



## A Synthesis of the Information Economics and Lens Models

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Research in accounting has developed in a number of distinct paths within the past decade. Human knowledge concerning the understanding of complex phenomena is often acquired through a succession of increasingly complex models. One strategy which may increase understanding of accounting phenomena is to integrate and synthesize two or more accounting research areas. Synthesis may be valuable per se or may be performed due to dissatisfaction with the specifics of each examined research approach. This note presents a synthesis of research in information economics and human information processing (specifically the lens model approach in the latter).

First, the criteria that a proposed model should satisfy are defined. Then the essential elements of the lens and information economics (I. E.) models are introduced and some limitations and difficulties are identified. This is followed by an integration of the essentials of both underlying models. The final section contains both an evaluation of the synthesized model in terms of the earlier established criteria and some future research questions.

The critical analysis of a model often leads to questions regarding the cost-benefit aspects of the proposed model over competing ones. For example, a more complete model may be more complex, which may render it difficult to put into operation. Unfortunately, the evaluation of the cost-benefit aspects of a model is not an easy task given the lack of well-defined criteria.

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We propose the following six criteria for model evaluation: (1) representativeness, (2) completeness, (3) parsimony, (4) logical basis, (5) originality, novelty, and (6) consistency. The first criterion must recognize that since accounting is an applied discipline, accounting models should be representative or descriptively valid of extant accounting systems. Of course, representative models should also possess predictive validity, as long as the accounting environment is somewhat stable.

A complete model is one that incorporates the relevant constructs, variables, and relationships of the research discipline. Since accounting is an information discipline, questions of information systems design dictate which variables, constructs, and relations are relevant. A parsimonious model, on the other hand, includes only the main variables and relations which are necessary to resolve accounting information systems design issues.

The criterion that the model be founded on a logical basis simply requires that conclusions be correctly derived from premises according to the accepted rules of logic (i.e., the "calculus"). This criterion is most pertinent to deriving normative implications of a model, which is the case in most information economics research.

The last two criteria require that a model should be consistent with prior research in terms of previous evidence concerning relevant variables, constructs, and empirical relations. Yet the model should contain some new information or, in other words, be somewhat novel and original. With these criteria in mind, we consider two models that have provided the basis for a significant portion of recent accounting research.

### *An Overview of the Lens and I/E Models and Some Shortcomings*

The two models differ sharply in their orientation. The I/E model is primarily normative, whereas the lens model is primarily descriptive. However, models which guide accounting research and practice rarely can completely ignore either of these dimensions. That is, normative models which lack some descriptive validity imply little for system design issues. Also, descriptive models which rely on principles that are not logically derived from goal premises are unlikely to remain in use. Other differences between the two models are summarized in table I. These differences suggest that a synthesis incorporating the best features of both models will be of value to accounting researchers.

These criteria were proposed by D. Driscoll in an early critique of this paper and are used here in essence as such by Ijai (1975, pp. 3-4) and Kerlinger (1973). See also other references in the modeling and simulation literature.

TABLE 1  
*Comparison of Approach Emphases*

I/E		Lens	
(1)	Emphasis on the states-of-the-world decisions and models	(1)	Emphasis on the stochastic relationships both between the event-related messages and between these events and judge's ensuing decisions
(2)	Stresses outcomes in terms of payoff functions	(2)	Stresses representations of informal decision processes
(3)	Used mainly for theory development	(3)	Used for behavioral explanation purposes

#### THE INFORMATION ECONOMICS MODEL

Many models that are used in business are founded upon economic constructs. In accounting and information systems, a common approach is to compare alternative information structures in terms of their net expected value. This approach, which is based upon Marschak's [1969] research in information economics (I/E), is founded upon a few primitive notions including probability, decision, and utility. One version of an I/E model can be found in Driver and Mock [1975, p. 491]. In the I/E model, the important relationships among elements are summarized in three functions: information ( $\eta$ ), decision ( $\alpha$ ), and utility ( $\omega$ ).<sup>1</sup> Additionally, constructs are specified in terms of five sets: (1) states-of-the-world  $X$ , (2) messages, signals, or data  $Y$ , (3) alternatives or actions  $A$ , (4) outcomes  $O$ , and (5) utility of payoff  $P$ .

As noted earlier, information economics is primarily an ex-ante normative formulation. Thus, information system alternatives, the decision rule, and the utility function must each be specified prior to selecting an information system. A model of this nature has a number of shortcomings when viewed from the perspective of the six suggested criteria. It was argued earlier that for an applied discipline such as accounting, even normative models must meet representativeness and completeness requirements. A major limitation of most I/E formulations is the absence of explicit consideration of human information processing, behavioral variables, and behavioral relationships.<sup>2</sup> A closer examination of this research reveals that an implicit, Bayesian information-processing rule is assumed. However, few studies have investigated the specification error that may exist if other processing rules and behavioral variables are more representative in extant information system choice situations. This leads to a lack of confidence in the predictive validity of payoff differences which are forecasted from typical I/E studies.

