Trying on Taxonomies:
Research Developing Taxonomies for Analyzing and Developing Icon-Based Visual Language Systems

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Abstract: Eighty years ago Otto Neurath led the development of the visual language system Isotype. Neurath's ambition to communicate across multiple cultural, language, and literacy barriers is a need felt as strongly as ever in today's rapidly globalizing society. However, rather than achieving greater clarity than our predecessors, now designers are faced with a dizzying array of contradictory terms and categories for describing visual language components: pictograms, icons, symbols, signs, indexes, glyphs, etc. We have no agreed-upon definitions for even the most basic vocabulary, no conceptual model for how these various terms might be organized into logical categories, in effect, no means to categorize and analyze icon or symbol-based visual language systems. A first step in developing advanced visual language systems is the development of a taxonomy of visual image terminology such as symbols, icons, pictograms leading to the development of standard definitions and shared understandings on some parameters for visual language development.

This paper describes research analyzing the visual language of Isotype using various taxonomic schemes and the application of those taxonomic schemes to current symbol systems. The aim of this research is to develop a shared understanding and controlled vocabulary for a collaborative, multi-center symbol development project, *Hablamos Juntos*. For this project five Universities are cooperating to develop and test the effectiveness a symbol system for use in healthcare systems where communication across multiple languages and cultures is essential. Taxonomic parameters explored include: image functions from picture to symbol and sign; classifying the interaction of these three terms; degrees of representation from exact/representational to minimal/abstract; levels of meaning intended for an image from representing a specific thing to an inclusive category of things.

Key words: Isotype, Symbol Taxonomy, Visual Language Systems

1. Introduction

Since the beginning of recorded history human populations have used images to communicate. Perhaps the most widely known examples of this are the ancient Egyptian hieroglyphs, created over four thousand years ago. This comprehensive visual language system contained detailed and colorful images using a combination of pictorial and abstract phonographic representations to communicate political, social, economic, and religious information. Similar image-based languages have been found in many other ancient civilizations throughout the world such as the Aztecs and Mayans in present-day Mexico and Central America. Although the motivation and context has changed drastically, the desire to communicate through visual language has continued through the past centuries on through today. Eighty years ago, Otto Neurath developed a system of symbols with the intent to convey social, economic, and political information across literacy, cultural, and language barriers [4]. This motivation behind Isotype, or International System Of TYpographic Picture Education, has remained consistent today due to the world's rapid globalization.

Unfortunately, history has contributed very little when it comes to simplifying the symbol creation process. Rather than achieving greater clarity than our predecessors, designers creating new visual language systems are instead faced with a dizzying array of contradictory terms and categories for describing visual language components. After introducing a brief history of Isotype and a discussion of the contradictory vocabularies used by various visual communication authors, this paper will use Isotype as a model for investigating several different image categorization and organization structures. The future aim of this research will be to develop a controlled vocabulary for future icon-based visual language development.

2. Background of Isotype

Isotype, developed in 1925 by Austrian philosopher Otto Neurath is a visual language system consisting of over 4000 symbols [4]. These symbols were intended primarily to teach Basic English and for the visualization of data in the fields of politics, industry, economy, and demographics [4]. Neurath believed that it was critical for the population, largely illiterate at the time, to have access to straightforward, clear information concerning the world around them if they were ever to improve their economic situation. He also believed these symbols would encourage users to form relationships with the information and become active, questioning learners [9].

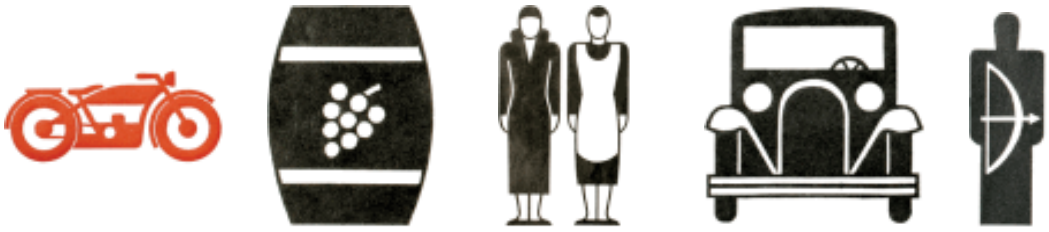

Figure 1. Isotype Symbols

In addition to improving the understanding of the local population, Neurath wished to use Isotype to promote global cooperation. In his instructional text, *International Picture Language*, he states this intention: "There are a number of signs pointing to a great development of international organization in the near future – though we are living in a time of warring interests and broken connections. Any work done on the question of international

