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ABSTRACT

Student motivation is a central issue in computer-aided instruction (CAI), since even the most sophisticated teaching programs will require directed and sustained effort at the learning task. Technical students, who have to master long and difficult courses, present special motivational problems. A review of the literature indicates that motivators for technical students can be classified under three main headings: task-related or "intrinsic" factors, need-related or "dynamic" determinants, and external rewards. It appears that elements of these motivators may be useful in encouraging CAI students in technical courses. To illustrate the application of motivating factors, a potential system which utilizes techniques from all three classes of motivators is proposed, first in the context of a military training course in radar repair and then in a job training program for disadvantaged youth. The system classifies students according to certain dynamic variables such as need achievement. Other features of the system include rewards of time off or cash for successful learning and student participation in goal-setting. (Author/JY)

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MOTIVATING THE STUDENT IN CAI TECHNICAL COURSES

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SECTION I. INTRODUCTION

Suppose that a CAI technologist has completed his work and delivered his product. That is, he has actually written and debugged a teaching program, subject-matter experts have certified the content material in it, students are reporting to the CAI terminals to receive instruction, and everything is working. So lessons appear on the displays; the students interact with the program via keyboard or light pen; students are branched, remediated, and graduated from one course segment to another; printouts of progress records are accumulated and distributed to management. The program may even improve itself as it goes along, by eliminating dud items and by building expectancy tables of student performance. It all looks good, particularly when the pupils and the staff are still intrigued with the exotic hardware.

Presently, though, you may observe that some students do not persist in their learning attempts. There will be unmistakable signs of student disinterest and boredom. Those clever branching routines and those "personal" tutoring messages which were supposed to individualize things for the student do not seem to maintain his interest. Indeed, a good fraction of the students may escape the instructional setting at every opportunity.

In situations like this, staff people watching the CAI operation may assert that some of the students are not motivated. They may say that "...motivation is the big problem in getting across the stuff," and follow this with the conjecture that a suitably motivated student will learn from just about any teaching system or test material. As discussion along this line proceeds among the teaching staff, various prescriptions may be offered for motivating the student. A good many cliches will be heard, too; it is hard to be around a technical training center long without somebody remarking that "...all behavior is motivated," or that "...some of these guys just won't try, regardless of what you do." If the training is being done at a military technical school, there will be discussion about the constraints that the military situation imposes upon the motivational effort. If the training is being done in a ghetto setting where students from marginal environments are being taught, the staff very quickly will be impressed with the problem of promoting directed action under those circumstances.

However we acknowledge it, there can be a genuine student-motivation problem for a technical school. It is possible that CAI technology will not induce suitable learning commitments in a good many of the students. For some centers, it could turn out that the motivational problem will emerge as the major unsolved problem in CAI technology.

The CAI literature seldom addresses itself directly to the business of keeping the student interested, trying hard, and involved in the learning task. Hickey's excellent and comprehensive review (Hickey, 1967), for instance, has no separate section on the subject, though of course many of the variables discussed in his review are presumed to exert some energizing and directional effects upon the learner. This report originated in the hope that a review of motivational theories and research specifically from a CAI standpoint would be worthwhile.

Actually, we first thought that this report would be oriented around the "intrinsic motivation" concept. The intrinsically motivated student, so the story goes, maintains his directed behavior in the apparent absence of external reward. If asked why he is so fully engaged in his learning task, he might say that he finds the materials "interesting," or "challenging." This answer is not very satisfactory; but the instructional technologist might undertake a search for whatever does seem to make a task interesting. After some preliminary scanning of the literature, it seemed to us that such ideas as intrinsic motivation should not be considered alone, and that it would be better to cover a broader range of motivational concepts and variables.

We do not attempt here, however, to undertake a critique of the many definitions of motivation that have been proposed, or to develop the historical aspects of the subject. Recent works such as the text by Cofer and Appley (1964) have already done that scholarly job. In our review, we continually sought to raise only those questions that seemed to be of most interest to the CAI researcher and manager.

As to definitions, we can follow Brown and Farber (1968) and propose that a condition, A, is motivating if presence of A following the appearance of a new response increases the probability of that response; if the onset of A following a response increases the strength of that reaction; and if responses appearing at the time of A tend to be more vigorous or energetic. Or if a more person-oriented definition is desired, perhaps the simple one given by Atkinson (1960) is as good as any:

> "...the term motivation refers to the arousal of a tendency to act to produce one or more effects. The term motivation points to the final strength of the action tendency which is experienced by the person as 'I want to ...'"

Besides our practical bias, there are two other major restrictions in the scope of this report. In the first place, we are concerned mostly with motivating students over a long period. Many CAI studies have limited their scope to teaching Ohm's law, or elementary digital arithmetic, or some other small segment of a technology. The students may be on the system only a few hours. Such studies can be informative and inspirational; indeed, they often are the only studies and demonstrations we have. But we believe that the real tests and payoffs in CAI will be realized only when the program will control fairly large blocks of a student's time for at least several weeks. Thus it is encouraging to see whole-course evaluations such as those reported by the Stanford CAI researchers (Suppes & Morningstar, 1969). In the electronics domain, where we might be teaching maintenance of prime equipment, perhaps a minimum hardware unit would be something like a transistorized hearing aid or a portable radio unit; if basic circuits are being taught, then we are thinking of a coverage equivalent to at least a month or two in the basic Army or Navy electronics schools. This means that "instant motivators" are not as significant to us as conditions that will work over a long haul.

A second restriction is due to the fact that CAI courses usually are conducted in relatively comfortable circumstances. This removes from our purview a great deal of the research literature on primary motivation; we ignore here such topics as hunger, thirst, temperature regulation, sexual behavior, and physical pain avoidance. What is left seems to order itself into three main categories, and the sections in this report reflect that organization.

Initially, we turn to intrinsic or task-related factors such as curiosity and exploration. People do seek knowledge and stimulation. Indeed, some theorists postulate the presence of "epistemic" or knowledge-seeking drives which can be satisfied by the acquisition of knowledge; the resulting drive reduction, it is alleged, then causes maintenance of the information-search behaviors. Besides the specifically epistemic or investigatory motives, there are general exploratory, playful, and imitative tendencies which may have significance to CAI people.

A second section scans briefly some dynamic theories of motivation. Though quite different in detail, these theories exhibit some related themes and consequences. Psychoanalytic doctrine, as one example, ascribes great importance to unconscious motivation, to anxiety, and to intrapsychic conflict. The Maslow concept of self-actualization places great reliance upon such factors as uniqueness of the individual, acceptance of self, and a certain detachment. According to theory, the self-actualized person is apt to be more energetic along certain lines, than one who has not achieved this state. Still a different view comes from the need-achievement school; in that approach, needs such as achievement, affiliation, power, and fear of failure are viewed as major determinants and energizers of behavior. Individual differences on these dimensions might be correlated with student task effort, and we attempt some estimates of how the CAI planner might utilize such information.

Extrinsic reward is the focus of the third section. We take up there the few studies where direct reward contingencies have been tried with human subjects. And we mention such general models as the Vroom (1964) multiplicative conception, which posits relations between reward and performance, and also includes intrinsic or task-intent features.

The last section of the report indicates which variables seem to be the best motivating techniques for the CAI planner at the present state of the art. A most attractive possibility for the CAI technologist is to employ external reinforcement (money, time off) to maintain initial performance at a high level, until such time as intrinsic reinforcement can take over to some extent. Perhaps the external rewards can then be thinned out according to some partial reinforcement schedule. "Surprisal" and uncertainty aspects of stimulus material are also potential devices for increasing student interest, and they do not seem to have been explored by CAI people. The motivational importance of individual goal setting leads to some procedural possibilities for handling that part of the motivation. There are possibilities, too, for exploiting small group effects in certain CAI settings. For practical use, we will need to try these ideas in a real CAI situation; and we think such tryout is well within reach of present technical capabilities.

SECTION II. SELF-MAINTAINING BEHAVIORS

Many behaviors persist without obvious external reward; indeed, a proper record of events might indicate that most behaviors could be so classified. Look at Koch's (1963) account of his day:

> "...will we not discover a rather surprising fraction of the time to be spent in such ways as 'doodling,' tapping out rhythms, being the owners of perseverating melodies, nonsense rhymes, 'incorrect' memory episodes; noting the attractiveness of a woman, the fetching quality of a small child, the charm of a shadow patterns on the wall, the loveliness of a familiar object in a particular distribution of light; looking at the picture over our desk, or out the window; feeling disturbed at someone's tie, repelled by a face, entranced by a voice; telling jokes, idly conversing, reading a novel, playing the piano, adjusting the wrong position of a picture or a vase."

Besides these casual activities and agitations, there are plenty of "directed" or "purposive" task behaviors which seem to "maintain themselves" well. Examples are easy to find: the hobbyist who devotes systematic attention and effort to a craft, the chess player who studies exemplary games by masters, and the student who "digs into" a subject long past the assigned lesson. Since the performer in such cases seems to be working at the task "in-and-for-itself," the behavior is often called "intrinsically motivated" or "intrinsically reinforced." Despite its fairly common use, intrinsic motivation is not necessarily an ideal term. We agree with Resnick (1970) that:

> "...it may be useful to consider reinforcers not as dichotomies into 'intrinsic' and 'extrinsic' classes, but as running along a continuum from reinforcers closely tied to a

> given task (i.e., intrinsic to the task) to highly generalized reinforcers that have no inherent relationship to the task itself."

In terms of this continuum, the self-maintaining behaviors we are talking about in this section are those that are close to the task-related end; in the fourth chapter we consider the external reinforcers.

Under the rather broad rubric of self-maintaining behavior there are several more or less distinct categories. For this chapter, we have chosen four for brief coverage: (1) curiosity, (2) play, (3) competence, and (4) vicarious reinforcement. Other systems of categorizing self-maintained behavior might serve as well; we selected these four because each seemed to have its own literature, and perhaps also to have some intelligible bearing on the CAI technology.

Curiosity. The classical scientific studies of "curious" or "exploratory" behavior were performed with animals. Good illustrations are found in the work of Montgomery (1953) and of Harlow (1953). Montgomery counted the number of maze sections that rats traveled, and observed that exploration was dependent upon the external stimulation. A second maze was explored less than the first; but this reduction was less when the second maze was more dissimilar to the first maze. So it appeared that magnitude of stimulus change might be a key variable in exploratory behavior. This observation is not a satisfactory explanation. For example, do animals seek to change their environment for no other reward than the change itself, or do they seek to reassure themselves that strange environments are safe? However that may be, exploration is found in problem tasks, too. Harlow's monkeys worked on puzzles:

> "...when no motivation is provided other than the presence of the puzzle. Furthermore, we have presented data to show that once mastered, the sequence of manipulations involved in solving these puzzles is carried out relatively flawlessly and extremely persistently."

