operator application.

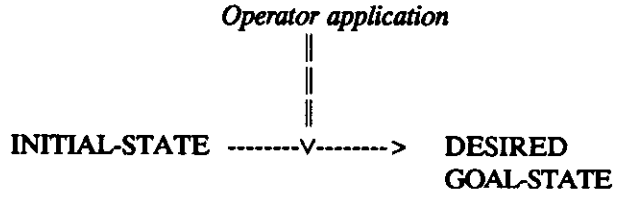


Figure 1: Model for Human Problem Solving adapted from Newell and Simon 1972)

To recast case analysis in terms of problem solving primitives, Steps 1 and 2 require the student to construct the INITIAL-SITUATION, as described by the case facts. Step 3 requires the student to understand the dynamics and make better sense of the INITIAL-SITUATION by identifying a problem that explains the constellation of facts in the INITIAL-SITUATION. Step 4 requires reasoning from the INITIAL-SITUATION to a DESIRED GOAL-SITUATION by applying alternate actions. This required reasoning is performed by the application of what we term **REASONING OPERATORS**.

In the case analysis domain, the INITIAL-SITUATION is voluminous and general. The entire case has far too many facts for the analyst to keep track. Limitations of the human short-term memory as an information processor have been well documented (Cyert and March 1963). It would therefore be reasonable to expect that the INITIAL-SITUATION, as described by the case facts, is continuously *abstracted* so as to maintain it in a more concise and summarized form to combat effects of memory overload resulting from excessive amounts of case facts being read (Norman 1984). The comprehension required to assimilate an ABSTRACTED-SITUATION from the INITIAL-SITUATION being read in the case is achieved by the use of what we term **COMPREHENSION OPERATORS** (see Figure 2).

A review of literature from the reading comprehension area distinguishes between comprehension and reasoning. Comprehension is described as "understanding what is read in the lines" while reasoning refers to the abstract ability of "extracting meaning via reading between the lines and reading beyond the lines in a hypothetico-deductive manner" (McCarthy 1976).

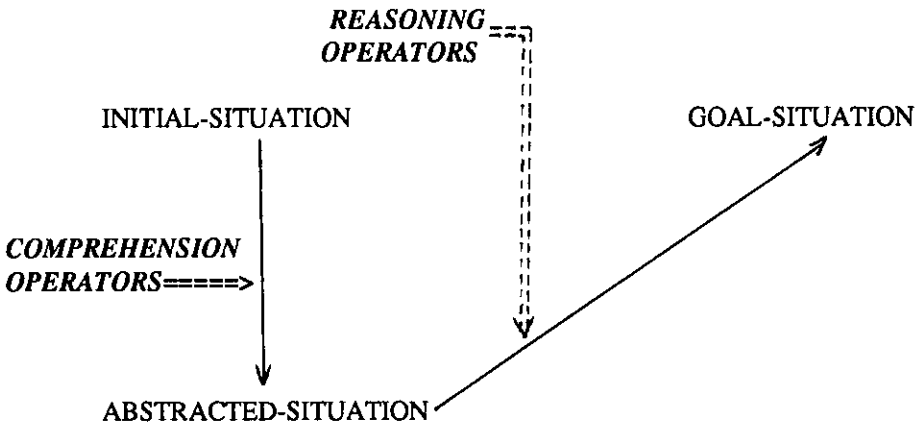


Figure 2: Case Analysis as Comprehension and Reasoning Process

In order to design the Living Case, we wanted to construct a model of expertise that formalizes the *process* by which a case is analyzed: the way an expert approaches analyzing a case. Casting case analysis as primarily a process of applying COMPREHENSION OPERATORS and REASONING OPERATORS to the facts of the situation has provided us with an overall framework for investigating such a model. First, a model of expertise in terms of the application of COMPREHENSION and REASONING OPERATORS is likely to be common across business disciplines. Using this as the basis for designing the elements of Living Case would enable wide applicability and usability. Second, if it is the application of these operators that produces a successful case solution, then a record of the sequence and frequency of operator application could provide valuable clues to the analysis rationale of a subject. This would further our objective in the Student Tutoring subsystem of providing customized, on-going feedback to a student as he is analyzing a case. Third, the application of these operators could be mapped to observable analysis activities that can be tracked and logged by the Living Case system. A taxonomy of case reading activities is tested in the next section as potential input signals which can be used to interpret operator application, which in turn can be aggregated to infer problem solving strategies and procedures. The ability to track these case reading signals as a means to recognize operator application will then determine in large part the user interface of the Case Delivery subsystem.

Following from the above observations, in the next section we model the comprehension and reasoning processes of an expert case analyst at a finer level of detail in order to be useful in providing customized feedback and in specifying some requirements for the user interface.

4. USER MODELLING FOR THE LIVING CASE

The theoretical background that provided guidance for observations and modelling objectives in our research design derives from work in the related areas of User Modelling and Intelligent Tutoring Systems (ITS). ITSs are computerized implementations which offer many of the features appropriate for the Case Delivery and Student Tutoring components of the Living Case concept. Research on ITSs has attempted to continuously monitor a student's learning so that teaching and feedback can be tailored to the individual student's needs while learning is actually taking place, i.e., hey can dynamically adjust teaching (Sleeman 1982). A "user model,"a vital component of any such individualized system, constructs a model by utilizing signals from the user's interaction with the system. User models are abstract representations of each individual user along dimensions relevant to the task domain under consideration (Rich 1983). Techniques for creating effective user modelling components in ITSs have been developed and utilized in many systems (Kass and Finin 1987; Sleeman and Brown 1982; Self 1974). A prerequisite to a user model is an "expert model." The strategies an expert brings to bear on successfully solving a problem reflect important regularities and invariants in the task environment that are not explicit and are learned after many years of practice and internalization (Hayes and Simon 1976; Todd and Benbasat 1987). Formalizing the process of expert case analysis will ensure an efficient and effective design of various elements in the Living Case.