languages – with a view to making a word language, or a helping picture language – will give support to international developments generally. An international language has to take into account international needs, and at the same time it has to be as simple as possible" [9]. He reinforces his confidence in the power of imagery to build cross-cultural relations in his Isotype basic instruction manual in the emphatic all-uppercase statement: "WORDS MAKE DIVISION, PICTURES MAKE CONNECTION" [9].

Neurath felt a symbol system employing images only containing the absolute essential information was critical for the retention and understanding of his instructional material: "It is better to remember simplified images, than to forget exact figures" [4]. Although these symbols were simplified, Neurath wanted there to be a meticulous hierarchy of information in each symbol: "At first look you see the most important points; at the second, the less important points; at the third, the details; at the fourth, nothing more – if you see more, the teaching-picture is bad" [9]. This desire for clear, unadorned communication along with his political ideals made illustrator Gerd Arntz well suited for executing the 4000 symbols within the Isotype system. Arntz's "clear-cut" style of abstraction within his personal artistic work and commitment to social ideals similar to Neurath made him very well suited to the Isotype objectives [4].

It is simple to infer that the physical production process of the Isotype system had almost as great an influence on the minimalistic nature of the symbols as Neurath's motive for straightforward, concise communication. Gerd Arntz executed Neurath's idealistic vision through the meticulous creation of individual linocuts for each symbol [4]. The linocut process is a printmaking technique involving the use of a knife to carve a relief image out of a piece of linoleum. Ink is applied to the cut linoleum and then transferred onto another surface producing a positive image. Every time a symbol is needed in a different size, a new linocut needs to be created. As a result of this, one can imagine how difficult it might be to enforce consistency within the system. Out of the 4000 Isotype symbols there are many duplicates symbols and, due to the hand crafted process, unavoidable variations occurring within these duplicates.

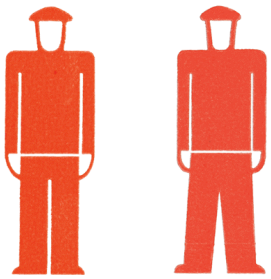

Figure 2. Variations on Isotype Symbols

3. Terminology Analysis

In order to begin the Isotype categorization process, it is important to first analyze where the consistencies and disagreements in visual language vocabulary exist. A limited selection of visual communication authors are included in this analysis: Rudolf Arnheim, Nora Olgyay, Henry Dreyfuss, Philip Meggs, Per Mollerup, Malcolm Barnard, Phil Baines, and Andrew Haslam. When developing the chart below (Table 1), it is troubling to notice how inconsistent the visual language vocabulary is between the different authors. Even the simple, overarching

term for the relationship between signifier and signified is extremely contradictory and confusing. Where Dreyfuss, Olgyay, Baines, and Haslam would use the word "symbol," Arnheim would use "image," and Meggs, Barnard, and Mollerup would use "signs." One can quickly understand how confusing this is. For the purpose of this paper and for simplicity's sake the overarching term used will be symbol.

Table 1. Classification Matrix [1, 3, 5, 7, 8, 10]

Author	Representational		Non-representational	Overarching Term
Dreyfuss	Representational	Abstract	Arbitrary	Symbol
Arnheim	Picture	Symbol	Sign	Image
Olgyay	Image-related	Concept-related	Abstract	Symbols
Meggs	Icon	Index	Symbol and Metasymbol	Signs
Barnard	Icon	Index	Symbol	Signs
Mollerup	Image or Icon	Index, Designation, Reagent	Symbol	Signs

To add to this confusion, there is disagreement as to exactly *how* the terms distinguish among themselves. For instance, where Dreyfuss makes the distinction on level of abstraction, Arnheim bases his on function, and Mollerup, Barnard, and Meggs (in blue) establish their terminology on Charles Pierce's semiotic model of differentiating between the terms by how the signs refer to their objects [3, 7, 8].

