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Task Complexity: A Review and Analysis

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In an attempt to identify those qualities that make a task complex, four fundamental task attributes are identified and are distinguished from other attributes usually associated with this concept. A typology of complex tasks is derived from the identified attributes. Finally, the implications of the analysis for both basic and applied research are considered.

The concept of task complexity has taken on increased theoretical importance, particularly in the area of goal setting. Investigators have begun to include both the characteristics of the task (e.g., Campbell, 1984; Earley, 1985; Earley, Hanson, & Lee, 1986; Huber, 1985; Jackson & Zedeck, 1982) and the cognitive processes of the task-doer (e.g., Campbell & Gingrich, 1986; Locke, Frederick, Lee, & Bobko, 1984; Okada & Matsui, 1982; Shaw, 1984) in their studies of goal setting.

While not abandoning their concern with motivational processes, researchers who study responses to complex tasks have begun to suggest that difficult goals can serve as a stimulus for *strategy development* (Locke, Shaw, Saari, & Latham, 1981). Thus, research that employs a complex task and a difficult goal might lead to improved task performance due to the effects of both cognitive and motivational processes (see, e.g., Campbell & Gingrich, 1986; Earley & Perry, in press; Earley, Wojnaroski, & Prest, 1987; Terborg & Miller, 1978).

If these promising developments are to continue, a systematic examination of the concept of task complexity is needed. Little consensus exists among researchers concerning the properties that make a task complex. Some researchers (Locke et al., 1981; March & Simon, 1958, p. 55) have emphasized the skill and knowledge requirements of complex tasks; others have emphasized the number of performance dimensions incorporated in a task (Latham & Yukl, 1975; Payne, 1976); while still others have focused on the psychological implications of complex tasks (Hackman & Oldham, 1975, 1976; Pierce & Dunham, 1976).

Approaches To Task Complexity

Task complexity has been examined in at least three bodies of research literature: the information-processing and decision-making literature (e.g., MacCrimmon, 1976; Schroder & Suedfeld, 1971; Shepard, 1964; Streufert & Streufert, 1978; Taylor, 1984; Wood, 1986); in the task and job design literature (e.g., Beer, 1968; Hackman, 1969a, 1969b; Schwab & Cummings, 1976); and in the goal-setting research literature (e.g., Campbell & Gingrich, 1986; Frost & Mahoney, 1976).

A simple classification scheme is used here to organize the various approaches in a way that can meaningfully cut across research boundaries. Complexity is treated as: (a) primarily a psychological experience, (b) an interaction between task and person characteristics, and (c) a function of objective task characteristics.

Complexity As Primarily Psychological. No studies were found that treated task complexity *exclusively* as a subjective, psychological experience of the task-doer. The closest approach to this position was found in the extensive literature on job and task design (e.g., Aldag & Brief, 1979; Davis & Taylor, 1979; Ford, 1969, 1973; Griffith, 1982; Hackman & Lawler, 1971; Hackman & Oldham, 1975, 1976; Miner, 1980; Nemiroff & Ford, 1976). In general, investigators of task design have built on the work of Hackman and his colleagues, and they have emphasized the *psychological* dimensions of the task (task significance, task identity, etc.). Often, this research seems to equate task complexity with enrichment.

This tendency is apparent in Pierce and Dunham's (1976) review, in which the terms *complexity* and *enrichment* are used interchangeably, as well as in numerous experimental studies in this area. For example, in Ganster's (1980) study research participants either individually built and tested an electronic communication system, or used an assembly line procedure to put the system together. In terms of task complexity (task *scope* in the study's terminology), Ganster emphasized the differential feelings of autonomy, variety, feedback, and identity that were experienced by participants in the experimental conditions. Similarly, in a study in which the effects of task *challenge* on motivation were examined, Taylor (1981) created sets of puzzles that participants experienced as more (or less) stimulating and difficult. Again, the notable point here is the emphasis on the subjective reactions of the individual to the task rather than on specific task characteristics.