Such studies gave some empirical meaning to the rather vague concept of exploration, and also led several researchers to postulate the presence of an "exploratory drive." There are interesting relations, too, between problem-solving skills and exploration. Harlow (1953) notes that although Cebus monkeys are inferior to rhesus monkeys on standard discrimination learning, the same Cebus monkeys can rival the higher apes in the situations of instrument stick problems. And he explained these remarkable Cebus achievements in terms of their curiosity and their manipulative tendencies, which are:

> "...more important than tissue tension, stimulus generalization, excitatory potential, or secondary reinforcement. It is the oscillation of the stick, not cortical neurons, that enables the Cebus monkey to solve instrumental problems."

It is reasonable to infer analogous motivators in humans. Berlyne (1960) for example, furnishes human subjects with an "epistemic" or knowledge-seeking drive. Epistemic curiosity involves symbolic processes such as concepts and ideas. The strength of the epistemic drive can differ widely from one individual to another. Testable hypotheses can be derived from the epistemic drive notion; to take one example, schedules of "information reinforcement" should resemble reinforcement curves found with other reinforcement situation. And, we might expect that information-seeking behavior would generalize in regular ways.

The idea of some kind of curiosity drive has engaged the attention of many investigators. But the scientific status of the curiosity construct is still not resolved. Koch (1963) remarks that:

> "...one can only wince at the current tendency to talk about such things as 'curiosity drives,' 'exploratory drives,' 'sensory drives,' 'perceptual drives,' etc., as if the 'activities' which are held to 'satisfy' each of the 'drives' (if indeed they are distinct) were just so much undifferentiated neural pap that came by the yard."

Brown (1953) is equally negative:

> "...the presence of a drive to explore is sometimes inferred from, and at the same time used to explain, behavior of moving from one place to another, especially if there is no other apparent reason for the movement. The postulation of an exploratory drive in this way is quite circular, and therefore of questionable worth as a scientific explanation."

These objections can be met in various ways. Berlyne (1969) defines three criteria for the presence of a drive: increase in drive leads to increase in overall activity, drives operate selectively in bringing certain types of behavior into force, and the strength of drive determines the effectiveness of reinforcement. He gives some evidence that exploratory behavior satisfies each of the criteria. Fowler's (1965) analysis gives a dual interpretation in terms of both boredom (drive) and curiosity (incentive motivation). That is, "curious" behavior is the subject's learned anticipation of the novel (or complex, or otherwise changing) stimuli that it experiences when performing some reinforced response. This positive or incentive curiosity may be distinguished from a boredom concept of deprived stimulation.

A few years ago Berlyne (1963) proposed that an essential concept in explaining curiosity was arousal, and that arousal was a U-shaped function of stimulus value. Thus arousal would be high under very familiar stimulation, and also high under very novel stimulation. The animal would then seek an intermediate level of stimulation, some optimal amount of novelty or change input. There is some physiological evidence for high-arousal with monotonous stimulation: human subjects in the sensory deprivation experiment display increased muscular, circulatory, pupillary, and EEG activity (Fowler, 1965). And the U-shaped arousal idea is consistent with the superimposition of other drives (and presumably more arousal): the hungry animal responds more to stimulus change than does the food-satiated animal. Children, too, may be exhibiting a U-shaped arousal tendency when they find states of mild excitement to be reinforcing (Leuba, 1955). But the U-shaped model has its difficulties, too. One is that "...the stimuli consequent on an investigatory response often have some reward value even when there is no prior period of stimulus deprivation" (Berlyne, 1963). There are still other objections, and these have been well summarized by Fowler (1965).

Brown and Farber (1968) tie several of these ideas together into a theory of exploratory behavior, and we can examine one of their illustrations in enough detail to get the flavor of it. There are two stimulus situations S_1 and S_2; S_2 is "preferred" to S_1. The S preference hierarchy is established by means of some independent criteria: a child, for instance, will usually prefer watching a TV picture (S_2) to watching a blank wall (S_1).

To enjoy S_2, the child must perform an observing response, and "...fractional components of the observing reaction (R_0) will become conditioned by contiguity to contemporary stimuli and will be evoked anticipatorily by S_1. Such antedating observing responses (r_o-s) are presumed to provide their own distinctive stimuli (s_o-s) as well as to increase level of motivation while the subject is in the presence of S_1...whenever r_o-s_o is evoked, (but) R_0 cannot be performed, a frustration-like arousal is produced." Thus the aversive level of S_1, relative to S_2, is increased as the subject learns to anticipate S_2. But if S_2 is originally <u>less</u> attractive than S_1, a parallel analysis can be made: the anticipated r_o-s_o components will now reflect withdrawal tendencies, hence learned anticipation <u>decreases</u> the S_1 aversive level.

Situations, however, are never simply aversive or attractive. S_1 is attractive relative to S_2, but it may be aversive with respect to S_3. Factors such as satiation can effect changes in the hierarchy, and S_2 may become simultaneously both more aversive and more attractive, depending on our frame of reference. By ingenious use of situational relativism and the simple notions of cues and anticipatory observing response, Brown and Farber can account for some surprisingly complex exploratory behavior, and they manage to do this without postulating any exploratory drive. Theoretically, one could set up cue-response relations among S_1, S_2 and S_3 so that nearly any new situation S_4 would be relatively attractive. But nearly complete stimulus control would be required, and this is not often feasible with technical students.

A rather different kind of curiosity research comes from information theory. Suppose that a person acts as if he has a high level of epistemic drive; that is, he actively seeks information. Well, information is technically defined as statistical uncertainty, so why not control uncertainty and watch for motivation effects? When Jones, et al., (1961) produced stimulus certainty in college students by isolating them for some hours, the students indeed acted as though new information (light patterns flashed on the ceiling) served as a goal condition or reinforcement. In addition, depriving the human subject of information seems to "summate" with other drive sources such as electrical shock.

All the curiosity research with animals and humans seems to support the idea of the organism as needing, seeking, and processing information. Continued exposure to the same stimulation results in something resembling a drive state of "boredom" or "certainty." If other needs are not pressing, the animal relieves this certainty state by placing itself in a novel or uncertain environment. Then, when uncertainty exists, exploratory responses may be among the most likely responses to be observed. These high probabilities, though, will tend to be reduced as the subject becomes more familiar with the previously unknown object or situation. It appears that, to "keep the exploratory responses going," a rather steady flow of new uncertainty may have to be programmed.

The CAI technologist who wanted to increase curiosity via the uncertainty notion would have to know those items which would be surprising to the students. Determining the surprisal value of different items would be easy enough, in principle: perhaps a pretest on an equivalent group of students would be sufficient. If there are major individual differences in surprisal, or if surprisal must be continuously estimated as the learning process goes foward, then the calibration will be more involved; but the idea is still relatively straightforward.

How much improvement in student motivation could be expected? In one study using statements about animals, Berlyne (1954) showed that subjects retained more surprising facts than they did control facts. Such gains attributable to surprise were small but significant, on the order of 10 per cent or so.

Another bit of evidence which may be related to surprisal is an informal experiment by Robert Mager. He began an electronics lesson by letting the students ask questions. None of the students, as it turned out, were curious about the nature of the electron, about Ohm's law, about resonance formulas, about the "basic circuits," or about any of the other matters so dear to the heart of the electronics teacher. It often happened that, if the instructor answered the question asked by the student, other questions quickly followed. But if the instructor started to lecture about the "basic fundamentals of electronics" the questioners soon lost interest and stopped asking questions. Mager's report of this teaching episode is too fragmentary to serve as a guide for the CAI planner, but it does suggest that many students exhibit something that looks like a high "epistemic drive," that this tendency can be manipulated in some degree by giving answers to those questions which are of most instantaneous interest to the student, and that students prefer their own definitions of what is surprising.

<u>Play</u>. Many of the statements made about playful behavior resemble those which are offered regarding curiosity or exploration. Thus, to Piaget play is sought as an "end in itself;" to Beach play has no immediate biological significance; to Schlosberg it is "useless;" and to other writers it is surplus-energy activity distinguished by rhythm, repetition, high frequency, and a "pleasurable state." Since play is indeed often pleasurable, teachers have often tried to introduce playful aspects into learning tasks that are not pleasurable; if this could only be done, then learning could be fun.

The classical literature on play does not seem to be of much help in our present context. It may be interesting to ponder the psychoanalytic claim that play provides substitute gratification of fantasy wishes, or that play is a relief from the constant surveillance of the superego. And Piaget's developmental scheme of play in the child will occasion some reverberatory flashes in anyone who has raised a family: "practice" or repetitive games occur first, followed by symbolic games, with rule-prescriptive games as a final elaboration. But these ideas hardly offer any clear formula to the instructional technologist who wants to "get some fun into transistor electronics."

Berlyne (1969) delineates four recurrent themes in the literary and scientific writings on play. His listing is probably as good a place as any to look for ideas that might apply to CAI technical teaching. His first theme is the self-reinforcing nature of play. We have already remarked upon this issue in connection with intrinsic motivation. Berlyne argues that if a behavior persists without external reinforcement, then it persists because of internal reinforcement or some effect on the central nervous system. "...So when we say that play or some other activity is engaged in 'for its own sake,' what we really mean is that it is engaged in for the sake of these inner consequences. It follows that it will be engaged in only when the organism is in the kind of motivational condition that makes these inner consequences awarding." Among these motivational conditions is relative freedom from immediate danger, and from strong primary drives such as hunger or sex.

A second theme is the differentiation of the play scene from the real scene. By making the play scene obviously "unreal," the players can indulge in certain types of aggressive behavior, for instance, without punishment; or if retaliation does occur, it will be a controlled or sanctioned retaliation.

Berlyne's third theme concerns the presence of temporary tension, unpleasantness, discomfort, and danger in many play activities. This can be noted in even the earliest play activities of the infant; placing a handkerchief momentarily over a baby's face apparently causes fear, yet the child "enjoys" the game and tries to continue it. Though many factors such as uncertainty, novelty, surprise, and complexity can be listed, perhaps all of them fall into the class of conditions that affect level of CNS arousal. To Berlyne, this arousal stems from discrepant inputs or conflicts: "A possibility that offers itself is therefore that conceptual conflict motivates play, with or without supplementary motivation from other sources."

The fourth issue is how play serves to reduce arousal or conflict. In many cases, the game is won or lost, and this information clearly reduces the uncertainty; even without scores the player may know about how well he did. Adaptation and habituation to previously ambiguous stimuli might also occur through play of a groping and testing kind.

Glancing over these four themes, perhaps only the second and third offer any practical hints to the technical teacher. Many technologies offer, via CAI display devices, a simulated or "unreal" world: the trainee can blow out hydraulic tubes, overload electronic circuits parts, impose fantastic currents and frequencies upon data processor units. Working with technical material in this unreal format could be an intriguing experience to the technical student: he could "push things to their limits" as one means of learning how the prime system operates. The permissiveness aspects of unreality through gaming may not have immediate application in our CAI setting, though one can visualize "elimination tournaments" among trainees for their performance, in which cutthroat competition would be tolerated and champions would emerge. Parenthetically, we can notice one quasi-CAI situation in which a champion of the world was crowned. This is O.K. Moore's Autotelic environment at Pittsburgh; the special environment utilizes a talking typewriter gadget to teach symbolic behavior. As a sort of *tour de force*, a three-year old girl was taught to "take dictation," in the sense that she could actually type, spell, and punctuate a small dictionary of words.