The middle gray column demonstrates the area of greatest confusion among the terms. If there any agreement exists among the authors on why an object falls under this category, it is simply because it does not meet the representational or non-representational criteria. Greater detail is provided in Table 2 below. Peirce's model for symbol classification principles gives the most detail in this column; however, the authors above still fail to integrate the information consistently. If we were to merely synthesize this column, this category would include any symbol that has a causal, metaphorical, and contextual connection to its object. For instance, a symbol of smoke to indicate fire would be an example of a causal connection. A light bulb could be a metaphorical symbol of a great idea. A contextual symbol might build meaning through its location: For instance, a symbol of a comb would mean hair salon if presented in a shopping mall, but if the same symbol were presented within a veterinarian's office it would mean pet grooming.

Table 2. Clarification of Gray Column [1, 3, 5, 7, 8, 10]

Author		Author's Definitions
Dreyfuss	Abstract	Reduction of elements of a message into graphic terms
Arnheim	Symbol	Portrays things at a higher level of abstractness than the symbol itself
Olgyay	Concept-related	Refers to perceptual concepts: metaphorical
Meggs	Index	Factual or causal connection that points toward its object
Barnard	Index	Causally or existentially related to signified
Mollerup	Index, Designation Reagent	Physically linked to object Designation: contextual Reagent: causal

Although the terminology is completely inconsistent, perhaps the most widespread agreement among the authors is what constitutes the representational and non-representational columns. The representational category shares a visual relationship with its object, whether it be a photograph of a landscape or simply an orange circle

signifying the sun. The non-representational column includes symbols that have an arbitrary or learned relationship to the objects represented. The western phonetic alphabet is an example of learned, arbitrary symbols because it shares no visual or conceptual characteristics with its referent. Even given this example of consistency, the matrix above demonstrates nonetheless how complicated and frustrating it can be to have a discussion pertaining to symbol development.

4. Categorization models

4.1 Arnheim Model

Of the symbol terminology examples above, possibly the most uncomplicated and easy to understand would be Rudolf Arnheim's model. Arnheim explains how the terms differentiate: "The three terms – picture, symbol, sign – do not stand for kinds of images. They describe functions filled by images. A particular image may be used for each of these functions" [1]. There are no complicated or intricate sub-categories, just simple cogent logic delineating the three:

> **Sign**: "An image serves merely as a sign to the extent it stands for a particular content without reflecting its characteristics visually…The letters of the alphabet used in algebra come close to being pure signs" [1].
>
> **Picture**: "Images are pictures to the extent to which they portray things located at a lower level of abstractness than they are themselves" [1].
>
> **Symbol**: "An image acts as a symbol to the extent to which it portrays things which are at a higher level of abstractness than the symbol itself" [1].

To help his readers better understand the differences between the three, he gives the example of a triangle as being an image that can fulfill the criteria of all three terms depending on its function: "A triangle may be a sign of danger or a picture of a mountain or a symbol of hierarchy" [1].

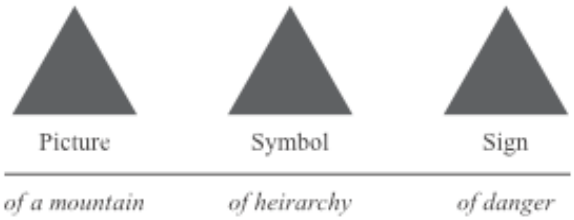

Figure 3. Rudolf Arnheim's examples of Picture, Symbol, and Sign

This same triangle also allows for the discussion of the importance of context on the classification and meaning of a symbol. "An identical triangle can function to mean three completely different things through context. The role of context on meaning is well established" [12]. The coherency between the three terms makes it an ideal candidate for constructing a categorization model (Figure 4). The terms are arranged in a triangular bull's-eye formation; symbol, sign, and picture create the vertices of the triangle. To allow the categorization of images that build meaning through the combination or building of the three terms, three intermediate categories are created: Picture + Symbol, Symbol + Sign, and Picture + Sign.

If an image were to use all three terms to build meaning, it would rest in the center of the triangle. Level of representation is also considered within this model: more representational images are positioned away from

the center, and more abstract, simplified images are placed near the center. Because the actual referents for many of the Isotype symbols were unavailable, and over 80 years have passed since the first symbols were designed, the categorization of many of these symbols was based on an educated guess. Given the importance of context and meaning to the classification of a symbol, this model would indisputably be more effective if the symbol referents were available, not only in the model below, but in the additional models included in this paper. However, given that Isotype is simply acting as the model to fill these taxonomic structures, and virtually any visual language system could be substituted, the exact assignment of each individual symbol into its originally intended category is less critical to this discussion than the overall observations made when organizing these symbol systems according to a variety of specific criteria.

