Conceptualizing Metadata via Repertory Grids: Exploring a Method for the Development of Domain-specific Systems for Knowledge Organization.

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D'Ambrosio, Donna M. **Conceptualizing Metadata via Repertory Grids: Exploring a Method for the Development of Domain-specific Systems for Knowledge Organization.** *Knowledge Organization, 34(1)*, 41-57. 28 references.

ABSTRACT: This investigation was undertaken to explore the prospect of using the repertory grid structured interview technique as a tool for creating metadata. The following question is considered: Could Repertory Grid technique be used as a tool in the creation of metadata? It is postulated that repertory grid technique may be used as a tool for creating metadata labels, or tags, where the labels or tags describe entities, which may be images, documents or expressions. Repertory grid technique can provide a method for examining the detail about an individual's mental models, or personal construct systems of lifeworld entities, which may include images, documents or expressions. The question were considered by looking at the results of an earlier study, which explored the personal constructs of systems analysts using the repertory grid technique to examine the mental conceptualizations that determine the extent of difference in conceptualization. Categorical core areas of expressions used during software requirements development emerge through classification of the conceptualizations of expressions elicited via the repertory grid interviews. Repertory grid also reveals, through cluster analysis, the subtle difference in the way each participant conceptually related one expression to another expression. The differences in conceptual relationship of expressions or concepts could represent insight about how people view entities of a lifeworld. In a situation where metadata are used to label entities of a lifeworld for organization and retrieval of information, the differences in conceptual relationships might influence the metadata created and how they are used in the lifeworld for the organization and retrieval of information.

1.0 Introduction

In the current electronic environment of the Internet, World Wide Web and digital libraries, the prevailing issues are resource discovery, use of information, the preservation of information, and the discovery and use of information across disciplines (Dempsey and Heery 1998). With the intention of facilitating resource discovery and retrieval, the resources or digital objects, may be characterized and defined by metadata, which afford a description of the resource and a method of labeling the object for retrieval. Providing a concise definition, Dempsey and Heery (1998, 149) define metadata as, "data associated with objects which relieves their potential users of having to have full advance knowledge of their existence or characteristics."

Metadata is the term applied to the labels within a representative database record, which describe the components of the resource or digital object. Thus, metadata should provide enough information about the digital entity to allow users to access and manipulate the information needed, keeping in mind that the definition of a resource is changing and expanding, therefore the need for more precise methods for describing a resource (Dempsey and Heery 1998). Accurate and meaningful descriptions might be obtained through the characterization of relationships between the entities or objects of the lifeworld. "Broadly defined, a domain or lifeworld is a socially constructed reality where rules, symbols and ways to communicate are developed. Although new rules, symbols and ways to communicate may evolve through the interaction of the individuals in the domain or lifeworld, each individual's perceptions, understandings, experience and social background contribute to the individual's mental models of various situations of the domain or lifeworld" (D'Ambrosio 2006, 18). For this investigation, context is equated with domain and lifeworld. The importance of metadata is clear in today's digital environment, and management and creation of metadata are high priority topics on research agendas for organizations such as the OCLC Online Computer Library Center.

The pursuit of accurate descriptions of lifeworld entities such as images, documents and expressions for storage, discovery and retrieval, has been an important theme in knowledge organization. Osborne's (1941) early 20th century article, *The Crisis in Cataloging,* notes the difficulties in the cataloging and classification of entities based on the judgments of one or two people rather than on a code or rules for description and cataloging. Even with cataloging rules, the description of entities remains a difficult intellectual task. The search for meaning of an entity is conceptual in nature in that, not defining an entity implicitly renders "the aboutness" of the entity open to individual interpretation and epistemology. Hjørland (2001, 774) suggests a method to determine the "aboutness of informational objects" is "closely related to theories on meaning, interpretation – epistemology." Knowledge of each individual's conceptualization of a lifeworld and of the common nomenclature within the lifeworld is important when organizing that knowledge, especially in this era of the emerging technology of Web 2.0, and novel practices such as social tagging, or user-created labels for personal information. The prevalence of these practices suggests there is a need for more than the formal methods of cataloging and classification of entities for storage and retrieval. The emerging social classification systems are based on the human activity within a lifeworld, both personal and business.

Marshall's (1998, 172) use of the phrase "human-created metadata" describes the creation of metadata for a particular purpose and "is thus vital for articulating the scope, intent, and function of a particular collection." Using ethnographic technique to collect data, Marshall analyzes the collected data "as a means of taking an in-depth look into the practice of creating and using metadata." Just as the ethnographic data collection technique used by Marshall elicited important information about the practices of creating metadata in a specific lifeworld, repertory grid technique has the potential as a tool in the initial stages of metadata element creation for a specific lifeworld, when the meaning of the elements is under consideration. Repertory grid technique is based on the theory of personal constructs (Kelly 1963) and posits the idea that individuals develop patterns or templates about encounters in their lifeworld as a way to make sense of that lifeworld.

2. Consideration of Personal Construct Theory and Repertory Grid

The following question is considered by looking at the results of a study, which explored the personal constructs of systems analysts using the Repertory Grid technique (D'Ambrosio 2006).

Could the Repertory Grid technique be used as a tool in the creation of metadata? D'Ambrosio's study was undertaken to examine the mental conceptualizations of requirements nomenclature to determine the extent of the difference in that conceptualization. The study illustrated that categorical core areas of expressions used during software requirements development, emerge through classification of the conceptualizations of expressions elicited via the repertory grid interviews. Similarly, Liu, et al (2006) showed core areas of categorization for individuals who are organizing their personal groups of images using a web-based tool to create labels, or metadata tags to organize the image information. Although the findings of the different studies appear comparable, in that categorical core areas are produced, what repertory grid also reveals, through cluster analysis, which measures the ratings of perceived similarity between expressions, is the subtle difference in the way each participant conceptually related one expression to another expression. The differences in conceptual relationship of the expressions suggest a depth of insight to the way people view the entities of the lifeworld. In a situation where metadata are used to label entities of the lifeworld for organization and retrieval of information, the differences in conceptual relationships might effect the metadata created and how it is used in the lifeworld for the organization and retrieval of information.