Arousal conditions (complexity, novelty, and so forth) have already been recognized in the preceding section, and nothing especially new about them seems to come from the play literature. It may be that technical students differ markedly in their susceptibility to arousal by conflict and uncertainty; if so, individual calibration and assignment could be carried out according to this susceptibility. Common observation would indicate that some people do have a lower threshold of interest than others, and these people may indeed be better students of new technologies.

Competence. Back in 1958 Woodworth distinguished between action due to need-primacy and that showed behavior-primacy. He considered behavior-primacy as basic: "We are making the claim that this direction of receptive and motor activity toward the environment is the fundamental tendency of animal and human behavior and that it is the all-pervasive primary motivation of behavior." Urgent drives can, of course, obtrude themselves into the ongoing behavior and direct it in new ways. But these redirected activities represent attempts to deal with the environment. Thus behavior primacy has a sort of logical primacy too.

White (1959) used the term competence or effectance to refer to this "...intrinsic need to deal with the environment...there is a competence motivation as well as competence in its more familiar sense of achieved capacity." White's major example is taken from the Piaget studies of childhood exploratory behavior. Piaget watched his own child Laurent carefully as the boy responded to stimuli such as rattles, dolls, and various toys. Laurent's behavior was certainly complex, even though he was only a few months old. He discovered that toys will make noise, that experiments can be performed (say by rubbing a toy against the side of the bassinet), that provisional ideas about a new object can be wrong but can be corrected. The motivation to make something interesting happen is fairly persistent, too; except when bodily wants are pressing, the baby repeats certain interesting actions for many minutes.

These activities can be separately classified and assigned appropriate motivators. In Berlyne's terms, the child might be trying to hold an optimal arousal level, with just the right mixture of familiarity and surprise. From a neuromuscular and maturational viewpoint, he is exercising attainable levels of coordination. White says that it maybe best to conceive of the activity as an integrated set of transactions with the environment. "The child's play can thus be viewed as serious business, though to him it is merely something that is interesting and fun to do."

The early Gestalists used to say that if you break down certain integrated behaviors into little bits, you lose the meaning of the behavior. Wertheimer's Phi demonstration was a unitary, "new whole" experience, and it could not be put together from separate fragments. White talks the same way about his effectance motivation as expressed in the child's play example. The significance of the play "...is destroyed if we try to break into the circle arbitrarily and declare that one part of it, such as cognition alone or active effort alone, is the real point, the goal, or the special set of satisfaction."

We have not done justice here to White's treatment of competence-effectance in terms of biological survival value, or his conjectures regarding environmental mastery and control as key parts of personality development. Those aspects probably do not concern the CAI technologist anyway. We can discern, however, at least two features of the competence conception which may have some immediate meaning for us. The first is that effectance requires vigorous <u>interaction</u> with the environment: the subject prods and challenges and tests the environment, the environment pushes back. This is something of an advance over the Berlyne novelty-arousal idea. Not only should there be novelty, or rather a suitable input blend of the novel and familiar, but the subject realizes more involvement when he obtains the information by personal environmental challenge-and-response. We can foresee a neat experimental investigation of the motivating effects of giving information, with and without direct environmental interaction by the subject.

We have no data on the satisfaction of exercising high-order technical competence beyond the common observation that persons who are very good at some difficult task like to have others observe their performance. A reasonable expectation is that certain levels of capability must be attained before the individual perceives himself as being competent. Perhaps overlearning, smoothness of choice behavior, and varied practice are essential. In electronics courses, it often happens that the student never achieves true competence in the early segments of the training. He passes tests, it is true, and moves on. But maybe he isn't ready; maybe he won't be ready until real mastery and fluency are there. The whole area of subjective competence feelings needs exploration. A beginning series of trials could be set up in CAI drill routines for technical courses; overlearning could be investigated as a means of promoting the student's sense of competence.

Vicarious Reinforcement. Bandura (1963, 1965) has demonstrated that children's responses are influenced by watching other persons; for instance, seeing a model person being aggressive against a plastic doll, and being rewarded for the aggression, led to imitation of the aggressive response. Those who saw the model being punished for aggression were much less likely to strike the doll. Children who saw a model being punished for playing with forbidden toys were not as likely to play with the same toys in a free-choice situation. These vicarious reinforcements are often remarkably effective.

For CAI, it should be possible to provide vicarious reinforcement via films. The new student could be shown films of other students performing successfully at the console, getting information and remediation, and perhaps receiving external rewards if there are any. Perhaps a few realistic learning experiences could be appreciated this way; by the time the subject gets on the terminal himself he will have seen the process through the eyes of another learner who is somebody about like himself.

We cannot be sure how much vicarious reinforcement should be programmed for the CAI students. Certainly, the introductory functions sketched above should be included, and they could control subsidiary learning behaviors such as asking for help from a nearby instructor.

Summary Statement

Curiosity can be controlled to some extent by introducing some surprise value into the material presented. Elements of "unreality" in the task situation or temporary tension may also facilitate attention or persistence of task effort. Vicarious reinforcement, achieved by observation of a suitable model person who is reinforced, is effective in promoting certain task identification; it might be quite useful for introducing CAI trainees to the concept of an extrinsic-reward performance-contingency system.

SECTION III. NEED THEORIES OF MOTIVATION

Some theorists furnish the organism with specific needs; when the organism does something, it always acts to fulfill one or more of these needs. In this section, we touch upon several need-oriented motivation models. Our treatment is brief, partly because we are in no way competent to explore fully such topics as psychoanalysis, and partly because the impact of some of these models upon a CAI practitioner seems to be quite indirect. Nevertheless, there are a few implications of interest.

Murray's Personality Model. H. A. Murray was perhaps the most influential of the early need theorists. He made up lists of needs, and arranged them in logical arrays; one famous study (Murray, 1938) posits over thirty needs such as achievement, aggression, nurturance, succorance, construction, and sex. Over the years, Murray occasionally reduced his number of needs down to twenty or so, combined some needs with others, and changed his emphasis on which needs were most important. A list of Murray-style needs would not advance a CAI planner very far, unless methods were available for measuring the presence of the needs in separate individuals and coordinating them with gross learning behaviors. Though he originated the Thematic Apperception Test, Murray himself never contributed much to measurement problems, as he preferred to discuss the need model in terms of his own clinical practice. His work did inspire some intensive studies into specific needs, however, and we now turn to them.

McClelland and Atkinson. For two decades, McClelland and Atkinson have intensively pursued a few of Murray's needs via projective methods. Three needs have been especially well studied: need for achievement (n Ach), need for affiliation (n Aff), and need for power (n Pow). These motives are learned, they are relatively stable aspects of the individual, and they can be aroused by a variety of cues and situations.

Measurement of McClelland-type motives can be done by several techniques, but the original work generally used a projective test method. Subjects were shown pictures and asked to make up stories about them. Standard questions (What is happening? Who are the persons? What led up to this situation?) helped to elicit constructive responses. The resulting protocols were then scored according to a category system representing the "themas" of the subject's story. A key assumption underlying the measurement process, then, was that motives can be expressed and detected through fantasy production.

There are some dubious psychometric aspects of the n Ach scores themselves (Cofer & Appley, 1964), but we shall not criticize them here. Supposing that the scores are satisfactorily stable, over scorers and over time, how do they relate to performance on a real task? The tendency or intention toward success (T_s) is a multiplicative function of the n Ach (M_s), the perceived probability of success (P_s), and the "incentive value" of success (I_s). The overall formula is then:

$$T_s = M_s \times P_s \times I_s$$

Now, to manipulate the intention, you could vary one or more of the three terms in the equation. An additional equation, though, is also postulated: $I_s = 1 - P_s$; this says that "value" is higher as difficulty increases. At first, this latter equation appears absurd:

obviously incentive value is a more complex conception than statistical difficulty. But when the three terms are put together, some non-trivial implications do follow; for example, here are two taken from Atkinson & Feather (1966):

> "1. The tendency to achieve success should be strongest when a task is one of intermediate difficulty, but the difference in strength of the tendency to achieve success that is attributable to task difficulty will be substantial only when n Ach is relatively strong.
>
> 2. When the difficulty of a task is held constant, the intention to achieve success is stronger when n Ach is strong than when it is weak, but the difference in the strength of the intention to achieve success that is attributable to a difference in the strength of n Ach will be substantial only when the task is one of intermediate difficulty."

There is already some supporting evidence for this model in a few academic-type experiments, but none that we know of for technical training classes. Perhaps the most relevant finding comes from the Atkinson group; they set-up "ability-grouped" classes in which probabilities of success and failure were nearly equal for most students. It turned out that students who were relatively high in n Ach showed greater interest in learning when they were "ability grouped" than when they were not. According to Atkinson & Feather (1966):

> "...the results of this study strongly emphasize that expectancy of success is a manipulable motivational variable."

The study could readily be replicated in a technical course environment.

Persistence at a difficult task is related to n Ach-type scores and to perceived likelihood of success. One difficult task, which was in fact insoluble, was a unicursal puzzle, and students were only permitted to work on it for twenty minutes. Since persistent behavior as measured in standard persistence tests is correlated about .30 with academic performance when intelligence is partialled out (Atkinson & Feather, 1966), it should be worthwhile right now for the CAI manager to obtain persistence-test scores along with n Ach.

To utilize the McClelland-Atkinson approach, a CAI project would require measurement of the variables on each subject. Objective tests which claim to produce n Ach scores, such as the Edwards Preference Schedule, apparently do not work, so that specially trained scorers would be necessary. There is no way to assess the impact on training except by serious tryout; we are genuinely perplexed in trying to estimate the payoffs, though we believe that <u>some</u> interesting correlates of n Ach, n Aff, and n Pow would turn up in a practical setting with young technical students.

<u>Psychoanalysis</u>. Freud traces the desire to know or to explore back to the libido or sex drive. The original instinctual energy is sublimated. There might be several components: a desire to see sexually arousing sights, the conversion of a hunger for food into a hunger for knowledge, and maybe even a sublimated anal-retentive motive, if the attained knowledge is perceived as powerful or valuable (Berlyne, 1960). The person who cannot express his urges since he cannot effect a full discharge of energy has a supply of "neutral energy" remaining; and "...the ego, thus supplied...actively scans the environment, storing up information useful to future tension releases" (Cofer & Appley, 1964). It is hard for us to see how such concepts would be useful in our present

context, so we will not consider psychoanalysis further. It might be, of course, that individual differences in psychoanalytically-derived vectors will eventually prove to be coordinate with learning performance.

Self-Actualization. First from the existentialists such as Fromm, and more recently from an array of psychologists, has come the notion of the self-actualized person. Such a person would exhibit some positive properties indeed; Cofer and Appley (1964) imagine him:

> "...to be open to experience, that is, not defensive; to love others and the self without admixtures of aggression or of manipulative needs; to act ethically, morally, and for the social good; to be expressive of his potentials in an autonomous, self-realizing way; to be spontaneous and creative; to be curious and exploratory."

