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Résumé de l'article

En anthropologie, les connaissances, le comportement et la culture matérielle font rarement l'objet d'une étude commune. Cependant, si l'on considère l'individu comme un système cybernétique à l'intérieur duquel énergie et information circulent entre raison, musculature, et monde extérieur, cela devient possible. Le présent article offre un compte rendu des découvertes préliminaires d'une étude consacrée aux activités productrices de certains artisans. Le projet visait à comprendre l'un des aspects du système cybernétique de l'individu, soit comment les connaissances se transforment en comportements et comment ces derniers se représentent dans la morphologie des objets créés. Cet article fait aussi part de la portée d'une telle étude pour l'anthropologie esthétique et l'archéologie.

The Need for A Cognitive Approach to The Study of Material Culture

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Anthropologists have seldom attempted to bring the study of cognition, behavior, and material culture into a single framework. One way to do this is to view the individual as a cybernetic system in which energy and information circulate among mind, muscles, and the external world. This article reports on the tentative findings of a project which studies the production activities of individual artisans in an attempt to understand how cognitive structures are translated into behavior and how behavioral patterning is reflected in the morphology of artifacts. Implications for anthropological aesthetics and archaeology are examined.

En anthropologie, les connaissances, le comportement et la culture matérielle font rarement l'objet d'une étude commune. Cependant, si l'on considère l'individu comme un système cybernétique à l'intérieur duquel énergie et information circulent entre raison, musculature, et monde extérieur, cela devient possible. Le présent article offre un compte rendu des découvertes préliminaires d'une étude consacrée aux activités productrices de certains artisans. Le projet visait à comprendre l'un des aspects du système cybernétique de l'individu, soit comment les connaissances se transforment en comportements et comment ces derniers se représentent dans la morphologie des objets créés. Cet article fait aussi part de la portée d'une telle étude pour l'anthropologie esthétique et l'archéologie.

Two branches of anthropology that have specialized in the study of material culture are anthropology of art and archaeology. Both of these sub-disciplines have tended to focus upon artifacts rather than upon the production process. Anthropologists of art, in addition to having an interest in the psychological and social functions of art, frequently view an artifact as an aesthetic object to be analyzed in terms of relations among formal design elements such as shape, color, line, and texture. On the basis of this analysis, the art object can then be placed in the context of other objects with which it shares design features. The dominant concept is, therefore, the concept of style, whether it be individual style or a broader construct such as the style of a group, region, or epoch.

Archaeologists also focus upon the design of the artifact, most commonly taking a variety of measurements which are translated into ratios dealing with internal relationships among various features of the object such as length versus width. As a result of this formal analysis, artifacts (especially projectile points) are classified into stylistic types such as Clovis or Oxbow.

Anthropologists of art and archaeologists have found the concept of style to be useful for describing and categorizing artifacts on the basis of easily observable and measurable characteristics. The concept of style has also allowed anthropolo-

gists to trace cultural connections. For example, the anthropologist of art can study the amount of stylistic influence between two adjacent groups of people, and the archaeologist can study the degree of stylistic similarity within an assemblage or stylistic connections between sites separated by time or space.

It cannot be denied that the emphasis upon stylistic analysis has made important contributions to anthropology. This emphasis has, however, distracted anthropologists from the study of the processes involved in the creation of artifacts. Despite a plea for process studies by archaeologists such as Binford (1981) and some evidence of a growing interest in the behavior behind the artifact (eg., Gould and Schiffer, 1981), archaeological classification is still largely static and overly-concerned with quantitative measurements. The process approach has made even fewer inroads into anthropology of art, with the consequence that this sub-discipline is generally relegated to the sidelines because it tends to be too descriptive and incapable of addressing itself to important theoretical issues.

The inability of anthropology as a whole to find a meaningful role for the processual study of material culture cannot be blamed solely upon the descriptive formalism of anthropology of art and archaeology. Blame can also be laid at the doorstep of cognitive anthropology which should have taken account of the fact that artifacts can provide important clues about the nature of information processing. For a variety of reasons, however, cognitive anthropology (including ethnosemantics and ethnoscience) has generally been limited to the study of how individuals in a given society categorize phenomena. The cognitive approach in anthropology is not really the study of cognition as much as it is the study of the rules governing verbal behavior. The inspiration is primarily linguistic in origin.

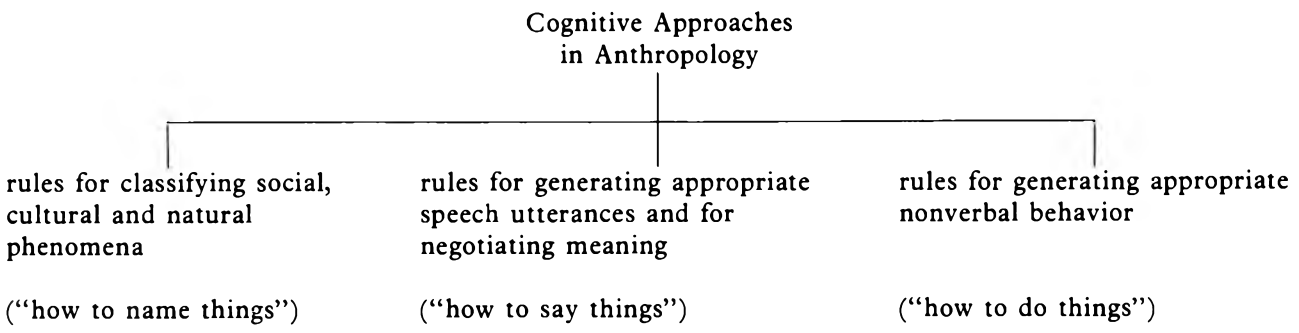
One notable exception to this generalization is the interest on the part of some cognitive anthropologists in rules as recipes for appropriate verbal or nonverbal behavior. For example, Wallace (1965) has dealt with driving a car, Spradley has written about what one needs to know to operate successfully as an urban nomad (1972), and Frake (1964; 1975) has dealt with various aspects of how to act like a native in Subanun. Such approaches deserve greater attention by anthropologists interested in bridging cognition and behavior.

