Final Report--Objective A, Task 3

December 1987

FUZZY SET APPLICATIONS IN REMOTE VIEWING ANALYSIS

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ABSTRACT

In FY 1987, fuzzy set mathematical techniques were applied to the problem of remote viewing (RV) analysis. Two analytical methods were developed: the first was designed to be sensitive to the verbal content of the RV response; the second was designed to account for the visual/spatial arrangements of response elements. A definition of "ground truth," against which these new analytical techniques could be tested, was also devised.

The verbal method is predicated on the application of fuzzy set mathematics to the figure of merit (FM) technology.* It also features a new descriptor list, which was introduced to provide a richer vocabulary for analysis. The list's hierarchical structuring in levels, ranging from very abstract to very concrete, affords considerable flexibility for analytical manipulation of descriptor elements. A pilot application of the verbal analysis was shown to correlate highly with ground truth.

The combination of fuzzy set technology and the new descriptor list also proved effective for the visual/spatial approach. The implementation of these techniques, in conjunction with a third technique known as "cluster analysis," has resulted in an algorithm for the production of orthogonal target sets. This has resulted in a significantly more effective rank-order analysis procedure.

The visual and verbal analyses were each determined to have certain strengths and weaknesses. The verbal analysis can be statistically more powerful with good RV responses and provides a more comprehensive breakdown of the verbal information in an RV response. It is quite labor intensive to apply, however, and it appears to be relatively insensitive to noisy RV data. "Noisy," in this context, defined as a preponderance of incorrectly identified response elements. The visual analysis system is inherently much less powerful statistically and is less capable of providing systematic objectification of the true RV signal content. It can be rapidly applied however, and is sensitive to the primary manifestation of true RV signal in noisy data--namely, to the visual arrangement of RV response elements, regardless of their verbal labels. Potential applications of these techniques in their current states have been suggested; areas of future research for their refinement have been identified.

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* The FM analysis has continued to undergo refinement since its inception in FY 1984.

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I INTRODUCTION

Since the publication of the initial remote viewing (RV) effort at SRI International,*[1] two basic questions have remained in evaluating remote viewing data:

- What is the definition of the target?
- What is the definition of the RV response?

In the development of meaningful evaluation procedures, we must address these two questions.

In the older, IEEE-style, outbound experiment, definitions of target and response were particularly difficult to achieve. The protocol for such an experiment dictated that an experimenter travel to some randomly chosen location at a prearranged time; a viewer's task was to describe that location. In trying to assess the quality of the RV descriptions (in a series of trials, for example), an analyst visited each of the sites and attempted to match responses to them. While standing at a site, the analyst had to determine not only the bounds of the site, but also the site details that were to be included in the analysis. To cite a specific example using this protocol: if the analyst were to stand in the middle of the Golden Gate Bridge, he/she would have to determine whether the buildings of downtown San Francisco, which are clearly and prominently visible, were to be considered part of the Golden Gate Bridge target. The RV response to the Golden Gate Bridge target could be equally troublesome, because responses of this sort were typically 15 pages of dream-like free associations. A reasonable description of the bridge might be contained in the response; it might be obfuscated, however, by a large amount of unrelated material. How was an analyst to approach this problem of response definition?

The first attempt at quantitatively defining an RV response involved reducing the raw transcript to a series of declarative statements called concepts.[2] Initially, it was determined that a coherent concept should not be reduced to its component parts. For example, a *small red VW car* would be considered a single concept rather than four separate concepts, *small, red, VW,* and *car*. Once a transcript had been "conceptualized," the list of concepts constituted, by definition, the RV response. The analyst rated the concept lists against the sites. Although this represented a major advance over previous methods, no attempt was made to define the target

* References are listed at the end of this report.

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site. It was also extremely labor intensive and did not readily allow for rapid processing of RV data.

During an FY 1982 program, a procedure was developed to define both the target and response material.[3] It became evident that before a site can be quantified, the overall remote viewing goal must be clearly defined. If the goal is simply to demonstrate the existence of the RV phenomena, then anything that is perceived at the site is important. But if the goal is to gain specific information about the RV process, then possibly specific items at the site are important while others remain insignificant. For example, let us assume that an office is a hypothetical target and that a single computer in that office is of specific interest. Let us also assume that a viewer gives an accurate description of the shape of the office, provides the serial number of the typewriter, and gives a complete description of the owner of the office. Although this kind of a response might provide excellent evidence for remote viewing, the target of interest (the computer) is completely missed. This response, therefore, does not yield information about the role of complex target elements at the site.

In FY 1984, work began on a computerized evaluation procedure,[4] which underwent significant expansion and refinement during FY 1986.[5] The mathematical formalism underlying this procedure is known as the "figure of merit" (FM) analysis. This method is predicated on descriptor list technology, which represented a significant improvement over earlier "conceptual analysis" techniques, both in terms of "objectifying" the analysis of free response data and in increasing the speed and efficiency with which evaluation can be accomplished.

It became increasingly evident, however, that this particular application of descriptor lists was inadequate in providing discriminators that were "fine" enough to describe a complex target accurately; it was also unable to exploit fully the more subtle or abstract information content of the RV response. To decrease the granularity of the RV evaluation system, therefore, it was determined that the technology would have to evolve in the direction of allowing the analyst a gradation of judgment about target and response features, rather than the hard-edged, (and rather imprecise) all-or-nothing binary determinations. A preliminary survey of various disciplines and their evaluation methods (spanning such diverse fields as artificial intelligence, linguistics, and environmental psychology) revealed a branch of mathematics, known as "fuzzy set theory," which provides a mathematical framework for modeling situations that are inherently imprecise.

This report describes the FY 1987 analysis program,* which focused on the application of fuzzy set mathematics to descriptor list technology. In addition, an effort was made to further reduce granularity by redesigning the descriptor list itself, and to introduce an altogether new adjunct technology for capturing visual/spatial RV information. A separate but parallel research line investigated the application of expert systems technology to the problem of RV analysis.†

* This report constitutes Objective A, Task 3, "Fuzzy Set Applications in Remote Viewing Analysis."

† The results of the expert systems approach to RV analysis can be found in the FY 1987 Final Technical Report.

II METHOD OF APPROACH

The method of approach was aimed at accounting for both the verbal and visual aspects of RV data. In this section we present the techniques that were developed to address these objectives.

A. Target Pool Preparation

A few preliminary guidelines governing target pool composition were distilled from two sources: (1) the opinions of RV monitors about the appropriateness of various kinds of RV targets for novice viewers, and (2) RV analysts' assessments about the difficulties encountered in using descriptor lists to score *National Geographic* Magazine target materials.

As a general rule, the current subjective consensus is that targets are inappropriate for experimental purposes if they exhibit any of the following qualities:

- They are contrary to the viewer's expectations. (For example, if the target pool is basic gestalt scenes, then there will not be a living room scene.)
- They are imbued with negative emotional impact.*
- They violate the "spirit" of the descriptor list's intended use.
- They exhibit descriptors that are ambiguously depicted.

Every effort was made in FY 1987 to create a target pool of 200 *National Geographic* Magazine photographs that did *not* exhibit any of the deficiencies enumerated above. Particular attention was paid to ensuring that all descriptors were unequivocally depicted: a given target would be rejected *a priori*, for example, if its particular photographic angle exhibited what was, in fact, a *lake* (a completely-bounded body of water) as a *bay* (a partially-bounded body of water). This approach was taken in order to minimize the potential for disputes concerning the visual content of any given photograph: in this way, it was anticipated that the feedback experience for the viewer would be unencumbered, as much as possible, by visual versus conceptual ambiguities.

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* Laboratory anecdotal evidence suggests that targets having negative emotional impact often result in psi-missing responses.

B. Fuzzy Set Theory

Fuzzy set theory was chosen as the focal point of the RV analytical techniques, because it provides a mathematical framework for modeling situations that are inherently imprecise. Because it is such an important component of both the verbal and visual analyses, a brief tutorial from an earlier report[5] will be recapitulated to highlight its major concepts.

1. A Tutorial

In traditional set theory, an element is either a member of a set or it isn't--e.g., the number 2 is a member of the set of even numbers; the number 3 is not. Fuzzy set theory is a variant of traditional set theory, in that it introduces the concept of *degree* of membership: herein lies the essence of its applicability to the modeling of imprecise systems. For example, if we take the concept of *age* (known as a *linguistic variable* in fuzzy set parlance), we might ascribe to it certain subcategories (i.e., *fuzzy sets*) such as *very young, young, middle-aged, old,* etc. Looking at *very young* only as a fuzzy set example, we must define what we mean by this concept vis-a-vis the linguistic variable *age.** If we examine the chronological ages from 1 to 30, we might subjectively assert that we consider the ages 1 through 4 to represent rather well a spectrum of the concept *very young*, whereas the age of 30 probably does not accurately represent *very young* at all. As depicted in Figure 1, fuzzy set theory allows us to assign a numerical value between 0 and 1 that represents our best subjective estimate as to how much each of the ages 1 though 30 embodies the concept *very young*.

Clearly, a different set of numerical values would be assigned to the ages 1 through 30 for the fuzzy sets *young, middle-aged,* and *old*--e.g., the age of 6 might receive a value of 0.5 for *very young*, but a value of 1.0 for *young*, depending on context, consensus, and the particular application of the system. In this way we are able to provide manipulatable numerical values for imprecise natural language expressions; in addition, we are no longer forced into making inaccurate binary decisions such as, "Is the age of 7 very young--yes or no?"

* It is important to note that the design of the fuzzy application occurs in accordance with the subjectivity of the system designer. Fortunately, the fuzzy set technology is rich enough that it allows for a virtually unrestricted range of expression. Technically speaking, *young* is the fuzzy set and *very* is the modifier, but it is beyond the scope of this paper to present terminology in depth.

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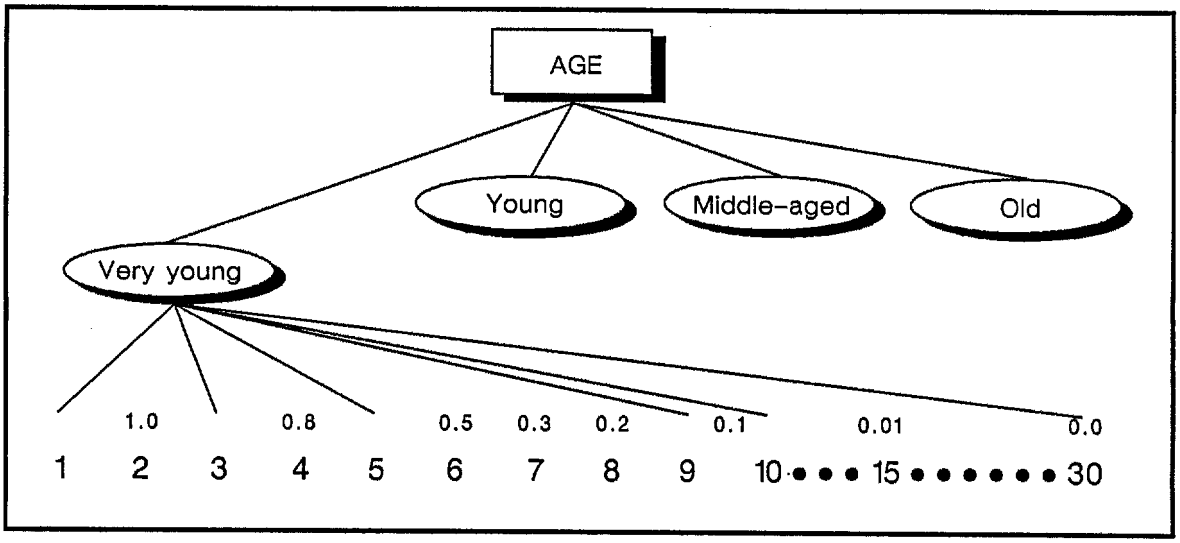

FIGURE 1 THE FUZZY SET "VERY YOUNG"

2. Summary of Definitions

In this example, the set of ages ranging from 1 through 30 is a *crisp* set and can be defined as the *universe of elements*. By crisp, we mean, for example, that the age "30 years and 1 day" would fall outside the universe of elements *by definition*. *Very young, young, middle-aged,* and *old* are *fuzzy sets* drawn from this universe of elements. They are called *fuzzy* because they contain members from the universe of elements that exhibit varying degrees of membership, ranging from partial to complete. These terms are important for understanding the design of the current descriptor list and the mathematical formalism underlying its implementation.