These possibilities exist for every real person; but, according to Maslow's famous hierarchy, they are only realizable after "lower" levels of needs have been achieved. The lowest level is physiological, followed by safety, social esteem, and finally self-actualization. The hierarchy is not absolute, and of course, some lower-level needs cannot be fully satisfied in some individuals. But if the lower needs are well enough contained to be non-dominant, then self-actualization might be realized.

A self-actualized person, despite his curiosity and creativity, might be a troublesome student. Maslow (1954) himself says that:

> "...the motivation of ordinary men is a striving for the basic need gratification that they lack. But self-actualizing people in fact lack none of these gratifications; and yet they have impulses. They work, they try, and they are ambitious, even though in an unusual sense. For their motivation is just character growth, character expression, maturation, and development; in a word 'self-actualization.'"

The responses of such an individual are conceived to be non-predictable, but post-dictable; that is, they make sense in terms of his own potentiality (Rogers, 1963).

While the lower levels of needs in Maslow's hierarchy can unquestionably energize and direct behavior, we have no very good evidence on the validity of the higher levels in the structure, or upon the real behavior of persons who are supposed to be at various levels. The self-actualization movement suffers from imprecision, and, perhaps, from some over-optimism about the basic "goodness" of people. At the moment, perhaps the only idea of value to CAI people is the conception of individual uniqueness. Branching routines recognize this in a matter-of-fact and standard way; but there may be possibilities for further individuation, if we put our minds to it.

Patchen's Job-Involvement Model. Martin Patchen (1970) has proposed a multiplicative model that is rather different from the Atkinson's need-achievement theory. Patchen, like Atkinson, postulates three motivational variables, including a motive to achievement. But the meaning of the achievement concepts is not the same; for Atkinson, need for achievement is a personality trait, whereas Patchen defines it in terms of such features as involvement of personally-valued abilities on the job, and the perceived importance of the task.

Patchen's findings that seem most relevant to this report have to do with task feedback and rewards for achievement. The rewards given include recognition by co-workers for good work, a chance to use one's best abilities, and influence over work goals. One indicator of worker-job motivation was a questionnaire self-rating of "interest in innovation." This interest factor was not correlated with amount of task feedback when the TVA technical workers received low rewards of the type mentioned above. However, for those workers who gained high rewards for good performance, there was a moderately high correlation ($r = .55$) between interest and feedback. The moral is plain: feedback *per se* is not a guarantee of job interest: a rewards package must accompany the feedback. This may be a reason why some short-term experiments on the effects of feedback have not produced much learning--feedback is not necessarily motivating, by itself.

Some incidental findings from Patchen's work might be of interest to CAI people. As one example, Patchen reports a correlation of .43 between "rated job interest" and "chance to do what one is best at." If this relation stands up it would imply that we could cause more interest by matching tasks to individual "best specialities." Over the course of time and in many informal ways, men tend to pursue their own best abilities anyway; we might as well facilitate the tendency.

Patchen reports high multiple R's (about .70) between his independent variables (opportunity to achieve, rewards for achievement, use of valued skills) and the dependent motivational variables of job interest, interest in innovation, and absences from work. This is encouraging indeed, and suggests that a sizeable fraction of the "motivational variance" can be controlled by functional methods of suitably rewarding the worker and allowing him to employ his full abilities. Patchen's subjects were industrial and professional workers, not students; his variables deserve immediate validation within a technical school setting. At the very least, his variables give the CAI planner a checklist of items to consider when arrangements are being made for student instruction.

The Patchen model is outlined in the three equations below. Participation influences both path and goal. The last equation would seem to be the one of most interest to the CAI administrator. It calls for extremely definite student perceptions of standards, feedback, difficulty, and learner control. Without these sharply defined perceptions task effort should be weak and unreliable.

Motivation to Produce	=	Extent to which achievement in specific work is an important goal (goal)	X	Extent to which effort in work situation is perceived as leading to achievement (path)

Extent to which achievement in specific work is an important goal	=	General need for achievement	X	Importance of work role in self-concept	X	Extent to which specific work goals are accepted as important part of work role ↑ participation affects goal acceptance

Extent to which effort in work situation is perceived as leading to achievement	=	Clarity of performance standards	X	Feedback on performance	X	Goal difficulty	X	Control over means to reach goals ↑ participation increases control

Fig. 1. Patchen motivation model.

Bales Evaluative Space Model. At first glance, the Bales (1970) system for dimensionalizing small-group behaviors would seem to have nothing to do with CAI operations. The system scores members of special groups on three dimensions: Power, Affectivity toward Others, and Conformity. Data sources for the three scores are subjective behavior ratings by observers, categorization of statements by the Bales method Interaction Process Analysis, and also some thematic study of value and fantasy material. There is quite a technology for coding all this material, and relating it to other personality tests.

Once you have a man scored on each of the three dimensions, then you can produce inferences regarding his personality structure. Sharp predictions are made, too, concerning his collaborative behavior and his role changes as a small group works on a common task. With three score levels on each dimension, there are 26 possible patterns or positions within the score space, and good reasons to believe that people in some of the 26 patterns are more (or less) amenable to group effects than are others.

It may be worthwhile, then, to relate Bales-type scores to persistence in staying at a hard learning task. Perhaps those who are high in power and low or neutral on the other two dimensions will be good bets for CAI, other things being equal. If an individual works alone, then he will not have to worry about interpersonal obstacles to task solution, but he is also denied interpersonal support and rewards which may be significant. The Bales approach may lead to differentiation of those individuals that will adapt to a CAI learning regimen -- and the regimen itself will certainly have some special aspects.

Howard-Sheth Theory of Buyer Behavior. One of the most elaborate models of purchase behavior is the one originated at Columbia University by Howard and Sheth (1969). Their action diagram, shown in Figure 2 on page 31, has an array of inputs and outputs; it also sets out a "perceptual subsystem" and a "learning subsystem" to represent the processes which intervene between display and purchase. The model was

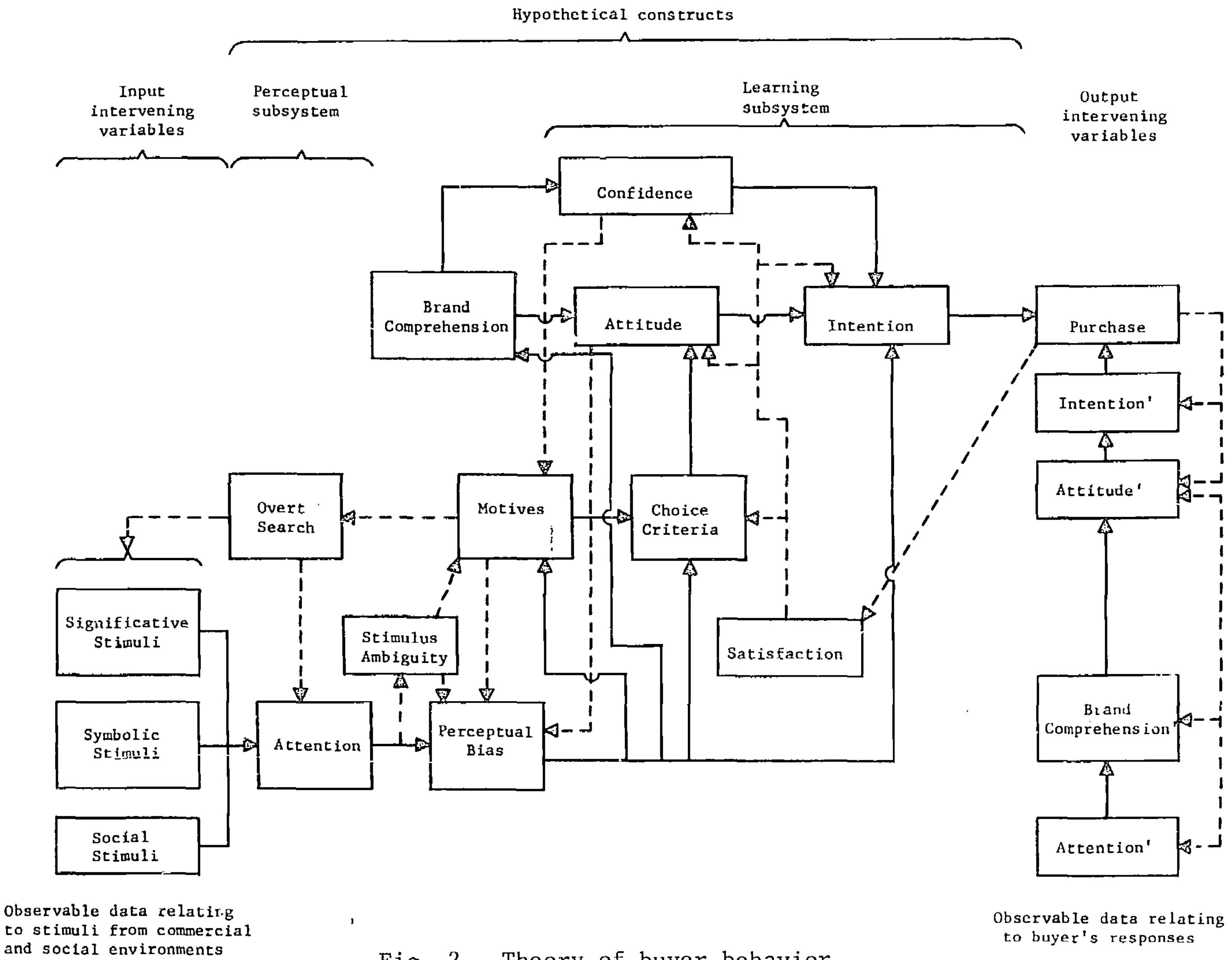

Fig. 2. Theory of buyer behavior.

specifically formulated to handle such behaviors as purchase of commercial products; but it is general enough to deserve our attention here. A student who continues to work at a CAI learning task is "buying" the task as something worth doing, as something that is high in his action hierarchy at the moment.

The buyer behavior model is too rich for a detailed critique; about the only thing we can do here is note a few things in it that other models seem to overlook. Attitude is a key construct in the Howard-Sheth approach; it is defined as the buyer's evaluation on a set of bipolar scales reflecting salient purchase criteria. Attitudes can change over repeated stimulus exposure, too, and there is some machinery (matrix operations, usually), for tracing these movements.

Part of the buyer model is devoted to the interaction of attention, attitude, and intention. "Source characteristics" such as power and attractiveness are assumed to be related to certain needs (ego defense, value expression). In this way, the buyer model draws on theoretical sources such as psychoanalysis and communication theory.

Except for the possibility of applying attitude measurement procedures to certain display or course-content features, we believe the Howard-Sheth model is too unwieldly for immediate CAI use. Perhaps it would be a worthwhile project to trace out all the variables in a CAI context. But for now, it seems to give us another checklist of potentially effective factors--and an extremely long checklist at that.

Summary Statement

Need-satisfaction models of motivation show promise for segregating CAI students according to achievement orientation, for predicting the effects of task difficulty upon performance, and for planning feedback arrangements.