The scope of the cognitive approach in anthropology is diagrammed in Figure 1. There are two criticisms, relevant to this paper, that can be made of the situation expressed in this diagram. First, even those cognitive anthropologists who are interested in the information that people employ for "doing things" very seldom study nonverbal behavior itself to see to what extent behavior rules are translated into action (see Burling, 1969, for a notable exception). Second, missing from the diagram is a column for "how to make things." Cognitive anthropologists have clearly failed to recognize the grammatical structure of the production process[1].

It is the contention of this paper that if it is to be true to its holistic roots, anthropology must not only continue to support specialized sub-disciplines such as anthropology of art, archaeology, and cognitive anthropology; it must also develop ways for studying the nature of the interaction among mental, behavioral, and material variables. Only in this way will material culture studies be meaningfully integrated into the discipline as a whole.

In the following sections, I will summarize the research activities of a group of people involved in what we call the "Project for the Study of Material Culture" housed in the Department of Anthropology at the University of Alberta.[2] The discussion will include insights from relevant literature plus

Figure 1. Major concerns of cognitive approaches in anthropology.



examples from our own research with artisans. Although I will use the umbrella of cognitive anthropology, I will refer frequently to concepts developed in cognitive psychology, the other discipline most relevant to our research goals.

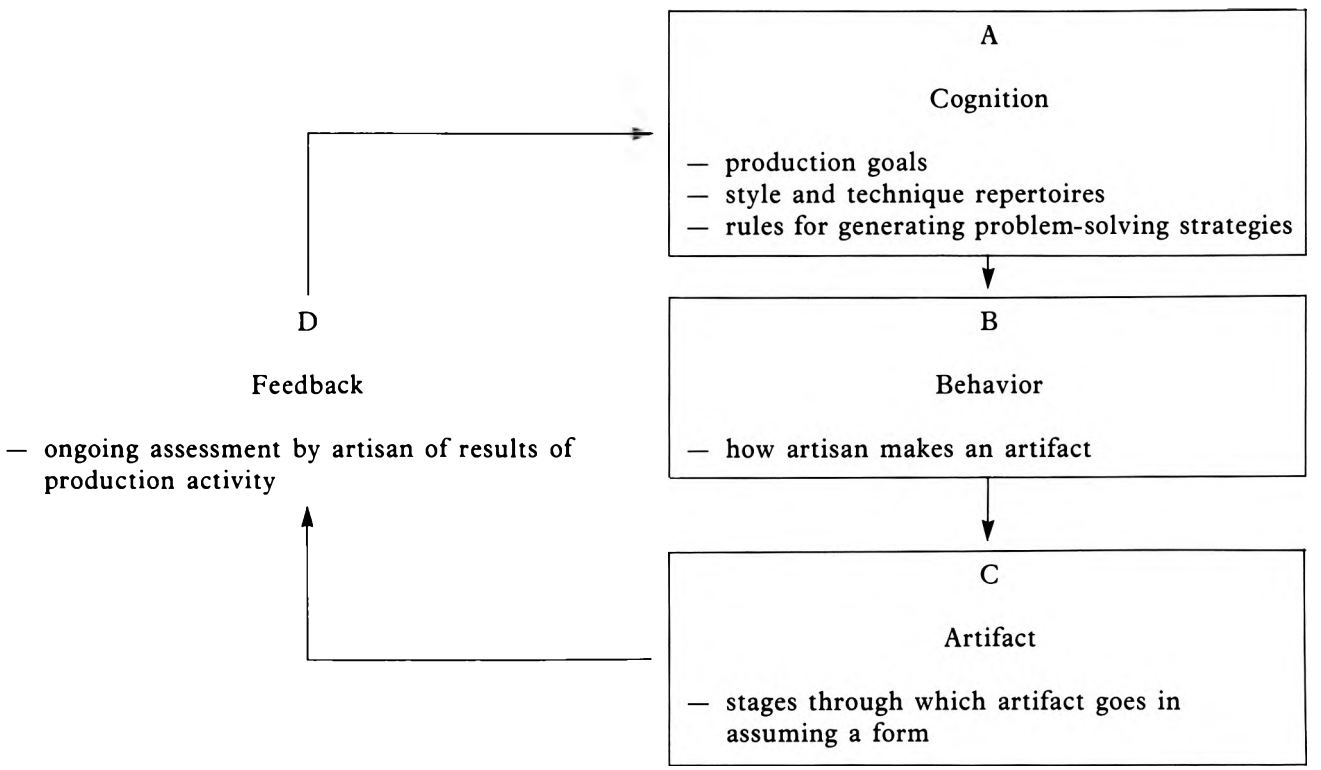
The goals of the Project for the Study of Material Culture are threefold: 1) to document endangered crafts, using a grammatical approach, so that these crafts can be re-created in the future, should they die out; 2) to study individual artisans at work in order to better understand the relations among cognition, behavior, and material culture; 3) to apply the findings from our study of living crafts to the interpretation of artifacts (such as those found in museum collections and archaeological assemblages) whose production histories were not recorded. These goals are not mutually exclusive in that all three frequently come into play within the context of a single study. For example, the study of endangered crafts such as skinworking, making baskets from bark, and flintknapping provide information on the relations among cognition, behavior and material culture; they also provide information relevant to understanding the archaeological record. Despite this overlap, the paper will consider each of these three goals separately.

Documenting Endangered Crafts

Documenting a craft entails: 1) isolating the grammatical structure of what an artisan knows and how this knowledge is translated into behavior; 2) isolating the grammatical structure of what an artisan does; 3) isolating the grammatical structure encoded in artifacts; 4) determining the nature of the correspondence between the grammatical structures on these three levels and building models to help explain the transformations that information goes through as it moves from one level to the other; and 5) assessing the nature of the feedback an artisan receives from the emerging artifact and how his evaluation of that feedback affects subsequent production activity. In brief, the production process (Figure 2) involves a loop which allows both energy and information to flow from the brain, through the muscles, into the artifact, and back again to the brain. Although the loop is closed, making it easier to study, the process involves feedback and is subject to modification on the part of the artisan (Moles, 1958). It is thus a dynamic, creative process.

Stated somewhat differently, the production process is a problem solving situation in which the

Figure 2. Energy and information feedback loop involved in the production process.



artisan utilizes a repertoire of skilled techniques developed from past experience to solve problems presented by the material. Choosing the techniques appropriate to the desired goal and sequencing these techniques into viable strategies requires the application of rules. Thus, in addition to being dynamic and creative, the production process is also structured and grammatical.

