Construct Relations Based On A Non-scalar View For Decision Support

It seems to me that few people come to a decision having assigned scalar values to each decision factor involved in the complex interaction which comprises a problem to be solved or choice to be made. While monetary systems provide a quick example of a scalar system of values common to everyday decision making, even that is a human abstraction which has rarely stabilized since its inceptual imposition on societal systems. Original paradigms of barter and trade did not involve modern tokens of quantitative value we know as "money". Indeed many examples can be found of the difficulty assigning a monetary value to a commodity. These examples range from our children, whom we claim "do not appreciate the value of" the item over which we harangue to the illogical fluctuations of international trade.

More conceivable is the notion that people sort and categorize with some complexity of prioritization and relative rather than scalar importance values. People *may not have* an ability to say how much more important one thing is over another, just that it is "more" important to them. Could it be that decisions are a product of a scaleless system of values? If so, then the issues of resolution become largely those of order and relationships of dependence. This, however, does not preclude objective analysis and the potential for technological decision support as will be seen shortly.

If, however, any persons do utilize scalar values in decision factor integration, such complexity may still be layered upon the simpler non-scalar world view. This should be true of decision support technology as well. Coarse treatment of decision factors on a relative basis may serve as a useful foundation or a "coarse focus" in decision support allowing scalar paradigms to "fine focus" or "fine tune" the contributions to localized search spaces in problem solving.

In either case, the exploration of the dependencies and relations between the concepts by which people construe their decision making world view would seem to hold great promise for any effort to develop decision support which emulates that unique world view. In the current milieu of self-actuation and self-empowerment, it would seem a timely exploration as well.

Categories of Relationships

It would be safe to assume that this classification perspective would involve three categories of relationships. Not only would we expect prioritized constructs but also distinct sets of constructs between which no relation of order exists and at the other extreme, sets of constructs which are functionally synonymous. These latter constructs offer the opportunity for a substitution model in the decision support process.

In supporting the decision process, it could be extremely helpful to know that a given construct has no relation whatsoever to another in a person's perspective or that one construct makes a perfectly good substitution for another. To illustrate the first, consider a person deciding which flavor ice cream to eat. For this individual, the type of cone the ice cream is served in may have no bearing on the choice whatsoever and to emulate his decision by factoring in the various choices of cones would be a wasted effort. However, if the choice of flavors is somehow also a choice of quantity (say there is only one scoop left of vanilla and only two scoops left of rocky-road while an unlimited supply of tootie-fruitie), the quantity available may be a good substitute for flavor in the either the decision process itself or its emulation.

Specific domain of interest

As a result of this non-scalar point of view, I am interested in exploring the constructs people use to approach their decisions, particularly in healthcare. The interest is not so much in deriving a geometric relationship among the constructs but to ascertain the dependencies and relations between them. This would involve the distinct partitions amongst the "whole" set of constructs employed in the domain and the ordinal relations between those which are found usefully kindred. While a "whole" set of constructs may be unrealistic to bound, the initiation of exploration of the universe of sets for both the individual and specific groups of people would presumably reveal ontologies useful for understanding the decision makers and providing fitting assistance in their decision process.

Background

This point of view is supported by the work of previous researchers in which constructs are elicited by structured interviews and represented in a scheme which lends itself to the discovery of the relation to other constructs of the same person or others.

George Kelly (1955) proposed that a decision maker utilizes a personal hierarchy of bipolar constructs to make judgments. The repertory grid technique for elicitation of these constructs has been widely utilized with a variety of adaptations. Specific adaptations for this proposal follow, but the reader is referred to the book by Fransella and Bannister, *A Manual For Repertory Grid Technique* (1977), for detailed information on the theory, design and operation of the technique.