SECTION IV. EXTRINSIC MOTIVATION

Tangible rewards can obviously be used to control student behavior. Considering the effectiveness of such incentives as money, it is indeed surprising that so few training institutions have used direct money payments for learning achievement. The standard objection is that the student would become dependent on cash payments, and would not perform without them. There are few data to indicate the conditions under which this dependency would or would not occur. Educators may feel, too, that direct payment would be a reflection on the teacher; since "social reinforcers" do work with many students, sufficient teacher ingenuity and persuasion should facilitate learning in even the most reluctant and unmotivated pupils.

Token reward systems have been found effective in several places. One of the most famous in the behavior modification attempt by Staats and Butterfield (1965). These investigators worked with a 14-year old Mexican boy who had a second-grade reading score and a long history of school delinquency. For completing programmed reading materials the boy was rewarded with tokens. His total amount of training time was 40 hours. The tokens he earned for mastering the various items had a total money value of $20.31, and he bought things such as stylish shoes with these earnings. Staats estimated that he made over sixty thousand single-word responses and learned 230 new words; and he also markedly improved his school behavior. To the school administrator the expenditure must have appeared to be quite worthwhile.

Another token scheme was employed at a home for delinquent boys (Phillips, 1968). The basic system worked on "points;" the boys accumulated points by performing appropriate behaviors (self-care, clean-up, academic learning); they lost points according to a system of fines for inappropriate behaviors (aggressive verbal behavior, dirty clothing, etc.) At the end of the week, points could be traded for privileges such as use of a bicycle, money allowances, snacks, and a trip downtown. Behaviors were markedly controllable under the system; number of aggressive statements, for instance, declined to nearly zero in a few weeks. An interesting practical aspect of this institutional study was that electing a peer-group "manager," and then holding the manager responsible for performance, was extraordinarily effective in getting things done by the boys. The manager could withhold or grant points himself, contingent upon whether the desired tasks were performed. Judging from the Phillips' results, this seems to be the best method available for producing clean bathrooms in boy's correctional homes!

Homme and his associates (1963) presented their subjects with a list of rewards the students could earn for performance of certain behaviors. Besides the standard toys and candy, students could also earn the right to engage in certain activities they enjoyed. And there might be negotiations between the subject and the reward distributing authority. Again, marked control and persistent direction of effort seems to be attained through tangible and "preferred activity" rewards.

We can also mention the Staats study with four-year old children. Staats wanted to teach them solve elementary reading skills, and they learned when he paid them with tokens which could be exchanged for toys. On the other hand, when only social reinforcers (notice, praise, blame) were employed, the

> "...children soon requested to discontinue the activity. It was concluded that the reinforcement system solved the major problem in teaching young children, namely, to keep them at the task over long periods of time." (Anderson, 1967)

A simple-minded application of these ideas to CAI training would involve the formulation of a "reward menu," along with a contingency plan whereby the students could earn the rewards they valued. Some valued rewards would not be feasible within the system; for example, direct money payments to military trainees. A highly-valued commodity in nearly any technical school, however, is free time, and it deserves serious investigation as a reinforcer. School managers might be pleasantly surprised to find out how much learning would take place, if the student is able to escape the learning situation, as a direct consequence of his learning! Skinner (1954) remarked on this possibility in one of his early teaching-machine papers. Some students, no doubt, would prefer to take their free-time reward on the same day; others would want to "save up" for a longer time away from the training base. An optimal contingency-reward arrangement would permit individual choice in this matter.

A model which combines extrinsic motivation with need theory has arisen in industrial psychology; it is called instrumentality theory and has been developed by Vroom (1964), Porter and Lawler (1968), and others.* The basic model is shown in Figure 3; there are two "expectancies," and two "outcome" levels.

Expectancy I is the subjective probability of achieving the desired outcome; this would reflect the trainee's confidence that he can successfully complete a course or course segment. Expectancy II is the perceived likelihood of whether the first-level outcome will occur, if success is achieved. First-level outcomes might be tangible rewards such as the money or free-time that we mentioned above, or less tangible ones such as eventual promotion, recognition, peer status, and instructor's approval.

The "valence" of an outcome refers to how valuable that outcome is to an individual. Valence is presumably related to its ability to satisfy the need for the individual; hence, a second-level outcome structure of needs is also shown in the diagram. Vroom proposed that outcomes are valued according to their "instrumentality" in securing the need satisfaction.

External task goals and internal task goals are distinguished in the schema. For a learner, external task goals might be things like scoring high on a final examination, or passing the course, while internal task goals might be that the learning be highly interesting to the student. Both kinds of goals have probabilities associated with them. This part of the model allows for conflict situations: the

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*Lewin, Tolman, Rotter, and Edwards have all set up models which have a "probability" or "expectancy" vector and a "valence" of "utility" vector. These two main components are generally held to be independent and multiplicative (Atkinson & Feather, 1966).

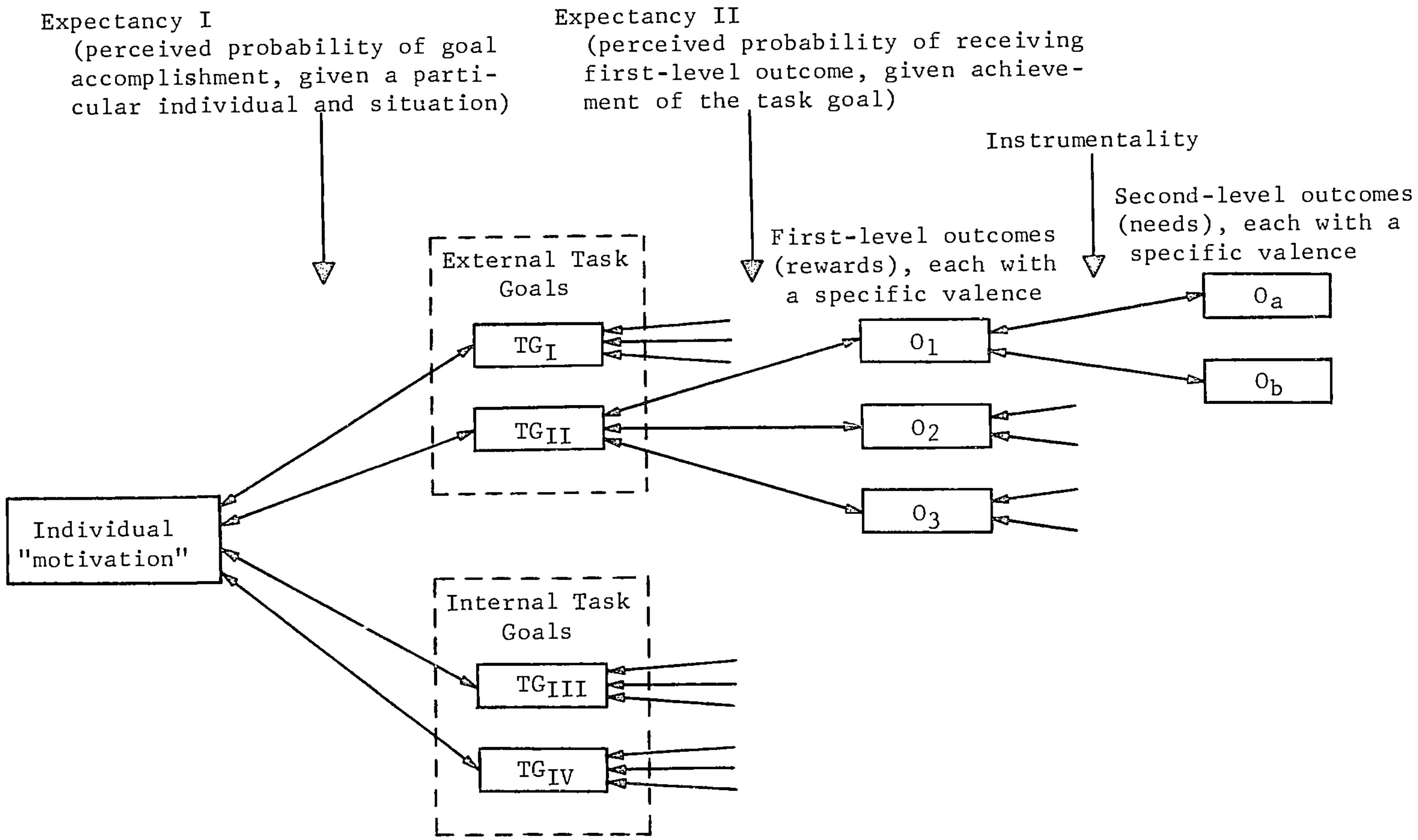

Fig. 3. A model of work motivation (from Campbell, et al., 1970).

student might perceive that he has a high likelihood of getting a passing grade in a course, but also a high probability of being bored by the material (Campbell, _et al_., 1970). Such a conflict would reduce the individual motivation shown in the first box.

Another version of the multiplicative model comes from Porter and Lawler (1968), and is reproduced in Figure 4. The major innovation is the "perceived equitable rewards" box; introducing subjective equity gives a more realistic flavor but also imposes another measurement necessity upon the motivation analyst. There are indications from the industrial relations literature that perceived equity can best be approached _via_ a negotiation approach. Nobody yet knows whether such an approach is feasible in CAI technical courses.

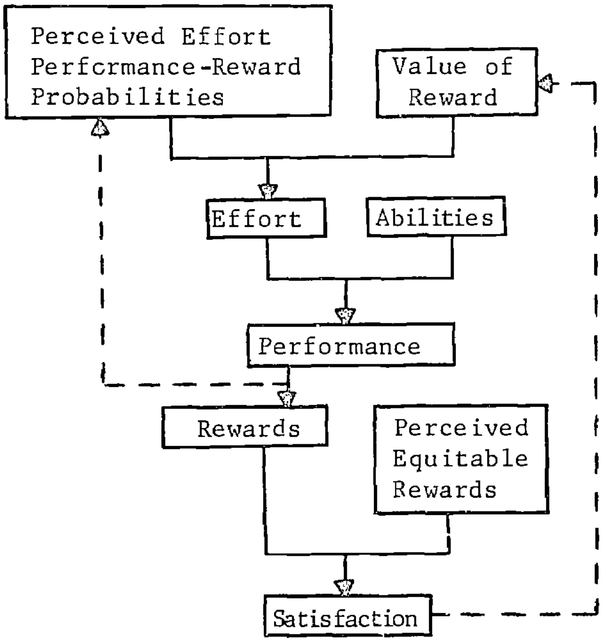

Fig. 4. Porter and Lawler Path-Goal Model

Porter and Lawler oriented their model to money compensation, but much of their theorizing applies just as well to non-monetary rewards. Take the "earning" of time-off from class as a compensation to the technical student; he is paid for a definite performance level by being allowed to leave the training situation; on some days, maybe he can start his CAI drill early in the morning and be able to leave the training base by 1 p.m. Such factors as the amount of time-off, the distribution of time-off benefits, the schedule of reward, and the secrecy of payoff can often be varied by the administrative authority involved. The tabulation below shows some anticipated effects, though again there is no data from a practical CAI situation.