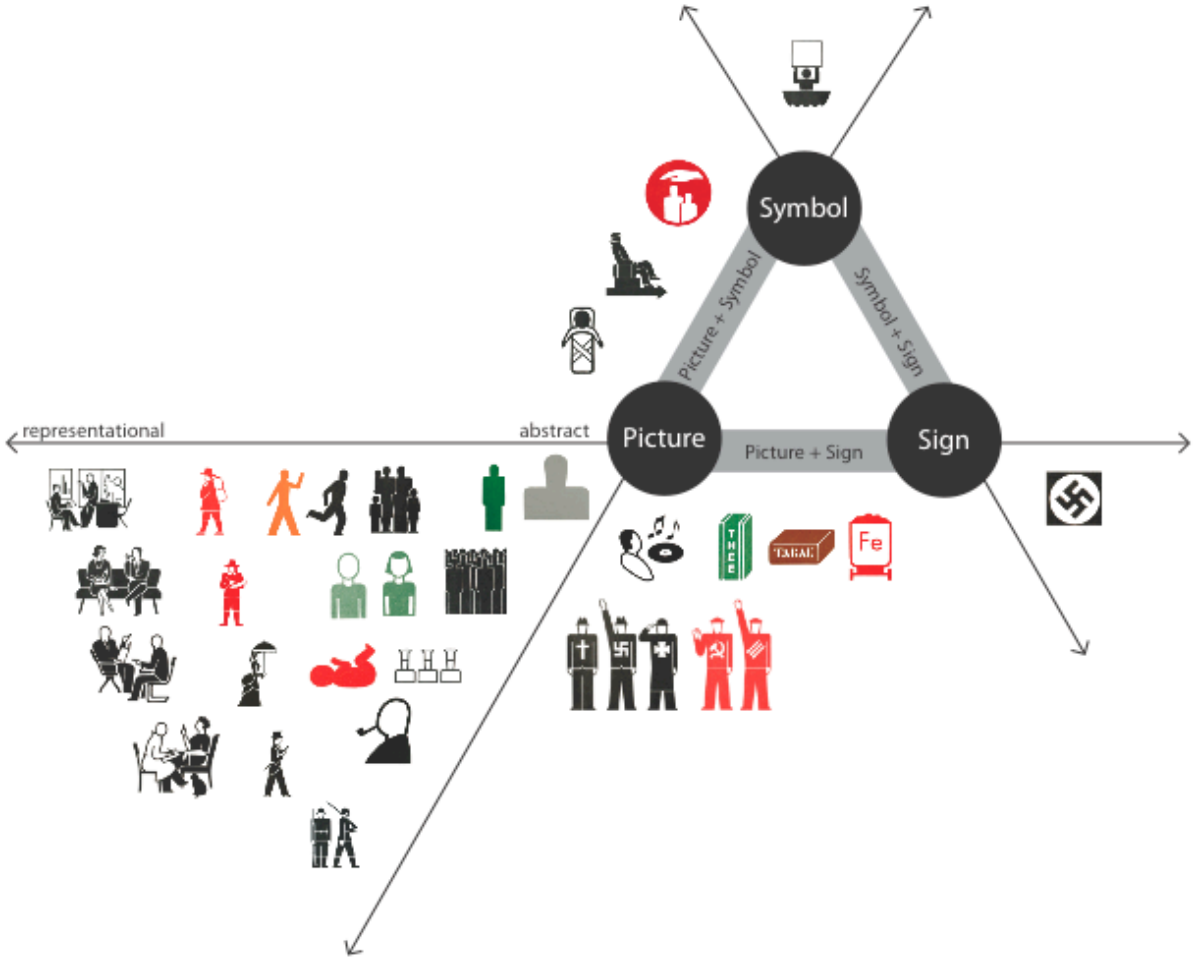

Figure 4. Arnheim Model

4.2 Pierce Model

As illustrated in the classification matrix above (Table 1), Mollerup, Meggs, and Barnard's terminology for types of signs stems from Charles Pierce's model of sign taxonomy. The horizontal axis of the matrix below (Figure 5) uses the following definitions:

> **Icon**: "a sign which refers to the Object it denotes merely by virtue of characters of its own which it possesses, just the same, whether any such Object exists or not" [11].
>
> **Index**: "a sign which refers to the Object that it denotes by virtue of being really affected by that Object" [11].