A qualification must be injected here. The task design literature does not ignore completely objective task characteristics. Such characteristics must be considered at least indirectly in order to bring about desired psychological states. Thus, the classification of job design research as primarily a psychological experience may represent an artificial distinction. Such research might just as easily be seen as reflecting a task-person interaction, and it can be discussed under that heading as well.

Complexity As A Person-Task Interaction. In contrast to a purely subjective, psychological approach, complexity as a person-task interaction seems intuitively more plausible. This middle-of-the-ground orientation can acknowledge simultaneously the importance of both the task-doer and the task when determining complexity. For example, March and Simon (1958, p. 55) defined complexity in terms of the abilities of the task-doer: tasks are more or less complex relative to the capabilities of the individual who performs the task. This same interactionist formulation can be inferred from Shaw's (1976) analysis of complexity. In his list of complexity characteristics, Shaw (1976, pp. 308–324) included *intrinsic interest* and *population familiarity*. Similarly, job design theorists have often pointed out that a task high in the core job dimensions can be experienced as boring or as overwhelming—an implicit recognition of a task-person interaction.

A number of investigators of the literature on goal setting have adopted an interactionist approach. Frost and Mahoney (1976) distinguished between tasks having *prescribed* and *nonprescribed* (i.e., variable) processes. Nonprescribed tasks (characterized by incompletely defined alternatives and several ways of reaching task completion) might be considered complex. Yet one can expect the degree of complexity to vary with the skills and the insight of the task-doer. That is, since the individual is expected to generate his or her own response hierarchy and to test responses until an appropriate one is found, complexity is both a function of the incompletely defined alternatives (i.e., task) and the response hierarchy of the specific task-doer (i.e., individual).

Hammond (1986) pointed out how the complexity of essentially similar tasks varies as a function of each task's mode of representation. For example, for judgment tasks, a distinction must be made between situations in which the judgment is based entirely on memory, and situations in which past information is displayed. Similarly, the physical form of information apparently can affect task complexity. Stock and

Watson (1984) found that accountants achieved better results when their bond rating judgments were based on schematic faces that were used to represent numerical data, rather than on the numeric data themselves. Finally, there also is the well-known finding of Tversky and Kahneman (1981) that individuals make different probabilistic-based decisions that depend on how the (objectively identical) probabilities are presented. Taken as a whole, this line of research implies that task complexity cannot be examined independently of considerations of short-term memory, span of attention, computational efficiency, and so forth, as they are affected by task representation.

Complexity As Objective Task Characteristics. Finally, some investigators have attempted to define complexity purely in terms of objective task qualities. For example, Schwab and Cummings (1976), reacting to the practice of formulating complexity in terms of an employee's affective or cognitive reactions to the task, attempted to provide an objective measure of complexity. They suggested measuring the impact of the task on the five sense modalities. This impact is gauged on (a) the magnitude of the stimulation, (b) the variation of the stimulation, and (c) the number of sensory modalities that were affected.

March and Simon (1958) also identified several objective task qualities that contribute to complexity. First, complex tasks are characterized by unknown or uncertain alternatives, or consequences of action (pp. 139–141). Second, such tasks are characterized by inexact or unknown means-ends connections (pp. 148–149). Finally, complex tasks are characterized by the existence of a number of subtasks, which may or may not be easily factored into nearly independent parts (pp. 151–152).

Similarly, Terborg and Miller (1978) defined complexity in terms of path-goal multiplicity (i.e., the existence of several ways for accomplishing the task: a means-ends conceptualization). Here, complexity can arise in two ways. First, the multiple number of paths to the goal is illusory; although there *appear* to be many possibilities, only one "works" (e.g., solving a jigsaw puzzle, as in Frost and Mahoney, 1976). In the second case, several ways of reaching the goal exist, but the task requires the individual to find the *best* or optimal path. Apparently this was the form of complexity encountered by the individuals in the Terborg and Miller (1978) study, because they worked on a tinker-toy construction task that could be completed in a variety of ways.