Compensation Policies Related to Path-Goal Attitude

Policy Dimensions*	Attitude Affected
1. Degree to which performance is the basis of pay increment	1. Increases perceived probability
2. Amount of pay increment	2. Increases value of reward
3. Choice as to form of increment	3. Increases value of reward
4. Variance of increments about the average	4. Increases value of reward and perceived probability
5. Frequency of increment distribution	5. Increases perceived probability
6. Degree of secrecy	6. Decreases perceived probability

---

*It is assumed that all policy dimensions are increased to produce the related attitude change. (The table is taken from Lawler, 1971).

It appears that the "hybrid expectancy" models shown above should be useful guides for the CAI administrator. At least they might help to elucidate which probabilities and outcome valences are influencing trainee task motivation. We urgently need information about the first-level outcomes that can be applied, the type of I and II expectancies held by technical trainees, and the need taxonomies that are most meaningful (Campbell, et al., 1970). There is already some experience with the model in tying together disparate bits of motivational information. An example comes from Litwin (reported in Atkinson & Feather, 1966), who found that individuals with high "need achievement" will report higher expectancies for success in certain laboratory tasks, when only a little information about the tasks is available to them. If this were generally so, then motivation might be improved by selecting on "need Ach;" and such individual differences would become part of the CAI management process.

A still different instrumentality approach, due to Galbraith, is shown in the equation below; here we see that five contributing valences and instrumentalities are laid out.

$$V_p = f\,(V_m I_m + V_{pr} I_{pp} + V_f I_{pf} + V_s I_{ps} + V_g I_{pg})$$

Where:

V_p = valence of high performance
V_m = valence of money
V_{pr} = valence of promotion
V_f = valence of fringe benefits
V_s = valence of supportiveness
V_g = valence of group acceptance

l_{pm} = instrumentality of performance for the attainment of money

l_{ppr} = instrumentality of performance for the attainment of promotions

l_{pf} = instrumentality of performance for the attainment of fringe benefits

l_{ps} = instrumentality of performance for the attainment of supportiveness

l_{pg} = instrumentality of performance for the attainment of group acceptance

Three industrial studies have investigated the usefulness of this five-factor model. The first study (Galbraith & Cummings, 1967) was carried out at the Cummings Engine Company, and showed that supervisor recognition of superior performance was the most potent variable. This was because wages, fringe, promotions, and group norms were not influenced by performance (wages were negotiated by the union, promotions were rare and based on seniority, _etc_.).

In a shoe manufacturing plant, however, wages turned out to be the most significant variable; here the workers were women, there was little interaction from one production process to another, not much hope (or desire) for promotion. In a third study done in a different shoe factory, supervisor behavior did turn out to be a significant variable, along with wage incentives. But in this case the company had a human relations program which had operated for some time. Thus the emergence of significant variables makes sense in all three studies. Taken together, these studies indicate the feasibility of the valence--instrumentality approach in practical motivation. And they also show the differential potency of the variables over situations. CAI planners will have to expect these kinds of differences in their applications too.

We cannot assume that extrinsic rewards, even when they are effective, act in automatic fashion, and that people "act like animals." What seems to happen is that the subject's goal and intentions control his level of effort, and that money and other incentives cannot by themselves occasion higher outputs. Locke and Bryan (1968) show that setting a definite "hard" goal is a key feature of high performance and high task commitment. Locke (1967) also describes an ingenious way for determining a "good" hard goal: he used a matched control group of subjects, and defined a hard goal for an experimental subject as about 10% higher than that achieved by a matched subject. If the experimental subject "made it," his succeeding goal was raised; if he failed, his next goal was lowered a bit. This regime produced about 15% better performance. Experience with such goal-setting policies over the longer term, and with realistic tasks, is certainly needed.

Locke's research also indicates that specific or quantitative hard goals tend to produce higher performance than a simple "do your best" intention. The apparent power of this specificity-of-goal factor is shown in the behavior of one subject in Locke's "do your best" group. This subject, who was performing addition of two-digit numbers, set himself the goal of working through the whole box of problem cards in an hour (there were 720 problems, one on each card). This subject was the only one in the "do best" group who worked at a faster pace during the experimental trials than during the pretest. But most of those who set hard, high goals continued to work very hard throughout.

We can foresee several major problems in carrying out a realistic program of extrinsic reward in the CAI setting. One of these is the fact that reward schemes, though superficially simple, may be responded to in various ways. The Wrobel and Resnick (1970) study gives an example: there were four distinct patterns of response to a token system for headstart pre-schoolers. In adult individuals, one may expect similar differentiation, and perhaps some social strains regarding comparative rewards among individuals.

A second problem is that managers will have to concern themselves more directly with student expectancies and student intentions. Assumptions about these mediator functions are often wrong. Take intention-to-learn: the student who does not have a personally-set goal of learning the material may evade "really" learning it, even as he goes through the motions in class, barely passes tests, and so on. With student goal-setting being recognized as a crucial part of the training process, it is possible that too-low (or too-high) goals will have to be subject to "remediation," just as subject-matter deficiencies are recognized and "branched" to remedial segments. The course manager cannot assume his own goals match those of his pupils.

A third point involves the conversion or the "weaning" of students from a direct-reward system into a real world where reinforcement is more delayed and more ambiguous. Research on reinforcement suggests that "thinning out" the payments according to a schedule can still maintain the behavior; and there is also the possibility that conditioned reinforcers (pairing of verbal praise with payment) can be established:

> "...In the first case, the hope is that praise alone will eventually be sufficient to maintain the behavior originally reinforced by the token; in the second, the aim is to make the academic performance itself reinforcing enough to maintain the requisite study behaviors." (Resnick, 1970)

The approach seems promising; we should remember, though, the importance of the perceived probabilities in the motivation diagram a couple of pages back; when Expectancy I probabilities become sufficiently low, it will take substantial boosts of Internal-Task-Goal desirability to compensate for them. This may, in fact, explain the frequent failure of students to maintain desirable learning behaviors "by themselves."

The fourth problem, and one that might override the strictly technical issues, is management willingness to dispense the rewards. Teachers and administrators, who themselves learned mainly under social reinforcement and delayed reward, may be reluctant to grant significant time off for academic performance. In terms of the expectancy mode, the outcome valences might then be so reduced that no appreciable motivation would result. There is no easy answer to this problem, but it might be reasonable to expect managerial cooperation if intrinsic reward programs are genuinely effective. Our guess is that, even under the constraints of military technical training, radical gains in student mastery of the material would be observed. Suppose the student could come in early, work hard at his learning, and then leave at 11:10 in the morning, if he has attained the competence goal set for that day. Groups of dedicated students should convince even the most reluctant CAI manager.

Summary Statement

Extrinsic rewards can be employed to control the effort applied to a learning task; they are apt to be most effective when thet are perceived as valuable in satisfying individual needs, and when they are believed to be reliably obtainable by sustained effort. Extrinsic rewards do not operate in a simple way, but are interpreted in terms of the goals and intentions of the subject working for the rewards.

SECTION V. APPLICATION

The preceding review, sketchy as it is, does show that motivation theorists have come up with many ingenious proposals for energizing and directing behavior. As we have remarked several times, the concepts and motivational variables proposed have seldom been tried out in a practical CAI setting. Our task in this final part of the report is to recommend some manipulations which seem to be ready for immediate application. To be definite, we posit two reference environments--one in military and one which operates with disadvantaged students in a big-city school system.

<u>Military Electronics Example.</u> Though the training center we envision is quite large, with dozens of courses and hundreds of students, we focus here on a special task: teaching electronics men how to diagnose failures in a new radar equipment. The trainees have all gone through a 9-month "basic electronics" school at some time in the past few years; most of them have been working recently as maintenance technicians and have been promoted once or twice; none of them know anything much about this new radar. A class consists of about 20 students. We plan to process five or six classes per year. The prime equipment itself is scarce; in fact, the training center has only one radar available for the student to practice on. But we suppose that it does have a couple of senior enlisted men who are exceptionally competent in troubleshooting this particular equipment. There are also good consultation and field engineer services provided by the equipment manufacturers, so that the radar itself is maintained in peak condition.

The new radar is quite complex; if taught in the usual lecture-lab manner, a "C" school course of eight weeks or so would be anticipated. For the arrangement we have in mind, let us suppose the course is broken down into three segments. First comes a week or so of familiarization. This is mostly lecture, with the usual block-diagram analyses, some occasional hands-on operating on the radar in its various modes, and perhaps also some demonstrations of typical gross failure symptoms. The second segment, and the one where CAI is to be intensively employed, is nominally five weeks long. It involves the learning of maintenance-significant <u>relationships</u> in the radar. There are a great many test signals in the equipment that can be monitored, and these signals often have diagnostic meaning, if properly interpreted. Students are supposed to learn the significance of the different tests that can be made, and how to chain the separate tests into effective diagnostic sequences. A final week or two of the course will be lab troubleshooting, usually with a "bugged" radar set. This lab experience is supposed to <u>confirm</u>, to the trainee, the validity of relationships learned during the CAI drill experience. The trainee is supposed to discover that the procedures he has learned on the CAI terminal will actually work on the physical equipment. In view of the fact that no one man can have much time on the equipment, several trainees may work together in this final lab phase.

Course materials for the CAI teaching have been made up into twenty-five units. Each unit represents about the amount of material that would be covered in a lecture training day: an early unit might be concerned with teaching front-panel symptom reading and use of <u>major</u> test points in the radar. Later teaching units would go deeper into the separate subunits, and would utilize finer-grained diagnostic tests to close in on fault card or components. Final CAI units would involve both general and specific tests: by then, the student will have learned the routines for gross localization of the trouble, and should proceed very smoothly in the early stages of a problem to "get it down to a subunit."

In nearly all the teaching units, the essence of the CAI teaching is drill: drill in performing the tests in order, drill in discriminating whether a test signal is "normal" or not, and drill in selecting the test to make next. The drill flavor extends also to performance criteria. That is, students have to be correct, and they also have to be reasonably expeditious in their selection and interpretation of symptoms. Each unit has a definite "fluency" or criterion test.

Fluency requirements cannot be completely enunciated from our present armchair; but since the CAI concept in our reference environment is supposed to achieve competence through branched drill, we can suggest fairly high achievement goals. The criterion test for a unit might consist of, say, five localization or trouble-isolation problems; each problem solution attempt by a student would be scored according to such criteria as correct eventual isolation of the trouble, search efficiency in chaining the tests together into a sequence, and intrusion of redundant or irrelevant tests and checks into the search. Considerable research has already been done on scoring such performances; for example, we know how to evaluate a technician against an ideal or Bayesian search algorithm. It might be reasonable to demand that a student should solve at least four of the five criterion problems in the unit, and that his efficiency should average 60% or better of that achievable by an ideal processor.

Such limits are somewhat arbitrary, of course. But one of the main troubles with present technical training is that search behavior of trained people is very low compared to the ideal. Hence a 60%, or even an 80% ideal efficiency criterion, might be indicated. Whatever the limits adopted, pretest and revision is an obvious necessity for the course materials. Large numbers of subjects are not essential for this. Our experience indicates that as few as a dozen pretest runs can catch most of the operational bugs and permit us to set provisional performance limits.