We analyzed twelve case analysis protocols to help model the process of analysis. Protocol analysis is a process tracing method that attempts to discover the dynamics of problem definition, hypothesis formulation, information search, and decision phases of human problem solving

(Ericsson and Simon 1980; Todd and Benbasat 1987; Turner 1990). It involves recording the spoken articulation and actions of a subject during task execution and analyzing them at a later time. The notion is that it provides access to what information a subject examines and the manipulations or evaluations conducted on this information. Concurrent protocols involve having subjects "think-aloud" during actual task execution. Scoring, or tabulating frequencies of certain key items of interest, is one of the methods that can be used to analyze the resulting think-aloud protocols. The objectivity of scoring and the generation of the coding scheme based on a priori hypotheses are some of the major factors that need to be ensured for this method to ensure reproducible results.

Twelve think-aloud case analysis protocols, six each from the areas of Business Policy and Accounting, were tape recorded. The subjects were a convenience sample from Faculty experts at NYU and were chosen to represent three groups: quantitative experts (from Accounting), qualitative experts (from Business Policy), and student experts (from Business Policy). The student experts were identified by the faculty member in charge of the relevant course as being an expert case analyst. Each protocol consisted of the analysis of a short case in the subject's area of expertise. All qualitative area subjects analyzed the same case (from Accounting) and all quantitative area subjects analyzed the same case (from Business Policy).[2]

4.1 Methodology: A Taxonomy of Reading Activities

The recorded protocols were analyzed in terms of the reading activities undertaken by each expert. In order to build an a priori coding scheme, a preliminary list of reading activities was constructed from a review of the reading literature. We borrow from the work of Harste and Burke (1978) which developed a framework of activities capable of representing any reading task. The seven different types of activities involved in reading and understanding any text range from "restating" text in the reader's own words to "confirmation/dissonance" which involves the reader searching for cognitive meaning. (See items 1 through 7 in Table 1.) During later scoring, we found that certain portions of the protocols we tape recorded could not be classified as any of these seven activities, thus calling into question the completeness of the Harste and Burke scheme. An example of such an unclassifiable protocol portion would be "this company might be operating in a recessionary industry." To make the list of activities adequately representative for classifying the case analysis protocols, we added two activities to the inventory of these seven reading activities, *Generation of Hypotheses* and *Deduction/Induction* (see items 8 and 9 in Table 1). Closure was established when the list was capable of exhaustively classifying each line of all protocols into one or another reading activity.

Table 1. Taxonomy Of Reading Activities (Adapted from Harste and Burke 1978)

1) RESTATING
2) STATING A RELATIONSHIP
3) SUMMARIZING/GENERALIZING
4) CLASSIFICATION
5) CONTEXTUALIZATION/JUDGEMENT
6) EXTENSION
7) CONFIRMATION/DISSONANCE

ADDITIONS TO READING INVENTORY
(Based on protocol coding requirements)

8) GENERATION OF HYPOTHESES
9) DEDUCTION/INDUCTION

Using definitions of comprehension and reasoning processes (Section 2.2), we classified the expanded list of nine reading activities into two categories: reasoning related activities and comprehension related activities. The descriptions of the activities are based on Harste and Burke's definitions. Table 2 presents this classification of activities along with their descriptions.

As the first step, each line of each protocol was classified as one of the nine reading activities of Table 2. Tables 3 and 4 use selected portions of protocols to illustrate the protocol scoring scheme. As the second step, this resulting listing of reading activities for each protocol was used to construct a *retelling profile* for each protocol (Harste and Burke 1978). A retelling profile is a time trace of the reading activities undertaken by the subject as he reads through and attempts to understand the case. Visually, the profile is a plot of time on the X-axis versus the reading activity undertaken on the Y-axis. It very succinctly displays the cognitive routes which the reader travels in an effort to construct meaning and analyze the case. The amount of cognitive activity involved in a reading task is a function of the frequency of switching among different activities. Note that the sequence of stacking the reading activities determines the visual look of the curves. Since the amount of cognitive activity is a function of the *frequency* of switch between the different activities rather than the distance of switch, the interpretation of the profile should be based on the number of switches between activities rather than the height of peaks. If this factor is kept in mind during analyzing the retelling profiles, it does not really matter which stacking order is chosen for the plots.

Table 2. Descriptions of Comprehension and Reasoning Activities

READING ACTIVITY	COGNITIVE BEHAVIORS
I. Comprehension Related Activities	
1. RESTATING	The text is restated using his own words. Subject considers this important, or does not understand the author's language.
2. STATING A RELATIONSHIP	Discovering a relationship that joins two propositions in the text, not explicitly joined by the author.
3. SUMMARIZING/ GENERALIZING	An attempt to organize data which crosses multiple propositions in the text. Results in abstraction and reduction of information overload.
4. CLASSIFICATION	Involves placing a new proposition in a data category, relative to case information already encountered.
5. CONTEXTUA-LIZING/JUDGEMENT	Involves making sense of an already known proposition in light of new facts.
II. Reasoning Related Activities	
6. EXTENSION	States a *new* proposition seen as relevant extensions of the text by applying past lessons and experiences.
7. GENERATION OF HYPOTHESES	Involves extrapolating from a set of already read facts of the text by applying concepts taught in theory.
8. CONFIRMATION DISSONANCE	Statements that demonstrate the reader is still engaged in search of cognitive meaning. Can relate to explicit facts read read from the case, or to extensions and generations from explicit text.
9. DEDUCTION/ INDUCTION	*Inferred* statements that manifest as chains of propositional hypotheses by applying causal or correlational relations derived from theory or experiential heuristic.