Data from "the Semantic Differential" (Osgood, et al., 1957) and from Repertory Grids have been analyzed with relational methodology proposed by Bandler and Kohout (1980). Constructs of physiotherapists have been utilized to evaluate Parkinsonian patients (Bandler and Kohout, 1980b), as well as other diagnostic data and patient management processes (Bandler and Kohout, 1979, 1986) and constructs of urban residents have been used to evaluate "quality of life" looking for non-symmetrical dependencies and implications among constructs (Stiller, et al, 1989). This would lead one to anticipate the ability of using similar methodology for the evaluation of "state of health" or "quality of life" in medical domains.

Perspectives with Interest in Constructs of Patient Decision Making

It is important from at least three perspectives, to formalize the terms by which patients evaluate their health status. It is most obviously important to capture the perspective of the patient in order to watch out for their interest and perhaps to improve their ability to participate in healthcare decisions in their own terms. Secondly, a more precise understanding of the patient's view on health care and their peculiar objectives would give healthcare providers more success toward the objective to improve compliance, dispel misunderstanding that leads to litigation and to wisely prescribe resources (to dispense medication to a patient totally unwilling to consume them is purely a waste). As tradeoffs in medical care become increasingly critical, this aspect becomes more important. Additionally, from the third perspective, that of third party payers, the more clearly understood the patient's preferences are, the better they can dispense resources tailoring budgets to the demand and/or recognize the need to alter the understanding of their clientele. It is not unreasonable for these three perspectives to overlap and interact. They can too easily clash (often inappropriately) with the current methods of factoring the patient's preferences into the process. These highly personal choices are too often constructed from impersonal methods with inadequate individual

representation. Improvements in the formalization of patient preferences should facilitate clarification and understanding and improve collaboration amongst all parties involved in medical decision processes, thereby serving everyone's best interest.

What Sort Of Constructs Are Expected?

An example of the type of constructs anticipated is found in figure 1. These are *not* the product of elicitation; rather they are the product of my imagination based on some experience as a diagnostician. The list serves only to give the reader a clearer picture of the character of terms I expect to find.

- pain free
  - dull throb
  - sharp
  - intermittent
  - movement associated
- wholeness (amputation absence)
- 100% functional
  - run
  - walk
  - swim, sports
  - play musical instrument
  - types of instrument
    - woodwind
    - horn/brass
    - strings
    - percussion
  - normal elimination bowels
  - normal micturition
- diet restriction absence
  - no salt restriction
  - no sugar restriction
  - no caloric restriction
- range of motion
  - right arm or dominant arm
  - left arm or non-dominant
  - Right or dominant leg
  - Left or non-dominant leg
  - right foot/left foot
  - wrist(s)
  - ankle(s)
  - Neck
  - Back
- longevity of life span
- sensory loss
  - vision - one eye, both eyes, R, L, Dom, non-dom
    - touch - thumb, finger, fingers, hand, arm, R/L Dom... , toe, toes, foot, leg, of extremities, below waist, urinary tract continence, bowel continence, erotic zones
  - smell
  - taste
- freedom from physician
- frequency of checkups required
- ability to travel
- death
- insomnia
- loss of appetite
- restlessness
- lethargy
- respiration
  - shortness of breath
  - lung loss (partial resection or biopsy)
  - airflow restriction
- disfigurement
  - torso
  - leg
  - arm
  - foot
  - hand
  - face
  - hair loss
- Art or Hobby capable
  - gardening
  - flying
  - woodworking
- art or craft ability
- job retention
- organ loss (example second kidney or other paired organ)
- colostomy
- implant required (e.g. pacemaker)

Figure 1. Possible terms by which persons might judge "State of Health" and "Quality of Life"

The terms in figure 1 are not listed in a "bipolar construct" form consistent with Kelly's personal construct theory beyond the notion of "is" or "is not". The method of elicitation would ideally establish the constructs in bipolar form, i.e.,- the "emergent pole" and the opposing "contrast pole" as Kelly refers to them. The idea is to understand the patient's point of view by elicitation not presumed theoretical concepts. Two unseemly juxtaposed attributes may be construed as opposing ends of a spectrum in an individual's point of view. For instance, a person's perspective may be that an "athletic" sole is healthy, but that is not to say that they view the "unathletic" as unhealthy; they might rather regard an "inactive" person as the opposite of their athletic perception. Care must therefore be taken not to presume the opposite of any pole of a person's construct which emerges in elicitation, but further interview so as to accurately capture the contrast pole of the construct being elicited.