<sup>1</sup>The notation used in this note follows decision theory conventions. Thus sets are denoted as capital characters with their elements indexed in lowercase. Functions are denoted as lowercase Greek and Roman characters.

<sup>2</sup>See, for example, Fishbein's [1972, p. 41] information evaluation model.

## THE LENS MODEL

While the I/E model concentrates on the major elements of information and decision processes, the Brunswik lens model emphasizes human information processing (HIP) elements. Three related sets form the basis of the lens approach (see Ashton [1974, p. 722]). First is the set of relevant decision or distal variables  $X$ . This set is similar in concept to the set of payoff-relevant events in information economics. The notion of distal variables implies that these events or states are separated from the decision maker by time or space. Thus the individual must form the second set, a set of judgments or predictions ( $\hat{X}$ ) concerning these variables. The third set in the model is the set of cues  $Y$  which are the data base upon which these judgments are formed.

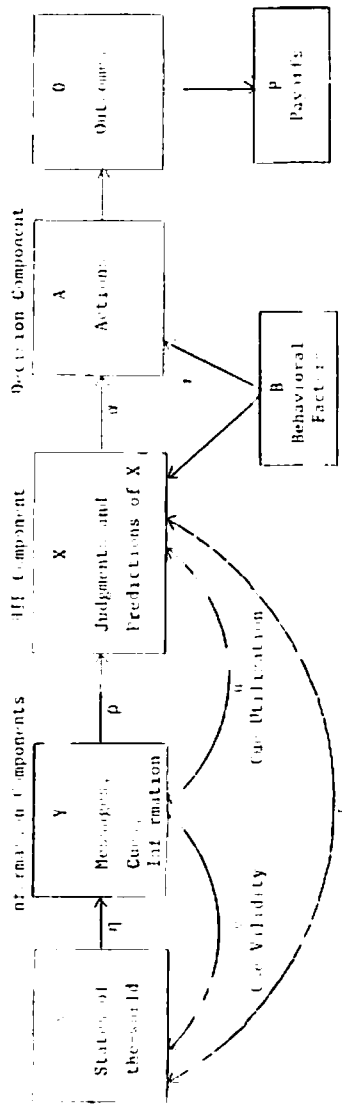
Upon examination of this model, the question arises of how these various sets (environmental variables, cues, and judgments) are interrelated. Such relationships are formally depicted in figure 1 as cue validity ( $v$ ), cue utilization ( $u$ ), and response validity ( $r$ ) functions. These functions are estimated in existing lens studies through the use of correlational, regression, discriminant, and ANOVA techniques.

Since it is primarily a descriptive model, the lens approach may be deemed to be more representative of empirical information-cue-processing systems. Compared to I/E formulations, both information-processing rules and relevant behavioral variables (such as overload constraints) have been incorporated into the analysis (see Driscoll and Mock [1976] and Libby and Lewis [forthcoming]). These studies, tend to be incomplete with respect to the decision rules ( $\alpha$ ) used and the ultimate payoff realized ( $\omega$ ). Failure explicitly to consider decision models and user objectives leads to several difficulties.

Suppose a behavioral variable such as category width (Eggleton [1976]), decision approach (Vasarhelyi [1977]), or illusory correlation (Ashton [1976]) is identified. How can the relevancy of such variables be evaluated without explicit consideration of decision rules and payoffs? Because many of the investigated variables are derived from psychological studies, this approach may lead to a misallocation of research resources to studies dealing with variables which are psychologically interesting but not relevant to the accounting information system.

Ashton [1977] has made a similar point in his analysis of the emphasis HIP researchers have placed on cue-weighting schemes. He notes that HIP researchers should place more emphasis on research "involving changes in the data set upon which predictions are made. This alternative is generally ignored by human information processing researchers in accounting" (Ashton [1977, pp. 15-17]). This alternative, of course, is the thrust of I/E research.

The lack of explicit formulations of underlying decision models has



**Information Economics Notation**

$S$  = Set of possible states of the world  
 $Y$  = Set of messages, cues, and information  
 $X$  = Set of judgments and predictions of the environment that is of concern to the decision maker (distal variables)  
 $A$  = Set of possible actions  
 $O$  = Set of outcomes (one outcome for each  $X, A$ )  
 $P$  = Set of payoffs (associated with each outcome)

**Response Validity**

$\eta$  = An information function relating states and messages  
 $\rho$  = A function (rule) such that  $A_i = \rho(Y_i)$   
 $w$  = A utility or preference function such that  $P = w(O)$   
 $A$  = Set of Possible Actions  
 $O$  = Set of Outcomes (one outcome for each  $X, A$ )  
 $P$  = Set of Payoffs (associated with each outcome)