The motivation for the current paper is to explore the merits of personal construct theory and repertory grid technique for gathering information about individual conceptualization of lifeworld entities, as feasible methodological perspective and tool for creating lifeworld- specific metadata.

3. Information Retrieval

It seems that just a few years ago the term *metadata* was the new kid on the block in the Internet jargon. Metadata creation was the realm of software developers and specialists in various fields as a means of information retrieval. These days we read about *social tagging* and *folksonomy*, the new buzzwords as they pertain to emerging conceptualizations of the World Wide Web. Web 2.0 in comparison to Web 1.0 maintains a new technological space for general users. O'Reilly (2005) explains that Web 2.0 is "a set of principles and practices" that allow a user to define the content of an Internet software tool to reflect personal needs, similar to the way in which metadata initiatives were started in different fields. When using an Internet software tool such as a search engine in the past, categories were already developed for users to select for retrieval. Recent developments in metadata creation and information retrieval needs allow users to label or tag information, as it is meaningful to their own needs. It is in this manner that the idea of social tagging or folksonomy is identified. Merlholz 2004. describes this phenomenon as "metadata for the masses," which is growing because many previous methods for classifying entities in a lifeworld, he contends, are not flexible and may create an unfamiliar view of the lifeworld for users. *Ethnoclassification*, a term used by Merholz, allows a user to develop a personally meaningful classification, including "terms that experts might have overlooked." Although we see rapid expansion of meaningful classes, and development of metadata for the use of personal, business, research and other discourse communities, how do new phenomena emerge and merge with former metadata creation methods?

3.1 Metadata Research and Development In The Past

In the past, the development of metadata has been a process spearheaded by standards organizations and discourse communities or lifeworlds. Campbell (2005, 50) contends that the evolution of metadata takes place in communities defined by their "own disciplinary background and objectives." Since metadata are created in a lifeworld, it would be assumed that they are representative of the ontological makeup of the lifeworld and, in addition, it might be supposed that the capacity for metadata creation is even realized by the individuals of the particular lifeworld. That is, would the individuals guess that they might have an innate ability to create ontologically meaningful surrogate descriptions of the nomenclature describing the entities and concepts of their lifeworld? It often seems that authorities or users in the discourse community may find categorizing the nomenclature used in that lifeworld a difficult task. Campbell (2005, 61) discusses different fields (discourse communities) as possessing "points of commonality" as the reason for the development of metadata,", which are described as a "specialized language" for the lifeworld, and for "representing information," within that lifeworld. The fact remains that many metadata initiatives still exist for different discourse communities and are currently in development, co-existing with the social tagging systems that are currently becoming familiar and widely used.

In the early days of computer technology for the library, Machine Readable Cataloging (MARC) representation of a bibliographic entity was developed as a specific type of database record containing information within labeled fields derived from the information extracted from the bibliographic entity, described by and interpreted by rules. The MARC database record, mimicking the classic catalog card, affords access to the bibliographic entity via title, author, subject and other labeled fields. The representation of the bibliographic entity was fashioned to include all the pertinent information derived from the bibliographic entity. Thus, specific labeled fields match specific types of information, such as, title, etc. Title and author may be one of the simpler fields to fill with bibliographic information, but there are additional labeled fields whose purpose may be esoteric to the variety of individuals extracting bibliographic information for placement into the record. How are fields labeled parallel *title* and *notes* to be interpreted for information placement?

Interpretation is the operative word in this endeavor to organize bibliographic information and is influenced by each individual's concept of the reality of the lifeworld. A concept, as an abstract idea in the mind of the individual, is associated with the individual's notion of the corresponding representation of that concept. Ferraioli (2005, 79) demonstrated this phenomenon in her work with creation of metadata by different individuals in the context of organizing paper documents based on "the individual's knowledge, perceptions, situational boundedness and membership within a knowledge lifeworld.". The individual factors described by Ferraioli need to be taken into account when metadata are created as a standard, as well as, in the assessment and use of social tags for personal information. The primary purpose of the MARC and Dublin Core standards is the retrieval of a bibliographic- or information-entity by providing "data about data," or labeling the information in a way that is intuitive for universal understanding, although, at times, understanding the metadata elements in a schema is not intuitive. The MARC tags and fields, for example, are very comprehensive and include all information found in a bibliographic record, which creates the need for cataloging rules and interpretations of those rules so that individuals using MARC know where to place information that is appropriate for a particular tag.

Conceptualization of the lifeworld objects may influence the understanding of knowledge and therefore how it is organized and, in turn, the creation of metadata. The act of conceptualization is important in knowledge organization as seen in the development of the MARC record as well as in the current creation of metadata for any lifeworld. The MARC record, as metadata, might be viewed as a forerunner to other metadata standards such as Dublin Core (DC), and other in-use and emerging standards. Essentially all of these standards contribute to resource access and retrieval by providing a means of pointing to various components of a work, like author, title, etc. and a controlled set of retrieval mechanisms.

Before metadata are created for a specific purpose within the lifeworld, the conceptual understanding nomenclature of the lifeworld ought to be addressed. Lifeworld nomenclature refers to a field; organization or culture as a lifeworld entity, which develops a vocabulary that evolves from the culture and the activities of the lifeworld entity.

3.1.1 What do Standard Metadata Represent?

Metadata are created for many areas of work and study to describe an entity such as a document, image or object, for the purpose of using that description for storage and, eventually, for the retrieval of the information described by the metadata. Caplan (2003, 3) contends that what is important about metadata created in a lifeworld is not what it describes but "what it is intended to accomplish." Within the last few years numerous metadata initiatives have been established in many subject fields to create metadata for specific uses. But until recently there had been no rules guiding design and development of metadata. Instead interested groups and government agencies proposed standards, which revealed the importance of a standard set of rules and guidelines for developing metadata within a specific lifeworld. The standards seem to represent whatever is necessary for information storage, retrieval and use of the specific information of the lifeworld. Table 1 shows a comparative overview of selected metadata or tags of two metadata initiatives, Dublin Core (DC) Metadata elements and the MARC tags, both allow visualization of the conceptualization of the lifeworld to some extent, although DC was intended to be more generic and useful in different lifeworld.