C. Descriptor List Design

The primary impetus in redesigning the descriptor list was to reduce its granularity by affording a richer vocabulary of terms for response and target interpretation. The following sections outline (1) the derivation of the list's universe of elements, and (2) the design philosophy that resulted in their hierarchical arrangement.

1. The Universe of Elements

The universe of elements--i.e., the entire list of descriptors shown in Figure 2--represents the union of the set of elements in the *National Geographic* Magazine target pool of 200 and the set of elements obtained from the FY 1987 RVs for which this pool supplied the targets. This set of elements was obtained in a blind fashion--i.e., in the absence of knowledge as to which responses correctly matched which targets. In the case of the RV transcript-derived elements, an effort was made to preserve the vocabulary used by the viewers. Some of the descriptors, therefore, are either response-dependent or target-dependent or both, while others (particularly at the more abstract levels) appear to be more potentially universal across descriptor lists.

2. Descriptor List Structure

The universe of elements is structured in *levels*, ranging from the relatively abstract (information poor) to the relatively complex (information rich). The current system has the capability of using seven primary and three secondary levels of descriptors: the main intent of this structure is to serve as a heuristic device for guiding the analyst into making judicious concrete descriptor assignments based on rather abstract commentary. A secondary goal is to make an attempt at objectifying the analyst's unconscious decision-making process. The use of levels is advantageous in that each descriptor level can be weighted separately and used or not, as the case may be, in a computerized data base. This enables various combinations of levels to be deployed, in order to identify the optimal mix of concrete versus abstract descriptors. *Optimal* here might be defined as the highest figures of merit, or perhaps by some other measure, such as a consensus rating of the experimental series in question.

The determination as to which descriptors belonged on which level was made after consideration of two primary factors: (1) the apparent ability of the viewers to be able to resolve certain features, coupled with (2) the amount of pure information thought to be contained in any given descriptor. In the first case, for example, it appears that viewers have greater difficulty on average in perceiving *waterfalls* as opposed to *rivers*. Some of these "factor one" determinations were based on the combined observational *subjective lore,* obtained by both analysts and monitors in the course of either analyzing or conducting numerous RV experiments; some were determined empirically from *post hoc* analyses of viewers' abilities to perceive various descriptor elements in previous experiments.

CONCRETE DESCRIPTOR LEVELS I

Experiment: ______
Trial: ______
Response: ______
Coder: ______
Viewer: ______

LEVEL	SINGLE STRUCTURES	SUBSTRUCTURES
10	1 ☐ fort 2 ☐ castle 3 ☐ palace 4 ☐ church (other religious buildings, monastery) 5 ☐ mosque 6 ☐ pagoda 7 ☐ coliseum (stadium, amphitheater, arena)	
9	8 ☐ bridge 9 ☐ [dam (lock, spillway)]	10 ☐ boats (barges) 11 ☐ pier (jetty) 12 ☐ [motorized vehicles (cars, trucks, trains)] 13 ☐ column 14 ☐ spire (minaret, tower) 15 ☐ fountain 16 ☐ fence 17 ☐ arch 18 ☐ wall (e.g., the Great Wall) 19 ☐ monument
8		20 ☐ roads

FIGURE 2 DESCRIPTOR LIST

CONCRETE DESCRIPTOR LEVELS II

Experiment: ____________
Trial: ____________
Response: ____________
Coder: ____________
Viewer: ____________

LEVEL	SETTLEMENT	ELEVATION	LAND/WATER INTERFACE	NO WATER OR VEGETATION	VEGETATION	AMBIENCE/ FUNCTION
7			21 ☐ port (harbor) 22 ☐ [oasis]		23 ☐ agricultural fields (orchards)	24 ☐ industrial 25 ☐ recreational 26 ☐ religious 27 ☐ mechanical 28 ☐ technical 29 ☐ agricultural 30 ☐ commercial 31 ☐ wilderness 32 ☐ urban 33 ☐ rural (pastoral) 131 ☐ historical (archaeological)
6	34 ☐ ruins (incomplete buildings)	35 ☐ mesa (plateau)	36 ☐ waterfall 37 ☐ glacier 38 ☐ canal (channel, manmade waterway)	39 ☐ desert	40 ☐ forest 41 ☐ jungle 42 ☐ swamp (marsh)	
5	43 ☐ isolated settlement 44 ☐ town (village) 45 ☐ city	46 ☐ single peak 47 ☐ hills (slopes, bumps, humps, mounds) 48 ☐ mountains 49 ☐ cliff(s) 50 ☐ [plain, delta] 51 ☐ valley (cleft, gully, irreg. depression) 52 ☐ canyon 53 ☐ [crater, bowl-shape, regular depression]	54 ☐ unbounded large expanse of water (ocean, sea) 55 ☐ completely bounded expanse of water (lake, pool, pond) 56 ☐ partially bounded expanse of water (bay) 57 ☐ island 58 ☐ river (stream, creek) 59 ☐ coastline		60 ☐ vegetation (trees)	

FIGURE 2 DESCRIPTOR LIST (Continued)

ABSTRACT DESCRIPTOR LEVELS I

Experiment: ______
Trial: ______
Response: ______
Coder: ______
Viewer: ______

QUALITIES

LEVEL	COLOR	OTHER VISUAL	IMPLIED TEXTURE	IMPLIED TEMPERATURE	IMPLIED MOVEMENT	AMBIENCE
4	61 ☐ yellow	71 ☐ shiny (reflective)	80 ☐ smooth	85 ☐ hot	89 ☐ flowing	91 ☐ congested (cluttered, dense, busy)
	62 ☐ orange	72 ☐ [gold]	81 ☐ fuzzy	86 ☐ cold (snow, ice)	90 ☐ other implied movement	92 ☐ serene (peaceful, unhurried, unfrenetic)
	63 ☐ red	73 ☐ [silver]	82 ☐ grainy (sandy, crumbly)	87 ☐ humid		93 ☐ closed in (claustrophobic)
	64 ☐ blue	74 ☐ [chrome]	83 ☐ rocky (ragged, rugged, jagged, rubbled, rough)	88 ☐ dry (arid)		94 ☐ open (spacious, vast, expansive)
	65 ☐ green	75 ☐ [copper]	84 ☐ striated			95 ☐ ordered (aligned)
	66 ☐ purple (pink)	76 ☐ obscured (fuzzy, dim, smoky)				96 ☐ disordered (jumbled, unaligned)
	67 ☐ brown (beige)	77 ☐ cloudy (foggy, misty)				
	68 ☐ black	78 ☐ old				
	69 ☐ white	79 ☐ weathered (eroded, incomplete)				
	70 ☐ grey					

ARCHETYPES

LEVEL	STRUCTURE	ELEVATION	INTERFACE	UNIQUENESS	AMBIENCE
3	97 ☐ building(s) (structure(s))	98 ☐ rise (vertical rise as well as slope)	100 ☐ light/dark areas (big swaths)	104 ☐ single (or central) predominant feature	106 ☐ manmade (or altered)
		99 ☐ flat	101 ☐ boundaries	105 ☐ odd (or surprising) juxtaposition of elements	107 ☐ natural
			102 ☐ land/water interface		
			103 ☐ land/sky interface (horizon)		

FIGURE 2 DESCRIPTOR LIST (Continued)

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ABSTRACT DESCRIPTOR LEVELS II

Experiment: ________
Trial: ________
Response: ________
Coder: ________
Viewer: ________

2-D & 3-D GEOMETRIES

LEVEL	RECTILINEAR FORMS	CURVILINEAR FORMS	MIXED FORMS	IRREGULAR FORMS	REPEAT MOTIF
2	108 ☐ rectangle (square, box)	112 ☐ circle (oval, sphere)	114 ☐ cylinder	117 ☐ irregular forms (irregular features)	118 ☐ repeat motif
	109 ☐ triangle (trapezoid, pyramid)	113 ☐ [torus]	115 ☐ cone		
	110 ☐ other polygonal (> 4 sides: hexagon, octagon, etc.)		116 ☐ semicircle (hemisphere, dome)		
	111 ☐ cross-hatch (grid)				

1-D GEOMETRY / VISUAL CORRESPONDENCE

LEVEL	1-D GEOMETRY			VISUAL CORRESPONDENCE
1	119 ☐ stepped	127 ☐ arc (curve)	130 ☐ meandering curve	☐ rank order fraction
	120 ☐ parallel lines	128 ☐ wave form (ripples)		
	121 ☐ vertical lines	129 ☐ spiral		
	122 ☐ horizontal lines			
	123 ☐ diagonal lines			
	124 ☐ V-shape			
	125 ☐ inverted V-shape			
	126 ☐ other angles			

FIGURE 2 DESCRIPTOR LIST (Continued)

The "factor two" determinations were made primarily by arranging the descriptors such that a descriptor at any given level represents the sum of constituent descriptors at lower levels. The world is not a very crisp place and not all of its elements are amenable to hierarchical structuring: certain violations of the "factor two" rule appear, therefore, throughout the proposed levels. It should be noted, however, that some of the more glaring violations were largely driven by the "factor one" determinations (i.e., the viewers' abilities to discern certain elements) enumerated above.

3. Target and Response Definitions

The descriptor list shown in Figure 2 was filled out for each of the 200 targets, according to a consensus (see Section III) reached by three analysts on each of the descriptors. This approach was used to mitigate the potential influence of any single coder's biases and idiosyncrasies. A numerical assignment (μ, $0 \leq \mu \leq 1$) was made for each descriptor in response to the following question:

How visually important is this descriptor to this target?

Each target's coded list served as its formal definition for the purposes of both verbal and visual analysis. It should be noted that the descriptor set was devised to define targets in terms of *visual importance*. If the analysis were to be re-framed along a different dimension of interest--e.g., conceptual, functional, allegorical, etc.--the descriptor set in Figure 2 would have to be revised to address the new mission.*

For responses in which verbal analysis was used, μ assignments for each descriptor were made in response to a different question:

To what degree am I convinced that this descriptor represents this response element?

Responses were coded according to this different criterion (but still using the list in Figure 2), because RV response composites are often not detailed enough to determine relative visual importance for any given element. For the purposes of verbal analysis,† the coded descriptor lists represented the formal definition of each response.

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* Details of these analyses can be found in Sections D. and E., below.

† An altogether different response definition was used for the purposes of visual analysis. This is discussed in Section E.

The assigned μ's, themselves, were one-digit fuzzy numbers between 0 and 1 (e.g., .1, .2, .3, etc.). In some rare cases, two-digit assignments (e.g., .15, .25, .35, etc.) were made; any finer assignments, however, were deemed to be meaningless.

D. Verbal Analysis: the Fuzzy Set Figure of Merit

The current RV verbal analysis is predicated on the application of fuzzy set mathematics to the figure of merit technology.

1. Fuzzy Set Definition of Figure of Merit

Once the fuzzy sets that define the target and the response have been specified, the comparison between them to provide an FM is rather straightforward. In previous work,[5] we have defined Accuracy as the percent of the *target* material that was described correctly by a response. Likewise, we have defined Reliability (of the viewer) as the percent of the *response* that was correct. The FM is the product of the two; to obtain a high FM, a viewer has to describe a large portion of the target material correctly in as parsimonious a way as possible. These quantities for the jth target/response pair are as follows:

$$\text{Accuracy}_j = a_j = \frac{\sum_k W_k (R_j \cap T_j)_k}{\sum_k W_k T_{j,k}} ,$$

$$\text{Reliability}_j = r_j = \frac{\sum_k W_k (R_j \cap T_j)_k}{\sum_k W_k R_{j,k}} ,$$

and

$$\text{Figure of Merit}_j = M_j = a_j \times r_j ,$$

where the sum over k is called the sigma count in fuzzy set terminology, and is defined as the sum of the membership values, μ, for the elements of the response, target, or their intersection--intersecting R_j, T_j, and $(R_j \cap T_j)$, respectively. A fuzzy intersection is defined as the minimum of the two membership values. In this version of the figure of merit definition, we have allowed for the possibility of weighting the membership values, W_k, in order to examine various linguistic contributions to the FM.

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For the above calculation to be meaningful, the μ's for the targets must be similar in kind to the μ's for the responses. As we noted above, this is not the case. The target μ's represent the visual importance of the element relative to the scene, and the response μ's represent the degree to which the analyst is convinced that the element is represented in the response.