Although the referent for Figure 2 is a feedback loop in which energy and information circulate, we cannot study this process directly. All the anthropologist has to work with are behavioral data: both verbal and nonverbal. These behavioral data provide the basis for inferences about how information is being processed by the artisan. Table 1 should help clarify this distinction.

In brief, data are collected for each of the four levels in the loop by utilizing methods appropriate to each level. Data from one level are then analyzed and the resulting patterns correlated with patterns from the preceding level. The essence of the approach is to work intensively with one artisan at a time, employing cognitive elicitation techniques and observing the artisan at work. Both verbal and nonverbal behavior are recorded on videotape for later analysis. Whenever possible, an artisan is studied within the context of an ongoing ethnographic tradition.

The entire production process, not just sample portions, is recorded. This produces a good deal of redundancy but redundancy is an important part of the activity of a skilled artisan. When feasible, an artisan is documented producing more than one example of a given artifact. This provides an opportunity to observe similarities and differences in two production events generated by the same production grammar. Other artisans are frequently invited to take part in elicitation. For example, a flintknapper has cooperated with me to help study another flintknapper, and a skinworker has helped study another skinworker. Finally, two or more artisans for a given craft are usually studied. This provides a basis for comparing individual information processing systems and how they contribute to cultural traditions.

A grammatical approach to the study of craft production is quite technical and cannot be illustrated in a brief article such as this. I will attempt to convey some sense of what is involved, however, with the following case material from two studies conducted by the Project for the Study of Material Culture. One study involved comparing the skinworking techniques of David Christensen, a nonnative from Montana who learned the basics of his craft on the Flathead Reserve, (Figure 3) with those of Russell Willier, a Cree Indian from northern Alberta (Figure 4). Both artisans were videotaped over a period of several years.

It proved impractical to follow a particular animal skin from start to finish as this can take a couple of weeks. At any given time, both David and Russell work several skins, each at a different stage in the process. While one skin is being "grained" (having the hair scraped off), another skin, free of both hair and flesh, may be soaking in a solution of brains and water (or soap and water) while a third

TABLE 1
How data are used to reconstruct the feedback loop

Referent	Means of Obtaining Data	Method of Analysis
A. Cognition	Elicit data from artisan	Infer grammatical structures on basis of elicited data
B. Behavior	Observe (and record) behavior	Subject behavioral data to pattern analysis and correlate behavior patterns with cognitive structures
C. Artifact	Photograph artifact and code morphological features	Correlate morphological patterns with behavior patterns
D. Feedback	Observe artisan's reaction and elicit information on his/her assessment	Determine how artisan's assessment is correlated with subsequent changes in strategy

Figure 3. David Christensen softening a deerskin which has been fleshed, grained, and treated with a brain solution.

may be drying on a frame. This creates a challenge to the ethnographer as eventually the entire process must be pieced together.

The ethnographer is assisted in this task by constantly asking questions, at the risk of irritating the informant, such as, "What are you doing now?" "Is there any other way you could have accomplished that task?" "Why did you change tools just now?" "What is the next step in the process?" A grammar is slowly built by compiling a series of contrasting ways of doing things and ascertaining the conditions under which one alternative is utilized rather than another.

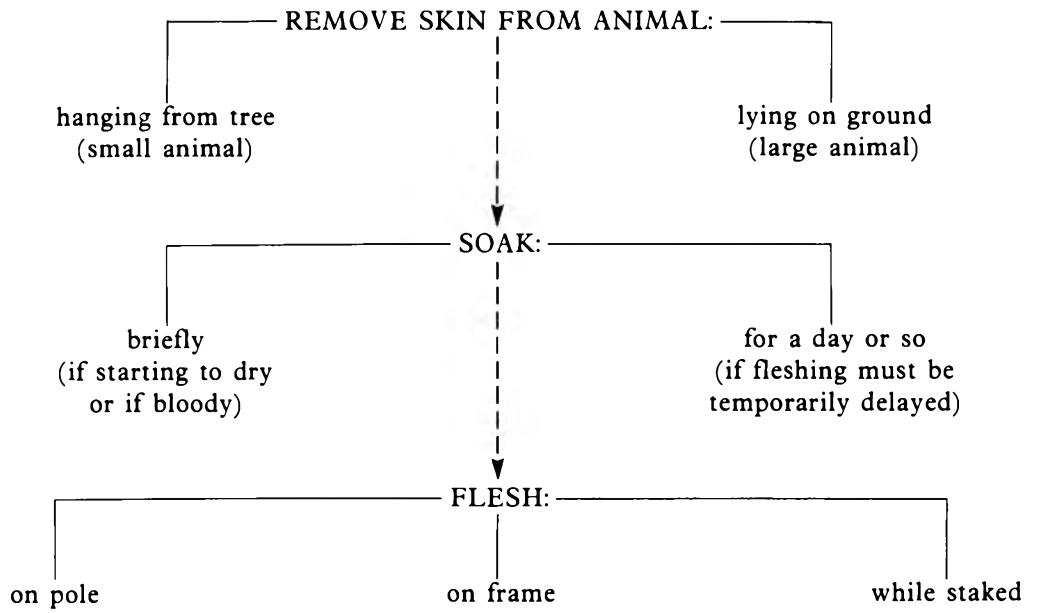
For example, to remove the skin from an animal, David Christensen has a choice of hanging the animal from a tree or skinning the animal on the ground. The former procedure is effective for animals up to the size of a deer because the weight of the hanging skin increases as the task progresses. As the skin is separated from the body, beginning at the top, it falls toward the ground and helps pull the rest of the skin away from the flesh. Larger animals, however, are too heavy to hang and must be skinned on the ground. After the skin has been removed, it is fleshed. Prior to fleshing, the skin is briefly soaked in fresh water if it is bloody or starting to dry. If fleshing must be temporarily delayed, the skin may be soaked for a day or so without causing it to rot.

For fleshing the skin, David has a choice of fleshing on a pole, fleshing on a frame, or staking the skin on the ground. Normally, a pole is used for fleshing skins of animals no larger than sheep, deer, or young elk as larger skins are too heavy to keep moving around on the pole. The width of the pole used depends upon the size of the skin. The wet skin is draped over the pole and downward pressure is applied with a metal or rib "beaming" tool. Large skins such as those of mature elk, moose, or buffalo are laced on a frame (if framing poles and rope are easily available) and scraped, after drying, with a bone flesher. If framing materials are unavailable, the skin is staked a few inches off the ground and fleshed by kneeling over the skin. If a large skin is to be used for a ceremonial robe, the edges (which are usually cut off because they contain the holes used for framing or staking the skin) are left on. Because it is too difficult to work around the ropes or stakes to scrape the edges, the edges of a large skin may be finished on a pole.