**Long Notation**

$X$  = Status of the environment that is of concern to the decision maker (distal variables)  
 $Y$  = Cues, messages, and information  
 $P$  = Human information processing function  
 $v$  = Cue Validity  
 $u$  = Cue Utilization  
 $B$  = Behavioral variables that impact upper core information processing and decision making  
 $r$  = Response Validity

Note: Related concepts are lined up; identical concepts are identified by the same variable.  
**FIG. 1.** An integrated model of decision, information, information utilization, environmental variables, and outcomes. (Single period without feedback.)

also led to methodological difficulties. Without well-formulated theoretical models, it is difficult to generate explicit hypotheses of the expected effects of various behavioral variables and information-processing rules. This has led to exploratory, descriptive statistical analyses, rather than formal hypothesis testing. In summary, what the lens model has gained in terms of representation and parsimony, it often has lost in terms of completeness and logical base for deriving information systems selection principles.

### *Integrating the Models*

In figure 1, a model is depicted which integrates the lens model within the information economics model. Figure 1 has added an explicit HIP component, an information-processing function  $\rho$ , and behavioral factors  $B$  to the typical I/E model. From a normative perspective,  $\rho$  may be specified as a maximum likelihood estimator of  $\hat{X}$  or, as Bayes's theorem dictates, in terms of a judgment process which produces posterior probabilities. The behavioral factors are added explicitly to include individual variables which may impact the information-processing and decision processes.

This model has been developed with the limitations of the lens and I/E models in mind. As such, it provides a means of considering the joint impact of research into information system and into human information processing. Mathematically, the action selected (and ultimately the payoff realized) may be represented as a series of functions:

$$\begin{aligned} \text{Information: } Y &= \eta(X), \\ \text{Processing: } \hat{X} &= \rho(Y), \\ \text{Decision: } A &= \alpha(\hat{X}), \\ \text{Payoff: } P &= \omega(a). \end{aligned}$$

The importance of the behavioral factors  $B$  which affect the information-processing system  $\rho$  and the decision system  $\alpha$  is evident in such a formulation.  $B$  and  $\rho$  were included in figure 1 as a result of the comparison of the I/E and lens models.

Notation comparisons in the notes to figure 1 indicate: (1) analogous elements such as  $X$ ,  $Y$ , and  $\hat{X}$ , (2) different emphases such as between  $\eta$  and  $\iota$  or  $\omega$  and  $r$ , and (3) elements missing or lack of emphasis in one of the models. Elements were added ( $\rho$ ,  $B$ ) where deemed theoretically necessary. These comparisons clearly display the processing emphasis of the lens model and the outcome-payoff concern of its I/E counterpart. The model of figure 1 is more complete than its components, but at the cost of added complexity.

Unfortunately, this model is still an incomplete representation of accounting systems, since it does not incorporate dynamics and feedback. This is a real limitation because much accounting information is intended for ex-post evaluations of decisions and actions.

The effects of accounting feedback can be modeled in terms of an

individual's response to feedback cues on his previous performance in a task. The feedback factor is incorporated in figure 2.

The actual use of feedback cues by an individual is an important learning-feedback variable in the entire information and decision process. Therefore, decision quality is also a function of the decision maker's overall feedback response.

Figure 2 displays a sequence of stages that are cyclically repetitive. Let  $t$  represent the time point of information processing and decision. Beginning at the left of the diagram, prior states-of-the-world provide environmental cues through an accounting measurement process. These are supplied to the information-processing function, which leads to an action which is subsequently implemented. This leads to a new set of states-of-the-world which include the results of implemented actions. Data on the subsequent results are then collected by the information system in the form of performance feedback cues which are used as an additional input for the information-processing function. The separation of environmental and feedback cues is depicted as a partition on the information in figure 2. A similar partition is also shown on the states.

The sequential nature of such a model is an improved representation of human information processes and can reflect, in a sequence of repetitive decision processes, the stimulus-response nature of some human decisions.

As an example of the increasing complexity and variation of features of studies based on these models, consider a study of a production decision. The foreman receives a set of data on backlogs, machine and labor availability, and departmental objectives. A HIP lens approach would model the cues received, the states-of-the-world, and the decision outcomes and attempt to explain the decision-making procedure through, say, a regression. An I/E approach would generally ignore how the manager actually makes his decision but would attempt to relate the states-of-the-world, cues, and outcomes and obtain a payoff-relevant, profit-maximizing solution. The model displayed in figure 1 would imply an attempt to optimize, but with the added limitations of how the manager processes information and what the behaviorally feasible solutions and implementations are. Finally, a feedback model would also consider the feedback effects of information which are intrinsic in the human learning processes and which change the behavioral and processing considerations included in figure 1.