With advanced viewers it might be possible to change the definition of the response μ's to match the definition of the target μ's. In this case, the viewer must not only recognize that an element is present in the target, but must also provide information as to how visually important it is. This ability is beyond the skill of most novice viewers. Alternatively, we have opted to modify the target μ definition, by employing the fuzzy set technique of α–cuts. An α–cut is a way to set a threshold for visual importance, so that all target elements possessing that threshold value or higher are considered to be full members of the target set. In fuzzy set parlance, an α–cut converts a fuzzy set to a crisp set. The result is that the target set is now devoid of visual information: a potential target element is either present or absent in the target set, regardless of its actual visual importance. Even with this conceptual change in the target definition, the FM formalism described above remains applicable, because a crisp set can be considered as a fuzzy set with all membership values equal to 1. It should be noted that the α–cut conversion does not occur in the data base proper, but rather in the analysis itself. In this way the integrity of the original visual importance information can be maintained, and the α–cut can be exercised as a variable.

2. P–Values for a Given Figure of Merit

It is difficult to arrive at a general assessment as to how well a given response matches a specified target. The ideal situation is to obtain some absolute measure of goodness of match. While the FM is an approximation to this measure, it provides no information as to the likelihood of a particular FM value. The answer to that question is nearly impossible, because it requires knowledge of the viewer's *specific* response bias for the session. It is possible to determine general response biases,[4] but that knowledge is only useful on the average. For example, a viewer may love rock climbing and may spend most of her/his free time involved in that activity. Thus, the general response bias would probably entail aspects of mountains, rocks, ropes, etc. Suppose, however, that the viewer spent the evening previous to a given RV session on a romantic moonlight sail on San Francisco Bay. For this specific RV session, the response bias might be apt to include romantic images of the moonlit water, lights of the city, and bridges.

The current solution to the problem is to provide a *relative* assessment of FM likelihood (i.e., a differential measure). A relative assessment addresses the following question:

"How good is the response matched against its intended target, when *compared* to all possible targets that could have been chosen for the session?" Unfortunately, the answer depends upon the nature of the remaining targets in the pool. An example of the worst-case scenario illustrates the problem. Suppose that the target pool consisted of 100 photographs of waterfalls, and the viewer gave a near-perfect description of a waterfall. Suppose further that this viewer had been well calibrated so that we can assume his/her description was not fortuitous. An absolute assessment of the resulting FM should be good, whereas a relative assessment will be low.

The worst-case scenario can be avoided, to a large degree, by carefully selecting the target pool. In section E.1 we describe an application of fuzzy set theory that addresses target similarities *vis-a-vis* the problem of target pool optimization.

To provide a relative assessment of the likelihood of a given FM, we define the p-value for the session as the fraction of targets out of 200 that have an FM equal to or higher than the given FM.

Consecutive RV responses by the same viewer are not altogether statistically independent. The statistically independent random element in the session is the target. Therefore using the p-value defined above maintains the trial-by-trial independence. The mean chance expectation for the p-values is a unit uniform distribution with a mean of 0.5.

We are currently exploring various methods for combining the session p-values to provide an overall assessment of a series of viewings.

E. Visual Analysis: An Application of Cluster Technology

The verbal analysis appears to afford a reasonably comprehensive estimate of RV response information along a certain dimension: namely, identifying what the response elements *are,* ranging from abstract to concrete descriptions. This analysis is quite insensitive, however, in accounting for the spatial arrangement of the response elements. It has long been the subjective opinion of analysts that it is the *visual arrangement* of response elements--irrespective of what these elements are actually *called* by the novice viewer--that comprise the major part of the true RV signal line. This hypothesis was the major impetus for the development of an analysis system that would account for this visual/spatial type of RV information.

1. Target Similarities

Target definition for the purposes of this mode of analysis is exactly the same as the one that was used for the verbal analysis--i.e., a given target is defined by its descriptor list, which has been coded to reflect the visual importance of each target element. Since the average number of elements that have been assigned a non-zero value is approximately 37, the fuzzy set representation of the target pool is rich in visual information. We used this information to determine the degree to which the target set contains visually similar targets.

It is beyond the scope of this report to describe the extensive work in the literature seeking to find algorithmic techniques that mimic human assessments of visual similarity. One recent article describes techniques similar to the one we used.[6]

We begin by defining the similarity between target j and target k ($S_{j,k}$) to be a normalized fuzzy set intersection between the two target sets:

$$S_{j,k} = \frac{\left(\sum_i W_i \, (T_j \cap T_k)_i\right)^2}{\sum_i W_i \, T_{j,i} \; \sum_i W_i \, T_{k,i}} .$$

For N targets there are N(N−1)/2 unique values (19,900 for N=200) of $S_{j,k}$. The value j and k that correspond to the largest value of $S_{j,k}$ represent the two targets that "look" most similar. Suppose another target (m) is chosen and $S_{m,j}$ and $S_{m,k}$ are computed. If both of these values are larger than $S_{m,n}$ (for all n not equal to j or k) then target m is assessed to be most similar to the pair j,k. The process of grouping targets based on these similarities is called cluster analysis.

Table 1 provides an overview of the 19 clusters found from the total analysis of the 200 targets. Figure 3 shows the graphic output of a single cluster in detail: a much more complex--and visually difficult--graph is generated for the full cluster analysis (see Appendix B); this smaller subset, therefore, has been chosen to be illustrative of the whole analysis.* All targets in this particular sample cluster are islands; the island in each photograph is visible in its entirety. Except for one outlier (i.e., a hexagonal building covering an island), the islands fall into two main groups, i.e., with and without manmade elements. The natural islands include three similar mountain islands, two sandbars, and two flat verdant islands.

* In order to make the graphic output more meaningful, we actually did the analysis with $1 - S_{j,k}$.

Table 1

NAMES OF THE 19 CLUSTERS

No.	Name	No.	Name
1	Flat Towns	11	Cities with Prominent Geometries
2	Waterfalls	12	Snowy Mountains
3	Mountain Towns	13	Valleys with Rivers
4	Cities with Prominent Structure	14	Meandering Rivers
5	Cities on Water	15	Alpine Scenes
6	Desert/Water Interfaces	16	Outposts in Snowy Mountains
7	Deserts	17	Islands
8	Dry Ruins	18	Verdant Ruins
9	Towns on Water	19	Agricultural Scenes
10	Outposts on Water		

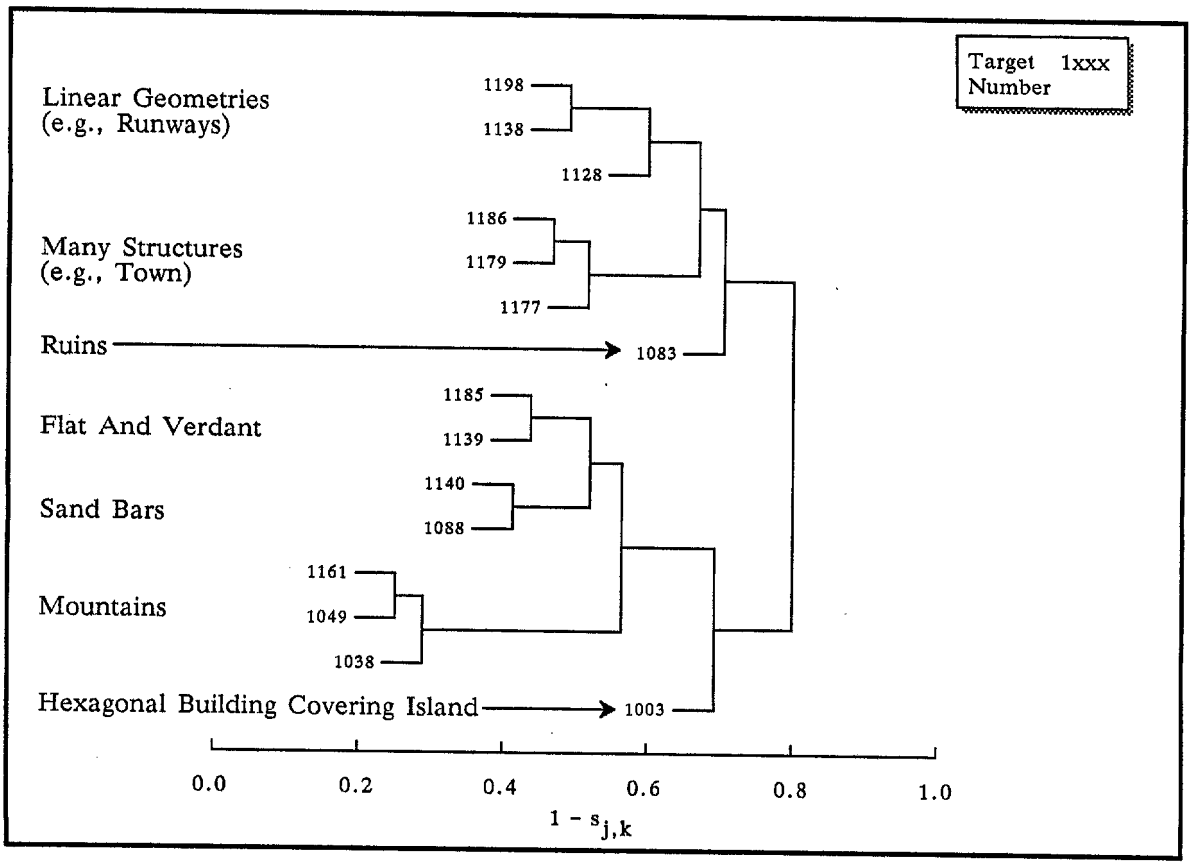

FIGURE 3 DETAILED CLUSTER ANALYSIS OF THE ISLAND CLUSTER

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2. RV Analysis Using Orthogonal Targets

The visual analysis of RV data has been the primary method used in simple rank-order judging. In the past, the technique involved a ranking of the actual targets in a series against a given response. There are two possible problems with this approach:

(1) The targets are not optimized for judging discrimination.

(2) Long series are difficult to assess.

Using the results of the cluster analysis, it is possible to select a number of decoy targets that are all different from each other and from the intended target, as well. The technique we have chosen involves a random selection of 6 out of 18 possible decoy clusters; the intended target cluster is not used. One target is randomly selected from each of these six decoy clusters. The intended target is added to the group of six decoys, and they are all numerically ordered on target number; these are then presented with the single response to the analyst for assessment.

The analyst's task is to rank order the targets from the best to the worst match based on a *subjective* assessment of the visual correspondence. Analysts are essentially instructed to pay primary attention to the drawings in a response (particularly, in terms of perspective) and secondary attention to the attendant verbal commentary, i.e., the written material is not to be ignored completely, but its contribution is small. The rationale for this is evident in the overall intent of the visual/spatial analysis. Analysts are also instructed to regard incongruent or surprising response elements as more salient, and to be slightly biased in favor of elements occurring at the beginning of a response. The reasons for these instructions are less evident and are largely attributable to the observations and subjective impressions of experienced and successful analysts. It was also determined that a consensus approach is useful for objectifying the decision-making process: for the FY 1987 data, all rankings were determined by a consensus of two analysts. For a series of many sessions, the sum of ranks for the actual matches is computed and a standard sum-of-ranks distribution is used to compute the p-value for the series.

The primary advantages to this approach are the following: (1) an analyst never has to provide an assessment for more than seven items at a time, and (2) the analysis can be rapidly applied for very long experimental series. The most important advantage, however, is that the six decoys and the intended target look as differently as possible, given the nature of the target pool at large and the fact that decoys must be selected randomly. The application of fuzzy set technology has provided an algorithm for the production of orthogonal target sets: this is perceived as the primary contribution to the success of this analysis technique.

F. Development of Ground Truth

To determine whether any of the new analytical approaches were effective, a standard had to be developed against which they could be measured. It was determined that this standard--known as "ground truth"--should consist of a "real world" normalized consensus as to the degree of correspondence between RV responses and their intended targets.

To achieve this objective, each person from a sample population of 37 was presented, on an individual basis, with six remote viewing responses and their associated targets. This set comprised an experimental series for Viewer 177 in an FY 1986 photomultiplier tube (PMT) experiment.[7] Each response was matched to its intended target; this created six such sets, numbered sequentially from 9001 through 9006. The responses were fairly typical of novice viewer output: they consisted of two to five pages of rudimentary drawings with some associated descriptive words. The targets consisted of six photographs of outdoor scenes selected from an FY 1986 *National Geographic* Magazine target pool.

Each person was asked individually for his/her subjective judgment as to the degree of correspondence between the remote viewing responses and their respective targets. This was to be accomplished without the benefit of a given definition of "degree of correspondence;" respondents were free to formulate their own criteria. The only information provided was that responses typically begin (on the first page or pages) with small bits of information and eventually culminate in a composite drawing at the end.