Latham and Yukl (1975) emphasized the *ends* aspect of complexity, which is termed *outcome* complexity. They argued that complex tasks have multiple performance dimensions, including nonquantitative ones. Complexity derives from the need to determine which performance configuration represents the optimal one, even though this determination may be inherently uncertain (e.g., because of unknown or unclear evaluation criteria or because performance dimensions are interrelated in complicated or conflicting ways).

In three studies, researchers attempted to define complexity in terms of objective task characteristics. In Campbell's (1984) study, participants performed a complicated employee scheduling task. It required individuals to determine the number, length, and starting times of work shifts, and it also required them to consider past work patterns, wage differentials, shift productivity differentials, overstaffing costs, and so forth. Thus, a complex task was defined as having several interrelated and conflicting elements to satisfy. Earley's (1985) study also used a scheduling task, and in it, complexity was defined in terms of the number of *rules* that needed to be satisfied.

In Campbell and Gingrich's (1986) study involving task type and participation, professional programmers composed either complex or simple computer programs. These authors defined complexity in terms of interrelated and conflicting elements, and they added the notion that a complex task placed *high cognitive demands* on the individual. Although this notion reflects a person-task orientation, the authors made it clear that these demands resulted from the nature of the task and not from the characteristics of the individual.

Research on multiple-cue probability learning also has generated definitions of complexity built upon objective task characteristics. For example, Steinmann (1976) suggested that complexity is derived from at least seven sources: (a) the number of information sources (i.e., cues), (b) cue intercorrelations, (c) cue reliabilities, (d) cue validities (i.e., task predictability), (e) cue and criterion variability, (f) function forms (i.e., linear, curvilinear, etc.), and (g) the principle underlying the integration of the information. Overall, Steinmann's analysis equates complexity with the absolute amount of information involved in a task, the internal consistency of this information, and the variability and diversity of the information itself.

Payne (1976) defined complexity as a function of both the number of alternatives facing the decision maker and the number of attributes on which each alternative was compared. Olshavsky (1979) used a similar definition.

Finally, Schroder, Driver, and Streufert (1967) identified three primary properties of a complex task (*environment* in their terminology): (a) the number of dimensions of information requiring attention (i.e., information load), (b) the number of alternatives associated with each dimension (i.e., information diversity), and (c) the rate of information change (i.e., the degree of uncertainty involved). Complexity increases as each of these dimensions increases. Table 1 provides an overview of the defining characteristics of task complexity from each of the three orientations.

An Integrative Framework

Although the literature reviewed here provides several conceptualizations of complexity, it does not provide a framework for integrating them. The information processing literature, particularly that of Schroder et al. (1967) on information load, information diversity, and rate of information change, seemed most useful for such a framework. These constructs provide a common language both for analyzing objective task attributes and for translating the implications of these attributes into person processes. Task complexity can be related directly to the task attributes that increase information load, diversity, or rate of change. Thus, complexity can be defined objectively, and it an be determined independently of any particular task-doer. Conversely, the three information processing factors also can capture the cognitive demands experienced by a task-doer in completing a task. Thus, a complex task also can be defined as one in which high cognitive demands are placed on the task-doer.

Objective Complexity

In the proposed framework, any objective task characteristic that implies an increase in information load, information diversity, or rate of information change can be considered a contributor to complexity. In Table 1, four basic task characteristics met this requirement: (a) the presence of multiple potential ways (i.e., paths) to arrive at a desired end-state, (b) the presence of multiple desired outcomes (i.e., end-states) to be attained, (c) the presence of conflicting interdependence among paths to multiple outcomes, and (d) the presence of uncertain or probabilistic links among paths and outcomes. Each of these characteristics implies a high level of information load, diversity, or rate of change.