A smooth curve signifies that *changes in cognitive activity* are minimal. This is not to say that there are not high levels of cognitive processing within reading activities. Rather, we have regarded the nine reading activities as a useful level of abstraction of cognitive activities for the purposes of modelling expert case analysis behavior. Minimal changes in cognitive activities could have one of two explanations. Either the subject is not attempting to understand, or not capable of understanding, the text and therefore not many reading activities are getting triggered. Or else, the subject is well-versed in the domain of the text being read and therefore does not need to engage in much cognitive processing (switching) in order to understand the text. Most often, an evaluation of the quality of the resulting analysis/solution can help in differentiating between these two cases. Similarly, an erratic or widely fluctuating curve could mean that the text itself is difficult to understand for the subject's level of expertise. Neither shape of the retelling curve is good or bad by itself; a consistent difference or uniformity in the shape of the curves from subjects of varying expertise performing the same task can, however, provide valuable insights into the process of performing the task being investigated.

As the final step of analysis, we compared retelling profiles of the different groups of experts in our sample: qualitative, quantitative and students, observing similarities and differences in the activation and sequencing of cognitive activity. These activities provide a blueprint for recognizing broad categories of user behavior. Our goal to aggregate reading activities over some time span larger than a single line into meaningful chunks of analysis behavior that could help in understanding the processes undertaken by experts in different phases of analysis.

Table 3. Annotated Excerpts from an Expert Protocol

TIME INTO ANALYSIS (%)	READING PROTOCOL (Text in italics represents an activity; remaining is verbatim case text being read aloud)	ACTIVITY CODING
0	...announced the highest sales in company history, lowest aftertax profits (as a percentage of sales) in many decades, and the retirement of its long-tenured president and chief-executive officer, Jerome Adams. ***So profits going down inspite of sales going up***	RESTATING
5	...founded in 1848, the Adams Company had long been identified as a family firm both in name and operating philosophy. ***Ah hah! Large family run organization, doing well so far. They're getting into operating trouble now***	SUMMARIZING/ GENERALIZING
16	...In 1980 all branches of the family owned or influenced less than one fifth of the outstanding shares of Adams. ***Oh, so family run was a thing of the past, now they control only 20%***	CONTEXTUALIZING
25	...Adams led the industry in the development of unique processes that produced a quality product at low cost and it paid off for a long time. ***Right. Originally, during their family run era they did very well.***	STATING A RELATIONSHIP
30	...But all that has changed in the past 20 years. Our three major competitors have outdistanced us net profits and aggressiveness. ***Because of their family ethos, aggressive competitiveness does not come naturally to them***	EXTENSION
35	...Our gross sales have increased to over $1 billion...net profits dropped....consumer action group designated us "best value".....we have fallen behind in marketing techniques, our packaging is just out of date. ***Problem is the entrenched family sense. Family run businesses get mismatched to today's professional management***	GENERATION OF HYPOTHESES
40	...salespeople were on straight salary with an expense reimbursement plan, which resulted in compensation under industry averages. ***Uh huh. Typical of family businesses. There's no such thing as an aggressive salesman if he is paid below industry averages. It probably worked in the family days, like in the Japanese culture even today.*** But...**	DEDUCTION/ INDUCTION

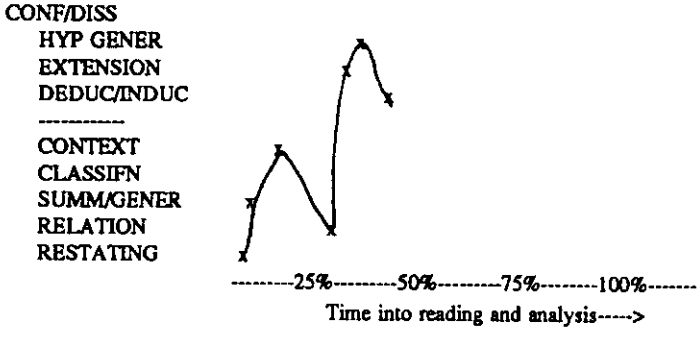
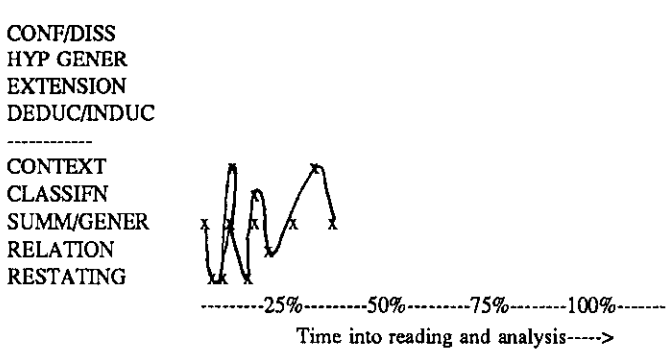
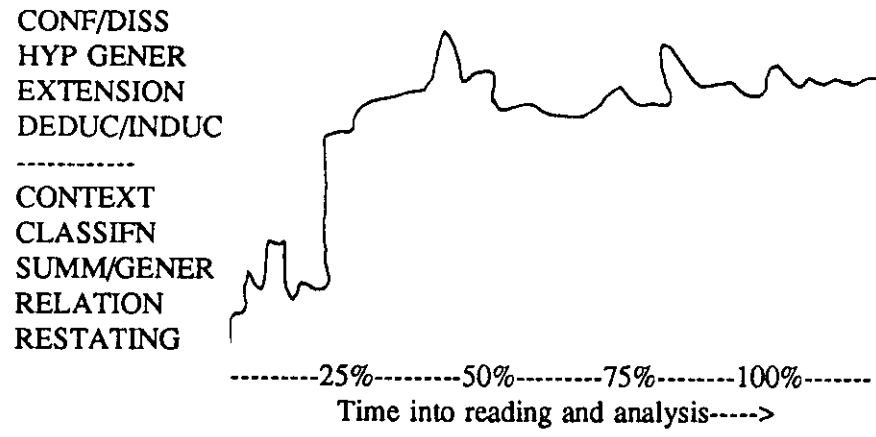