These options, and the rules for using them, are summarized in Figure 5 which constitutes only a small part of the process a whole. After the skin is fleshed it must be grained, "whitened," treated with brains, softened, smoked, and made into clothing. Each of these major steps involves a variety of options in terms of techniques employed and tools utilized. Piecing together the repertoire of options and the rules for generating specific strategies constitutes a grammatical analysis.

Figure 4. Russell Willier and friend graining a moose skin laced on a frame.

Figure 5. Portion of production code used by David Christensen in working a deer skin.



David Christensen and Russell Willier both have to perform the same major steps in order to create a thin, soft material capable of breathing—the hallmark of native tanning (in contrast to modern factory-tanned hides). Specific techniques for accomplishing these steps and the reasons given for their usage, however, differ considerably. For example, David Christensen uses animal brains to lubricate the fibres of the skin and keep them apart. Russell Willier, on the other hand, uses (in sequence) bear grease, brains, and soapy water to accomplish the same end.

Differences in technique, though they may be equally effective, do not create identical results. For example, scraping the hair off a dry skin necessitates leaving the roots of the hair in the skin. This creates a somewhat "bristly" effect on one side. Graining on a pole, on the other hand, involves soaking the skin until the hair is slightly loose. The wet skin is draped over a pole and pressure is applied with the beaming tool to "slip" off the layer of skin containing the hair roots. This creates a smoother finish. Other morphological differences may be more difficult to ascertain. They can, however, be isolated by chemical analysis and electron microscope photography. The point is that morphological differences can always be tied back to specific production grammars, whether these production grammars are typical of individual artisans or group traditions.

As in the case of any application of the grammatical approach to the study of craft production, the finer the distinctions provided by the grammatical reconstruction, the finer the morphological differences that can be accounted for in the finished product. By utilizing a process approach to understand the cause and effect relationship between cognitive-behavior input and morphological output, it is possible to build up an understanding of the craft to the point that a remarkable amount of information can be reconstructed from an artifact whose production history either was not recorded or was lost. This has obvious applications in archaeology, as will be discussed later in the paper.

In contrast to this skinworking study which compared two artisans working in different traditions, a study of birch-bark basketmaking compared the production grammars of Suzanne Ahkim-nachi and Alice Providence who live on the Assumption Reserve in northern Alberta. Both artisans work in the same tradition in the sense that

the finished products fall into a limited number of shape categories such as the "berry baskets" shown in Figures 6 and 7. Despite this formal similarity, however, details of the production grammars differ considerably. For example, there are differences in the way the bark is collected and prepared, how the spruce root used for sewing is soaked and split, how the pattern is situated on the birch bark and cut out, and how the bark is sewed together.

There are also differences which can be observed on the finished baskets themselves, most of which involve both design and technological decisions. For example, there are differences in size, type of handle used and method of attachment, use of contrasting bark colors, number of bark layers in the lid, design on the lid, design of the reinforcing strip at the top, whether or not the dogwood rib used in the rim is split, design of the stitching along the sides, spacing of stitching on the rim, size of spruce root used for stitching, and inside finishing. Some of these differences are evident in Figures 6 and 7.

We were somewhat surprised at the number of differences between the two artisans studied until we realized that, unlike settlement patterns such as African villages in which people perform many of their activities in the streets where they can easily be observed, northern artisans frequently carry on their creative activities in houses that may be separated by considerable distances and that do not allow outsiders to see inside easily. Thus, the two birch-bark basketmakers, although they had frequently seen each other's work, had never observed each other actually making a basket. When we showed the videotapes of one artisan at work to the other artisan, she was constantly breaking into expressions of surprise at a particular technique being depicted upon the screen.

Figure 6. Suzanne Ah-kim-nachi attaching rim to a birch-bark berry basket.

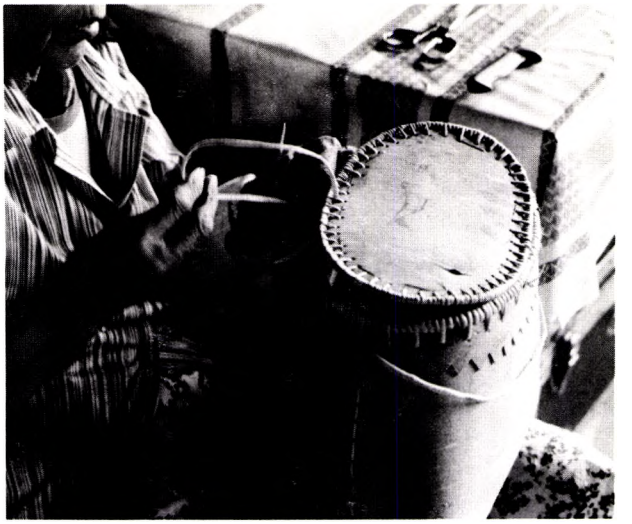


Figure 7. Alice Providence attaching lid to a birch-bark berry basket.

It is important to document the range of variation which exists within a given tradition and attempt to isolate those factors, such as settlement pattern described above, which favour culture sharing as opposed to those which favour the development of unique family, or even individual, production grammars and styles. Unless we have good ethnographic descriptions of the social, cultural, and environmental contexts of material culture production, we cannot make meaningful generalizations about the amount of technological and stylistic variation which might be expected in a specific group of a given size. Being able to make generalizations about variation in production grammars within a group is important for addressing issues pertaining to social and cultural integration; it is also important if we are to use ethnographic analogues in interpreting the archaeological record. Unfortunately, there are very few ethnographies which even begin to address these issues. The detailed research on material culture production being conducted by the Project for the Study of Material Culture is an attempt to address this need.

Relations among Cognition, Behavior and Artifact

An artisan utilizes two kinds of stored information: 1) information pertaining to formal qualities (such as shape, structure, color, and texture) and to general techniques for producing those qualities; 2) information on motor skills involved in translating general knowledge of techniques into behavior. Information on formal qualities and general techniques is consciously considered and manipu-

lated by the artisan in setting production goals and planning overall strategy. Information on motor skills, because of its unconscious nature, appears to be stored and accessed differently, and to be enacted more or less automatically. Let us consider these two kinds of information in more detail.