After this brief introduction to the task, each individual was instructed to examine all of the responses and their intended targets. Then, on a session-by-session basis, the subject was asked: (1) to assess the degree of correspondence between the remote viewing response and its intended target, and (2) to register this correspondence assessment by making a vertical hash mark across a 10 cm scale ranging from "none" to "complete." Figure 4 provides a sample of the form that the respondents used to indicate their six assessments.

After completing the assessment task, respondents were then asked to furnish some minor autobiographical information (i.e., age, occupation, male/female, handedness, belief in ESP). Degree of belief in ESP was also registered on a 10 cm scale: each individual simply made a vertical hash mark at the appropriate point on a continuous line between "no belief" and "complete belief."

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ANALYSTS' INSTRUCTIONS FOR REMOTE VIEWING SERIES 900X

Thank you for helping us perform a *post hoc* assessment of a series of remote viewings. The targets were actually 35 mm slides that were attached to a photomultiplier, a device to measure small amounts of light. We were searching for possible physical correlates to remote viewing.

You will find in your packet six remote viewing responses labeled 9001–9006, respectively. Also shown is the target number of the intended photograph. We have supplied the original, rather than the 35 mm slide.

We would like you to make a *subjective* judgment as to the degree of correspondence between the remote viewing response and its associated target. Familiarize yourself with the task by first looking at all the responses and their intended targets. Then, on a session-by-session basis, rate your assessments. You are completely free to define what is mean by "Degree of Correspondence." Indicate your judgment by marking one line across the appropriate continuous scale shown below. A vertical line near the "None" end of the scale will indicate that you feel there is very little correspondence between that response–target pair. Likewise a vertical line near the "Complete" end of the scale will indicate that you feel that there is a significant degree of correspondence.

Many of the responses begin with a little information and build toward a composite drawing at the end. Please assess the response in its entirety as best you can. Thank you again.

SESSION	DEGREE OF CORRESPONDENCE	TARGET
	None ——————————— Complete	
9001	|———————————|	1034
9002	|———————————|	1042
9003	|———————————|	1065
9004	|———————————|	1094
9005	|———————————|	1005
9006	|———————————|	1024

Age: ____________________

Occupation: ____________________

Male/Female: ____________________

Handedness (R/L) ____________________

Belief in ESP: \|———————————\|

None ——— Complete

FIGURE 4 SAMPLE GROUND TRUTH FORM

To perform the ground truth analysis, distance measurements were taken from the left end point of each scale to the vertical slash mark for each assessment. These measurements were then entered into a computerized data base. The first step in analyzing this aggregate of data was to compute the mean and standard deviation for each individual's set of assessments. In order to nullify response bias, each analyst's set was normalized by a z-score transformation. For a given target/response pair, all analysts' data could then be combined. The mean and standard deviation were then computed over all analysts' assessments for each target/response pair. Figure 5 shows these normalized means for each target/response pair: these constitute the basis for the ground truth against which other techniques were measured. See Section III, Results. The solid bars illustrate the degree of positive correspondence between the remote viewing responses and their intended targets, while the shaded bars represent the degree of negative correspondence (i.e., worse than average for this set of six). Note that these are relative to the others in the set. All six correspondences in the set could be good.

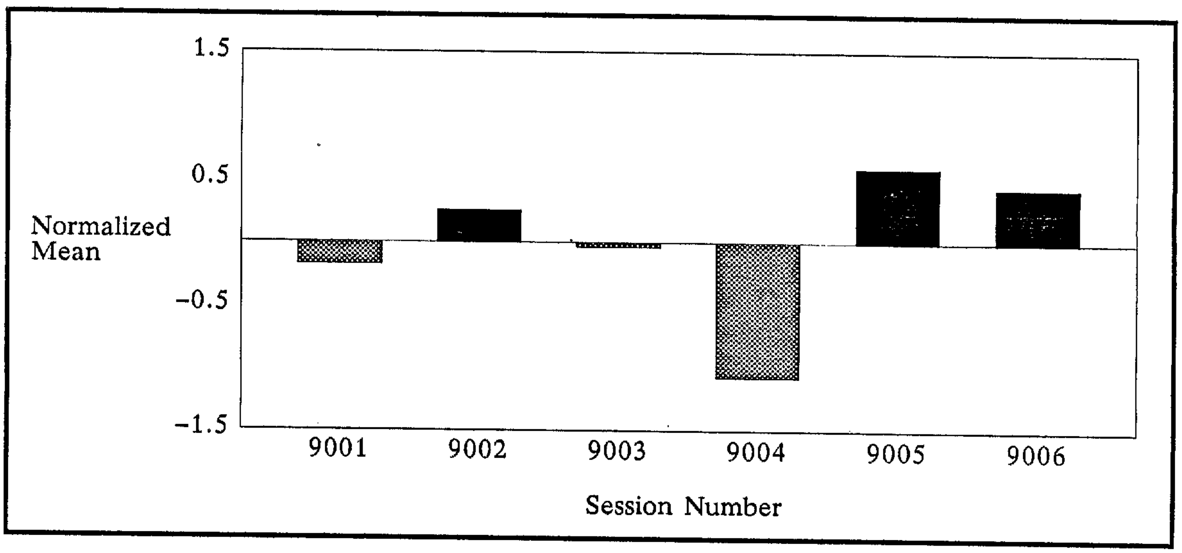

FIGURE 5 NORMALIZED MEAN FOR EACH TARGET/RESPONSE PAIR

III RESULTS

To effect a meaningful comparison between ground truth and the verbal analysis, the same PMT series that served as the ground truth set was also analyzed by the fuzzy set figure of merit method. The verbal fuzzy sets (μ's) for the six targets and six responses were consensus-coded by five analysts ranging from expert to novice. A typical spread of μ assignments was ± 0.1 with an occasional outlier. Some of the elements were vigorously debated until a consensus was reached. Figures of merit were calculated for each target/response pair, and all possible unique differences ($n(n-1)/2 = 15$; $n = 6$) were computed. These differences were then correlated against similar differences computed from ground truth (described above).

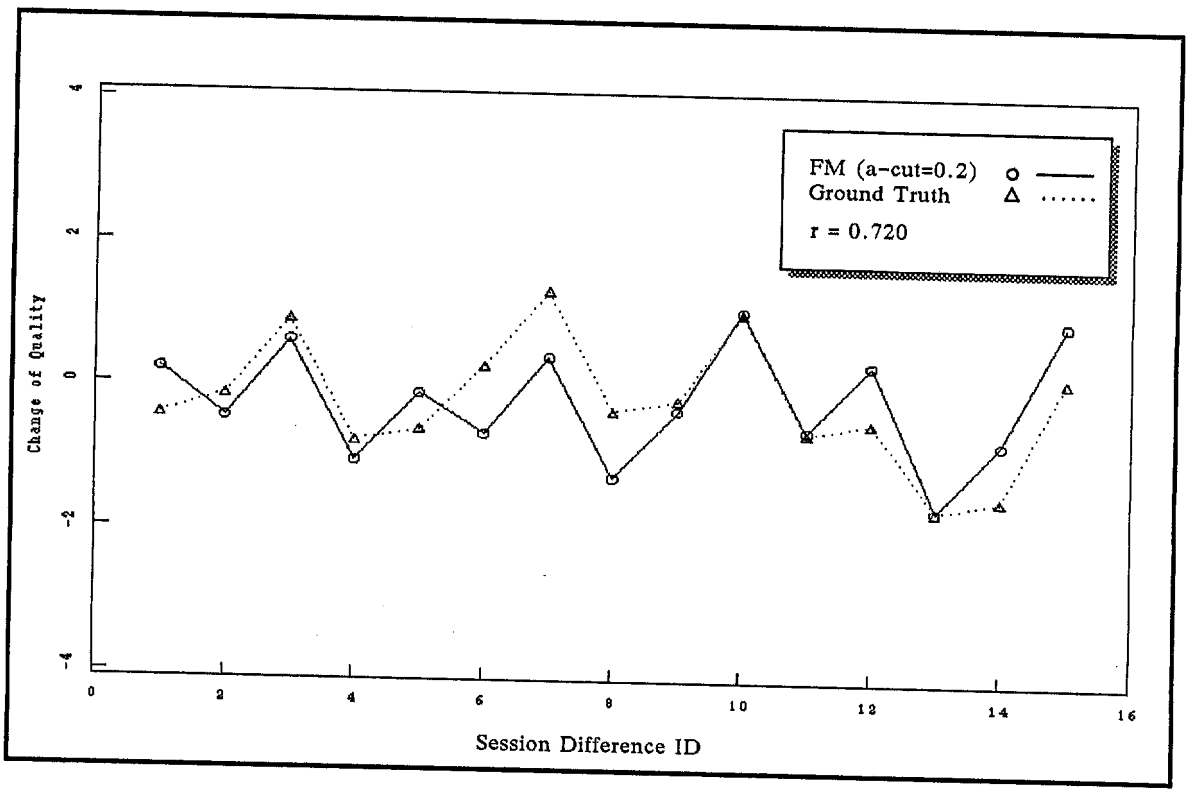

FIGURE 6 GROUND TRUTH COMPARED TO VERBAL FM

Figure 6 shows the results of this calculation where RV quality difference for verbal is shown as open circles and ground truth quality difference as triangles. The visual qualitative

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agreement is supported by the linear correlation coefficient between the two sets of points of 0.720.

This implies that the combination of (1) the structure of the universe of elements (i.e., the verbal hierarchical structure), (2) the fuzzy set mathematics, and (3) a consensus approach to assessing the fuzzy sets themselves, provided an accurate representation of the subjective scoring of the same data by a large number of randomly selected individuals. In short, the FY 1987 verbal analysis system provided output that closely correlated with ground truth.

To summarize, the visual and verbal analyses each have their own respective strengths and weaknesses. The verbal analysis is statistically more powerful and provides a more comprehensive breakdown of the verbal information in an RV response. It is quite labor intensive to apply, however, and it appears to be relatively insensitive to noisy RV data.* "Noisy," in this context, is defined as a preponderance of incorrectly identified response elements. The visual analysis system is statistically much less powerful and is less capable of providing systematic objectification of the true RV signal content. It can be rapidly applied, however, and is sensitive to the primary manifestation of true RV signal in noisy data--namely, to the visual arrangement of RV response elements, regardless of their verbal labels. It was the consensus of experimental monitors that the FY 1987 data were relatively noisy. Therefore, although the visual analysis system has yet to be formally compared to ground truth, it was chosen as the primary analytical method for the FY 1987 RV experiments.

* The PMT experimental series chosen for the pilot verbal analysis application turned out to be considerably more robust than much of the data obtained from the FY 1987 experiments.

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IV RECOMMENDATIONS AND CONCLUSIONS

A. Possible Research Areas for Refinement of the Current Systems

Several future research areas are suggested for the refinement of the current analytical systems. One area that needs to be examined systematically is the use of both inter- and intra-level weighting factors. For the purposes of the FY 1987 analyses, all levels and descriptors were accorded equal weight. The ideal goal would be to determine the optimal weighted mix of abstract versus concrete elements, as a means to achieving the following objectives:

(1) refinement of the cluster analysis for targets, in an effort to simulate, as closely as possible, what is meant by "visual similarities" between targets, and

(2) refinement of the verbal analysis of responses, in an effort to achieve even greater correlations between the fuzzy set figure of merit analyses and various forms of ground truth.

Another area that requires examination in some detail is the set of descriptors (i.e., the universe of elements), and the hierarchical nature of its structure. It is probable that some descriptors are more appropriate than others; furthermore, they might be more effectively structured in a semantic network as opposed to a true hierarchy. If a hierarchical structure is retained, then some attention must be paid to the formulation of logical consistency rules that govern descriptor use. This would include numerical relationships governing the values (μ's) of higher-order descriptors (e.g., *port*) *vis-a-vis* the combined value of their constituent parts (e.g., *city, river, boats, jetties, commercial, etc.*).

One perceived inadequacy of the verbal system is that it atomizes conceptual "units." For example, if the response element is *red box*, information is lost in separating *red* from *box*. Current research in fuzzy set theory indicates that fuzzy aggregates of fuzzy elements--"fuzzy sets of fuzzy sets"--are mathematically complex but possible. Some effort should be made to determine whether this technology could be implemented, as a means to capturing the information content of the RV response with greater accuracy.

For the visual analysis, research into visual similarities between pictures of natural scenes may serve as a potential refinement tool. The aim here would be to enhance the visual orthogonality of the decoy targets as much as possible. Experiments in normal perception of

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similarities would assist in determining whether scenes are perceived as similar because of their low–level geometries, concrete elements, or some combination of factors. Should the lower, abstract levels prove important to similarities perceptions, then Fourier decomposition of target materials might assist in providing more accurate target μ's at these levels. In any case, the ultimate aim would be to refine the target cluster analysis such that it closely simulates ground truth perceptions of orthogonality.