In an effort to develop mechanisms for resource discovery, the World Wide Web Consortium conceived the Dublin Core Metadata Initiative as a cross-disciplinary, international effort. The main focus of this initiative was to define the semantic nature of the resources rather than provide syntax with which to describe the electronic resource, as is the case of the MARC record. This standard was created as a tool that could be used by many lifeworlds; it is more of a generic schema and guidelines exist for development using this technology that are available from a variety of Web sites. It remains that metadata creators must contend with the many types of metadata used in different lifeworlds and ways in which the resources within these lifeworlds can be related and accessed.

Table 1 illustrates the tags used for MARC and DC defining the general terms such as document, author and text, for example. A clear one-to-one relationship between the elements of different metadata standards does not exist even when the entities are labeled in a similar manner. One reason, it seems, is the degree of granularity or specificity built into these standards during their creation for the use in a specific lifeworld , but more importantly, there are "semantic differences between the definitions of su-

Categories developed from metadata elements of each standard	**DUBLIN CORE ELEMENT**	Definition	**MARC TAG**	Definition	Criteria used for items placement into category	Comments
Document	<Title>	The label for the digital object.	245	Title from title page.	Title or header of entity	The title for digital objects is not always as obvious as the title from a title page
Author/creator	<Creator>	The individual, institution or corporation responsible for the intellectual content of the digital object.	100	Author qc	Name of creator	The creator of a digital object may not be the owner of the intellectual content.
Text	Description	Provides additional information about the digital object.	700 300	Notes Physical description	Entity with textual content only or textual content plus a graph, picture, table, equation	This description may consist of URLs and description of graphics

Table 1. *Comparison of Dublin Core and MARC record tags.*

perficially similar data elements" (Attig, Copeland and Pelikan 2004, 255). That is, although data elements of different initiatives appear "equivalent" in factors such as context value and intended function, the elements may have been created with different value and use intent. Attig et al. contend that even an element created in each initiative designed for subject could be used differently from one initiative to another. The Dublin Core element set was created with less structure and specificity than the MARC. These latter two element sets define a specific lifeworld with different purposes (D'Ambrosio 2001).

In addition, placement of data into element fields may be a subjective endeavor when trying to use a particular schema to represent an entity even with someone who is familiar with the lifeworld. The column in Table 1 labeled, *Criteria used for items placement into category*, is an attempt to describe the physical item and then some of the content of the item – or the actual work. The instructions for use of each element are somewhat ambiguous making the use of the metadata difficult. Using the Dublin Core for all websites and pages may not be as practical because the information presented about a particular website may not contain the same relevance or usefulness for every user. On the other hand, use of this element set in a specific lifeworld may be useful because the DC elements may be standardized and become meaningful to users in that lifeworld.

The MARC standards can almost be viewed as precursors to the metadata standards, which have appeared over the last decade and those emerging currently, as a result of the growth of networked environments like the Internet. Placement of values in element or tag fields could be an intellectual task as well. Metadata standards like the Dublin Core (DC) follow the traditional philosophy for providing "data about data" to aid storage and retrieval of knowledge, but attempt to meet the needs of different lifeworlds in a networked environment. It appears that each of these standards, traditional and new, employs the two approaches proposed by Burnett, et al (1999, 1210), who suggest that the bibliographic control approach to providing storage and retrieval through "bibliographic description, subject analysis, and classification" and the data management approach, which provides also storage and retrieval but adds "data security, data sharing and data integrity," are reflected in the development of metadata. But current developing Web technologies show that these approaches may not apply to all situations of data organization and retrieval using the Internet.

3.1.2 What does Personal Use Metadata (Social Tags) Represent?

An interesting study exploring the characteristics of the social tagging phenomenon (Lin, Beaudoin, Bui and Desai 2006) reviewed three characteristics of social tagging using three case studies. One case study compared social tagging with traditional indexing methods, another case study examined the way in which tags were categorized and another case study reviewed tag distribution in the dataset. The case study reviewing the categorization of individual tags using a set of categories reflecting user needs, developed by the researchers, is most pertinent to this current review. The data used for the categorization study were obtained from an Internet application that allows users to label images. For this study the investigators were interested in learning the reasons users develop tags and whether the tags could be categorized into predictable conceptual groups.. Individuals created personal metadata for digital personal information. The results are interesting, revealing that the participants placed some tags into more than one category and some tags could not be categorized using the predictable conceptual groups provided by the investigators. The results also suggested that users preferred the compound category for tags thus using expressions rather than terms, for labeling images. In the case of social tagging, the individual's conceptualization of the meaning of their information and how it will be used is anything but standard. More research into the social tagging phenomenon is needed to understand the conceptual nature of these "social" lifeworlds for the purpose of organizing personal information. Social tagging presents a new venue for knowledge organization.

3.1.3 Meaningful Metadata Creation in Two Different Contexts

In the metadata standards field, the data elements for particular schemas are developed by individuals working within the discourse community or lifeworld, in which those metadata are produced, to create a metadata element set, which reflects the information organization, and retrieval needs of that particular lifeworld. Theoretically, the individuals within the lifeworld should have a conceptualization of what is needed. But what is their mental conceptualization of the nomenclature that is defined by the metadata? Metadata elements seem to represent data that are collected and stored for retrieval by members of that lifeworld. For example, users of VRA core categories work with visual resources. With social tagging, the individuals in the Lin, et al (2006) case study, create the tags for their image data, through a conceptualization method of which they alone are aware. Part of that study included categorization of the tags. Interestingly, the researchers reported that participants had difficulty categorizing some of the personally developed tags and at least 5% of the tags could not be categorized by the participants because the participants could not discern meaning for some of the tags (p.12). It seems that many of the tags that could not be placed in a category appeared to be most meaningful to the creator of that tag. This is also an issue with controlled vocabularies, as well as metadata schemas, developed by experts in a field.