What Can Be Done With Constructs?

While the method for eliciting constructs has not yet been specified, let us first examine what can be done with constructs once they have been elicited. Such a diversion is justified in that the analytical process may cast constraints or requirements on the data acquisition process. Assume then that we have a set of constructs found to be associated with health. These can be represented by a single term or symbol associated with the pole of better health. Assume also that the appropriate opposing pole is known allowing appropriate statements to be made about what is "unhealthy." Let us refer to the person who's constructs we wish to capture, the subject of the structured interview, as the "respondent". If the respondent is asked to first fill in a list of roles (roles might be one or more of any of the following: friends, relatives, recent encounters, etc.) with people from their personal experience and then to rate each role filling person with regard to the established selection of constructs, we can represent the results in a matrix like that in figure 2. Let us further assume at this point that the constructs are all binary which is to say, in this case, that the person filling the role either exhibits the "healthy" pole of the construct or does not (which is to say they exhibit the opposite "unhealthy" pole). The constructs might be athletic, eats well, sleeps well, energetic, desirable body weight, asymptomatic, good lifestyle, safety minded, etc. The roles must be filled by persons adequately familiar to the respondent to enable the response. Selection of roles utilized could be an additional experimental variable.

Representing a Relation

resp A	p_1	p_2	p_3	p_4	p_5	p_6	p_7	p_8
c_1	+		+	+	+			
c_2		+				+		
c_3	+	+			+	+	+	+
c_4			+	+	+			
c_5	+	+	+		+	+		+
c_6		+	+			+		
c_7	+		+	+	+		+	
c_8		+		+	+		+	+

Figure 2. Results of a (fictitious) structured interview. The Respondent, *A*, has been asked to rate the person filling each of the 8 roles, p_j, as having the positive trait of each of 8 constructs, c_i, or not (no "+").

The chart in figure 2 is a "matrix representation" of the *relation* between these constructs and these people according to respondent A. Its interpretation is as follows: The respondent attributed construct one to persons one, three, four, and five. "The set of people to whom the respondent attributed the construct" is referred to as the *afterset* in relational theory terminology. Similarly, the aftersets of each of the other constructs are found as the positive elements in the rows to the right of each construct. "The constructs which the respondent attributed to a person" are found in the columns of the chart and referred to as the *foreset* of each person in relational theory terms. Specifically, if c_4 is normal body weight, the respondent said that the third, fourth and fifth persons were normal in body weight.

The natural language form of the relation description is:
"the respondent attributes construct _____ to person _____."

The symbolic representation of the relation between these two groups (constructs and persons) is:

$$c_i \mathbf{R} p_j$$

The afterset is represented symbolically:

$$c_i \mathbf{R}$$

The foreset is represented symbolically:

$$\mathbf{R} p_j$$

The Inverse of a Relation

The inverse of the relation may be represented in matrix form:

resp A	c_1	c_2	c_3	c_4	c_5	c_6	c_7	c_8
p_1	+		+		+		+	
p_2		+	+		+	+		+
p_3	+			+	+	+	+	
p_4	+			+			+	+
p_5	+		+	+	+		+	+
p_6		+	+		+	+		
p_7			+				+	+
p_8			+		+			+

... in symbolic form:

$$p_j\mathbf{R}^{-1}c_i$$

... or in natural language as:
"the respondent attributes to person _____ construct _____."