B. Possible Applications of the Current Systems

The verbal and visual analytical methods exhibit different strengths and weaknesses and appear to account for different aspects of the RV signal line. Even without further refinement or modification, the systems appear to be quite sensitive and accurate in their respective domains: the verbal system, for example, correlated highly with collected ground truth.

This suggests that they might be used effectively in their current state for certain applications. One possibility is that the two methods might be used in combination to afford operative definitions of "advanced" versus "novice" RV functioning. One might predict, for instance, that verbal scores for novices would be relatively low, while their visual scores would be somewhat higher. An advanced viewer, on the other hand, might be one who consistently produces scores in both areas above certain predetermined thresholds. It is also possible that this approach might eventually provide a formal definition for RV "learning." As the two analytical systems are deployed and refined, other applications may be identified for systematic investigation in the future.

REFERENCES

1. Puthoff, H. E., and Targ, R., "A Perceptual Channel for Information Transfer Over Kilometer Distances: Historical Perspective and Recent Research," *Proceedings of the IEEE,* Vol. 64, No. 3 (March 1976).

2. Targ, R., Puthoff, H. E., and May, E. C., *1977 Proceedings of the International Conference of Cybernetics and Society,* pp. 519–529 (1977).

3. May, E. C., "A Remote Viewing Evaluation Protocol," Final Report (revised), SRI Project 4028, SRI International, Menlo Park, California (July 1983).

4. May, E. C., Humphrey, B. S., and Mathews, C., "A Figure of Merit Analysis for Free-Response Material," *Proceedings of the 28th Annual Convention of the Parapsychological Association,* pp. 343–354, Tufts University, Medford, Massachusetts (August 1985).

5. Humphrey, B. S., May, E. C., Trask, V. V., and Thomson, M. J., "Remote Viewing Evaluation Techniques," Final Report, SRI Project 1291, SRI International, Menlo Park, California (December 1986).

6. Zick, R., Carlstein, E., and Budescu, D. V., "Measures of Similarity Among Fuzzy Concepts: A Comparative Analysis," *International Journal of Approximate Reasoning,* Vol. 1, No. 2, pp. 221–242 (April 1987).

7. Hubbard, G. S., May, E. C., and Frivold, T. J., "Possible Photon Production During a Remote Viewing Task: A Replication Experiment," Final Report, SRI Project 1291, SRI International, Menlo Park, California (December 1987).

APPENDIX A

INSTRUCTIONS FOR ANALYSTS

ANALYSTS' GUIDE TO THE FY 1987 NATIONAL GEOGRAPHIC DESCRIPTOR SCHEME

A. Introduction

This document is intended to assist analysts in the assessment of novice level remote viewings (RVs) of *National Geographic* Magazine targets. As we are all aware, novice transcript data can be quite sparse or abstract or both: these characteristics have often resulted in considerable loss of information within the framework of the previous twenty-bit descriptor list. In FY 1987, we have attempted to reduce the granularity of the analysis system by incorporating the use of fuzzy set mathematics and by introducing the ability to interpret responses and targets in more abstract terms.

The degree of abstraction and atomization that transcripts and targets can usefully tolerate are open questions at present. One method of exploring these parameters involves the use of *levels* of descriptors, ranging from the relatively abstract (information poor) to the relatively complex (information rich). The proposed new evaluation system has the capability of using seven primary* and three secondary levels of descriptors, through which we hope to parse and to objectify the chain of logic that analysts employ for making decisions about concrete descriptors based on rather abstract commentary. The intent here, of course, is to make an attempt at bringing the analyst's unconscious decision-making process out of the murky realm of superstition and magic and into the hard, cold, scientific light of day! The use of levels is advantageous in that each descriptor level can be weighted separately and used or not, as the case may be, in a computerized data base. This will enable various combinations of levels to be deployed, in order to identify the optimal mix of concrete versus abstract descriptors. *Optimal* here might be defined as the highest figures of merit or perhaps by some other measure, such as a consensus rating of the experimental series in question.

It is anticipated that most of the potential problems will occur on the abstract descriptor end of the spectrum: *how abstract* can a descriptor be and still be useful? To illustrate the potential problems posed by increasingly abstract descriptors, consider the fact that all responses

* Consider the elegant symmetry here between the descent into hell, Dante-style, and the appropriateness of having seven primary levels of analysis.

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and targets contain some admixture of the two highly abstract elements *horizontal lines* and *vertical lines*; to perform fuzzy assessments along these dimensions, therefore, may not enhance the distinguishability of targets and responses. On the other hand, a concept such as *rectangular forms*, while still quite abstract, is only selectively present in transcripts and targets: it may prove useful, therefore, for capturing data outright that have heretofore been acknowledged only tacitly via the process of interpretation. It may be, therefore, that the ideal system would encapsulate a degree of greater abstraction, without adding levels of descriptors that are so abstract as to be universally represented in all responses and targets. In any case, this is what the new system proposes to explore systematically. In the next section an overview of the descriptor levels will be provided.

B. An Overview of Descriptor Level Theory

The entire list of descriptors represents the union of the set of elements in the *National Geographic* Magazine target pool of 200, and the set of elements obtained from the FY 1987 RVs for which this pool supplied the targets. This set of elements was obtained in a blind fashion--i.e., in the absence of knowledge as to which responses correctly matched which targets. In the case of the RV transcript-derived elements, an effort was made to preserve the vocabulary used by the viewers. Some of the descriptors, therefore, are either response-dependent or target-dependent or both, while others (particularly at the more abstract levels) appear to be more potentially universal across descriptor lists. The determination as to which descriptors belonged on which level was made after consideration of two primary factors: (1) the apparent ability of the viewers to be able to resolve certain features, coupled with (2) the amount of pure information thought to be contained in any given descriptor. In the first case, for example, it appears that viewers have greater difficulty on average in perceiving *waterfalls* as opposed to *rivers*. Some of these factor one determinations are based on the combined observational *subjective lore*, obtained by both analysts and monitors in the course of either analyzing or conducting numerous RV experiments; some have been determined empirically from *post hoc* analyses of viewers' abilities to perceive various descriptor elements in previous experiments.

The factor two determinations were made primarily by arranging the descriptors such that a descriptor at any given level represents the sum of constituent descriptors at lower levels. Obviously, the world is not a very crisp place, and so there appear to be violations of this rule throughout the proposed levels. Keep in mind, however, that certain of the more glaring violations are largely driven by the factor one determinations (i.e., the viewers' abilities to discern certain elements) enumerated above.

For the purposes of our experiments, the higher the level in number, the higher the weighting factor (W)--which is to say that more concrete information merits more credit. Fortunately, the analyst need not concern himself with the Ws, because these consist of predetermined multipliers built into the mathematical structure of the system. The Ws consist of a two-dimensional weighting system that reflects mission-dependency: in this case, the overall mission is to accord greater weight to more specific kinds of information. The secondary mission is to provide a mechanism for assessing the viewer's (or viewers') ability to resolve a given descriptor within a given level.

The numerical values that the analyst *will* have to concern himself with are the values given to the individual descriptors themselves (μ's). For targets, the μ's will be assessed on a descriptor-by-descriptor basis according to the presence or absence of each descriptor in terms of visual importance. For responses, the μ's will be assessed according to the analyst's best estimate as to whether each descriptor is present or absent at all. The concept of *visual importance* is not relevant for novice-level responses, because the data are often not detailed enough to form meaningful composite pictures.*

C. The Descriptor Levels and Their Use

With this basic theory in mind, it is appropriate at this juncture to provide an overview of what each level typifies and how the descriptors in these levels might be used by the analyst. All subsequent commentary, therefore, is in reference to the actual descriptor sheets themselves, which will be used for encoding the FY 1987 targets and responses. As a general comment on some of the mechanics of the sheets, descriptors in parenthesis, are simply alternate words that may be encountered in lieu of the main descriptor--e.g., *rise (slope)*; descriptors in brackets, will probably be encountered only rarely--e.g. [oasis].

Perhaps the simplest way to obtain an overview of the seven descriptor levels is to proceed from the bottom up--i.e., from the simplest or most abstract, to the most complex or concrete.

1. Abstract Descriptor Levels II: Levels 1 and 2

Levels 1 and 2 are provided to account for the abstract geometry present primarily in responses and secondarily in targets. Level 1 contains one-dimensional geometric elements and is aimed at the most primitive RV ideograms. For example, the following situation might occur:

* More complete information on the mechanics of making the μ assignments is provided in Section D.

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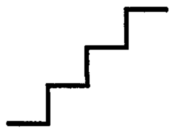
The viewer draws this:	Labels it this:	And	The target is this:
	"Stepped" and "City"		 "Mesa"

It would seem reasonable to assume here, that a *mesa* might be adequately described as a *stepped* feature and that the viewer's initial ideogram represented some amount of "true" signal. In the previous twenty–descriptor system, there was no mechanism for giving the viewer credit for the validity of his raw ideogram, despite the fact that he misinterpreted its meaning. In the new system, the viewer can receive Level 1 credit straightaway for the perception of *stepped*. The Level 1 weighting factor (which the analyst need not worry about) will probably be small, because the Level 1 elements are primitive, ubiquitous, and information poor. As a result, the viewer won't receive *very much* credit for a primitive perception like *stepped*, but this would appear to be reasonable: logic would dictate that a higher order perception such as *mesa* should in fact be worth more credit.

Level 2 consists of combined 2–D and 3–D geometries. The rationale for combining the two geometries resides in the observation that viewers' drawing skills are primitive: a *box*, for example, usually has no more representational information than a *rectangle*.

The principal problem for the analyst in using levels 1 and 2 will be in attempting to decompose concrete target elements into abstract geometries, such that some meaningful overlap between targets and responses can be achieved. Fortunately, fuzzy set theory holds promise for ameliorating some of this difficulty, in that it will enable the analyst to make small numerical assignments for "low confidence" descriptors. For example, if the target were a series of mountain peaks, an analyst might be willing to make small numerical assignments for the highly stylized descriptors of *inverted V–shape, repeat motif, triangle,* and perhaps, *cone* (if the scene looked particularly volcanic). In the optimal situation for target coding, there would be descriptor lists constructed for *each viewer,* such that the list used for any given viewer would be specifically tailored to the vocabulary and ideogramic idiosyncrasies *of that viewer alone*. In this way, targets could be abstractly decomposed in a given viewer's own terms. Unfortunately, we do not have the luxury of doing this at present, because one list must suffice for a group of viewers. The governing rules in making assignments at levels 1 and 2, therefore, would appear to be the following:

(1) Targets should be as liberally *but defendably* interpreted (albeit with probably small fuzzy values) across as many geometric descriptors as

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seem reasonable, in order to be inclusive of all the viewers' potential drawings and debriefs, while

(2) Response geometries should simply be chronicled in the descriptor list as they are literally observed. Level 2 descriptors such as *rectangle* are not to be parsed into the constituent parts of *horizontal lines* and *vertical lines*. To assign μ's for "constituent parts" bits, response elements have to be clearly and discretely identifiable as these things *in and of themselves*.

In most cases, there are probably both literal and stylized descriptors for any given target element that require higher and lower values, respectively. In the *mountains* example above, for instance, mountain ranges usually qualify most literally as *irregular forms*, whereas the more stylized interpretations involve *inverted V-shapes*, etc. *In any case, it should be noted that any assigned target* μ *will have to be defendable on a visual basis.*

It is anticipated that when a truly significant geometric form is encountered in a target, such as in the *Transamerica Pyramid*, it will be accorded a higher *triangle* fuzzy value than would be accorded for *mountains,* because the *Transamerica Pyramid* is more unequivocally a triangular/pyramidal form. In this way, if a viewer registers a *triangle* ideogram for the *Transamerica* target, he will receive substantially more credit than if he uses a *triangle* ideogram for a mountain target.

There is little doubt that the process of decomposing the concrete target elements into clusters of somewhat "imagined" viewer-derived abstract elements is going to be a noise-producing exercise. We're assuming here, however, that (1) not every concrete feature can be decomposed into every abstract feature (e.g., the analyst will not typically be able to justify decomposing *mountains* into a *cross-hatch (grid)* geometry, but in all likelihood, he'll feel comfortable in doing so for *city*), and (2) there is enough true viewer signal to effect significant overlap between targets and responses. Even at the abstract levels, one hopes the true signal line will rise above this very noisy background. The true advantage of this system, however, is that levels 1 or 2 or both can be turned off in the data base and the analyses rerun, if it appears that these initial hypotheses are incorrect.