3.1.4 The Importance of Mental Conceptualization

Understanding the conceptualization of expressions, concepts and phrases common to a lifeworld may provide a view of the context, including the activity, of the lifeworld. For example, D'Ambrosio's (2006) study of systems analysis revealed that the meaning of the nomenclature used to label software requirements is often ambiguous and misunderstood among systems analysts. The purpose of that research was to understand the mental conceptualizations of systems analysts in their use of the nomenclature used during software development, in research and practice to describe requirements, activities and processes that may occur during requirements engineering and management. D'Ambrosio (2006) suggests that social construction of the lifeworld takes into account communicative and linguistic behaviors of the sender-receiver communication between individuals. This occurs within the ontological perspective of the knowledge lifeworld or lifeworld, as social construct of the reality in which the communicative discourse is occurring. An ontological view expresses the knowledge lifeworld or lifeworld in its true nature even as it changes with time. The particular nomenclature of the lifeworld as its representative language and form of communication has the capability of representing changes in the lifeworld. Winograd and Flores (1986) postulate that within the environments we construct design languages. Mental conceptualizations can affect conversations and the explicit and intrinsic meaning of the expressions used in the discourse as the sender and receiver interprets it. Mental conceptualization also becomes important in the creation of metadata due to the semantic variance of data elements and the "variability of values entered into the elements" (Attig, Copeland and Pelikan 2004, 256).

4. Brief Overview of Personal Construct Theory

Mental models, or mental conceptualizations, which are the individual's view of a lifeworld, give details about the course of understanding communicative activity, via mental processes, with which the mind interprets the sign to form a mental representation, as well as, structure through which subsequent signs and symbols of discourse are funneled. The receiver of the sign develops a mental model of his interpretation of the sign. The formed mental model or interpretant of that sign may elicit other mental models for that sign. Eco defines this phenomenon as "unlimited semiosis" (Eco 1979).

The theory of personal constructs maintains that individuals develop patterns or templates about encounters in a lifeworld so that they can make sense of other events occurring in the lifeworld. Kelly (1963) labeled the pattern a construct. From this theoretical framework the repertory grid structured interview technique was developed. The theory of personal constructs and the use of the repertory grid technique are well known. There are regional professional groups, training in personal construct theory and repertory grid method, electronic journals, newsletters, and conferences (with an upcoming 17th conference scheduled for 2007 in Brisbane, Australia). As well, numerous computer programs are available to aid in the gathering and analysis of repertory grid data.

Repertory grid technique has been used in classification research as a means of understanding the "way individuals categorize entities" (Kwasnik 1994, 45). In addition, repertory grids have been used to understand the users' mental models of search engines (Crudge and Johnson 2004) and also to understand how user characteristics might affect the use of retrieval systems (Zhang and Chignell 2001). Repertory grids have also been used to understand users' conceptualization of the effectiveness of systems analysts (Hunter 2000). Beside the disciplines of library and information science, repertory grids have been used in psychological, social, and educational research and for business applications. Most pertinent to this current exploration is the use of repertory grid in linguistic studies. Fransella, Bell and Bannister (2004, 204) state, "linguistic meaning can be theoretically defined as relationships between personal constructs, and it can be operationally defined in grid terms." A study reviewing early repertory grid use reported findings of average relationships between subjects' labels (constructs) for dictionary meaning of terms, and (Mair 1966, 205): "relationships for an individual between their constructs were not precisely those which a dictionary would have predicted." These findings suggest the idea that individual construal is an important factor when defining and understanding the lifeworld.

5. Use and Results of Repertory Grid Structured Interview Method for Understanding Requirements Nomenclature

D'Ambrosio's (2006) study methodology and findings are used as an example of Repertory Grid use in the investigation of mental conceptualizations. The primary objective of this particular study of requirements nomenclature was to obtain an understanding of the mental conceptualization or mental models of systems analysts perspective of the expressions used during requirements discourse using structured interviews. The reasoning for using this technique considered that data from the structured interviews would reveal the systems analyst's mental conceptualizations of nomenclature used during requirements development for a software product. New approaches for requirements elicitation, which is a component of requirements engineering and management, are necessary due to myriad ways in which the expressions, used by systems analysts, are conceptualized and understood by different individuals.

Eight participant systems analysts were selected from a variety of organizations. The repertory grids for the eight participants were analyzed individually adapting Jankowicz's 2004. methods of descriptive analysis, which includes process analysis; "eyeball" (observation) analysis; construct characterization; and examining relationships between elements and other elements, constructs and other constructs, using cluster or dendritic analysis. There are many ways to analyze repertory grids remembering the essence of the repertory grid is finding meaning of the expressions that make up the elements, as they are perceived by an individual (Jankowicz 2004, 72): "you need the words to express and communicate a construct – a dimension through which meaning can be expressed." Basically, analysis of the grid consists of identifying meanings and drawing implications from discourse during an interview with a participant.

The initial action using repertory grid is process analysis, a mental review of the interview process, that is, how the participant responded to the topics, elements, constructs and ratings and may begin with notes taken during the interview. Next is "Eyeball (observation) analysis" or a sight overview of the final grid to get an idea of the participant's thoughts in making sense of the topic. The types and number of constructs are also important to observe, noting any distinctions between the construct poles of similarities and differences. As well, the ratings present a great deal of information about construal noting the rating number of each element against a construct, whether ratings are missing, how many middle of the road ratings are seen, and observation of the element ratings on all of the constructs. From these observations, conclusions can be determined. After this, the analysis consists of determining the type of construct from what the construct seems to convey, such as prepositional constructs that describe something, like male or female, or evaluative constructs that convey an opinion or an assessment. A last measure is determining relationships within the grid between elements and constructs, between elements and elements and between constructs and other constructs. Simple relationships between elements and other elements and constructs and other constructs by using the ratings in a process of comparing the sums of differences for ratings on elements and constructs and calculating percent similarity scores. This time-consuming procedure is done manually to obtain a clear understanding of each individual grid. Finally, cluster analysis is performed for each grid to uncover relationships between constructs and elements within the grid.