Multiple Paths. An increase in the number of possible ways to arrive at a desired outcome increases information load, and thus it increases complexity. Of course, this assertion must be qualified. If all paths are likely to result in the desired outcome, such redundancy actually may *reduce* task complexity. Multiple paths *increase* complexity under the conditions noted earlier: (a) when only one path leads to goal attainment, although many paths *appear* as possibilities, and (b) when there is an efficiency criterion embedded in the task, and the paths are evaluated against this efficiency criterion. In both cases, complexity grows according to the number of paths involved.

Multiple Outcomes. As the number of desired outcomes of a task increases, complexity also

Table 1
Summary of Task Characteristics Used in Defining Task Complexity

Complexity as a Psychological Experience
enrichment factors (variety, significance, autonomy, etc.) (e.g., Pierce & Dunham, 1976)
challenge (e.g., Taylor, 1981)
stimulation (e.g., Taylor, 1981)
arousal (e.g., Taylor, 1981)

Complexity as a Task-Person Interaction
difficulty (e.g., Huber, 1985)
experience (e.g., Shaw, 1976, pp. 308–324)
familiarity (e.g., Shaw, 1976, pp. 308–324)
interest (e.g., Shaw, 1976, pp. 308–324)
requirements relative to capabilities (e.g., March & Simon, 1958, p. 55)
nonprescribed processes (e.g., Frost & Mahoney, 1976)
capacity of short-term memory, span of attention, computational efficiency, etc., as affected by task (e.g., Hammond, 1986)
substantial cognitive demands (e.g., Campbell & Gingrich, 1986)

Complexity as a Function of Objective Characteristics
multiple path-goal connections (e.g., Terborg & Miller, 1978)
multiple end-state alternatives (e.g., Latham & Yukl, 1975)
inexact means-ends connections (e.g., March & Simon, 1958, pp. 139–141)
interrelated and conflicting subtasks (e.g., Campbell, 1984)
multiple alternatives with multiple attributes (e.g., Payne, 1976)
uncertain/unknown alternatives or outcomes (e.g., March & Simon, 1958, pp. 139–141)
information load, diversity and rate of change (e.g., Schroder et al., 1967)
information interrelationships (e.g., Steinmann, 1976)
constraints that need to be satisfied (e.g., Earley, 1985)

increases. This can be seen abstractly, by thinking of each outcome as a task dimension that requires attention. Typically, each dimension entails a separate information processing *stream*, and information processing requirements will increase as the number of streams increases. However, there is one exception to this general conclusion: If the desired outcomes are positively related, the degree of complexity is reduced. The positive relationship builds in redundancy.

Conflicting Interdependence Among Paths. In contrast, complexity can occur because of *negative* relationships among desired outcomes. If achieving one desired outcome conflicts with achieving another desired outcome, complexity will increase. The stereotypic illustration of this type of task involves quality and quantity outcomes: Typically, the activities that increase quality preclude the activities leading to quantity. The scheduling task used by Campbell (1984) provides another illustration. This task not only required that incoming checks be processed quickly, but it also required that labor costs be minimized. The actions that were necessary in order to achieve quick processing conflicted directly with the actions that were needed in order to minimize labor costs.

Uncertain or Probabilistic Linkages. Information processing requirements will increase substantially if the connection between potential path activities and desired outcomes cannot be established with certainty. If probabilistic linkages exist, information load will be affected (i.e., potential paths cannot be eliminated quickly), and diversity will be affected (i.e., different action-outcome contingencies must be evaluated). Uncertainty also can increase complexity by enlarging the pool of potential paths to a desired outcome. If path possibilities are not completely bounded, then uncertainty about the existence of another, more effective path must be considered.

Associated Characteristics. An examination of Table 1 suggests other characteristics that are often associated with task complexity. These characteristics (i.e., lack of structure, ambiguity, and difficulty) require special consideration because their relationship to objective task complexity is not straightforward.

Complex tasks often are ill-structured, ambiguous, and difficult. These qualities are a consequence of the more basic task characteristics. That is, tasks having multiple paths that are imprecisely linked to several desired but conflicting outcomes are likely to be unstructured, ambiguous, and difficult. Thus, if a task involves one or more of the basic complexity attributes, it also is likely to possess one or more of these associated attributes.