2. Abstract Descriptor Levels I: Levels 3 and 4

Levels 3 and 4 are aimed primarily at viewers' archetypal and visceral/qualitative impressions, respectively. While levels 3 and 4 are more information-rich than the primitive ideogramic geometries, they are still not sufficient in and of themselves to produce a coherent, concrete picture. Generally speaking, if an RV session is proceeding in an "on-line" fashion, a geometric ideogram (levels 1 and 2) will be debriefed by descriptors from the level 3 and 4 menus.

Because levels 3 and 4, like levels 1 and 2, are generally response-derived rather than target-derived, the same rules for application pertain:

(1) Targets should be as liberally *but defendably* interpreted (albeit with probably small fuzzy values) across as many descriptors as seem reasonable, in order to include all the viewers' potential drawings and debriefs, while

(2) Response elements should simply be chronicled in the descriptor list as they are literally observed.

Again, the principle foreseeable problem will occur in trying to encode the target materials. The analyst will need to show some flexibility in understanding that a lush abundance of *vegetation*, for example, might be viscerally perceived by the viewer as the texture *fuzzy*, or the hard edge of a modern skyscraper might be experienced initially as *smooth* and *shiny/reflective*. Perhaps the guiding principle here is for the analyst to be imaginative, but not excessive, in determining which descriptors merit fuzzy values. *Any assigned target* μ *will have to be defendable on a visual basis.* Again, as in the case with levels 1 and 2, some descriptors are more stylized than others and should probably be assigned lower values accordingly.

It might be noticed that levels 3 and 4 contain some pairings of descriptors that are opposite in meaning--e.g., *rise* versus *flat, ordered* versus *disordered, complex* versus *simple,* etc. This will enable the analyst to make assignments along opposing dimensions when they are present in targets or responses. For example, a *mesa* in the middle of an otherwise flat *plain* would presumably merit high values for both the *rising* and *flat* dimensions. If you recall, we had considered at one point having a single descriptor, *elevation*, for which a "0" would have indicated total flat or horizontality, and a "1" would have indicated total rise or verticality. In the mesa target example just cited, *elevation* would probably merit a 0.5, to indicate 50% flat and 50% vertical rise; a 0.5 value along this single dimension would make this target indistinguishable from a target containing a single 45° slope mountain peak with no background except sky. This would appear to be conceptually incorrect because of the resultant loss of information across both dimensions in the case of the *mesa*. This kind of problem is the primary rationale for the inclusion of opposites. Clearly, it was not appropriate to supply an opposite for every descriptor, because most negatives are usually not asserted by viewers--e.g., if there is no perception of *flowing*, the viewer isn't apt to say *not flowing*.

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3. Concrete Descriptor Levels II: Levels 5, 6, and 7

At level 5 and above, the descriptors are primarily target-derived rather than response-derived. Levels 5, 6, and 7 contain the bulk of the kinds of descriptors that we were accustomed to using in the previous twenty-bit list. Using the concrete descriptor levels poses a different set of problems for the analyst, because of the shift in the interpretive burden from target encoding to response encoding. The primary guidelines, therefore, for making assignments at all concrete levels are as follows:

(1) Target elements should simply be chronicled in the descriptor list as they are literally observed, while

(2) Response elements should be liberally but judiciously interpreted, with the actual numerical assignments made by taking into account, to whatever extent possible, *the given viewer's response biases and idiosyncrasies.*

This second point is a difficult one and requires further clarification. In an optimal situation, we would have complete and systematic retrospective knowledge--a track record, as it were--for each viewer, in which we knew from *post hoc* analyses the probability for any given abstract response ideogram correctly matching any given concrete descriptor. Unfortunately this is quite a labor intensive investigation, and we haven't had the opportunity to perform it as yet. Clearly this is a critical area of research to move into, if we are ever to have any ultimate success at objectifying the analytical process.

What we *do* have at present are experienced analysts, who have looked at many years' worth of data that have been obtained from the viewing population in question. Although we haven't systematically codified our observations, we have some sense that when certain viewers say or draw certain abstract things, they are more apt to mean one thing as opposed to another. In general, the analyst should be fairly liberal and inclusive in his choices of which concrete descriptors are candidates for fuzzy values; where the awareness of response idiosyncrasies should come into play is in the assignment of fuzzy values for these choices. For example, if viewers 105 and 177 used the quality descriptor *fuzzy* in their responses, it would probably be reasonable in both cases to select *vegetation* as a possible interpretive descriptor for this impression. An experienced analyst, however, might be justified in determining that this interpretation is more valid for 177 than it is for 105, and would accord a higher numerical value for *vegetation* in the case of the former. Of course, if an experienced analyst has very high confidence that a certain combination of abstract elements simply *cannot* be interpreted as a certain candidate concrete descriptor for a given viewer, then that concrete descriptor should be eliminated from the candidate list altogether. Until the response biases of each viewer are somehow systematized and objectified, it is certainly in the analyst's best interest to have a sound grasp of the response styles of his viewing population insofar as it is possible.

4. **Concrete Descriptor Levels I: Levels 8, 9, and 10**

It is a matter for discussion as to whether levels 8, 9, and 10 are appropriate for inclusion with our core group of novice viewers at all, given that we infrequently see these levels of response detail. At present, therefore, they have been labeled as secondary rather than primary levels. Another matter for discussion is whether these sub-elements, as they are currently configured, belong at higher informational levels than 6 and 7. In some sense, in order to "build" the perception of a level 7 *port*, a viewer must have either consciously or unconsciously registered the impression that there are *boats* and perhaps *piers* (currently level 9) in the target. On the other hand, if a viewer says *mosque*, and is correct, this is much more useful from an information perspective than if he says *religious*. In any case, the current configuration of levels appears to require some form of readjustment.

D. **Overall Guidelines For Making the Numerical Assignments**

For targets, a numerical assignment μ is made for each descriptor in response to the following question:

How visually important is this descriptor to this target?

It should be noted that the descriptor set has been devised to define targets in terms of *visual importance*. If the analysis were to be re-framed along a different dimension of interest--e.g., conceptual, functional, allegorical, etc.--the descriptor set would have to be revised to address the new mission.

For responses, μ assignments for each descriptor are made in response to a different question:

To what degree am I convinced that this descriptor represents this response element?

Responses are coded according to this different criterion, because RV response composites are often not detailed enough to determine relative visual importance for any given element.

The μ's themselves will typically consist of one-digit fuzzy numbers between 0 and 1 (e.g., .1, .2, .3, etc.). In some cases, it may be appropriate to make two-digit assignments (e.g., .15, .25, .35, etc.); any finer assignments, however, would probably be meaningless.

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The sequence for using the descriptor hierarchy is different for targets and responses. For targets, it is easiest to start with coding the concrete elements at the top of the hierarchy and work down to the abstract interpretations. For responses, the following sequence appears to be the most efficacious:

(1) Go through the response and assign a "1" to every element explicitly stated by the viewer.

(2) Go through the response again and assign μ's for elements that appear to be depicted rather unequivocally in the response (like a rectangle, for instance), but which is not labeled *rectangular form* or *structure* as such. These kinds of cases don't merit "1s" per se (because they require some inference on the part of the analyst), but the μ's would be pretty high. Other situations that would probably fall into this category are instances when a viewer explicitly names something like *hill* but equivocates by adding qualifiers like *could be* or *might be*.

(3) Once you are comfortable with (1) your explicit "1" assignments throughout the levels and (2) the μ assignments you have made at the lower levels (primarily 1–4), you should now be ready to make your "interpretive leaps" to the concrete descriptors in level 5 and beyond. Confidence will probably be fairly low in synthesizing these higher order composites, and the μ's should reflect this accordingly. Of course, if the weight of all your evidence really leads you to believe that the viewer has constructed a certain kind of scene--i.e., if your confidence is high--then give it a high μ. The important idea here is that the judicious interpretive leap should be made whenever possible. The inclusion of the abstract levels does not relieve us of the responsibility of undertaking reasonable interpretation--rather, they are included at least in part to serve as heuristic devices for synthesizing higher order composites. There may be a few cases in which the response data are simply so sparse that they cannot lead to reasonable concrete interpretation so do not interpret, as long as it is defendable. These cases are anticipated to be exceptions.

After the coding process has been finished for any given target or response, it is a useful exercise to take a Gestalt-oriented look at the coding. The important question to ask is following: does the descriptor portrait you have painted of this response or target strike you as reasonable? If not, try to evaluate where the portrait goes awry, and adjust the μ's accordingly.

E. Specific Guidelines For Descriptor Use

In the course of pilot attempts to use the descriptor list, certain preliminary guidelines have emerged for the use of specific descriptors. These are summarized by level and by descriptor below.

1. Level 1: 1–D Geometry

a. Parallel Lines

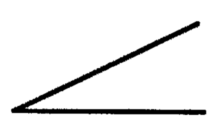
This descriptor should include *curved* as well as *straight* parallel lines. If an assignment is made for *parallel lines,* an attendant descriptive assignment for *arc, horizontal lines,* or *vertical lines* is also in order.

b. Vertical Lines, Horizontal Lines, and Diagonal Lines

For targets, these configurations of lines need to be interpreted as they appear in the *3–D projection of the photograph. Vertical lines* are to be interpreted as perpendicular to the plane of the earth; *horizontal lines* are lines that are parallel to the plane of the earth; *diagonal lines* are lines that are projecting diagonally out of the plane of the earth.

One might justifiably argue that in certain instances, this interpretation for targets (particularly with respect to *diagonal lines*) will result in the loss of some information. For example, if the target is a picture of an agricultural field that contains a vivid diagonal dividing line between two varieties of crops, we *will not* be allowed to make an assignment for *diagonal lines* because the line is in the plane of the earth. On first examination, this would appear to be a potentially catastrophic loss of information. We must remember, however, that we have the *visual correspondence* analysis that will enable us to recapture much of this kind of photographic perspective information. In some sense, this division of the interpretive burden may be ideal, because we will be able to account for the true linear geometric information contained in the target site itself, as well as account for the given target photograph's perspective view of that site.

For responses, the *intent* of the viewer is the central consideration for the analyst in making an interpretation. For example, the following situation might occur:

The viewer draws this:	And	Labels it this:
		"Flat"

In this case, the analyst would make *no* assignment for *diagonal lines,* because the viewer's intent was to draw the edge of a plane in perspective.

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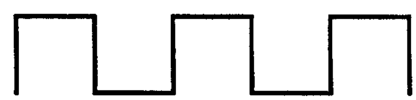
c. **Wave Form**

The *wave form* descriptor is intended to encompass both actual and stylized manifestations of *wave forms*. It will most usually receive a value for a viewer's primitive and stylized depiction of water:

It should also receive a numerical value for any target manifestation of waves or ripples--i.e., the boat wake in the Gatun Lake target (1024) is a case in point.

It is probably inappropriate to make *wave form* assignments based on a strict physics interpretation. For example, it would most likely not be a viewer's intent to have the following possible drawings interpreted as *wave forms*:

or



2. **Level 2: 2-D and 3-D Geometries**

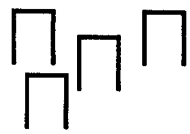
a. **Irregular Forms (Irregular Features)**

Because *irregular forms* can be visualized in almost every target, it is the current consensus that this descriptor should be used parsimoniously.

3. **Level 3: Archetypes**

a. **Building(s) (Structure(s))**

The *building* descriptor for targets should receive numerical assignments according to the *prominence* (i.e., visual presence or absence) of the buildings for the given target. In the Havana target (1005), for example, the buildings are quite prominent; in the Florence, Italy target (1056), on the other hand, one knows in the aggregate that the target is a *city*, but the buildings, themselves, are not individually prominent or resolvable. The *building* descriptor, therefore, while given a numerical value in both cases, would probably be higher in the former than in the latter. For responses, the following situation might occur:

The viewer draws this:	And	Labels it this:
		"City"

In this case, the analyst would be correct in making a numerical assignment for *building(s)* through inference.

For targets, an assignment for the *structure* descriptor should occur *only* when a justification can be made for the misinterpretation of a *natural* feature as *manmade* feature. In a target photograph of a *mesa,* for example, the *structure* descriptor would merit some value, because of the knowledge that *mesa* geometries are often misinterpreted by viewers as *building* profiles. Response codings are usually less ambiguous, because a viewer will typically respond overtly with *"structure,"* in which case the numerical value would be "1."

b. Boundaries

The *boundaries* descriptor is to be used in the sense of a distinct or discrete dividing line between different elements in a target or response. It may serve to demarcate one kind of land form from another, land from water, etc. It can also serve in the more traditional sense of a fence, a wall, etc.