Subsequent to the analysis of the individual grids, the eight grids are evaluated using content analysis of all constructs to discover themes or categories through development of categorical core areas and then allocating the individual constructs to the categories. Once again, the cluster analysis results are examined to uncover relationships between constructs within grids and then compared to the categories developed during core-categorization.

5.1 Observed Results of the Repertory Grid Interviews

During the interview, each participant was presented with ten triad-sets of elements, which uses a set of the expressions typically used in the requirements engineering and management communities. After the initial question, the participant will usually state a few phrases leading to a final phrase, which will become the construct. Quite often the participant speaks a few phrases, which are combined to create the constructs. The researcher's next question after this distinction was made is, in your opinion what makes those two elements similar to each other and different from the third element? The resulting answer becomes the construct, that is, the way in which the participant construes these expressions. Results from the interview are placed on a pre-designed structured form.

When examining the way the participants arranged the elements with regard to the different or similar poles, the "different element" was chosen as a method of looking at patterns for this initial review of the data. For example, it is observed that for the first triad given, more than half of the participants chose *quality requirement* as the expression (element) that was different from the other two expressions. Two participants chose *derived requirement* as the different element and one participant chose *functional requirement* as the different element. For the second triad, *quantifiable requirement* was chosen by more than half of the participants as different, *two participants chose process requirement* and one participant could not differentiate this triad. Other triads with more than half of the participants choosing the same element were triad 5 with *business requirement* being chosen, triad 6 with *process requirement* being chosen, triad 8 with *constraint* being chosen, triad 9 with *functional requirement* being chosen.

5.1.1 A Summary of Overall Repertory Grid Themes

From the analysis of the data collected the following observations were made. One participant shows an understanding of the element expressions using primary and secondary themes dealing with issues specific to the software application to be developed, such as the internal programming of code for the application itself. For example, when participants were given the triad that included the expressions, "functional requirement", "derived requirement" and "quality requirement" and chose the same expression as the different element, the comments revealed slightly dissimilar models of thinking about the expression as they examined the triad.

Additional themes presented by the participant's constructs were related to boundary conditions that could affect requirements, which, in turn, could affect the programming of the application. An emerging secondary theme was labeled task and workflow, whereby, expressions deal with user practices. Similarly, another participant construes certain expressions as conveying specifics about the application or initial product to be developed. The initial product idea and the final product were also important concepts, developing an important secondary theme of defining factors, which could alter the initial ideas for the product that might limit or constrain how the product is to be developed. These themes seem to reflect expressions that convey situations specifying how the initial product idea will be developed into an acceptable end product. A third theme emerged as well, which referred to the final product, to be a combination of the initial product, plus the affecting factors to create the end product. Thus the final product is an entity, which is comprised of the initial ideas that have been molded by the affecters. Themes dealing with the application and what happens to the application internally and externally through the life cycle were a prevalent notion.

In addition to repertory grid interview data, a work experience questionnaire was administered to all participants. Table 2 presents the information about education and current work experience as well as constructs they developed during the interview.

The data in Table 2 suggest that the participants' thematic construal or mental models of expressions is influenced by their job position and the work tasks they do on a daily basis, which appears to reflect their work lifeworld. As an example, Participant 1's position as a Director of Information Technology and the tasks of analyzing the hardware and software requirements of users who will need specific types of applications seems to influence the manner in which the expressions were understood. Participant 1 was concerned about work and task issues and the internal programming of the application. Similarly, the VP of software development who designs, develops and oversees development of software would be thinking about the functions of the software, any limitations that would affect the product, and how the product will be implemented. There was no definitive suggestion from the data that educational background and amount of time in the position affected the participant's mental models but the participant's work lifeworld appeared to be the greatest influence in construal.

5.1.2 Similarities and Differences Between Individual Findings

In most cases, given the same triad of element expressions, the participants separated the triads differently. The differences occurred either by element expression or by the participant's comments about an element expression that is perceived as different. For example, the first triad presented to the participants during the individual interviews was comprised of the expressions functional requirement, derived requirement and quality requirement. Five of the participants chose the expression quality requirement as the different expression, but each of the participants construed the expression from a different point of view, where explanations ranged from a vague or ambiguous expression to an expression that referred to measurement about how close the product matched the original goal for the product. A few of the participants could not determine similarities and differences among the triad elements.

Further examination of the data reveals that certain expressions elicited similar reasons for the difference of the element. For most of the triads, two to five participants chose the same expression as being different from the other two expressions, but as previously discussed, it seems that the construal or understanding of the expression is slightly to moderately different, although the expression "quality requirement" elicited very similar explanations from the participants who chose that as the different element. There were similar findings with the other element triads. What does this suggest about the participants' understanding of expressions used in requirements discourse? The data suggest there may be a wide range of communication differences during requirements discourse.

Data analysis leads to two important concerns. The first is that three of the participants chose alternative expressions as the "different" expressions in the triad, possibly signifying that each participant is thinking differently about the expressions, even at the beginning of the communicative interaction. The second concern is that there are five different explanations given for why the expression was thought to be different from the other two expressions in the triad. For one participant, the expression "quality requirement" means how close the end product fit the proposed goal for the product but for another participant, the same expression is a vague term and is loosely defined. From the viewpoint of individual analysts on the same software development team, looking introspectively, each analyst may be thinking differently about the design rationale, because their mental models of the expressions used in discourse as well as possibly what was said in the discourse, may be completely different. At first glance, it would seem that the participants seemed to construe the elements in a similar manner but interesting variations in construal of requirements expressions arose from the cluster analysis and construct characterization (generic content analysis).