To understand how an artisan decides on a production strategy it is useful to employ the concept of *schema* (see Casson, 1983, for a review of the influence of this psychological concept upon anthropology). Schemas are constructs that mediate between perception, memory recall, and behavior. They are abstractions or preconceptions which assist in identifying incoming information, recalling associated items from memory, attributing meaning to the new data, and formulating a plan of action (Bartlett, 1932; Minsky, 1975; Neisser, 1976; Anderson, 1980). Schemas are thus screening devices which facilitate information processing by weeding out irrelevant data and by providing structure to the remaining data. They are an essential part of thinking but they can also lead one into various sorts of errors frequently associated with stereotypic thinking.

In terms of the production task, an artisan has a repertoire of prototypic images from which he/she selects a formal goal—an object with specific shape, size, and color (Miller, Galanter, and Pribram, 1960). This prototype acts as a schema in that it provides a normative model which guides the artisan's action and against which the emerging artifact can constantly be compared. Although an image may be quite vivid in the mind of an artisan, once in place, it works in a way that is not necessarily under the control of the individual. The extent to which a schema is conscious or unconscious depends upon the type of schema and the extent to which it is associated with conceptual activity. For a thorough discussion of this issue, see Tyler (1978).

The distinction between conscious and unconscious information processing becomes more clear cut when we move from the area of formal goals and related techniques to the area of motor skills. The concept of schema, conceived of as an information screening device, is equally applicable to the recall and utilization of motor skills. By definition, however, skill is a proficiency in motor behavior which has been achieved through practice and repetition. It is thus automatic and does not require the attention of a central processor (Posner, 1973). In some cognitive models, (cf., Kahneman, 1973), the central processor (or equivalent) has a limited capacity and consequently relegates as many tasks as possible to habit so conscious attention can be employed in critical decision making.

There is a debate, however, over whether these areas of automatic behavior result from the gradual withdrawl of attention as the individual increases proficiency in a given task (LaBerge & Samuels, 1974) or whether motor skills involve a qualitatively different kind of information processing in which automaticity is the result of a different mechanism altogether (Stelmach and Hughes, 1983). Namikas (1983), going back to the early work of Bryan and Harter (1899), opts for a qualitative difference, arguing that learning a skill is characterized by discontinuous plateaus in which an initial cognitive stage of learning is followed by an intermediate associate phase, and finally by a fully automatic phase. At each level, skills are developed as far as they can until, eventually, there is a leap forward to a new level which is organized quite differently from the preceding level.

At the automatic level, motor sequences are frequently serial in operation, which means that the artisan is preparing for the next movement even before the current movement is terminated. Namikas refers to Tulloss' data (cited in Keller, 1958) on typing as an example. The skilled typist does not operate in terms of single letters. He/she has to conceptualize the word or sentence initially but once this is done, the fingers take over in a blur of activity, a process which the typist cannot think about without inviting an error. The ideas of Namikas are dramatically supported in the interesting phenomenological self study by Sudnow (1978), who describes learning to improvise in jazz. Sudnow describes the first stage as "initial grabbing", learning to grasp the chords so they feel comfortable to the hand. In what may correspond to Bryan and Harter's associate phase, Sudnow became a skillful player but he still had not achieved the full freedom of improvization. Eventually, however, he reached the point where he was able to bring the full range of his "vocabular" resources into play: "I don't think about where I am going, I make it up as I go along" (p. 143).

Regardless of differences of opinion on the nature of automaticity, there seems to be some concensus that information pertaining to motor skills is stored differently from cognitive information. Thus, a distinction is frequently made by cognitive psychologists between verbal short term memory and motor short term memory. Verbal short term memory is where cognitive schemas, activated from long term memory, are temporarily stored for purposes of evaluating incoming information and for formulating strategy. The number of items which can be held in verbal short

term memory is approximately seven, plus or minus two (Miller, 1956). The function and span of motor short term memory is not as well understood. It is, for example, unclear whether motor short term memory temporarily holds information on the motor units themselves or whether it holds sensory feedback stemming from action (Marteniuk, 1976).

Associated with the concept of motor short term memory are the concepts of recall memory and recognition memory (Wolford, 1971). Recall memory is responsible for sending out commands to the muscles whereas recognition memory is responsible for evaluating sensory feedback. Both are apparently automatic programs which do not involve the central processor once they are activated.

If the experimental evidence is correct and artisans process information pertaining to motor skills differently from information pertaining to formal qualities like shape and size, this has interesting implications for archaeology, as will be discussed in the next section. Before considering those implications, however, let us turn to a few of the findings of the Project for the Study of Material Culture which have a bearing upon the relation between cognitive and motor skills.

Although cognitive psychologists have made some progress in understanding how motor information is stored and processed, research in this area is relatively undeveloped compared to the study of verbal memory and learning. Experiments that have been done on motor behavior tend to focus upon the performance of very specific laboratory tasks which have no relation to what the subject does in real life. Speaking of the importance of devising experiments that involve real life variables, Namikas (1983: 96) says, "such studies should not only incorporate the complexity, but also some approximation to the time scale in which these tasks are acquired and performed." Namikas also emphasizes the importance of "looking in" once in a while to find out what the subject is actually doing and thinking about as he performs his experimental tasks. He feels that verbal reports from a subject may provide information about the learning process that is even more useful than the behavior itself.

In the Project for the Study of Material Culture, we work with skilled artisans rather than experimental subjects. Like the experimental subject, the artisan is able to provide us with verbal reports about what he/she is thinking and doing. But unlike the experimental subject, the experienced artisan is an expert whose skills have been developed to the point that they have reached the level of automaticity referred to above. Thus, what we are studying is not how a novice learns a new (and frequently meaningless) task, as in the case of most experimental work, but how well developed skills relate to the conscious, decision-making aspects of the production process. I do not mean to imply that our approach is superior to the laboratory approach. It is not. It has its own problems, particularly the problem of how to isolate the effects of specific variables in a situation over which the anthropologist has little control.