The reverse is not necessarily true, however: A task may be difficult, ambiguous, or ill-structured for reasons that are independent of the basic characteristics of the task itself. Consider a relatively clear and uncomplicated task that has been made ambiguous and difficult because of a communication failure (e.g., a situation in which a new employee has received an incomplete orientation to the job). In terms of objective characteristics, the task is not complex, but because of an external factor that is essentially irrelevant to the original task, the task may be experienced as complex. This experienced complexity stems from the lack of clarity caused by the communication breakdown.

This distinction between basic and associated characteristics of complexity requires a specific view of task. It is assumed that the essential nature of a task can be recognized and distinguished from arbitrary or artificial elements. Without this assumption, it would be impossible to label the communication failure as an *external factor*. Of course, this view of task poses some difficulties in that the determination of inherent versus external task factors is judgmental. Nonetheless, such a view can be justified on common-sense grounds, and it is useful for ensuring that complexity is rooted in task content and not in task context.

Also, the relation between task complexity and task difficulty is worth considering. Complex tasks are, by their nature, difficult. Thus, sometimes the two notions can be used interchangeably (e.g., Campbell & Ilgen, 1976; Earley, 1985; Huber, 1985; Taylor, 1981), but not always. Locke et al. (1981) illustrated this point by contrasting the digging of a foundation with the planting of a flower: Task difficulty is a relevant dimension in this comparison, whereas task complexity is not. The general point is that certain tasks can be difficult (i.e., require high effort), without necessarily being complex; in contrast, other tasks are difficult *because* they are complex.

Also, the notion of difficulty represents a person × task interaction. A task of specified complexity may be difficult for one person, but not for another. For example, flying an airplane is easy for a veteran pilot although a new student may find it difficult—even though the objective characteristics of the task are identical.

Typology of Complex Tasks

Complex tasks can be classified by using the basic complexity attributes [i.e., presence of multiple potential ways (i.e., paths) to arrive at a desired end-state; presence of multiple desired outcomes (i.e., end-states) to be attained; presence of conflicting interdependence among paths to multiple desired outcomes; and presence of uncertain or probabilistic linkages among paths and outcomes] to create a typology of complex tasks. Complexity is determined both by the degree to which a task incorporates each of the individual attributes (e.g., present or absent; high or low) and by the total number of basic attributes contained in the task. Table 2 represents the set of hypothetical task types implied by the four basic attributes. For the sake of clarity, the table treats each attribute as present (×) or absent (−), which results in 16 possible task types.

Inferences about task complexity must be drawn quite cautiously from Table 2. For example, an exact ordering of tasks from less to more complex remains difficult because the *relative* contribution to complexity of each of the four basic attributes is unknown. Nonetheless, the classification may be useful for making reasonable judgments about relative complexity and for distinguishing between tasks that include different kinds of complexity.

The 16 possible task types are mutually exclusive, and they allow any specific task to be classified according to its complexity attributes. In the following section, however, several task types are considered under shared headings (see Table 3). The rationale for each of the categories and the encompassed task types is discussed. Other categorizations can be created or the 16 task types can be used without grouping them.

Simple Tasks. As Table 2 indicates, Type 1 tasks contain none of the attributes of complexity previously identified. Thus, they can be considered simple tasks.

Decision Tasks. An examination of Table 2 indicates a set of task types (3, 7, 9, 12) whose common emphasis is on choosing or discovering an outcome that optimally achieves multiple desired end-states. Path multiplicity is irrelevant for tasks in this group. Within the category, task types are differentiated by either the presence or

Table 2
Complete Typology of Complex Tasks

	Sources of Complexity			
Task Type	$Source_1$	$Source_2$	$Source_3$	$Source_4$
1.	—	—	—	—
2.	X	—	—	—
3.	—	X	—	—
4.	—	—	X	—
5.	—	—	—	X
6.	—	—	X	X
7.	—	X	—	X
8.	X	—	X	—
9.	—	X	X	—
10.	X	—	—	X
11.	X	X	—	—
12.	—	X	X	X
13.	X	—	X	X
14.	X	X	—	X
15.	X	X	X	—
16.	X	X	X	X