	Degree Earned	Position Title	Time at Position	Description of Job Tasks	Job Tasks	Thematic construal Mental models (constructs)
1	MS Information Technology	IT Director	3-5 Years	Oversee IT department	Analyze Hardware/Software Requirements for off the shelf software applications	Application specific to internal programming Boundaries affecting the internal programming Task/workflow
2	MS Computer Science	VP Software Development	6-10 Years	Manage engineering teams	Design, develop/oversee design/development of software	Application specific, what it will do Factors defining or limiting the product Final product implementation
3	MS Engineering	Chief Technologist	6-10 Years	Chief architect for product development	Analyze Hardware/Software Requirements	Application purpose Limiting or defining factors
4	BS Computer Science	Programmer/Analyst	6-10 Years	Design, program	Design Hardware/Software Systems	Operating and background realm Developer or user need
5	BS Computer Science	Project manager	Greater than 15 Years	Design, develop software	Design Software Systems	Requirements perspective facets Temporal: early or later in cycle Point-of-view: developer or user Verbal communication Changeability or stability implied
6	MS Computer Science	Assistant Professor	No timeframe given	No description given	College courses in Computer Department	Related directly to end product Workflow Descriptive language
7	AS Information Technology	CIO	Greater than 15 Years	No description given	Analyze Hardware/ Software Requirements	End product purpose Procedures Descriptive language
8	Other (UK) Physical Sciences	Control Manager	Greater than 15 Years	Manage projects and the control staff	Manage Programmers and other staff.	End product purpose Temporality Point-of-view: business or technical

Table 2. *Emergent thematic construal versus participants' background (Adapted from D'Ambrosio 2006)*

5.1.3 Cluster Analysis from Repertory Grid Interview Data

Cluster analysis, in regard to repertory grid interview data, is a method for viewing relationships characterizing a grid. It is a statistical procedure where the grouping of elements and constructs based on participant ratings, which are part of the interview, are examined for relationships. The elements are the expressions, which were examined during the structured interview; the constructs are the participant's conceptualizations about the elements. Essentially, cluster analysis allows the study of the structure of the grid (Jankowicz 2004). The representation of

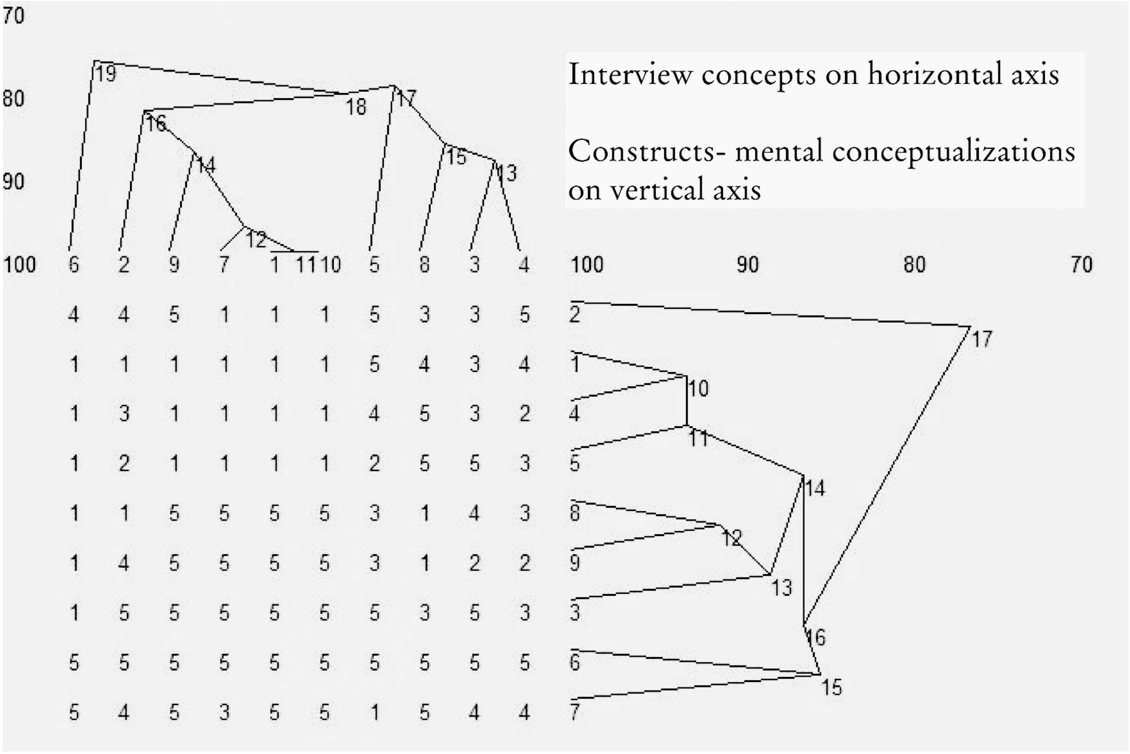

Figure 1. *Dendritic (Cluster) Analysis – Matrix of Ratings for Participant 1*

cluster analysis data from participant 1 shown in Figure 1 was selected as an example. The convergence of the lines on both vertical and horizontal axis shows the relationships within an individual's grid.

The Enquire Within (EW) repertory grid analysis application used for calculation of the cluster analysis data portrays the data as a matrix of ratings consisting of elements and constructs. EW groups closely correlated elements and constructs and then processes the data by re-sorting the two most closely correlated elements, determined by the ratings, and places them adjacent to one another on the graph. On a scale calibrated from one hundred to zero on the left-hand axis, EW delineates a virtual numbered location depending on the degree of correlation. From this virtual numbered location downward, two lines connect the closely correlated elements. A virtual element is given a number at the location on the percent scale, where they correlate. Figure 1 gives a visual depiction of how close the correlation is between elements to other elements and constructs to other constructs for this participant.

For this participant's data, elements three and four become the virtual element thirteen, showing a close correlation at about 87%. Elements one and ten are correlated at 100% and element seven is correlated with one and ten at 97%. These correlations present the participant's mental conceptualization about how the participant understands and construes the expressions. For example, this participant takes the expressions *functional requirement* and *process requirement* to have the same meaning and thus they are synonymous in the mind of this individual. In addition, the expression *business requirement* is very closely correlated with these two expressions. In the participant's own words they convey, "what needs to happen, how it needs to happen." The matrix is examined in the same way for the constructs, revealing related construct families that suggest the participant's interpretation of the topic in the context of the given elements representing the expressions used in requirements engineering and management. Each participant's cluster analysis matrix was different. Table 3 presents selected results of cluster analysis after the review of the dendrogram for all eight participants showing those elements (the expressions) are perceived as synonymous and which constructs were perceived as closely related.