Even a real life situation, however, can be structured to some extent. For example, as the artisan works, he/she is not only videotaped but asked various questions concerning intent, repertoires, rules, strategies, and procedures. These questions frequently produce a rich body of verbal data which can be used to help interpret the behavioral data. Although elicitation procedures may be considered a nuisance by the artisan in that questions slow down the normal production process, they strike a balance between a real life and a laboratory situation in terms of data collection and the sophistication of subsequent analysis.

In conjunction with experimental laboratory studies, our approach should help provide some insights into problems of mutual concern to both cognitive psychologists and anthropologists. A few of these preliminary insights (some of which may strike the reader as "common sense" and some of which may appear to be highly tentative hypotheses in need of further testing) are summarized as follows:

1. Producing an artifact is seldom a matter of applying a simple recipe. It consists of drawing upon different repertoires of options for solving different kinds of problems encountered in the production process. In other words, despite the great amount of redundancy (a function of skill), and despite traditional or technological constraints, choice is always involved. For example, in a study of Richard Hunt (Northwest Coast) carving a bear mask, it became quite evident that although he had access to a well developed repertoire of traditional designs for eyes, teeth, ears, etc. (of the sort described so well by Holm, 1965), and although he used a highly structured repertoire of carving techniques, each associated with specific tools, the carver was faced with a dynamic, constantly changing situation in which both design and technique were continually adapted to problems presented by the wood and were also influenced by the craftsman's reactions to what he had already done. This is similar to the Oriental brush painter who first learns a repertoire of calligraphic strokes which can be combined in rather mechanical ways, using specific

brushes, to form mountains, trees, flowers, birds, and trees. The master painter, however, is one who, having internalized these mechanical aspects, is free to exercise creativity in a more spontaneous fashion.

2. The open ended nature of the creative process is particularly apparent when studying crafts involving materials such as rock and wood. To the extent that the material "has a mind of its own," the artisan is faced with a constant stream of problems which have to be solved if the final morphological goal is to be achieved. Thus, making two copies of the same object, such as a stone tool, may involve quite different production processes. Although the behavior units employed by an artisan may be standardized and used with great consistency (Boas, 1927), the way they are strung together to solve problems presented by the material can vary greatly.

3. Choosing among available options requires rules. Therefore the production process, no matter how creative or open ended, has a grammatical structure which can be analyzed. Whereas two or more artifacts may be produced by quite different sequences of behavior units, they may (if produced by the same artisan or two or more artisans working in the same tradition) be products of the same grammar at the structural level. The structural level can be revealed only by analyzing the production process in terms of the repertoires of forms and techniques represented plus the rules for sequencing and relating these forms and techniques.

4. The decision-making process is complicated by the fact that a choice on the part of the artisan is not made independent of other choices but is both backward and forward looking. Thus three images come to bear on an artisan's choices: the image of what one has already accomplished, the image of the next intermediate form, and the image of the desired end product (prototype) which is used to judge the first two images.

5. The motor behavior of a skilled artisan is highly patterned. Thus particular techniques are associated with particular motor patterns. This association remains relatively constant throughout a production process and even over much longer periods of time. For example, in a lithic replication experiment involving two skilled craftsmen, Robson Bonnichsen and Errett Callahan (reported in Young and Bonnichsen, 1984), Bonnichsen employed a substantial pressure thinning technique 203 times during the course of the experiment. He used a pointed tool surface 73% of the time, strong support 100% of the time, medium force 94% of the time, and a less than 90 degree angle 79% of the time. This impressive consistency is not too surprising in light of the fact that the raw material imposes rather narrow limits on how material may be removed. If the force is not just right, the effort may result in failure. A skilled artisan is one who controls the input variables to a very high degree. Callahan, in fact, took delight in using a piece of chalk to draw, on the artifact, the outline of the flake he intended to remove next. Most of the time, the resulting flake would split the chalk line or approximate it very closely.

6. Our data supports the contention of cognitive psychologists that cognitive and motor information are processed in different ways. We have found that artisans are generally able to talk freely about goals, strategies, and general techniques. But they are usually not able to describe the input variables associated with motor units, such as angle of force. To recover this information, it is necessary to code the behaviors, using etic variables formulated by the scientific observer. In brief, the artisan is able to supply emic verbal data (inside information) which are useful for interpreting etic data (the outsider's description of the observable behavior).

7. A distinction can be made between technology (the way an artifact is made in terms of tools and motor behavior employed) and shape (or form); they can vary independently. Thus a variety of techniques can be used to produce the same shape and, vice versa, the same technique can be used to produce a variety of shapes.

Interpreting Prehistoric Artifacts

The goal of a grammatical approach to the study of prehistoric artifacts is to understand the decision-making and behavior processes that are encoded in a finished artifact. To the extent that this can be done, artifacts can be classified and compared in terms of their production grammars rather than in terms of measurements or shapes. We believe that reconstructing the production grammar for each artifact in an assemblage and comparing these resulting production grammars, while time-consuming, is the only way to solve major methodological problems facing the archaeologist. For example, one such major problem is determining whether the artifacts in an assemblage were produced by a single group of people, were deposited by various groups using the same campsite, or represent a mix of indigenous and trade items. The most common way to analyze an assemblage is to take numerous measurements, representing design and/or technological attributes, of all the items in the assemblage and subject these measurements to statistical analysis designed to look for central tendencies or to sort the artifacts into types.

Such a procedure may not be able to deal adequately with the possibility of a mixed assemblage because even an assemblage representing artifacts from different times and places can exhibit central tendencies or modal types. This is because individual attributes are usually plotted across the entire assemblage rather than examining the structural relationship among attributes in single artifacts. In other words, the uniqueness of real artifacts tends to be lost. For example, an assemblage may contain a trade item whose attributes, considered individually, may fall within the normal

range for the assemblage as a whole. If so, a statistical analysis will probably not distinguish the foreign artifact regardless of how unique it might be in terms of how its attributes were produced or are related to each other. A grammatical approach, on the other hand, reconstructs the production grammar for each artifact and then ascertains extent of overlap among these production grammars. Artifacts that may appear to be similar in terms of shape and material attributes may be produced by radically different production grammars. Likewise, artifacts that appear to be quite different in terms of shape may, upon closer scrutiny, exemplify the same production grammar.

There is insufficient space in this article to explain in detail how to reconstruct the production grammar for a prehistoric artifact. In general, however, the method involves working intensively with living practitioners of a prehistoric craft in order to obtain first-hand information about production techniques and the morphological results obtained by applying specific techniques to specific materials. The following symplified example is taken from Young and Bonnichsen (1984).