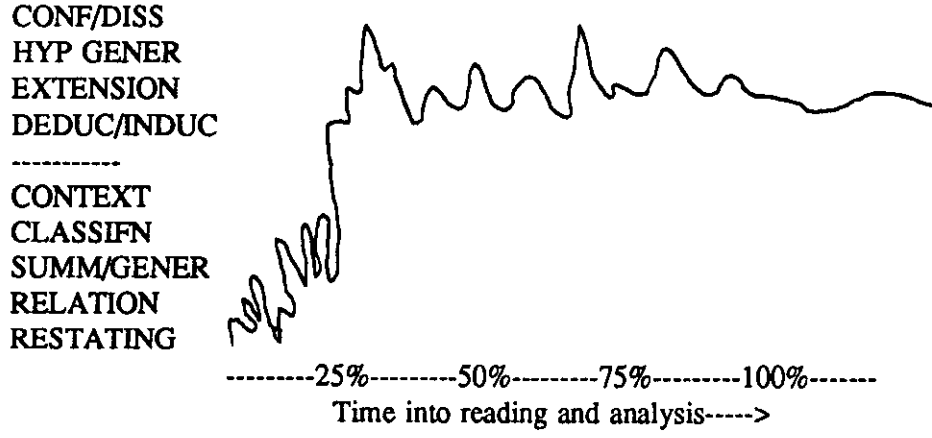
Table 4. Annotated Excerpts from a Student Protocol

TIME INTO ANALYSIS (%)	READING PROTOCOL (Text in italics represents an activity; remaining is verbatim case text being read aloud)	ACTIVITY CODING
0	...announced the highest sales in the company's history, lowest aftertax profit (as a percentage of sales) in many decades, and the retirement of its long-tenured chief executive officer....***There is a fundamental change in the environment of this company. Low profits, highest sales, retirement...all are suspect***	SUMMARIZING/ GENERALIZING
5	...Holy Bible and the concept of family stewardship provided all guidelines needed to lead his company. company. ***Interesting. Holy Bible***	RESTATING
7	...goodness of mankind, power of fair play, and importance of personal and corporate integrity were his trademarks. ***Those are traditions of the sixties***	RESTATING
	Anytime a family or senior member leaves an organization, I'm worried that it is trouble	JUDGEMENT
	I got to get an idea of the dates here. Is it the sixties here? Company founded in 1848. Today is 87. So what's the grandfather involved in this? Is the gradfather Jerome Adams? Uh, I'll figure it out later.	SUMMARIZING/ GENERALIZING
12	...all branches of the family owned or influenced less than one-fifth of the outstanding shares. ***One-fifth. Hm...still enough to run the company***	RESTATING
15	...of quality, brand-name consumer products for the American, Canadian, European markets. ***Well, here we finally get to find out the type of product. Quality brand name consumer products. What does that mean? Consumer products, whatever they are***	SUMMARIZING/ GENERALIZING
20	...sold by a company sales force in thousands of retail outlets. ***So what are we looking at here? Sneakers. Hm...hm...whatever***	CLASSIFICATION
25	...always been production-oriented and volume-oriented and it paid off for a long time. ***OK. That's nice. I guess competition got stiffer and that explains their profits down***	STATING A RELATIONSHIP
28	...Our strategy was to make a quality product, distribute it, and sell it cheap. ***OK. Obviously they are not a regional company. Sales offices all over***	SUMMARIZING/ GENERALIZING
35	...all salespeople were on straight salary with an expense reimbursement plan, which resulted in compensation under industry average. ***I've never known a salesman...a good salesman who would work straight salaries. So why aren't they paying them commissions?***	JUDGEMENT
	** *OK. Corporate structure seems adequate***	SUMMARIZING

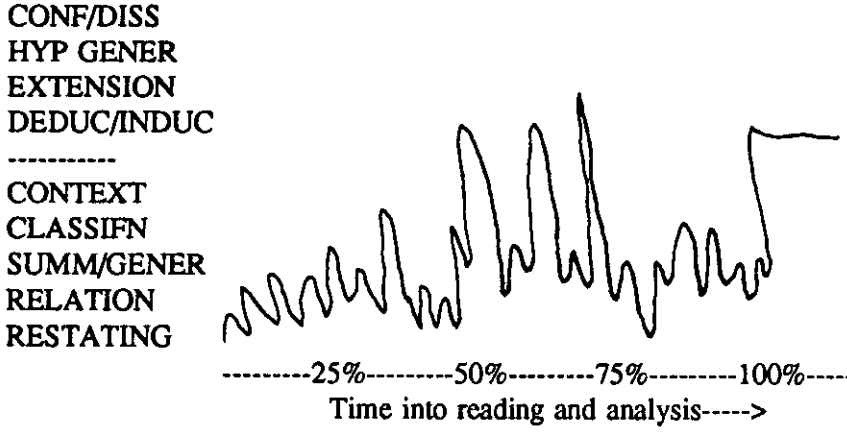




(i) QUANTITATIVE ACCOUNTING EXPERTS



(ii) QUALITATIVE ACCOUNTING EXPERTS



(iii) STUDENT ANALYSTS

Figure 3. Schematic Representation of Retelling Profiles

4.2 Interpretation: Differences and Similarities in Case Analyses

Figures 3a, 3b and 3c are a schematic presentation of retelling profiles for the three groups of experts in our sample. They are schematic in the sense that they depict only the general trend of each profile curve. It was necessary to choose this summarized form of presentation in the interests of brevity. The figures plot comprehension related and reasoning related activities stacked up as two separate groups on the Y-axis and time (into *reading*) as the X-axis. We chose to group these activities together on the visual plot in order to make our observations clear to any reader. However, as explained in the previous section, the imposed ordering does not bias results or conclusions in any way. The retelling profiles extend beyond 100% time, which means that time for *analysis* usually extends beyond the time taken to read through the entire case.