4. Level 4: Qualities

a. Weathered

The *weathered* descriptor is one that should be used parsimoniously; most of nature (and the targets used) should be regarded typically as falling somewhere in the range between 0 and 0.1. The intent of this descriptor is to address the strikingly *weathered* quality of such targets as the *Grand Canyon* or any number of *ruins* sites.

b. Implied Texture

All of the *Implied Texture* descriptors are to be used according to *what the target element looks like,* as opposed to *what the analyst imagines the target element would feel like.*

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c. **Fuzzy**

Under the heading of *Other Visual,* the *fuzzy* descriptor (a synonym for *obscured*) is intended to denote atmospheric obscurity. Under the heading of *Implied Texture,* however, the *fuzzy* descriptor is intended to address textures only. Obviously this is a descriptor that must be carefully examined in context. If a viewer writes *"fuzzy"* and clearly associates it with a response object, then the analyst should be inclined to assign a value to the *Implied Texture fuzzy* descriptor; if, however, a viewer writes *"fuzzy"* and clearly associates it with a horizon line or the word "sky," then the analyst would be apt to assign a value for the *obscured* descriptor.

d. **Striated**

The *striated* descriptor is intended to suggest the presence of grooves, furrows, channels or narrow bands or lines.

e. **Hot and Humid**

Under the *Implied Temperature* heading, the two most potentially problematical descriptors are *hot* and *humid.* Both descriptors should only be used for targets if the visual indicators are overwhelming. An analyst might be justified in using *hot,* for example, if the target is a photograph of a desert scene with visible heat waves radiating off of the dunes. The *humid* descriptor might be used appropriately if the target were a photograph of a dense rain forest with water clearly dripping off of dense foliage. Clearly, the general rule is to be parsimonious in making assignments for these descriptors. (See the discussion for *weathered,* above.)

5. **Level 5**

a. **[Plain] (Delta)**

This descriptor is to be used only in the literal sense as stated; for *plains* or *deltas*. It is not the intent that it should be used in the more general sense of *flat land.*

b. **Coastline**

This descriptor is to be used only in the sense of a typical ocean coastline, not as the coastline of a lake, or other inland body of water.

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6. Level 7

a. Wilderness

The *wilderness* descriptor is perhaps most aptly thought of in the more general sense of *untouched by the hand of man.*

F. Potential Problems

One very persistent conceptual problem appears to be the one–to–many aspect of certain descriptors in the list, a situation which the list has no clear way of handling. For example, the descriptor *repeat motif* is one that could be applied to more than one element in a target or response. In a hypothetical target for instance, one would like to be able to say that there is a *repeat motif* of *structures* as a *city*, a *repeat motif* of *irregular forms, inverted/or V–shapes*, as *mountains*. Given the out–of–third–normal–form nature (to use data base parlance) of the current list, we are only able to make a single overall assessment for *repeat motif*; information seems to be lost (or distorted) in the breaking of the link, therefore, between *repeat motif* and its intended element. The same argument would probably be germane for the descriptors *manmade* and *natural.*

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APPENDIX B

TARGET POOL CLUSTER ANALYSIS

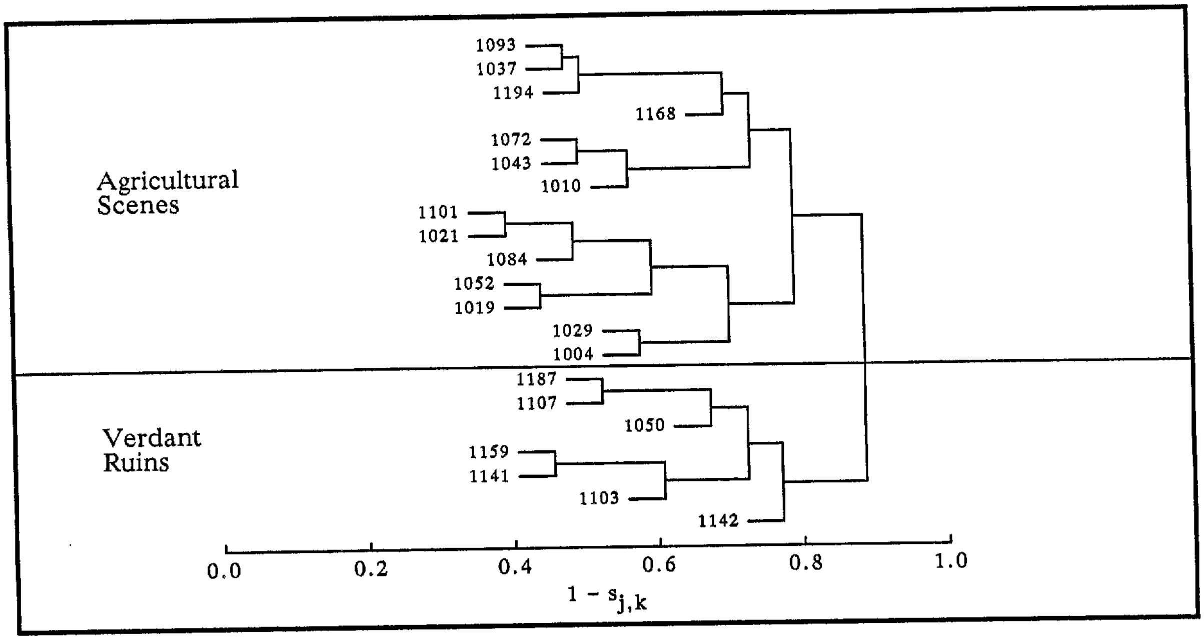

FIGURE 1-B CLUSTERS 18 AND 19

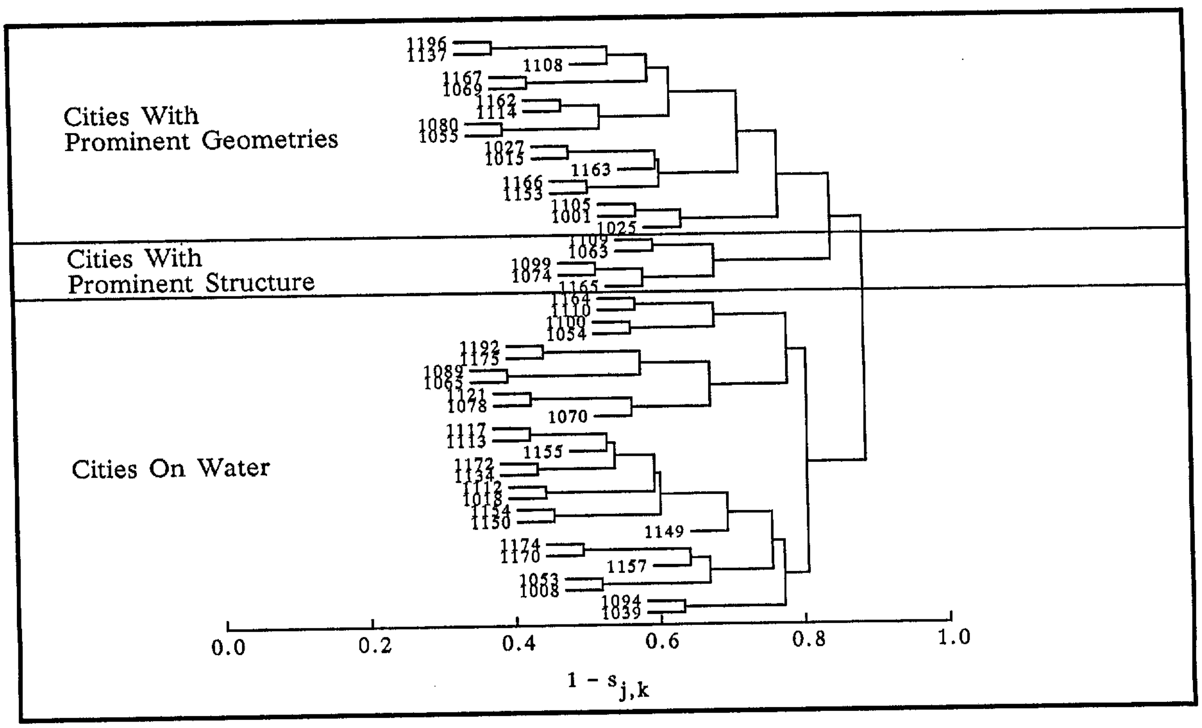

FIGURE 2-B CLUSTERS 4, 5, AND 11

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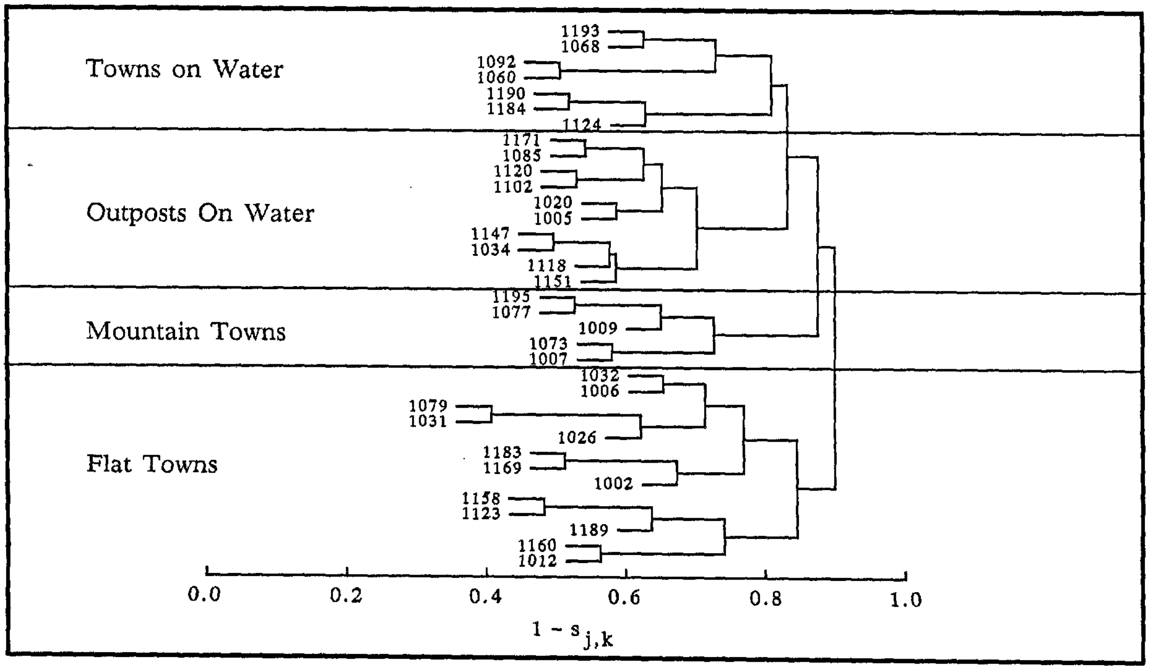