The study involved having two expert craftsmen (Errett Callahan and Robson Bonnichsen) replicate the same prehistoric lithic artifact. This provided some controls in the sense that both craftsmen used the same raw material and attempted to create a replica of the same size and shape as the original. The experiments were videotaped. As the craftsman worked, each flake removing behavior (or uninterrupted series of the same kind of behavior) was assigned a unique number which was read on to the tape; the resulting debris was bagged and given a corresponding number. Elicitation techniques were employed to solicit verbal information on what the craftsman was doing, the range of alternative techniques available for a given task, rules governing his choice of options, strategies involving the stringing together of a series of behaviors, his assessment of the results of his strategies, and other relevant information.

After the artifacts were completed, they were photographed and the photographs were blown up for detailed morphological analysis. By using the videotape record plus the bagged flakes, it was possible to assign specific behavior units to specific flake scars and thereby establish how different kinds of behavior input produce different kinds of morphological result. Hypotheses concerning the match between behavior and resulting morphology were subsequently tested over a period of several years with a variety of materials. These experimental artifacts provide a reference collection which is currently being used as the basis for inferring the decision making processes and the behavior inputs responsible for flake scars on prehistoric artifacts.

How this approach can be used to address culture historical questions can be illustrated in reference to the "Clovis problem" (see Young and Bonnichsen, 1984, for a detailed discussion). Clovis points have a triangular lanceolate form, flutes on both faces, and are distributed across the American continent. One group of scholars argues that Clovis points represent a single migration from Beringia about 11,500 years B.P. and that these big game hunters spread across the landscape, taking their Clovis technology with them. Another interpretation is that America had been populated earlier. Due to climatic changes at the end of the Pleistocene, the large animals declined and local groups responded by hafting projectile points (thus the flutes) to produce more efficient weapons such as the atlatl.

If the second hypothesis is correct, one would expect that despite a superficial similarity in shape and in the presence of flutes, Clovis points were made in different ways by local populations. To test this hypothesis, we analyzed sample artifacts from two widely separated Clovis assemblages, one from Maine (the Calais site) and the other from Montana (the Anzik site).

We found that although individual measurements of the artifacts from both sites overlap in almost all cases, and although there is impressive overlap in production techniques represented within each site, there is considerable difference between the production grammars represented by the two sites. Although our reconstructions may contain some errors, it became quite clear to us that the evidence tends to support the hypothesis that the so-called Clovis points are actually made in a variety of ways, depending upon the area in which they are found.

Another test of the grammatical approach to archaeological problems has recently been provided by John Pollock's analysis (1984) of two sites located near each other on the shores of Lake Abitibi in Ontario. Figure 8 depicts the results of analyzing a sample of artifacts from each of the two sites. The artifact number is shown inside the outline of each artifact. Percentages show the degree of overlap in the production grammars of any two artifacts. It can be seen that the only strong connections are within each of the two sites. The Jessup site has one artifact which has equally strong links to both sites, and the Jordan site has

two artifacts which are not clearly associated with the other artifacts in that site. Despite these ambiguities, it is clear that there is a core group of artifacts in each site which have a good deal in common technologically, though not in shape. It is also clear that the two sites have little in common in terms of production grammars. Pollock (1984: 303-304) concludes his analysis as follows:

> In summary, there is virtually no overlap between the two grammars. The Jordan craftsman produced more symmetrical and better finished artifacts, largely due to techniques which allowed greater control (indirect percussion and pressure flaking). In contrast, the Jessup artifacts tend to be more irregular in shape and surface detail, having been produced with less controllable techniques such as percussion with hammerstone. With its more limited repertoire, the Jessup site may be more typical of quarry workshops for mass production of preforms.

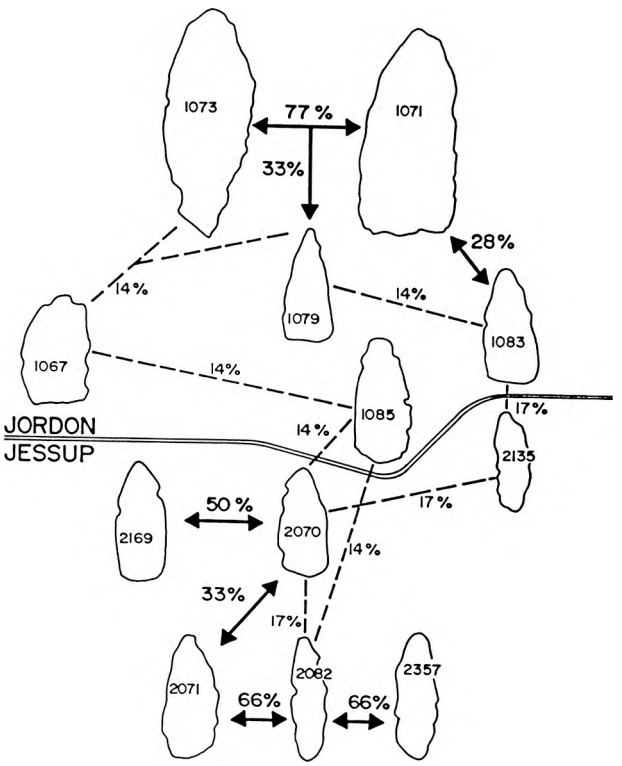


Figure 8. Degree of overlap in production grammars of artifacts from the Jordon and Jessup sites, Lake Abitibi, Ontario.

NOTE: From Pollock (1984).

Conclusion

I believe that the preliminary findings summarized above warrant continued, and expanded, research with artisans because research of this sort can, first of all, help us understand something about the psychological processes involved in doing and making things in real life situations. Second, this sort of research has important implications for those subdisciplines of anthropology, such as anthropological aesthetics and archaeology, that are interested in artifacts and the role artifacts play in adaptation to cultural and physical environments. Let me expand briefly.

Cognitive anthropologists are interested in how cognitive processes and structures are reflected in what people say. To a lesser extent, cognitive anthropologists are also interested in the cognitive constructs, such as "event schemas" which lie behind nonverbal behavior (see Casson, 1983 for a review). It has been argued in this paper that "making things" is equally grammatical and needs to be studied as well. Artifacts are an important link in the process by which individuals interact with their environments. To leave artifacts out of the equation is to leave a hole in the feedback loop through which both energy and information circulate. Studying artisans from a cognitive perspective is one way that cognitive anthropologists could fill this hole and gain a broader perspective upon fundamental psychological and biological processes.