Maybe we should say a word or two about preparation of CAI problem materials. One thing is sure: you cannot simply give the radar equipment maintenance manual to a group of CAI programmers and tell them to "program the material in the manual." In the first place, most of the information appearing in the manual is of no use to the technician who is trying to diagnose and repair failures. For another thing, the equipment manuals seldom provide a complete and effective troubleshooting logic. Advanced programming techniques such as TASKTEACH (Rigney, et al. 1969) approach this problem in a constructive way; that is, once the essential test-symptom relations are defined, the program itself selects troubleshooting problems, generates "guidance" and "prompting" data, and branches the student as he works. Deriving the input to TASKTEACH is still a highly skilled job, but the analytical work follows a definite plan and can be performed by senior technicians who know the equipment well.

We have our five-week CAI course, then, broken down into twenty-five drill units. A student who meets our solution and efficiency requirements on every one of the 25 units has "finished the course" and is presumed to have a high fluency in working through the symptom-malfunction relations of the radar. Thus the objective of the CAI teaching is to provide this fluency in every trainee who graduates.

What about the students themselves? We can predict that they will be rather above average in verbal intelligence, and that they will be at least moderately interested in electronics. However, their previous schooling, and their military experience generally, may have encouraged a certain cynicism about individual effort in a school setting. Most of them will view the actual school work as a chore, and not particularly exciting in itself. Most of them are expecting the ordinary lecture-lab-quiz sequence. To some students, the assignment to the course is viewed as desirable regular workday, no extra details, because it promises some environmental goodies (nearby city or resort area) in the off-duty hours. But since these benefits are distributed without regard to changes in learning behavior, there may be little incentive to change. It is not going too far, perhaps, to consider these students as only partially motivated toward learning the new radar.

An important thing to do in this training environment, we propose, is to devise a system for providing immediate extrinsic reward to the learner. Rewards should, according to theory, be made contingent upon performance; and the learner should have some flexibility in deciding just when he is to apply his efforts to the learning task. There are other conditions that should also be satisfied if payoff is to be a CAI motivator; the list below is a modified version of Lawler's (1971) payoff analysis:

1. Students must attach a high positive valence to the payoff.
2. Students must believe that good performance does in fact lead to high payoff.
3. Students must believe that the quality of their job performance reflects to a large extent how hard they are trying. In other words, they must feel that they can control the quality of their job performance. Unless this condition exists, employees will not believe that working hard will eventually lead to high pay.
4. Students must see the positive outcomes attached to good performance as greater than the negative ones.
5. Students must see good job performance as the most attractive of the behavior options available to them at the time.

What would an extrinsic reward system look like in our reference environment at a military site? Of course, a big decision would revolve around the nature of the payoff--whether payment is to be made in money, time-off, promotion, recreational privileges, commodities, future work assignments, or whatever. For illustration, let us assume that time-off is the reward for good learning performance. Time-off here <u>really means timeoff</u>: you can leave the base when you pass the criterion test for a unit. The drill material to be learned appears on a CAI terminal, and the student-terminal interactions have been arranged so that the CAI program knows when the student has attained certain levels of proficiency. Appropriate control procedures are maintained: for instance, occasional human monitoring is carried out to be sure that the student himself accomplishes the learning and that a few ringers are not actually doing the work and setting a whole group of people free.

Now if a student can expect to start on the terminal at a time of his own choosing, "go hard" on the unit lesson, and then be free to leave the base when he passes our stringent criterion test on that unit, we propose that he will tend to try hard when he is on the terminal, and that on almost any criterion his learning will be more efficient than it would be under a standard 9-to-4 training day. Furthermore, if the student can accumulate considerable time-off by working weekends, nights, or early in the morning, we should expect occasional dramatic learning performance wherein a student finishes the whole course in a few days. He might then collect his time-off reward in the form of an extended furlough.

Parameter determination (difficulty of items, amount of trouble-shooting fluency to be achieved per hour off, _etc_.) is likely to be an important aspect of early runs, because the time-off rewards must be large enough to function as incentives and yet not be so costly as to be intolerable to the training authority. Performance distribution from pretest students should be of some aid in setting payoffs, but the new payoff system is likely to produce a different score distribution when it operates in the real world. The CAI terminal area itself should be available at all hours; it should be lightly staffed with a subject-matter expert on hand or on call; arrangements for administering payoffs to the students should be capable of quick response to individual achievement.

Industrial incentive plans, such as cash for piece-part production, usually result in performance gains, say on the order of 10 to 20 percent. The percentage improvement might be even larger in CAI drill learning under time-off reward, because the negative social and economic consequences of high industrial production may not be so important in a training school. Industrial workers (non-union ones, anyway) on piece-rate pay are typically afraid that if production is very high, rates will be reduced arbitrarily by management; so production is often less than half what it could be (Lawler, 1971). If our CAI student is convinced that the payoffs are real and that they will persist at least during his tenure as a student, really striking efforts might be expected from him.

Some educators have seriously proposed the formation of student-management committees to negotiate payoff schedules and to explore inequities. Patchen's model, summarized back on page 29, had participation affecting both goal acceptance and effort instrumentality. We believe that, in the reference environment described here, informative tests of the concept can be accomplished without such arrangements; if early payoff trials are at all promising, then student participation in rate-setting can be investigated. At first, it appears that management should risk setting the payoffs a bit "too high," in order to get a powerful effect. Negotiating or reducing payments can then be attempted on later classes or at different training locations.

On an earlier page we referred to Resnick's proposal for "thinning out" external reinforcement as the learning proceeds. We cannot say much about this in a CAI context; certainly the real world does not pay off a mechanic for every little bit of performance or for every little bit of added competence. Perhaps the best suggestion right now is to follow a provisional policy; if truly impressive gains in learning are achieved <u>via</u> "earned" time-off, then gradual changes can be contemplated in the payoff schedule toward the end of the course. The important thing is to get some big effects first; subsidiary manipulations can always be carried out as the training experience moves forward.

Need achievement projects report rather consistent differences in short-term motivation as a result of achievement scores. These differences extend into areas as diverse as persistence, anxiety, fear of failure, and class heterogeneity. We glanced at some of this research in Section III. We believe it would be worthwhile to obtain n Achievement scores on each trainee and to group trainees together on the basis of them; those with a high n Ach and low test anxiety will benefit from the challenge of an ability-grouped class of peers. Those showing relatively low achievement motivation may do better in heterogeneous groups. Hence our first class of 20 or so students might be split into two sections for the CAI drill. If the early time-off system seems to work, differential payoff rates for the ability-grouped trainees might be tried as an additional motivator. Generalizing from previous academic experiments, we should expect slightly higher learning achievements under these conditions.

Trainees should also be given some of the standard persistence tests before the class begins, in order to see whether these scores are indicative of achievement on the CAI course units. Arrangements should also be made to administer a small battery of intellectual tests to the trainees. The scores could be used to check on the correlation of basic abilities with CAI performance; if Patchen's results can be generalized, people are motivated to do what they can do best. As a practical rule, perhaps the training management should allow a full school day for all the testing on mental ability, achievement, and persistence factors. For the n Ach measurement, several people will be required, and for this reason it might be best to have a special visiting team perform all the testing.

We are in something of a puzzlement regarding Locke's goal-setting process in a CAI course at a military base. The mechanics of a goal-setting procedure should be easy enough <u>via</u> the CAI terminal, because the terminal can show the student a genuine (or rigged) achievement distribution, and can let him choose a personal goal to shoot for. It might take some additional programming, though, to provide for just the right goal adjustments. Maybe we can use an idea from Gordon Pask's adaptive machines for teaching keypunch operators. The keypunch student had to improve slightly to "keep up" with the rate of stimulus material. If errors became too frequent, though, the input speed, or "goal" in our present context, was reduced back to a lower level (Lewis & Pask, 1965). The challenge placed on the student was thus varied according to "what he could stand." Perhaps at the beginning, we could simply level with the student and furnish him with reasonable payoff expectations for his hours of effort, or even slight over-estimates of the amount of time he will need to finish a course unit. These expectations in fact could be computed by regression methods and presented in a graphic display. And again assuming access to the CAI drill terminal, we could allow the trainee to apply flexibly his effort toward the rewards sets for himself. We always have to remember that it is the trainee's expectations and goals that are the motivators, and that we cannot just move payoffs up and down and manipulate expectations in a simple unidimensional way.

The drill system outlined above is procedurally oriented and we have said little about content aspects of the course. What about the novelty, curiosity, and epistemic arousal factors that we mentioned in Section III? Our present stance is that advanced CAI programs tend to incorporate some of them already. But even the best-organized electronics courses are still going to be difficult, to be lengthy, and to require a lot of plodding and rather dull practice. If seems to us more profitable to accept this, to reward pupils for doing the necessary drill quickly, and to hope for intrinsic reward/competence satisfaction effects <u>after</u> the trainee has reached a pretty high level of skill. We already have a little bit of experience running practice subjects on the TASKTEACH program at USC: after a few dozen problems, the student may get caught up and interested by the material, and remark upon his satisfaction in mastering the maintenance drill material. Some students respond to task-related novelty aspects, others would be subject to other need determinants, so that the ultimate requirement is for a cafeteria of all kinds of motivators. For right now, we hypothesize that an external reward scheme should be at the center of the motivational system, and that the many other aspects that might have energizing significance should be kept in mind as we shape up the system.

Hardened training people may react to our proposal with a feeling that "it'll never happen." It is true that most military training units are conservative and will feel threatened by new methods; that management will fear the loss of control over the students; and that it will not like to contemplate students leaving school at odd hours of the day or spending Sunday night at the CAI terminals. Our response to these stock objections is simple: the research we have seen indicates that such a system should work. If management really wants high level of directed learning it will have to recognize and provide for those factors that control individual effort at the learning task. We believe that a system like the one sketched here, or something very much like it, will be given a serious trial within a couple of years.

What if such a system should not work? It is always possible that an attempted application will fail. We expect that the main causes of failure should be quite evident. For example, if the time-off payoff is not high enough, or is not administered quickly enough, the subjects would be quick to remark about it and remedial adjustments should be straightforward. Of course, the drill program itself may not be an especially good teaching routine--though we should hope that it would be technically adequate before being put on-line. Perhaps the most likely causes of unsatisfactory tryout would be the managerial difficulties of running a system that permits so much individuation of effort and practice. That is one reason why we recommend restricting the first tryouts to occasional courses with rather few students. It might be reasonable, too, to demand that each student complete some minimum number (e.g., six) of the CAI drill units per calendar week.

If management is administratively (and emotionally!) prepared to run a trial and the learning still appears unsatisfactory, then our recommendation would be to return to the instrumentality diagrams mentioned earlier and to trace down the difficulties within the model. There may be unexpected social effects deriving from competition and disappointment which are somewhat outside the model; perhaps these may be approached through the goal-setting or n Ach framework.