$Source_1$ = presence of multiple paths to a desired end-state
$Source_2$ = presence of multiple desired end-states
$Source_3$ = presence of conflicting interdependence
$Source_4$ = presence of uncertainty or probabilistic linkages

absence of conflicting interdependence among the outcomes and by either the presence or absence of uncertainty. These tasks are labeled *decision* tasks because normally they involve selecting the *best* alternative from many possibilities.

For example, the basic (i.e., Type 3) form of this task is found in the literature on decision making in which a set of alternatives (e.g., houses) must be evaluated along a set of dimensions (e.g., size, price, neighborhood, etc.), and then the best alternative is chosen. In this case complexity is a function of the number of alternatives and the number of relevant dimensions (i.e., *desired outcomes*). However, the existence of an alternative that is considered best on all the desired dimensions substantially decreases task

Table 3
Complex Task Classifications

Task Type	Complexity Sources	Examples
A. Decision Tasks (Types 3, 7, 9, 12)	Number of desired outcomes to attain; Conflicting interdependence among outcomes; Uncertainty. (Path multiplicity irrelevant).	Employee selection; Choosing a house; Selecting a bulding site.
B. Judgment Tasks (Types 4, 5, 6)	Conflicting and probabilistic nature of task information; Uncertainty. (Multiplicity of desired outcomes and multiplicity of paths irrelevant).	Intelligence analysis; Stock market analysis; Multiple cue probability learning.
C. Problem Tasks (Types 2, 8, 10, 13)	Path multiplicity to a single desired outcome; Conflicting interdependence among paths; Uncertainty. (Outcome multiplicity irrelevant).	Chess problems; Personnel scheduling; Personnel placement.
D. Fuzzy Tasks (Types 11, 14, 15, 16)	Outcome multiplicity; Path multiplicity; Conflicting interdependence; Uncertainty.	Business ventures.

complexity. Thus, more typically, tasks of this kind also incorporate conflicting interdependencies among the outcomes (Task Type 9), in which alternatives are high on one subset of desired outcomes but low on another, and so forth. The experimental tasks used by Payne (1976) are decision tasks.

Judgment Tasks. Task Types 4, 5, and 6 form a second category of complex tasks. The shared emphasis is found in the conflicting and probabilistic nature of task-associated information. The notions of multiple desired outcomes and multiple paths are not relevant to tasks in this category.

Tasks in this group require the task-doer to first consider and integrate diverse sources of information, and second to make a judgment or prediction about the likelihood of some future event. Thus, they have been labeled judgment tasks. In the usual case, the sources of information are to varying degrees inconsistent or contradictory; further, any particular informaion source is only uncertainly related to the future event. Thus, accurate judgment or prediction requires the task-doer to (a) determine which pieces of information to pay attention to, (b) weight these pieces appropriately, and (c) combine the weighted information to arrive at an overall judgment. Examples of such tasks are intelligence analysis, stock market analysis, and (in laboratory situations) probability learning tasks (Steinmann, 1976).

Problem Tasks. An examination of Table 2 reveals several task types (2, 8, 10, 13) whose common characteristic is a multiplicity of paths to a well-specified, desired outcome. Within this category, task types differ in terms of the paths' relationship to each other and to the desired end. These tasks have been labeled *problem* tasks because they involve finding the best way to achieve the outcome.

For example, with Task Type 2, complexity is a function of the number of potential paths to the desired end. Typically, if sequencing is disregarded, only one of the potential paths results in the desired outcome, and the task-doer is expected to find this path from among the possibilities. The task contains within itself the universe of path possibilities (i.e., at least hypothetically all possibilities can be specified), and each path's connection to the desired outcome can be determined with certainty. Some examples of such tasks are anagrams (Taylor, 1981), chess problems (Campbell & Ilgen, 1976), and jigsaw puzzles (Frost & Mahoney, 1976).