The research started out with only two sets of experts: qualitative area experts and quantitative area experts. However, we found the retelling profiles of the three expert-students in our sample consistently different from the qualitative area faculty experts. In addition, the student retelling profiles shared a common underlying pattern. Accordingly, we treated them as a separate group and report on their analysis behavior separately. This finding has an important significance from the student tutoring point of view. It means that the Living Case system could track retelling profiles via a student's reading interactions and differentiate between non-experts and experts. The major observations and comparisons between the three groups of subjects analyzing the case are summarized below.

1. **All Experts:** Very soon in the analysis process, their retelling profile shifted from comprehension to reasoning related activities. In fact, once in the reasoning phase, almost no more comprehension activities were undertaken. Experts have a reasonably smooth curve and do not seem to exhibit high amounts of change in cognitive activity in terms of widely fluctuating curves. Since experts, by definition, perform a good quality of analysis, a smooth retelling curve in this context suggests they were not switching frequently among activities. Once in an activity, they remained in it for a while. This is suggestive of a feed-forward control scheme which is characteristic of experts who know what is ahead.

2. **Experts Analyzing Qualitative Versus Quantitative Cases:** Our experimental design administered a different case for analysis to each of these two groups. Therefore, the observed differences between the groups cannot be conclusively explained: differences could result from differences in the nature of the cases or from the nature of the expertise in the two groups. In general though, the overall character of the profiles is almost identical. The only differences arise from the lesser use, by quantitative experts, of comprehension activities in Phase 1 and the larger use, again by quantitative experts, of the DEDUCTION/INDUCTION activity in Phase 2. We believe this results from the nature of the case being analyzed rather than any differences in the abilities or analysis strategies of the subjects in the two groups. The quantitative case was oriented toward financial statement analysis requiring many more calculations using equations/relations. This requires repeated DEDUCTION activity.

3. **Experts versus Non-Experts:** This comparison yielded the most interesting contrast. Students continued performing comprehension activities until the very end of the case, with very sporadic use of the EXTENSION activity. Subsequent to reading and comprehending the entire case, they engaged in concentrated DEDUCTION/INDUCTION activity. The amount of switches among cognitive reading activities displayed by students is also much higher than experts (a much more fluctuating curve). Since the same text, i.e., the case, did produce a smooth curve in the experts group, the non-smooth curve indicates that students struggled and cognitively worked more than experts in analyzing the case. The erratic, widely fluctuating nature seems to imply that their quest for meaning in the text appeared to be very undirected and rather unfocussed.

In sum, experts appeared to analyze cases in two phases: a short phase involving comprehension and a longer phase involving reasoning activities. Once in the reasoning phase, expert subjects remained in that phase rather than return to comprehension. Students differed from experts by remaining in comprehension activities over the entire case reading session and then beginning concentrated reasoning activities only at the very end.

Observations from the retelling profiles have allowed us to make considerable headway in formalizing the case analysis process. If the Student Tutoring subsystem of the Living Case can track the reading activities being undertaken by a subject while analyzing a case, it may be able to interpret the problem solving phase that the subject is engaged in. Moreover, the profile of reading activities undertaken could also serve to distinguish among subjects with different levels of skills. Most importantly, our work suggests that case analyses in areas as diverse as Accounting and Business Policy may share a

deep underlying structure that is common at the level of a generic problem solving process.

4.3 Expertise in Case Analysis: Analogical Strategies

The retelling profiles have helped formalize the process of case analysis but have not explained the source of differences in behavior between novices and experts. The explanation of differences is necessary for a complete specification of the expert case analysis models as well as for re-orienting non-experts with efficient analysis strategies. What might explain these differences in problem solving behavior between experts and novices for case analysis?

Strategies are designed to direct case analysis with a minimum of effort, both to speed up time and reduce strain on cognitive activity (Bouwman 1983). The retelling profiles indicate that experts, in our sample, did not analyze each situation afresh from basic principles. Instead, they seemed to jump, early on, to very directed, deliberate application of cognitive activities. Based on numerous studies of expert behavior in a large variety of task domains, the key determinant of expertise is the availability of task specific knowledge (Turner and Kumar 1991; Chi, Feltovich and Glaser 1981; Hayes and Simon 1976). Experts possess a large task-specific "knowledge base" which allows them to recognize many different situations upon which to draw as a source of hypotheses and direction (Turner 1987). These seem to be stored in memory as an image or template that characterizes typical firm behaviors. When cases and situations can be solved by recognition of previously encountered patterns, *efficiency of analysis* and decision making is greatly enhanced (Norman 1984). Solution by analogy is a strategy adopted by experts in many fields (Vicinanza, Prietula and Mukhopadhyay 1990). It enables reduction of a very complex or difficult task by recognizing similarity with an already completed task.

Consider, for example, the following extract from a protocol.

> I see they [the company] have almost no competitors...monopoly...and stable industry....I guess they might want to grow further....let's see what they are doing with their profit margin. I bet their product costing needs work....and such companies always have good debt to equities (Quantitative Expert Subject).