The Relationship Between Constructs

The difference between $\mathbf{R}^{-1}$ and $\mathbf{R}$ is nil, however they are by definition two different relations. The following use of the inverse concept leads to a more interesting relation, that between the constructs themselves. Such a relation is called a *self-inverse* relation. It is the conjugation of an afterset of a relation with the foreset of its inverse by means of a defined operator. Let us illustrate with the simplest of operators, the *circlet* product. The circlet product is defined as follows:

A relation is said to exist between elements if there is an intersection between the afterset of one relation and the foreset of another relation.

Applied to the self-inverse relation, a relation exists between elements where there is an intersection between the afterset of a relation and the foreset of its inverse.

Symbolically the self-inverse relation by the circlet product is represented:

$$c_i\mathbf{R} \circ \mathbf{R}^{-1}c_k$$

The pairs for which the self-inverse relation by the circlet product exists can be found in the following matrix representation:

resp A	c_1	c_2	c_3	c_4	c_5	c_6	c_7	c_8
c_1	+		+	+	+	+	+	+
c_2		+	+		+	+		+
c_3	+	+	+	+	+	+	+	+
c_4	+		+	+	+	+	+	+
c_5	+	+	+	+	+	+	+	+
c_6	+	+	+	+	+	+	+	+
c_7	+		+	+	+	+	+	+
c_8	+	+	+	+	+	+	+	+

The relation is so prolific that it is hard visually to find the exception to its existence and does not inform us much about the relationship between constructs. The absence of the relation does exist on infrequent occasion and to understand what that means we must consider the natural language representation for the relation.

The natural language representation of the self-inverse relation by the circlet product is: "This relation exists between constructs if there exists a person among those to whom the respondent attributed one construct who is also among those to whom the respondent attributed the other construct." The absence of this relation is equivalent to saying that pair of constructs are never attributed to the same person by this respondent, in other words the constructs are mutually exclusive.

More interesting is the self-inverse *subtriangle* product relation. The subtriangle product relation is defined to exist if the afterset of one relation is found within the foreset of a second. Applied to the self-inverse relation it is defined to exist if the afterset of the first element of the set is found within the afterset of the second element considered from the set. This is symbolically represented:

$$c_i \mathbf{R} \lhd \mathbf{R}^{-1} c_k$$

and in matrix form for the example relation, R, as follows:

resp A	c_1	c_2	c_3	c_4	c_5	c_6	c_7	c_8
c_1	+						+	
c_2		+	+		+	+		
c_3			+					
c_4	+			+			+	
c_5					+			
c_6						+		
c_7							+	
c_8								+

Specifically this relation can be stated in natural language as, "The persons to whom the respondent attributed construct _____ are among those to whom the respondent attributed construct _____."

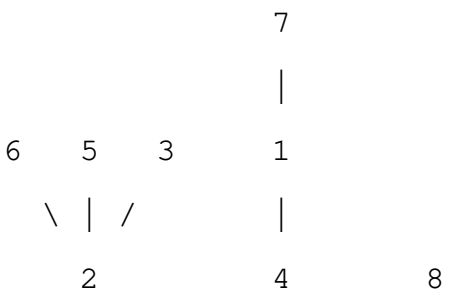
Properties of Relations

Some interesting properties become notable at this point. As most easily seen in the matrix representation, the relation is reflexive, meaning that if a construct is related to anything, it is related to itself. Also, while the self-inverse by circlet relation is symmetrical, the self-inverse by sub-triangle is not necessarily symmetrical. With the assumptions made to this point, the relation also is transitive (the proof has been provided by relational theorists).

An Alternative Graphic Representation

An additional representation useful at this juncture is known as a *Hasse* diagram which is a digraph where loops from each node to itself are assumed and not drawn and the transitive property is assumed and not drawn. By convention, these graphs are drawn without arrowheads and all arcs indicate an upward direction.