FIGURE 3-B CLUSTERS 1, 3, 9, AND 10

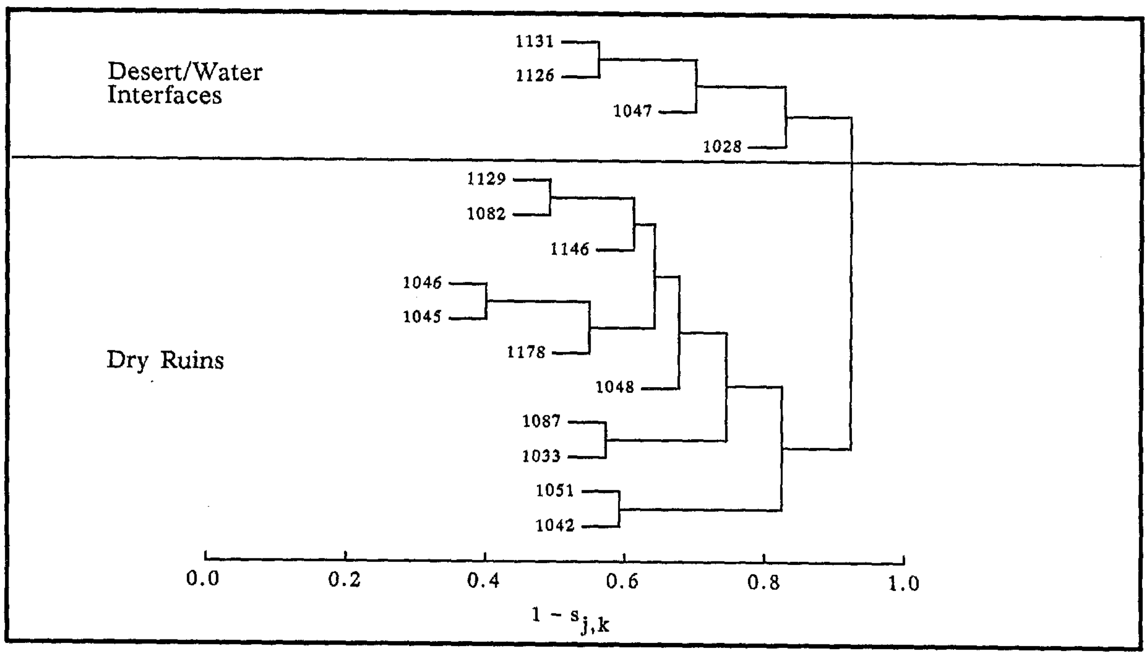

FIGURE 4-B CLUSTERS 6 AND 8

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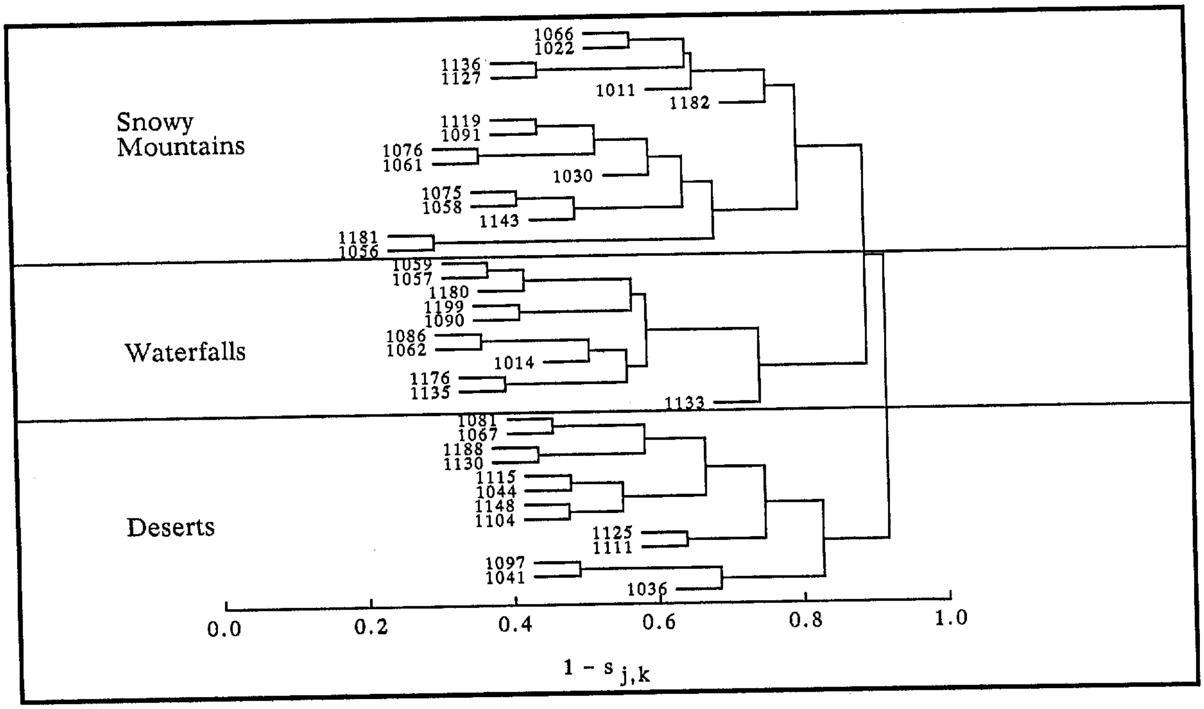

FIGURE 5-B CLUSTERS 2, 7, AND 12

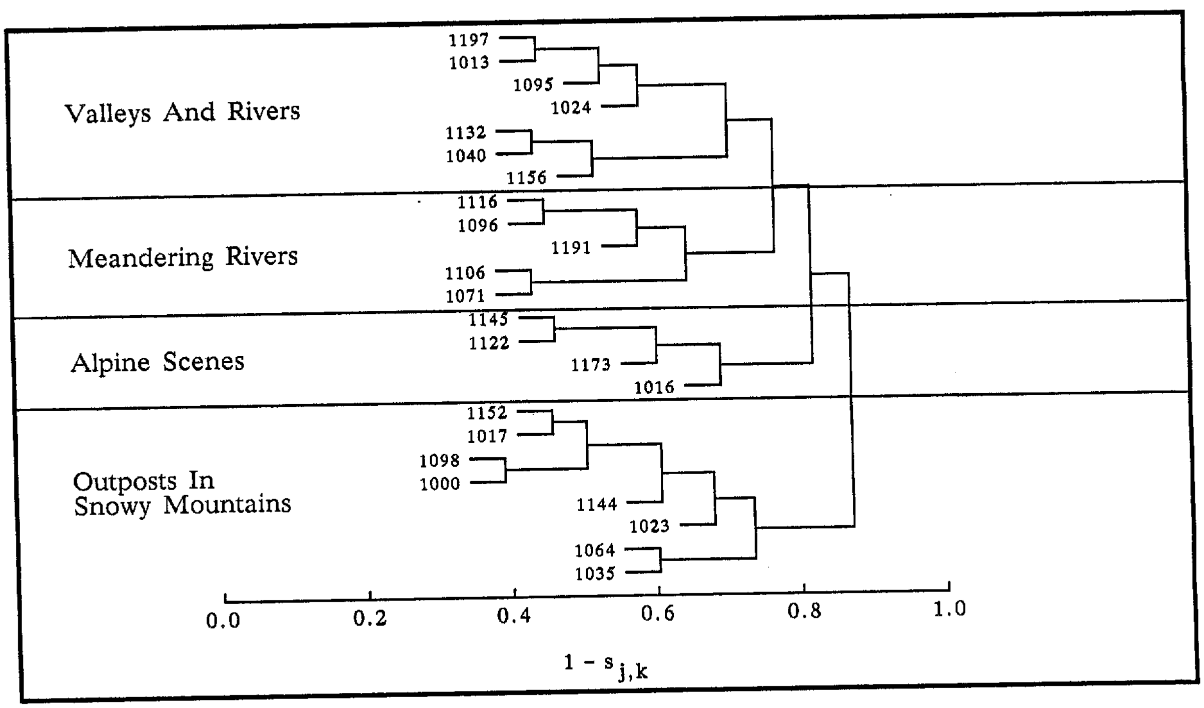

FIGURE 6-B CLUSTERS 13-16

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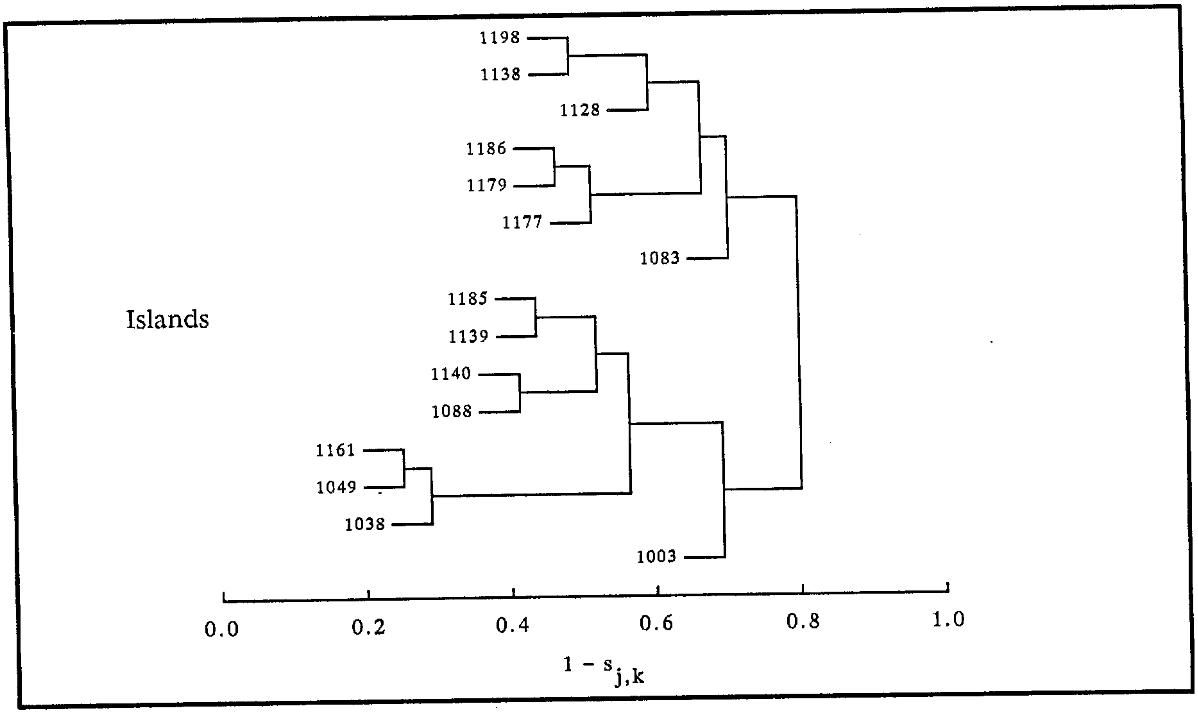

FIGURE 7-B CLUSTER 17

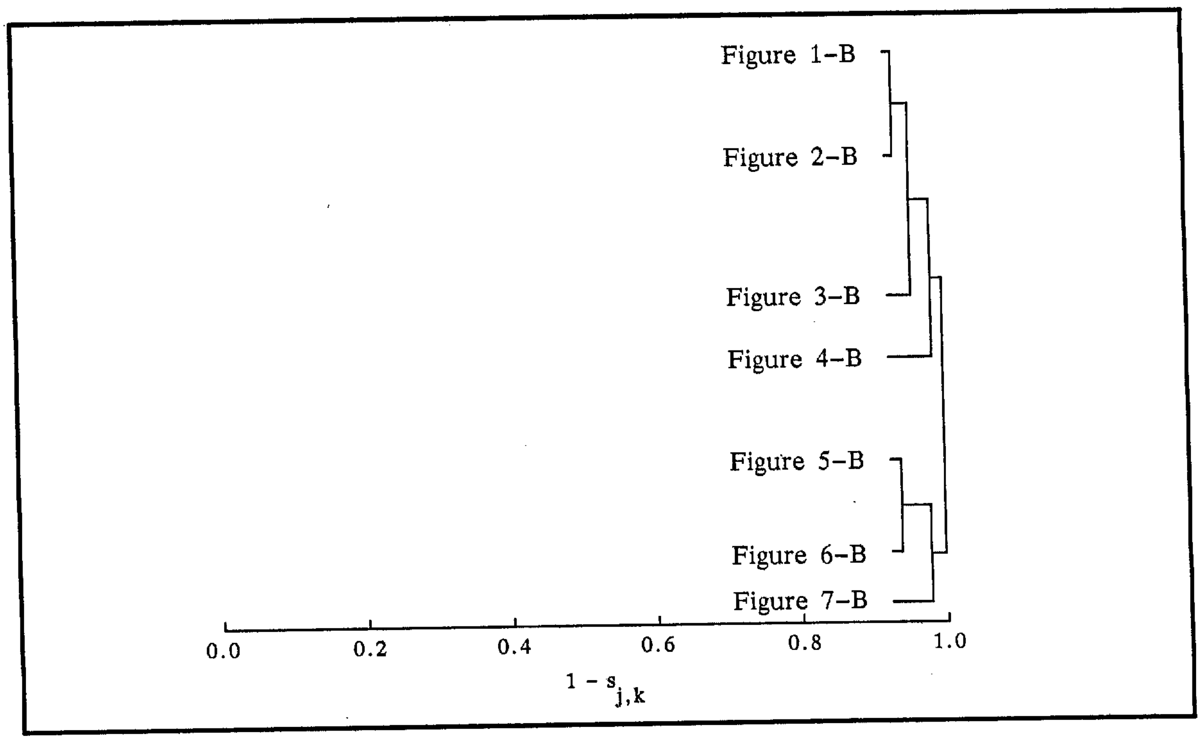

FIGURE 8-B CLUSTER OF CLUSTERS 1-19

"Verbal vs. visual"

— can be spatial, arrangement [illegible] (less on content'

— not spatial (con form) more on content'

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