Table 3 shows that six of the eight participants perceive the expression "functional requirement" as being synonymous with one or more expressions, but for each, some or all of the expressions were different from other participants' relationships. None of the synonymous expression groups were the same

	# 1	# 2	# 3	# 4	# 5	# 6	# 7	# 8
Elements	Functional, Process requirement	Functional, Business requirement	Functional, non-functional, process requirement	Quality, quantifiable requirement	Functional, non-functional Requirement	Functional, performance requirement	Functional, business, process, quality requirement	None synonymous
Constructs	Straight forward; Defines programming; Easy to define	Refers to product; internal; defining factor	Defining; constraints; defining, limiting	Operating realm; visible; tangible; user needs	Concrete; stakeholder involvement; shows entire picture of final product	Systems performance; intertwined; related; cause/affect	Goals to be met	Business point of view; defining requirement

Table 3. *Synonymous Elements and Closely Related Constructs*

Categorical core areas	**Explanation of category criteria**	**Participant constructs**	**Total constructs delegated to category % of total constructs**	**Expressions in category – type of requirement nomenclature**
End product	The software application as an end product … activities essential to create end product; closely related to the criteria for end product.	What happens around deliverable Defines programming.	18 16.36%	Functional Non-functional Process Derived
Criteria for end product	The end product, closely related to end product.	Essential Not optional Clearly defined.	16 14.5%	Quantifiable Functional Non-functional
Internal environment	Any other occurrences in the organization in relation to the work toward a deliverable or end product of the process or project.	Background realm General Ambiguous	13 11.8%	
External environment	Activities and influences outside of the organization and application.	External External to the application	2 1.8%	
Task and workflow	Processes that pertain to the entire software system both internal and external.	System, immediate, operation realm Flow, activities, action	4 3.6%	Functional Business Process
Auxiliary	Miscellaneous activities that take place around and during the development of a software product.	Non-system Less specific implementation decision True or not true	12 10.9%	Constraint Non-exhibited
Testing and measurement	Organizational approaches and processes related to quality assurance of the end product.	Level of fidelity Goals Goals to be met	8 7.3%	Functional Performance Business
Stakeholder	Involvement of the individuals directly and indirectly involved with the end product.	User driven Related to user need Stakeholder	8 7.3%	Functional Non-functional Derived
Points of view	Technical or stakeholder perspective of a particular situation.	Technical point of view (3x) Developer need.	10 9.0%	Performance quality
Constraints	Anything that will limit feasibility and development of end product.	Boundary conditions Value added	12 10.9%	Constraints Derived
Temporality	Time periods with the development lifecycle.	Considered early in project Later defined could change Not considered	3 2.7%	All expressions could be in this category

Table 4. *Generic Content Analysis of Total Constructs*

for any of the participants. Participant 1 construes the expression "functional requirement" and "process requirement" as conveying the same meaning according to his construct. Three of those six participants think "functional requirement" is synonymous with "process requirement," and two of these participants also perceive "functional requirement" to be synonymous with other expressions. An interesting finding has to do with the constructs shown in Table 3, in that the closely related constructs deal with the factors that define the application or end product. These factors are straightforward, internal to the application, related, and may show an entire picture of the product.

The important finding is that, although the same expression may be used in discourse, the connotation of that expression might be understood differently. The data suggest how commonly used expressions in this lifeworld are viewed and understood from the different mental models of each participant, therefore, different expressions may be used interchangeably by individuals in this lifeworld. If an individual perceives certain expressions are synonymous, other individuals might not understand that perception and might fail to understand the first individual's dialog when the expressions are used interchangeably. Additional information about synonymous use is shown through content analysis and cluster analysis.

5.1.4 Generic Content Analysis

After the repertory grids were examined using the descriptive analysis techniques and cluster analysis described by Jankowicz 2004., the data were then analyzed by means of generic content analysis of the constructs developed by the eight participants. Table 4 summarizes the data from the generic content analysis described by Jankowicz (2004, 148) as "bootstrapping." In this procedure, the content unit, or basic units of analysis are the constructs. The process basically consists of grouping like expressions after an overall comparison of the expressions. The categories are created during the comparison and placed into groupings of similar expressions.

During this analysis, related constructs were grouped to form categorical core areas of understanding. A definition is then developed for the construct grouping. The column labeled sum and percent shows the number of constructs from the total constructs developed and the percentage of constructs overall that were used in a particular categorical area. The last column shows some of the expression that were used to develop the constructs that made up the categorical area and it is evident that the same commonly used expressions can be developed into different categorical areas depending on how those expressions are construed within the triad. The participants developed a total of 104 constructs.

6. Repertory Grid and Cluster Analysis: What does it Represent?

The repertory grid data reveal core areas in systems analysis nomenclature through classification of the conceptualizations of expressions, developed via the repertory grid interviews, that are commonly used in requirements elicitation and development. The selected population of systems analysts created the core areas, which generally compare with those found in the standard literature (Vessey and Conger 1994). Similarly, Liu, et al (2006) showed core areas of categorization for individuals who are organizing their personal group of images through social tagging, using a web-based tool. In each case the categories appear as pertinent expressions to the lifeworld and the users in that lifeworld. This fits with the corollaries of personal construct theory developed by Kelley. The Range corollary defines the idea of range of convenience where constructs operate within a context or lifeworld; the Organization corollary defines the way in which individuals construct their reality but relating concepts; and the Individuality corollary maintains that individuals see things differently (Fransella, Bell and Bannister 2004). The interesting finding for both studies, although different methods for data gathering were used, is the unique nature of conceptualization, which influenced the placement of expressions or entities into categories. The development of core categorization could be used in the creation of metadata elements and schemas.