For Task Types 8, 10, and 13, complexity is not only derived from the multiplicity of paths available, but also it is derived from the conflicting or probabilistic nature of the paths. In some cases (Task Type 8), the pursuit of one path eliminates the possibility of comparisons with other potential paths. For example, when one attempts to achieve optimal personnel placement, initial placement "changes" the individuals who are involved. This makes it impossible to determine precisely the utility of the chosen placement configuration relative to others that had been possible. In other cases (Task Type 10), complexity is heightened because the link between the paths and the desired outcome is characterized by uncertainty (i.e., inexactness in determining a path's specific relationship to the outcome). The employee scheduling problems used by Campbell (1984) are a good example. Because workload forecasts were imprecise, the connection between any particular work schedule and the optimal schedule was necessarily probabilistic.

Fuzzy Tasks. Table 2 reveals a final category (Task Types 11, 14, 15, 16) whose common characteristic is the presence of *both* multiple desired end-states and multiple ways of attaining each of the desired outcomes. As above, within the category, task types differ with respect to either the presence or absence of conflicting interdependence or uncertainty. These tasks are labeled *fuzzy* tasks because there is only minimal focus for the task-doer.

Often, tasks that are representative of this category are found in business contexts. For example, a firm might wish to manufacture a new product that includes several innovative and attractive characteristics (i.e., multiple desired outcomes), with each characteristic attainable through several different production methods (i.e., multiple paths). Assuming the desired characteristics were not interdependent and the production processes were certain, this example illustrates Task Type 11. If conflicting interdependence exists among the desired outcomes (e.g., large size and fuel efficiency), it illustrates Task Type 15. And, if the production processes are only uncertainty linked to the desired outcomes, it illustrates Task Type 14. If *both* uncertainty and conflict are present, the task represents Task Type 16, and it contains all four attributes of complexity.

Experienced Complexity

It is useful to distinguish between the objective complexity of a task and the subjective complexity that is experienced by a task-doer. Although these two factors are related, they are not necessarily identical. A person's familiarity with the task; his or her short-term memory, span of attention, and computational efficiency; the availability of tools, time constraints, and so forth, can moderate the relationship between objective and experienced complexity. In this light, experienced complexity is merely a *reaction* to task characteristics. Such reactions, however, also may be evoked for reasons other than task characteristics (e.g., task context, self-doubt, anxiety, fear, etc.).

Two theoretical perspectives are particularly relevant here. First, activation theory (Scott, 1966) suggests that an individual's activation level (i.e., the degree of excitation of the brain stem reticular formation) is related directly to the intensity, variation, uncertainty, and meaningfulness of the stimulus. Similarly, Berlyne (1960) implied that the activation level of the brain increases with the sum of total stimulation experienced by the individual. Thus, to the extent an objectively complex task implies a greater number of stimulus sources, more uncertainty, and so forth, it will create a heightened sense of arousal within the individual.

However, Scott (1966) and others have noted that caution must be emphasized. Such arousal responses are not elicited solely by task characteristics. Arousal can be induced by the presence of another person in the workroom, by the promise of a performance-contingent reward, or even by daydreaming.

The information-processing approach developed by Schroder et al. (1967) represents a second theoretical perspective linking objective and experienced complexity. In their experiments, task performance moved from suboptimal through optimal to suboptimal again, as task complexity increased from low to superoptimal (Schroder et al., 1967, pp. 55–66). This performance pattern was explained in terms of the information processing demands of the task: When these demands exceeded the capacity of the task-doer, performance disintegrated.

In terms of experienced complexity, the noteworthy aspect of these findings was that the point of performance disintegration varied from individual to individual. Typically, "cognitively complex" task-doers were better able to sustain their performance than were "cognitively simple" task-doers. Apparently, cognitively complex individuals experienced the task differently than did cognitively simple individuals, underscoring the conclusion that objective and experienced complexity are not identical.