This subject looked at certain information and decided it was a "stable company." Subsequently, alternative problems such as low profit margin and work needed on product costing, suggested themselves a priori. In addition, certain associated case facts, such as growth objective and good debt ratios, were assumed and marked for verification with a subsequent reading of the case.

Our protocols suggest that ***templates of typical companies*** are a key component of expert analysis. Research in other areas such as chess, linear programming, physics, and financial analysis has also established the critical importance of templates (DeGroot 1965; Newell and Simon 1972; Bouwman 1983; Dhar, Lewis and Peter 1988). A list of typical firm behaviors, often encountered in real life and in written cases, exists in the vocabulary of experts analyzing a (business) case. These templates are cast in terms of the issues and concerns relevant to the experts' business discipline. A template has many advantages. It codes different probable data categories under one convenient label: firm facts, associated problems, and workable action decisions. As the expert reads the case, a combination of case facts already assimilated matches the data slots in some template. This triggers the expert to remember other data associated with that template. Subsequent analysis is then guided by a motivation to confirm the applicability of the template to the case situation. Once a template is confirmed as being valid for the case situation, the associated problem hypotheses and probable action solutions are retrieved from the template in memory rather than generated and reasoned afresh. This once again replaces a reasoning process by a *recognition* process, which is faster and requires less cognitive effort (Norman 1984). Use of templates also has the potential to significantly improve the case solution because they represent experiential knowledge sifted from a number of past real life and written case encounters.

In our model of case analysis as a problem solving activity, a template can really be conceptualized as representative of the GOAL-SITUATION. Case facts are regarded as givens in the INITIAL-SITUATION, and different templates are tested and matched to the case facts. The cognitive structure of available templates is fitted to the case scenario at hand and the one that best fits the case is chosen as the desired GOAL-SITUATION. Thus, the expert can embark on a very directed data gathering and reasoning path, guided by the template contents. This reduces the time and effort involved in the analysis process and explains the smooth curve obtained in the retelling profiles of Figures 3a and 3b.

Note that templates represent only heuristic strategies which are not guaranteed to produce the optimal solution. They generate likely problems and the most probable solutions associated with the general case scenario

identified. The use of templates by experts represents an *efficient* strategy; their smooth retelling profiles could produce sub-optimal or generic solutions while the students' non-smooth profiles could produce much more creative, innovative and customized solutions. It is thus important to stress that expert strategies improve efficiency of solutions in case analysis and mostly, but not always, the effectiveness of the solution. If the time and resources available for analyzing real life decision situations was not a constraint, efficiency of solutions would become a second priority in preference to effectiveness. We believe that recognizing these strategies and attempting to add them to the students' repertoire of case analysis techniques will greatly support the learning objectives of the Living Case.

Having discussed some of the research behind our attempts to interpret user behavior, a key open issue in the design of the Living Case, we now provide a more detailed description of the instructional system.

5. LIVING CASE SYSTEM DESCRIPTION

The Living Case begins with the Case Authoring subsystem. The case author sits at a computer terminal and writes a case in much the same way as he would use a text editor to prepare a normal written case. As part of this process, the case writer enters into a dialogue with the Case Delivery subsystem. He specifies to the system (1) the segments and subsegments,[3] in different media, which comprise the case, (2) the instructional concept(s) that each segment illustrates, (3) the linkages between segments and subsegments that represent a concept or a logical progression of ideas, and (4) the normal sequence for reading material in the case. He then enters the case material into the system using a text editor, scanner, cd, or by importing files. The system builds an index of concepts and a hierarchy of segments and subsegments, as well as concepts, based on author specified linkages. The author then identifies buttons and links concepts to them.

The student using the Case Delivery subsystem sees a screen with text (or graphics) in the upper portion and a menu bar below. Commands allow the student to

- read text forward or backward a page at a time according to the author specified reading sequence,
- activate a button and traverse a link,
- jump to the head or the tail of a link,
- display an index of pages with those that have been read marked and an indicator for the page currently being displayed,
- display a concept list (created by the author). When the student selects a concept, a set of linked pages of material relating to that concept are traversed using keyboard commands,
- place a mark on a page,
- display marked pages, return to a marked page,
- open a second window with either a text editor for taking notes or the same or a different page displayed,
- retrieve and display a note file, and
- record all key strokes that are entered by the student and the pages corresponding to the strokes.

Each page may contain text or graphics that are highlighted "buttons" (hypertext) which are linked, as specified by the author, to other material or to other pages in the case. When the student activates a button, the linked text is displayed along with a display of the link tail. This permits introducing auxiliary material, such as a spreadsheet, or additional detailed information without disrupting the normal flow of the case. The student can traverse the link backwards as well as return to the tail of the link in one keystroke. Periodically, the student receives messages from the Student Tutoring subsystem across the bottom of the display (above the menu). Context sensitive help is always available.

The notion of a concept list requires explanation. One of the purposes of a case may be to illustrate certain concepts or principles. For example, a case about information systems planning may involve creating a portfolio of application systems for funding. A goal of the author (and presumably, the instructor) may be to illustrate a type of information system cost-benefit analysis. The author might, therefore, set up concept list entries for "information system benefits" and "information system costs," linking together materials that explain and illustrate these concepts and also pointing to material in the case that could be used to establish the costs and benefits of specific systems.

The Case Delivery subsystem is used in the following manner: The student can view the text page by page as one would read a normal written case. Or the student can jump to related material located elsewhere in the case (identified in reverse video), using hypertext buttons,

command options, and choices in concept lists that were built during the case writing dialogue. Markers can be left in the text and a command option enables the student to return to a marker at any future time during the analysis. Inquiries can be made about what material has already been viewed and this is displayed symbolically on the index. A notepad in which the student can write can be opened in a second window. This is meant to serve as a "highlighter" for case facts that the student considers important to remember.