The *Hasse* Diagram for the chart above is as follows:



This says that if a lower node construct was used then any connected node above was used. The seven/one/four must not be consolidated because, although 4 implies 1 and 7, 1 implies 7 but not 4. 2 implies all of 3, 5, & 6 but any of the later in no way imply each other. Specifically in terms of the original relation data, if the respondent attributed construct 4 to any person, then the respondent attributed constructs 1 and 7 as well to that person.

Relationships Between Constructs Resumed

Yet of interest, is the self-inverse *square* product relation. The square product of two relations is defined to exist if the afterset of one relation is exactly the same as the foreset of a second relation. The self-inverse square product relation between elements is then defined to exist where the afterset of the relation is exactly the same as the foreset of the inverse of that relation. Although no example of this is present in the example relation, this would be the case where (in natural language form):

"The respondent attributes the *i-th* construct to the exact same set of people to whom the respondent attributed the *k-th* construct."

In the matrix form representation this is manifest by matching rows of "+" marks. The symbolic form of representation is (generically):

$$C_i\mathbf{R} * \mathbf{R}^{-1}C_k$$

These elements of the set (constructs in our case) are synonymous as far as this relation is concerned.

We can use the self-inverse *square* product relation at another level to arrive at some of the same aspects visible in the *Hasse* diagram, namely the distinct groups between which there are no dependencies but which have not been distinguished by the self-inverse circlet product

relation (recall that such a relation manifests mutually exclusive constructs). Consider the previous matrix of

$$c_i\mathbf{R} \lhd \mathbf{R}^{-1}c_k \text{ as a single relation, } c_i\mathbf{P}c_k$$

and then the symmetric closure of $\mathbf{P}$ which is the intersection of $c_i\mathbf{P}$ with $\mathbf{P}^{-1}c_k$ symbolically represented:

$$c_i\mathbf{P} \cap \mathbf{P}^{-1}c_k$$

or in matrix form:

resp A	c_1	c_2	c_3	c_4	c_5	c_6	c_7	c_8
c_1	+			+			+	
c_2		+	+		+	+		
c_3		+	+					
c_4	+			+			+	
c_5		+			+			
c_6		+				+		
c_7	+			+			+	
c_8								+

By rearranging the columns and rows, it is easier to see the effect has been to partition the set of constructs into groups:

resp A	c_1	c_4	c_7	c_2	c_3	c_5	c_6	c_8
c_1	+	+	+					
c_4	+	+	+					
c_7	+	+	+					
c_2				+	+	+	+	
c_3				+	+	+	+	
c_5				+	+	+	+	
c_6				+	+	+	+	
c_8								+

As stated at the outset, these distinct groups represent clusters of concepts among which exist some dependency. If a pair of constructs are not in the same group, they have not been shown

to be dependent. This is the same as being a member of different digraphs of the *Hasse* diagrams above. This is *not* the same as saying the pair of constructs is mutually exclusive, i.e.,- that the two constructs were never applied to the same person. It is only a statement that no dependency was expressed.

Crisp Versus Multi-valued Logic

We have now traversed from the "boundary" at which there is no relation between the constructs (via the self-inverse circlet product relation) to a group of relations among constructs (via the self-inverse subtriangle product relation) and on to the opposing "boundary" beyond which there is no further distinction between the constructs as used by our respondent. The exploration of the region between these boundaries has been superficial and deserves more attention. The concept that the natural constructs people use in decision making are all binary is unrealistic. The paradigm is far more robust if it accommodates a multi-valued logic.

Two Entry Points

There are two levels at which multi-valued logic might enter the picture. The first is when the respondent attributes the construct initially. This might more naturally or realistically be done by degree. As with traditional survey idioms, like "on a scale from *x* to *y* rate the ...", the recent popularity of survey methods employing Dartmouth COOP Functional Health Assessment/WONCA charts (e.g.,-Wasson, *et al*; 1994) supports this idea. These are queries that, in lieu of a numeric scale on which to score a response, provide the respondent with a series of graphics (e.g.,- a series of "smiley face" like circles with incremental expressions ranging from frowns to smiles) along with text by which to indicate responses.