To summarize the military application sketched above we would propose the following major arrangements:

1. Provide a CAI training package of 25 drill units; each unit will cover malfunction-analysis drill material for the technician, and will include a criterion test of several problems. The interaction of the student and the computer in problems should, on occasion, allow the student to "push" the signals and system relationships in order to explore and test the parametric limits.

2. Pretest the CAI course units on a small sample (say 6 to 10) of technicians, and adjust practice and criterion demands so that four to five hours of steady work will result in completion of each unit.

3. Test all students in the class on need for achievement, for power, and for affiliation _via_ the McClelland projective format; also test everybody on standard mental abilities and persistence tasks.

4. Separate the class into two groups on the basis of need-achievement scores; if score distributions favor it, the split should be near the median.

5. Now split the half of the group with high need-achievement scores into two sections; one section has relatively high ability scores, the other section has relatively low ability scores. We now have three groups: (1) high n-Ach, high ability; (2) high n-Ach, low ability; and (3) low n-Ach. Insofar as feasible, these three groups should be kept intact through the CAI teaching phase.

6. Terms of time-off reward are explained to the students; students must advance at least six units a week, but if they choose to, they can leave the area any time they finish a unit in any one day. Work outside of regular class hours is encouraged.

7. The reward system is demonstrated via a special film which shows "model" technicians working in the CAI framework. A first technician model is shown working at the CAI terminal; actual details of his goal-setting and learning are shown; the student makes mistakes, solves problems, gradually attains fluency, and receives his time-off reward. He leaves the base early in the day, after starting his course unit early in the morning. A second model is shown completing two units on one day and working on a Saturday and Sunday. He accumulates two extra days off, and receives a long weekend for this achievement. This modeling approach stems from Bandura's work on identification and imitation.

8. When a student first appears at a CAI terminal, his performance expectation is computed for him. Thus the computer might say that, "our prediction is that you will finish the first lesson in about four hours of on-line work." These predictions would come from a regression model which is built into the teaching program, and which utilizes test scores and pretest difficulty information. The student is asked to set a performance goal for himself for each unit. A printout of goal-vs-actual scores will be accumulated for each student, and these will be posted for each of the three groups.

9. Provide an office or desk for certifying learning progress and for approving student exit, and gear it for rapid response.

10. Administrative recognition for high achievement should include special rewards; within a time-off orientation, time-off bonuses for perfect or near-perfect criterion performance might be instrumented. The highest-achieving students might also be invited to demonstrate their competence by explaining their methods and performances to other students and to resident training staff.

11. A supply of extra-hard problems should be on hand for the better students; opportunity to work on these, and explicit recognition for solving them, would go to superior achievers in each of the three groups. We can recall here the famous Hungarian "Problem Book," which offered challenge to generations of young mathematicians in Central Europe.

Overall we are optimistic and believe that success is a good possibility. The variables we propose to manipulate have been shown to have a powerful influence upon behavior; we can hardly find a single study when a highly-valued reward has not been instrumental in manipulating intentions, and hence effort (Berman, 1971). When a teaching authority can provide external reward with some attention to need-Ach groupings, an opportunity to use best skills, and programmed interaction between student and the CAI drill, the motivational effects should be positive.

Urban Disadvantaged. The prevailing wisdom is that many urban youths would benefit from the acquisition of new technical skills. Hence the many programs, centers, and contracts which are supposed to provide training in the desired skills. Rather few programs, though, attempt to provide "really technical" training. One Job Corps installation, for instance, had in 1969 some courses in automotive work and electronics, and there were shops and instructors in these subjects. Students did not, however, "get into" the complexities of their technologies; the instruction remained at a very superficial level. There seemed to be an implicit belief that these subjects simply couldn't learn anything "deeper" or more complex. Visitors to this training site were often informed by the teachers that not much could really be expected of these students. And the students, whatever their academic limitations, were probably aware of these teacher attitudes.

Yet we have indications that CAI can radically reduce cultural disadvantages. The Stanford researchers (Suppes & Morningstar, 1969) proved that their math and reading programs work just as well in Mississippi, and in Africa, as they do in Palo Alto. A key to success, apparently, is regular drill in the subject matter, with this drill suitably controlled and individuated <u>via</u> CAI. Wherever they are, the children who work on the Stanford courses quickly perceive that the CAI terminal is non-threatening, that real progress can be made in the course, that the teaching routine is honest, patient, and so forth. Many of these factors should apply to any CAI student, regardless of age or course content.

In any event, we can take as our second reference environment a Federally-supported training unit in a large city. We suppose that most of the trainees are drop-outs of one kind or another; that they will have poor academic records and low aptitude test scores; and that nearly all of them will be suspicious of the administration of the training project. Such trainees have not in the past exhibited sustained effort at learning tasks.

Assuming that we want to teach them how to repair small gasoline engines, such as those in lawnmowers, minibikes, and portable compressor units. (Even in the present period of mild recession, skilled workers who can accomplish such repairs are readily employable.) The principal subtasks in fixing small engines are disassembly and reassembly, identification, procurement, and replacement of faulty parts, tuning, and various mechanical linkage adjustments. Nearly all these behaviors, we believe, could be taught *via* a CAI routine which is keyed to a slide or video sequence, and which is accompanied by actual hardware right alongside the CAI terminal display. If the trainee is learning to take apart a Briggs & Stratton engine, an engine is given him, and the disassembly actions are shown to him on the screen. When he completes an action, he pushes a terminal button to indicate compliance. Some of the instructions are given over an audio channel, so that reading is minimized. In the early stages of training, the CAI routine may be little more than a page turner; but in later stages the format can become more interactive, the student can be asked over the speaker or headphones whether he has eliminated a choked filter as the cause of hard starting in this particular engine, and so forth. It is easy to imagine a CAI course of this kind, again broken into reasonably compact work units of about two hours apiece, and with a few floating instructors to serve as resource people.

Motivation of trainees in this environment might be organized around immediate cash payments for completion of a CAI unit. Fringe benefits, promotions, group acceptance, intrinsic rewards in the performance itself--all these, though perhaps eventually operative, would not be perceived as possessing immediate valence to the typical trainee. The valence of money can be safely assumed, however, and it might work for a large fraction of the students in this setting.

We do not know enough about the effectiveness of cash payments of this sort. But it should be good practice to administer all payoffs as soon as they are earned, to arrange for payments that are perceived to be fairly high by the recipients, and to demand a certain minimum achievement, say per week or per day, from all those who remain in the system. There are some intriguing technical questions about the exact schedule to employ in paying the learners, and just how raises for additional effort should be dispensed. There are indications that it may help to involve the trainees themselves in discussions regarding the distribution of payoff, because of the greater commitment that comes from seeing a pay plan as "our plan" and not just an imposed management technique (Lawler, 1971, Chapter 10).

Something like three dollars per initial (approximately two hour) unit might be a reasonable starting value. An energetic trainee could earn a fair return everyday, and the money costs would not be unreasonable in a Federal-support context (Job Corps programs often cost six to ten thousand dollars per trainee year). Those who have seen the rather listless performance in regular urban-youth courses might be ready to try direct payment for learning.

Many of the steps in realizing such a cash payment program would be similar to those we outlined for the military electronics course. Thus we would operate around a unitized course (though here our units are shorter), and we would break in the students to the payoff system by means of a special film which showed successful model trainees. There would be less testing and grouping, though, and probably the whole teaching plan should be geared to quick payoff, even on the first day the trainee appears. And the training system would have to be ready to respond to such problems as frequent trainee drop-out after a few days on the terminals. The emphasis throughout would be upon simplicity and direct imitation.

If cash payments are dispensed for each successful lesson completed, and if they are effective in producing high levels of attendance and effort, then cash expectancies for post-training performance become a major matter for the training authority. We mentioned earlier that one of the objections to money-for-learning is that if the money ever stops, then the effort stops. In the absence of empirical information on what happens to paid trainees, we can say little. The trainee who actually does possess, perhaps for the first time, marketable skills may appreciate his new status so much that he can readily accommodate the change to a non-immediate pay regime. A few months of experience with pay-for-learning should articulate some of these issues.

<u>Concluding Comment</u>. The two foregoing examples were chosen because they seem to be "naturals" for CAI application, and because we believe that we know something about motivators that are likely to be effective in those situations. As it happened, both our examples were organized around immediate performance-payoff contingencies. We could have presented some other cases which would stay closer to task-related satisfactions, epistemic drives, or whatever. Perhaps the best message from hypothetical examples like these is that, whatever the circumstances, motivational and incentive conditions are dependent on definite factors

which can be hypothesized, tried out, and improved through the motivation-model diagrams of the Vroom and Lawler type. A given CAI application should start with some such model and should refine it as the system is phased into practical use.

To demonstrate that we already possess a considerable technology about the administration of pay for performance, we close this report with a table from Lawler's text. Here he calls out four organizational factors, and recommends appropriate pay plans for each configuration. The four variables are (1) human relations climate, (2) production type, (3) size, and (4) degree of centralization. The table shows that some configurations do not appear to allow for an appropriate pay structure. Lawler's table was originated in the industrial context and it does not fit the CAI motivation problem perfectly. The table does indicate, though, how information on something as complex as pay can be systematized. It should be possible for CAI researchers eventually to provide a similar "motivation table" for those variables that are most salient for efficient teaching.

Appropriate Pay Plans for Various Types of Organizations (from Lawler, 1971)

Authoritarian	Mass and unit	Large	Cent.	Individual basis; objective criteria
			Decent.	For workers--individual; for managers--group plan possible on profit center basis; for all objective criteria
		Small	Cent.	Individual basis; objective criteria
			Decent.	For workers--individual; for managers--group plan possible on profit center basis; for all objective criteria
	Process	Large	Cent.	None very appropriate; companywide bonus possible for managers
			Decent.	Group plan based upon objective subunit performance criteria
		Small	Cent.	Organizationwide bonus plan
			Decent.	Group plan based upon objective subunit performance measures
	Professional service	Large	Cent.	None appropriate
			Decent.	None appropriate
		Small	Cent.	None appropriate
			Decent.	None appropriate
Democratic	Mass and unit	Large	Cent.	Individual plans based on objective criteria as well as soft criteria, such as participatively set goals
			Decent.	Same as centralized, but for managers use data from their subpart of organization
		Small	Cent.	Some consideration to performance of total organization; individual plans based on objective criteria as well as soft criteria, such as participatively set goals
			Decent.	Same as centralized except subpart performance can be used as criteria in both individual and group plans
	Process	Large	Cent.	Organizationwide plan based on objective and subjective criteria; individual appraisal based on soft criteria
			Decent.	Group plan based on plant performance; objective and subjective criteria
		Small	Cent.	Organizationwide plan based on company performance
			Decent.	Group plans based on subunit performance
	Professional	Large	Cent.	Design individual plans; high input from employees; joint goal setting and evaluation
			Decent.	Same as centralized but some consideration to performance of subparts
		Small	Cent.	Some consideration to performance of total organization; design individual plans; high input from employees; joint goal setting and evaluation
			Decent.	Same as centralized, except that data for subpart of organization may be relevant

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