An experimental prototype of the Case Delivery system has been implemented using Pascal on a PC. The system simulates the Case Delivery interface for two existing, already authored cases (Blue Shield of Massachusetts and Xerox Systems Review Board). This user interface of the Case Delivery subsystem is available for reading and viewing the case flexibly according to the student's choice. The system can track and maintain the student interactions with the case. It monitors and records the segment viewing sequence, the commands used, and the notes and calculations made by the student while analyzing the case. Although this first version of the Living Case did not contain multi-media material, provisions were made in the design to incorporate it at a later time. Segments and subsegments are treated as logical entities, independent of their physical form.

5.1 Preliminary Evaluation

Initial experiments with subjects using the system have been encouraging. A number of informal evaluations were run while the first version of the interface was under development. We were concerned, also, that reading a case using a PC would be obtrusive; students would feel that the technology acted as a barrier to gaining information they needed when compared to a written case. We felt the convenience and familiarity of the normal written case might outweigh the flexibility and skill augmentation offered on a PC.

An experiment was also carried out using a convenience sample of two part-time MBA student volunteers from NYU. The subjects were selected because they stood near the top of their class, had prior experience with PCs, had done extensive case work using traditional cases, and were also working in real settings. The subjects were given short hands-on instruction on the Living Case using specially prepared materials. One of the subjects was then given the Living Case version of one case followed by the normal, written version of the other, while the second subject was given the normal version of the first case followed by the Living Case version of the other. Subjects were asked to prepare a short, written analysis and recommendation for each case. Subjects were recorded and video taped during their reading of the case, their preparation of the case analysis, and during a post-test interview with the researchers. Although a detailed protocol analysis has not been performed yet, a preliminary review of the tapes, interviews and inspection of the work products suggests that the PC was not intrusive. Interestingly, two patterns of reading case material were observed. One of the subjects read cases sequentially, attempting to place all information into a consistent mosaic, while the other subject latched on to a concept and then searched for material in the case that would expand that concept. This second subject used more of the features of the Living Case than the first one and felt that after he had used the system for a while (with enhancements of concept lists and hypertext buttons included), the flexibility of the system would enable him to do better and faster analyses.

We are currently building a new version of the Living Case, with a graphical user interface for the Case Delivery subsystem, designed to be more "active" than the first version. The system, built on top of Windows for a 386 PC, uses the metaphor of an organization and a desk. A consultant (systems analyst) receives a letter from the Director of Personnel of a financial institution to look into designing a system of historical personnel records for the firm. The letter contains a number of names of people to contact in the firm for information and makes reference to several in-house studies that define the need for a system. The consultant is asked to prepare a feasibility study of the system. Available on the consultant's desk are icons representing central files, a telephone, electronic mail, a spreadsheet, a database, and a coffee pot. Mousing on an icon opens a window with appropriate functions and indices. The system is multimedia and hypertext, so that a document may have buttons, which can, in turn, invoke other documents, pictures, graphics, etc. The Student Tutoring subsystem monitors student activity and generates appropriate feedback to keep the student on track and away from standard pitfalls. We currently have a research project underway, with a major financial institution, gathering information to populate and construct this case.

The Living Case project has, of course, been much more complicated and difficult than we originally anticipated. The next section describes some of what we have learned.

6. DISCUSSION

In this section, we touch on some of the insights we have gained from designing the Living Case, the issues that remain to be resolved, the innovative instructional uses

we see for the system, and our plans for evaluation and future research.

The most challenging design issues have been

- uncovering a deeper structure for the case analysis process and identifying a set of primitive activities or generic tasks that students undertake when analyzing a case.

- providing feedback based on interpreting the goals and performance of a student and the facts, issues, and concepts represented in a specific case. Accomplishing this relies heavily on uncovering a deeper structure for case analysis.

- designing a data structure that has the best combination of properties to represent a case, its related concepts and multi-media segments.

- finding a way to present "navigational" information so a student always knows where he is in case space.

- managing the complexity that results in learning by exploration systems.

- developing active and multi-media case materials.

- delivering instruction that is heavily technology based to a large number of students.

We are encouraged in our search for a deeper and common structure for a process regarded as variable between disciplines, cases and individuals. Rather than a routine following of steps advocated by some observers, there is clear evidence of goal directed behavior on the part of expert case analysts, which suggests a lot of richness in the case analysis process. Once understood, the analogical strategy followed by experts may be gainfully taught to students. In fact, it would be worth investigating whether templates can be articulated from expert vocabularies and taught to students, just as formulas and equations are taught today. We believe this level of understanding is necessary in order to diagnose shortfalls in student analysis and to remedy them in the long term.

For our objective of implementing the Student Tutor subsystem, the cognitive model developed represents one step in formalizing its representation. We believe we have a sufficient understanding of the underlying cognitive processes of reading and reasoning to attempt accomplishing our goal of automated recognition based on the sequence of material traversed and the system commands evoked. For example, if a subject uses a facility for INDUCTIVE/DEDUCTIVE inference, the system can infer that an attempt to accommodate a template to the ABSTRACTED-SITUATION is being made. Also, the stage at which the accommodation activity is being undertaken can be a clue to a gross classification of the expertise level of the subject. So, if a reasoning activity is performed one-fifth of the way into reading the case, the system can infer that the subject is not a novice in the area and adjust performance objectives accordingly. Finally, it may be possible to program into the system expected activity sequences. If we know how experts read the case and at what stage the case facts should trigger a stereotypical activity template, any deviance from this expected behavior can be tracked. When the difference between expected expert behavior and system-user behavior exceeds certain levels, the system can prompt and re-orient the user. This could permit us to accomplish the goal of providing dynamic, on-going feedback to students based on an analysis of their specific learning needs. It could form the basis for remedial tutoring of students.