Secondly, the discussion thus far has employed what is referred to as a *crisp* definition of the subtriangle product. The consideration so far has been that the afterset is either completely contained by the foreset or the relation is considered non-existent. If in fact there is some overlap between these two sets, that information could be useful and therefore it could be useful to capture this in some way. In natural language we are talking about a statement something like, "the persons to whom the respondent attributed the $i\text{-}th$ construct were among those to whom he attributed the $k\text{-}th$ construct to some degree." More than one potential definition exists for the assignment of degree.

Assignment By Degree

One definition for the assignment of degree to which the afterset of one construct is among the foreset of another construct might be the number in common divided by the total number of constructs. For our hypothetical relation, the self-inverse subtriangle product relation would look like this:

resp A	c1	c2	c3	c4	c5	c6	c7	c8
c1	4/8	0/8	2/8	3/8	3/8	1/8	4/8	2/8
c2	0/8	2/8	2/8	0/8	2/8	2/8	0/8	1/8
c3	2/8	2/8	6/8	1/8	5/8	2/8	3/8	4/8
c4	3/8	0/8	1/8	3/8	2/8	1/8	3/8	2/8
c5	3/8	2/8	5/8	2/8	6/8	3/8	3/8	3/8
c6	1/8	2/8	2/8	1/8	3/8	3/8	1/8	1/8
c7	4/8	0/8	3/8	2/8	3/8	1/8	5/8	3/8
c8	2/8	1/8	4/8	2/8	3/8	1/8	3/8	5/8

Alternatively, the definition for assignment of degree for the same relation might be the number in common divided by the total number of assignments made of the first (left hand side) construct; in which case the matrix form would look like:

resp A	c1	c2	c3	c4	c5	c6	c7	c8
c1	4/4	0/4	2/4	3/4	3/4	1/4	4/4	2/4
c2	0/2	2/2	2/2	0/2	2/2	2/2	0/2	1/2
c3	2/6	2/6	6/6	1/6	5/6	2/6	3/6	4/6
c4	3/3	0/3	1/3	3/3	2/3	1/3	3/3	2/3
c5	3/6	2/6	5/6	2/6	6/6	3/6	3/6	3/6
c6	1/3	2/3	2/3	1/3	3/3	3/3	1/3	1/3
c7	4/5	0/5	3/5	2/5	3/5	1/5	5/5	3/5
c8	2/5	1/5	4/5	2/5	3/5	1/5	3/5	5/5

With either definition the result is an array of numbers between zero and one. These can be returned to a crisp relation by the consideration of a threshold (referred to as an α-cut) above which the construct pairs will be considered "related" and below which the pair will be

considered "unrelated". The results may be transformed into the same *Hasse* diagram form for visualization. The matrix or *Hasse* diagram for progressively higher thresholds (values of α) will in some cases manifest interesting "evolutions" of dependencies between the constructs. I refer here to the patterns of change between constructs as the values of the cut-off level is raised (or lowered).

Although the use of a non-crisp definition for the subtriangle self-inverse product relation does not ultimately guarantee a partition on the set as does a crisp definition, Bandler and Kohout (1980b, 1986, and 1986b) have used what they refer to as a "transitivity index" to monitor to what degree the actual resulting matrix differs from the transitive closure of the result. They then use the transitive closure as a substitute approximation in order to successfully prescribe a partition of the constructs. The approach is to disregard outcomes if this transitivity index drops too low. The effect is to enable this observation of dependencies which change as the cut-off level for the relation's existence is loosened even in the advent of partial overlap in construct application by the respondent. This is the equivalent to a means to adjust the granularity of the partitioning of the set of constructs in accordance with the respondent's perspective.