Conclusions

An understanding of task complexity is important not only for its own sake, but also for its potential implications for research in applied areas such as goal setting. First, it is clear that investigations of the differences between simple and complex tasks are insufficient. Programmatic research that focuses on the attributes of complexity is required for theory development in this area. Such research would involve the systematic variation of the actual bases of complexity in laboratory experiments.

Similarly, empirically grounded theory must be developed to clarify the processes by which complexity sources affect task performance. Investigators of goal setting (e.g., Earley, 1985) have explored this issue, but this initial work has not progressed far. Figure 1 illustrates a general approach to the task complexity–task performance question.

Although this approach is merely illustrative, it suggests the kinds of questions that are most in need of answers: Do different sources of complexity stimulate different goal types, such as qualitative overall goals versus quantitative, specific goals? Do different sources of complexity lead to predictable differences in the kinds of strategies a task-doer develops? Does goal type influence search behavior and strategy development?

Although the research literature does not provide answers to these questions, it does provide a foundation. In terms of the cognitive activities evoked by complexity, the work of Simon and his colleagues (e.g., March & Simon, 1958; Newell & Simon, 1972; Simon, 1981) is particularly relevant. Assuming that performance on the task is seen as a "problem," complexity will stimulate

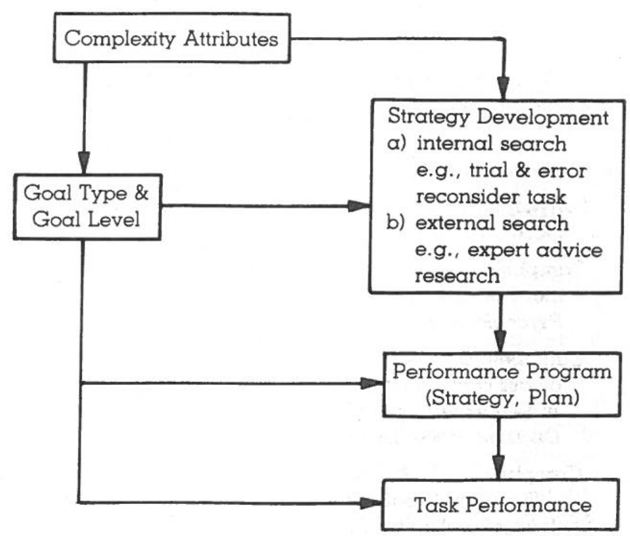

Figure 1. Illustrative relationship between task complexity, goals, strategy, and performance.

the individual to review already stored heuristics (i.e., "programs") in an effort to determine if any are likely to apply to the task at hand. If this review fails to provide a useful program, then the individual sets about to develop a new program that is specifically geared to the task. Given the perspective developed in this paper, each source of complexity would need to be examined for the impact it has on heuristic selection or development.

Past research also may be helpful in linking sources of complexity to individual variation. Although the review emphasizes the need to separate task characteristics from person characteristics, consideration of *both* is necessary in accounting for actual task performance.

Along these lines, DeLuca and Stumpf (1981) argued that fundamental differences exist in the cognitive processes associated with problem solving and decision making. Problem solving requires *convergent* processes and analytical skills, whereas decision making requires *divergent* processes and creativity. The relevance of this argument becomes apparent when examining Table 3. Based on the typology developed, a significant number of complex tasks primarily involve judgment, decision making, or creativity. The DeLuca and Stumpf analysis (1981) implies that certain task-style combinations will be more effective in terms of performance than others (e.g., "problem" tasks and convergent processes, etc.). Thus, research of this nature provides a promising starting point for the development of programs to help individuals adopt the appropriate task-style combination. Schroder et al.'s (1967) work on cognitive complexity also could be cited here.

Clearly, the suggested research program overlaps with problem-solving and decision-making investigations, and it may require consideration of even more basic cognitive processes (e.g., Siegler, 1983). Such cross-fertilization of research perspectives holds promise for all the areas that are involved.

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