Several candidate structures have been identified and the most promising of these, a concept hierarchy, is being modeled. We are attempting to learn whether this structure has sufficient richness to satisfy the Student Tutoring subsystem.

Our initial notion for handling the navigational issue was to provide an index of material in the case with the current location marked. As case space became non-linear and more complex with multi-media segments, a richer form of representation was needed. We are currently tending toward continually representing three parameters: life cycle (simulation) time, a check list of items to cover, and current location of the item displayed in all windows.

The problem in developing an active case is to faithfully capture the various interleaved story lines. Instead of writing one case, you must develop multiple, synchronized cases. Rather than attempting to accomplish this retrospectively, we have been participating in the ongoing development of an application system, gathering coordinated multi-media information as it occurs. While this partially solves the coordination problem, making sense out of the situation is still difficult.

Finally, building an instructional facility to deliver the Living Case environment to more than a handful of students is expensive and time consuming. These considerations have governed our choice of platform (PC instead of workstation). However, support and faculty training issues still must be overcome.

6.1 Research Directions

We do not aim to replace classroom case teaching with the Living Case system; instead, we desire to exploit flexible presentation capabilities of the case delivery subsystem and provide customized feedback which encourages the student to diagnose and solve business problems independently. Much remains to be done. We must test for discriminate validity among our states of operators for recognizing reading activities. Sequences of reading activities and template usage that signify problem situations need to be developed and integrated with the student modeling mechanism. This portion of the system has to be constructed and field tested to ensure that feedback to students is helpful and bears an understandable relationship to what a human tutor would provide.

Another important area for further study is the use of templates by experts. Although our observations yield evidence for their usage, we would like to build a database of useable templates in a business discipline. We need to specify the data slots, hypothesized problems and likely action solutions for a set of generic, discipline-specific templates. This would also help in specifying the points in the case that should trigger templates into the expert's consideration. We can then program into the system an expected activity sequence. A second area that needs investigation is the effect that "level of expertise" has on the form and content of the templates. It would be useful to categorize template types according to expertise level. This would be invaluable in diagnosing and tutoring student subjects. Finally, sources of shortfalls in student analyses, for example why a relevant template fails to get triggered or triggers at wrong points in the case, should be studied. This would provide a strong basis for remedial action with students.

6.2 Potential Uses of the Living Case

Let us assume we are successful in constructing the Living Case system. What could be done with it that would be of interest educationally?

- The information that students actually use in case analysis and the operations they perform on it could be studied. With the case analysis methods in use today, we have no way to observe how students conduct case analysis.

- The case preparation behaviors of outstanding and poor students could be compared. It may be that a poor student can be recognized by patterns in the way he uses information and the methods used in case analysis. These, in turn, may suggest blockages and deficiencies that can be addressed directly.

- The environment we have described would be suitable for supporting remotely located, synchronous work groups. This could make case instruction available to those students, who for whatever reason, cannot come to a centralized instructional location. This might make the benefits of case instruction available to a much wider educational audience in a manner similar to the way satellite teaching is used for lecture material today.

- The environment is an excellent test-bed for developing instructional tools to augment case analyses processes. With the wide variety of IT based support facilities that can be harnessed and integrated in this environment, the potential for augmenting human analysis is extensive.

- One of the most difficult problems in education is student motivation. We see concepts such as learning by discovery, multi-media materials, and active systems making case instruction more vivid and interesting and, thus, more effective.

- Efforts to model student behavior, a necessary component for providing customized feedback, may provide insights into basic learning processes.

6.3 Summary

The *Living Case* was designed as a method for flexible, interactive presentation of cases and dynamic, on-going feedback of the analysis to students. We attempted to understand the process of analyzing a case in order to build this computerized implementation of the delivery and analysis mechanism for business cases. Our aim was to investigate the design elements of a new, IT based, learning environment and to formalize the process of analyzing a case so the system could interpret student behavior and provide relevant assistance.

The case analysis process was cast as the application of comprehension and reasoning operators. Interpretation of the retelling profiles for experts analyzing a case enabled us to uncover a deeper structure to case analysis which is common across business disciplines, cases, and analysts. The inventory of comprehension and reasoning operators used in the process of analyzing a case provides a starting point for designing the interface of the Student Tutoring subsystem. The experts' use of templates to improve analysis efficiency will provide the basis for building the instruction and feedback mechanisms in the Student Tutoring subsystem. Above all, in the process of building the Living Case prototype, we have gained insights into the issues involved in the development of

this class of systems. We have thus begun to see more clearly the potential that active, multi-media systems hold for improving case instruction.

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9. ENDNOTES

1. For example, "Fierce competition + market share going down" could imply price cutting measures as a solution. However, "Fierce competition + market share going down + dominant image of own brand" might justify an inference of more aggressive promotions as a solution.

2. We label these groups "quantitative" and "qualitative" in the most general meaning of the terms and in keeping with the colloquial references to the respective disciplines within the business school. This terminology is not to be confused with the presence of both qualitatively and quantitatively trained experts within the same business area.

3. Segments are high level divisions, or partitions, of the case that are strongly related. They express a unified idea or theme. Often a paragraph, section, or subsection is designed using similar guidelines. In this context, a segment would signify an idea or concept relevant to the vocabulary and theory of the business discipline (or subdiscipline) to which the case pertains. For example, one segment might be an interview with an actor in the case, the description of a time series of events, a financial data set, or competition information.