Attribution By Degree

Returning to the first level at which multi-valued logic enter into the picture, that of original construct assignment by the respondent, there is a somewhat similar approach which may be taken. If the multi-valued assignment scheme for the respondents choice can be mapped into a binary form, the presented analysis can easily be applied. To accomplish just such a mapping we need to consider the respondent's assignment of a value for a single scalar construct. How does this person arrive at a value. If we maintain the original perspective that people are unlikely to think directly on a scalar basis, one alternative could be that the value is decided by consideration of a set of subconstructs which together compile to something by which the person can assign a scalar value; a checklist if you will of qualities upon which the person might judge the larger construct value.

Is This Still A Non-scalar Concept?

In aquatic diving competition, the judges do not say that the dive itself was a 7.3 or some other value between 1 and 10. They are actually considering a group of dive features or constructs such as the "take-off", distance from the end of the board (not measured but qualitatively), height of the dive's arc, orientation at water entry, the size of the splash (again not measured but qualitatively), etc. These elements of the dive flash by in an instant and equally fast the dive judges produce a Real number without a calculator.

If then the resolution of values attributed to choices in a decision are a tree of constructs composed of constructs, one might hypothesize that as some level of sub-construct is reached the cognitive evaluation is not significantly different than a checklist of binary constructs no matter how logically scalar the construct's concept is. Consider the medical diagnostician who is given a patient's temperature. The clinician may quote a real number in either Fahrenheit or Celsius, but isn't the nugget of information they are integrating actually the presence of a fever? After all, as a rule diseases are characterized as having a fever among their symptoms or not. On occasion the degree of fever is significant in categorizing the diagnostic differential but the

medical student is hounded away from hard boundaries for such a parameter. More diagnostic success is associated with a qualitative refinement for the degree of fever when it matters.

This may even be somewhat of an appropriate model for the topmost level of interest. In the pursuit of what a person considers healthy is, consider asking a respondent the question, "How healthy is person X ?" The response could well be, in effect, "Well, they have 5 of 17 things I consider part of being healthy (and 12 of the 17 I consider to be unhealthy)." This may not at all be saying that the person is 5/17ths healthy; not because of the varying weights of the constructs (although that may enter into the fray to some degree), but because this respondent has a categorical mindset and their reply is the result of a checklist type review. To consider this value scalar may be too artificial too represent reality. Is this a realistic concession? Consider when we meet 9 of our 10 goals. Are we 9/10ths successful? Or are we successful in 9 of our 10 goals?

If then, we have a scheme by which the non-crisp value for a construct can be assigned on the basis of a checklist of binary sub-constructs, we can then proceed with the manipulation presented above to represent the relations of exclusion, dependence with a controllable degree of granularity, and synonymy. The *Checklist Paradigm* proposed by Bandler and Kohout (1980b and 1986) stems from just such a perspective and attempts to provide a means of assigning a non-crisp value for the degree to which one construct composed of a checklist of binary sub-constructs implies another such construct.

Design Of The Structured Interview

What remains then is the determination of just what constructs to build a structured interview from. Intuitively it would seem most accurate to ask the decision makers themselves, that is, ask persons likely to be patients what their constructs are rather than ask the professional or academic community to suggest a list to impose upon the respondents. To elicit the constructs direct from the general population would seem most natural and least likely to generate any skew or omission. At the outset, any method which causes people to verbalize constructs could initiate a library of candidate constructs. A history of Personal Construct Theory has much to offer in refinements for the process. *A Manual for Repertory Grid Technique* (1977), is useful for the design of experiments. Journal references reveal repertory grid technique more recently applied to evaluation of native persons' attitude toward development of tourism (Mansfeld, 1994), psychoanalysts' interpretation of client behavior (McLennan, 1993), and student/teacher perspectives in teaching and learning (Solas, 1992).