Although the findings of the different studies appear similar, the use of cluster analysis in repertory grid technique provides an advantage as a technique in that it allows the individual a deeper understanding of the lifeworld as they answer questions delivered by the researcher during the interview. Often, a participant would comment on their new or different viewpoint of a common concept. In addition, the cluster analysis feature of repertory grid provides a detailed breakdown of conceptualization of expressions from each individual by the examination of the relationships among the concepts and personal mental models on each individual's grid. D'Ambrosio

	PARTICIPANT 1	PARTICIPANT 2	PARTICIPANT 3	PARTICIPANT 4	PARTICIPANT 5	PARTICIPANT 6	PARTICIPANT 7	PARTICIPANT 8
Elements	Functional Process	Functional Business	Functional Non-functional Process	Quality Quantifiable	Functional Non-functional	Functional Performance	Functional Business Process Quality	None synonymous

Table 3a. *Component of Table 3: Synonymous Elements*

(2006) suggests that background and work environment, or the work lifeworld, affects individual perceptions and understanding of concepts and, according to the cluster analysis results, there are subtle differences in the way individuals look at and relate expressions of the lifeworld. Fransella, Bell and Bannister (2004, 144) wrote:

> The repertory grid technique not only reveals the mental model of each individual participating in the interview, but it helps each individual understand their own way of thinking about the expression they commonly use, as well as give some thought to the tasks and activities they perform on a consistent basis and that are defined by the expressions.

The individuality corollary might explain differences in standard metadata elements as well as user-generated social tags, and supports the argument that additional information through structured interview dialog is needed to make the practice more effective. It is the findings listed above that suggest the Repertory Grid technique could be used as a tool in the creation of metadata.

6.1 *Implications of the Repertory Grid Results for the Creation of Metadata*

For this paper, the author was interested in exploring the use of Repertory Grid technique as a tool to be used in the initial data gathering stages of metadata creation rather than the later processes of metadata creation or schema development. That includes the way in which an individual or standards group actually selects the particular element or tag to describe data for storage and retrieval. D'Ambrosio (2006) suggests that each individual's view is different and may change with context. Different mental conceptualizations about the use of metadata, may affect how metadata is created for a particular lifeworld and, therefore, the way in which metadata elements or social tags are "selected" by the creator of the metadata. As well, D'Ambrosio (2006) shows that there are subtle differences in construal of expressions, and that construal of expressions is affected by practice and context in the lifeworld.

What repertory grid technique can provide, as well as the opportunity for dialog during the interview procedure, is a process for refining the individual's conceptualization through additional techniques such as laddering up, laddering down, and pyramiding. These techniques afford a way to obtain more detail about an individual's derived constructs by asking additional, more specific questions in relation to the participant's response and their rating of the construct developed by questions related to the lifeworld expression. Also, grids may be developed and standardized for a particular lifeworld and used as a tool on an organization's intranet or on a website. Jankowicz (2004, 104) maintains that gathering data about an individual's understanding using repertory grid technique "is an attempt to make tacit knowledge explicit, to get inside their head." In D'Ambrosio's study, the cluster analysis uncovered the elements (concepts defining lifeworld expressions) that were deemed synonymous by the participants. Table 3a and 4a are components of Tables 3 and 4, showing selected results of the cluster analysis and the content analysis, respectively. Table 3 shows how each participant views certain expressions as though they were the same.

What are the implications of the results shown in Table 3a? In the lifeworld of the systems analyst, the terms functional requirement, process requirement, business requirement, etc., are often used to describe a software product in development. When participant 1 defines a particular item in a requirements document as a "functional requirement," the participant also perceives this item as a "process requirement". For participant 2, "functional requirement" also means "business requirement," and so on. If we use the term "functional requirement" as an example of a metadata tag, will the content it labels be a process requirement or a business requirement in the mind of different individuals?

Categorical core areas developed from analysis of constructs	Expressions in category – type of requirement nomenclature
End product	{Functional} Non-functional {Process} Derived
Criteria for end product	Quantifiable Functional Non-functional
Internal environment	
External environment	
Task and workflow	{Functional} Business {Process}
Auxiliary	Constraint Non-exhibited
Testing and measurement	Functional Performance Business
Stakeholder	Functional Non-functional Derived
Points of view	Performance quality
Constraints	Constraints Derived
Temporality	All expressions could be in this category

Table 4a. *Component of Table 4: Synonymous Elements*

Table 4a illustrates the element expressions that are considered synonymous in the mind of the individual, but the synonymous expressions have also been placed into categorical core area, developed be analysis of the constructs by the investigator. The categorical core areas developed from repertory grid technique might be useful as metadata elements or tags and individual construal of these expressions could be refined through dialog and additional questioning as well as the techniques of laddering up or laddering down.

7. Conclusions

D'Ambrosio's (2006) research using repertory grid technique suggests that past socialization and experience as well as the lifeworld of practice are influential in determining the conceptualization of expressions, concepts and phrases characterizing a lifeworld. Repertory Grid cluster analysis shows subtle differences in individual understanding of expressions and the meaning attached to those expressions. Differences in mental conceptualization are influential in the storage, organization and retrieval of information by affecting the description of lifeworld entities. Repertory grid technique has potential as a tool in the initial stages of metadata element creation for a specific lifeworld, when the meaning of the elements is under consideration in the development of metadata standards and even in the social tagging of personal information. The potential for lively discussion between the researcher and participants during the repertory grid interview provides the opportunity for development of the participant's mental conceptualizations of their lifeworld giving clarity to individual conceptualization, or constructs. A clearer representation, in the individual's mind, of the information needs and uses for storage, organization and retrieval of lifeworld information may contribute to the creation of metadata elements, and eventually metadata schemas that are a better description of the lifeworld's needs and uses of information. Repertory Grid also provides a method for detecting relationships between the lifeworld expressions with other expressions, personal constructs to other personal constructs and lifeworld expressions to personal constructs. This component of Repertory Grid affords an stimulating exercise in understanding the meaning of personal constructs in different contexts.

Repertory Grid is a complex technique that has been in use since Kelly (1963) posited the Theory of Personal Constructs. Future work is in the early planning stages at this point but it will include the development of a generic interview template and process to be administered to various populations involved in metadata creation. The initial work will begin with a review of research in the use of Repertory Grid and information studies as well as the reporting on metadata creation subsequent to the development of the instruments.

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