Cognitive psychologists have begun to move in this direction with their developing interest in motor movement, but they too have failed to extend their research to the creation of artifacts. In fact, psychologists, in a search for what Brunswik (1956) called "ecological validity", are increasingly placing a stress upon the necessity of studying individuals in real life situations (Neisser, 1976; Namikas, 1983) and sometimes even include anthropology in their deliberations about how to do this (Jahoda, 1982). The time is ripe for joint research efforts by cognitively oriented social scientists interested in how cognition is related to what people say, do and make in the real world. The focus of such research should be idiographic, i.e., upon understanding the individual (Kelley, 1955; Goodman, 1967; Plog, 1977; Lamiell, 1981), not as a cog in a social system or as an example of the group to which he belongs, but as a being who brings together psychological, biological, cultural, and material factors into a living system which must be studied as a legitimate phenomenon in its own right.

The importance of such an approach for aesthetics is that it would supplement the traditional concern for style (defined as the distinctive attributes shared by two or more artifacts) with an emphasis upon process—how artifacts are made. Although there have been studies of artists at work (cf., Bunzel, 1928), such studies have not generally

employed a grammatical approach. The value of a grammatical approach is that it most clearly ties the production process to the behavioral strategies and decision making processes that lie behind the observable behavior. A grammatical approach also emphasizes the fact that the resulting artifact has a structure which, at least to some extent, reflects the behavioral and cognitive structures responsible for its creation.[3]

The importance of a cognitive, idiographic approach for archaeology is that it offers a different perspective upon artifact classification schemes and the way such schemes can be employed to help reconstruct culture history. To the extent that one can "read" the process information encoded in a finished artifact, artifacts become bridges to certain aspects of past cultural knowledge and activity (Lechtman, 1975; Hodder, 1978; Whittaker, 1984). Research employing the cognitive approach indicates that stone tools *can* be read with a reasonable degree of accuracy.

Moreover, if shape information, an image gestalt, is stored in one way in the brain whereas motor skills are stored in another way, it can be argued that shape information is more easily accessible in terms of both perceptual and cognitive manipulation. This means that new shapes can be learned quickly and shape can be sketched or talked about easily by a artisan. Technical and motor skills, on the other hand, cannot be learned quickly nor talked about easily (Hill and Gunn, 1977). Complex production techniques must be learned in an apprentice situation and internalized through long periods of practice (Jopling, 1975). This would seem to indicate that technology may be more conservative than shape over time and in the face of innovation. This applies to both individual artisans and to cultural traditions. Artisans can best be identified by their techniques (rather than by the forms of what they made) and technology is a better cultural marker than shape, at least under conditions where artisans in a group have apprenticed together. In other words, artisans who learn together should have more in common than those who do not, even when working on different shapes (cf., Jopling, 1975; Hardin, 1977).[4]

These hypotheses need to be tested by additional case studies of individual artisans and by ethnographic studies oriented toward material culture. It is critical to determine the range of variation in both formal attributes and technology that is permitted to develop within groups of people of varying sizes (Redman, 1977; Plog, 1983). To the extent that shared technological systems are characteristic of hunting and gathering groups, it should be possible to associate differences in how artifacts are made with cultural differences. This is particularly relevant to sorting out mixed assemblages (the deposition of artifacts from different times or places in a single assemblage).

There are other applications. But these examples should suffice to illustrate the fact that the type of cognitive approach advocated here, because it is based upon reconstructing the cultural knowledge and behavior responsible for producing artifacts, has the potential of making artifact classification more dynamic and of building bridges between cognitive anthropology and other subdisciplines such as archaeology and anthropological aesthetics.

NOTES

1. Throughout the paper, I use the terms "cognitive approach" and "grammatical approach" more or less interchangeably. There are many possible definitions of both terms, but to me, the essence of the cognitive approach is its emphasis upon the ability of individuals to employ internalized categories and rules to generate behavioral strategies appropriate to the situation. The categories and rules constitute the grammar, and the result of generative activity is a grammatical performance, whether it be verbal or nonverbal. A grammatical analysis involves working backward from the performance to the underlying cognitive structures (rules and categories).

2. Individuals other than myself active in the Project for the Study of Material Culture include Dr. Trudy Nicks, Dr. John Pollock, Marjolaine Boutin-Sweet and Ruth McConnell. The Department of Anthropology has, over the past several years, provided the project with assistance in the way of laboratory space and student assistance. Funding has generously been provided by the Central Research Fund at the University of Alberta and the Boreal Institute for Northern Studies, also at the University of Alberta. Additional support in the way of vehicles, photography, and personnel has been provided by the Provincial Museum of Alberta. The project has an informal affiliation with the Center for the Study of Early Man, University of Maine at Orono, under the directorship of Dr. Robson Bonnichsen.

3. The approach advocated in this paper is to do detailed studies of how individual artisans employ repertoires of goals, images, strategies, techniques, motor skills, and rules to solve problems presented by their materials. Although there are very few process studies of this sort, the grammatical approach has been used productively in the study of style. For example, Holm (1965) has assembled a useful collection of design motifs used in Northwest Coast Indian art and has described in some detail the rules pertaining to formal relations among these motifs in completed objects. Thompson (1969) has traced the evolution of the style of Abatan, a master potter of the Egbado Yoruba, Hardin (1977) has

documented individual differences in the rendering of design elements in San Jose pottery painting, and Kjorup (1977) has analyzed film as a type of language. The work of Muller (1977; 1979) illustrates how a grammatical approach can be used to describe individual variation in art styles, particularly in a prehistoric context. Other examples could be referenced to illustrate the growing interest in grammatical approaches. Hopefully, this interest will be extended to the study of production behavior.

4. Although a number of additional studies could be referenced to support this conclusion, the evidence is not unanimous. For example, Hill (1977) summarizes an experiment in which he had Tijuana potters paint designs on unpainted pots as follows (p. 83): "... in all likelihood artisans who are siblings and are taught to paint by the same teacher will share no more similarities in their motor performances than will artisans who are unrelated and taught separately." Additional experimental and ethnographic studies on variation within and between learning groups are clearly called for.

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