Although the ultimate idea is to have an ontology of constructs which contains predictive power useful for decision support, it would initially be unnecessary to limit the constructs used in interviews. The evaluation of all initial collections could involve interviews which may be conducted over as many constructs as a respondent's attention span allows. Two types of initial interviews have arisen as good candidates to initiate collection. First, true to classic Personal Construct Theory, a respondent can be asked to fill a number of roles (the quantity to be adjusted with early experience), say between 3 and 20, with adequately familiar persons. The roles should be specified and the respondent asked to associate each person with a label (the role title will suffice in most cases) to avoid confusion in the ensuing communication. For instance, "Think of the following 3 persons... your mother, father, and a sibling or cousin." The interviewer must allow appropriate substitutions in the event a given role proves inadequate (e.g.,- mother died at childbirth). The interviewer then asks, "In terms of being healthy, how are two more alike than a third?" Record the reply as a single emergent pole of the construct and

ask how the third is unlike the others as a means to determine the contrast pole of the construct. After this much elicitation, enough conversation or structured interview should be employed to ascertain the validity of the construct as perceived by the interviewer. Former research in *repertory grid elicitation* has manifested the concepts of *laddering* (using "Why?" type questions to evoke superordinate constructs for each current pole) and *pyramid construction* (queries for generic examples of each pole type to evoke subordinate constructs) among others. Another tactic traditionally employed has been to ask the person to reveal where they place themselves within the construct after having divulged the concept. If additional terms arise in the process of eliciting a primary response, return to each and similarly pursue the revelation/clarification of emergent and contrast poles for each construct evoked exhausting the opportunity. Additional trios of roles might be employed to re-ignite the quest if the well runs dry. Each construct elicited should have with it recorded the roles which evoked it, as statistics in this regard may prove useful.

A second idea may prove useful, perhaps more as follow-up to the first method. The simple direct approach of asking the respondent what they think may work. Having oriented the respondent's thinking with the first approach, it may prove fruitful to simply ask the person, "In what terms do you judge health?" "What makes a person healthy?" To remain consistent in the bipolar construct perspective, individual terms evoked should be considered as emergent poles and matching contrast poles elicited.

With a collection of such elicited constructs, a broad list of constructs could be used to interview subsequent respondents allowing either binary responses or three valued responses: 1) yes, 2) no, 3) does not matter. This would reveal construct utilization which could be compared between people. The point of the investigation is to first collect a batch of constructs which are elicited rather than imposed. These constructs can then all be part of a second wave of investigation in which the frequency of use and the interrelationships between them can be analyzed with this paradigm.

As laddering or pyramid queries are employed and recorded, terms which the respondent uses to initially respond but give way to clearer root or offspring terms in fact suggest construct/sub-construct structure as well as design for further study in method or topic. These verbal responses indicate a hierarchical structure which may or may not be supported by the respondent's behavior. The objective record created by the structured interview (the one composed of the ultimately assembled construct set) could be compared with these self-proclaimed hierarchies.

The Objective Revisited

As collection ensues, the presented analysis should be performed looking for the relations pointed out in this presentation, namely, the mutually exclusive partitions, the synonyms and the ordinal non-symmetrical dependencies which lie between. As respondent data accumulates, I anticipate common patterns to be revealed and clustering of different "types of respondents" to be manifest. The main question I propose to investigate is whether the clustering and/or dependencies possess any useful patterns for decision support. In the process, I hope to establish common hierarchies or orders and the concept of a pseudo-sensitivity to common construct pedigrees. By this I mean to observe varying degrees of "ease" with which the partitioning of the related constructs "bud off" an independent construct group with the change in threshold or α-cut employed to study the individual responses. The dual question would be,

"How tightly related is one construct to its neighbors?" or "How much change in α-cut must occur before a specified construct is disjoined from others?" Additionally, I wish to find ways to partition the set of respondents or sub-groups of respondents with a higher order application of this same classification paradigm.

The paradigm presented has a sound manipulative process which appeals to common sense and gives repeatable results. While robust, it appears to be a potentially rich bed of meaningful information that at the same time lends itself to programming technology which could render that information readily accessible if found useful for customizing decision support.

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