#### *Evaluation of the Integrated Models*

The verification of the cost-benefit superiority of any model is difficult to achieve. However, the integrated models do offer some advantages over either a lens or an I/E formulation. First, a model which considers both normative and descriptive elements can better meet the criteria of completeness, representation, and logical basis.

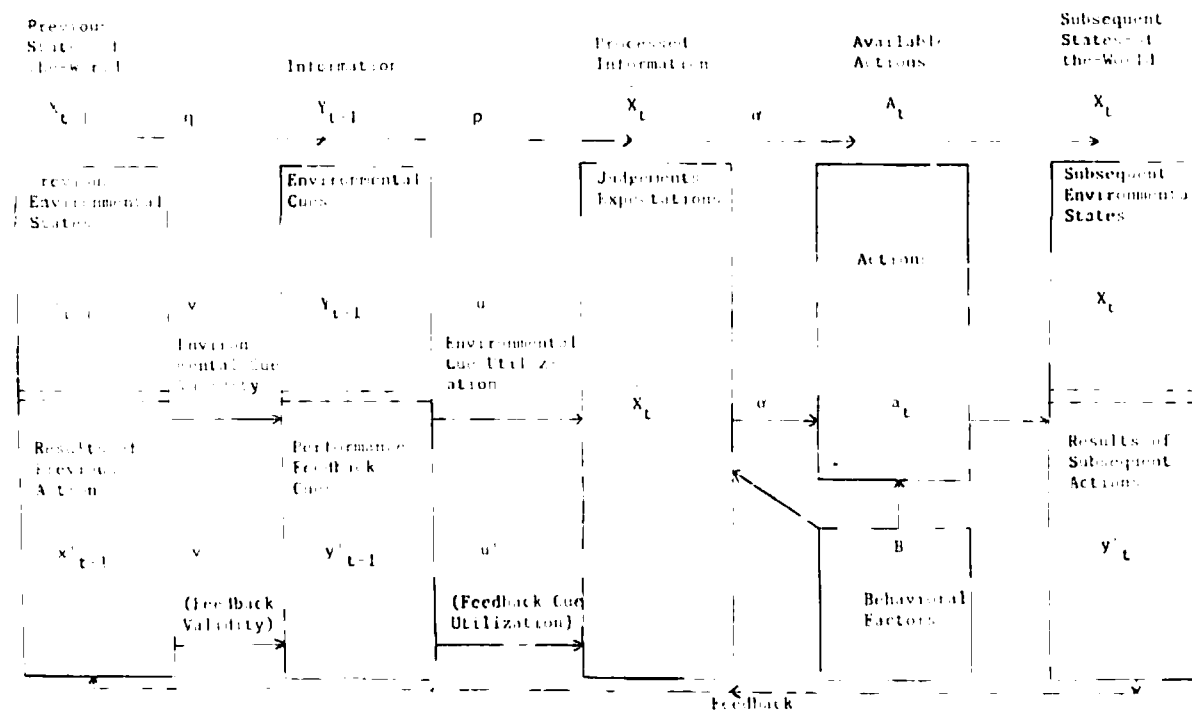


FIG. 2. — A human information-processing model that explicitly incorporates (performance) feedback



Completeness is approached in the sense that HIP functions and behavioral factors are added to the typical I/E formulation and explicit decision rules and payoff (cost-benefit) considerations are added to the typical lens study. Representation will be improved for the I/E model by adding information utilization functions which are more descriptive of actual user behavior. It is also improved with the inclusion of sequential dynamic (feedback) elements. The logical basis for inferences concerning selection of accounting systems should be improved by incorporating the logic of decision analysis and the more representative premises of HIP research. The latter point also leads to models which are more consistent with prior (psychological) research results.

The originality and novelty of an approach is difficult to establish. All we can point to are recent studies which may have been stimulated by the integrated model (e.g., Casey [1977], Mock and Vasarhelyi [1976], and Vasarhelyi and Mock [1977]). Also, Ashton [1976] uses feedback information for the evaluation of potential reduction of illusory correlation in an experimental context.

The integrated models may also stimulate alternative research paths, questions, and issues. One area of research that might be explored is the use of more explicit hypotheses (which may be derived from decision theory) in the lens-type studies. For instance, rather than merely using regression analysis to measure correlation among cues and judgments, researchers could begin testing hypothesized relationships between information processing and decision rules.

Another relevant question is the importance of various information-processing models and behavioral factors to information selection issues. This question was raised earlier with regard to studies concerned with category-width, decision approach, and illusory correlation.

Our note should be viewed as a preliminary proposal for an integrated model that can provide interesting insights into human information processing. The key question of its value is contingent upon the ways its modules and parameters are put into operation. This process, leading to a more complex model, may prove to bring improved benefits which may or may not justify its adoption over simpler and more direct approaches such as the lens or I/E models.

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