Symbol: "a Representamen whose Representative character consists precisely in its being a rule that will determine its Interpretant" [11].

Along the vertical axis are five levels of "perceptual information" provided in an image. These categories, are delineated in Phillip Megg's text, *Type and Image*:

Representation: "attempts to replicate the natural appearance of the subject in specific light conditions" [7].

Line as Tone: "depends on the ability of the human brain to construct a gestalt from fragmented data Black and white linear patterning is interpreted as the seamless tone of the image" [7].

Contour Drawing: "imaginary outlines trace the edges or boundaries of the forms in space."

Silhouette: it presents the specific shape of a subject instead of a universal prototype" [7].

Pictograph: "the primary forms of the subject are reduced to elemental geometry, which becomes universal rather than specific" [7].

Notation: "is linear, reductive, and characterized by economy and brevity. …The essence of the subject is captured by minimal graphic means" [7].

The location of the majority of the Isotype symbols within this matrix was foreseeably in the Icon column. Sections containing the majority of the symbols are coded in blue; darkest blue indicates highest concentration. Isotype, especially when representing data, primarily uses a pictographic, geometric approach in order to eliminate visual confusion perceived by the viewer. When the symbols become more detailed and greater resemble contour drawings, they are less likely to be used as the actual units within the charts and graphs, and more likely to be used as the introductory illustrations intended to stimulate conversation and interest for its viewers. Silhouetted symbols appear to only be used when more greater detail is needed that cannot be provided by simple geometric representation.

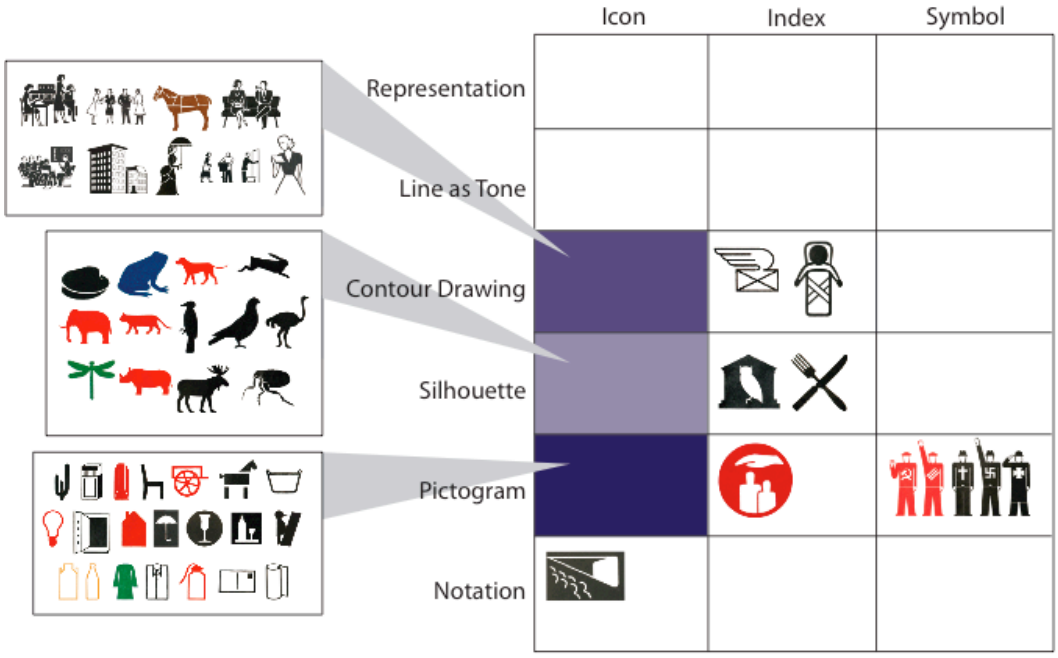

Figure 5. Pierce Model

4.3 Specificity / Representation Level Model

Instead of organizing symbols into categories of sign, symbol, picture, icon, or index, the model below uses a scale approach (Figure 6). Symbols are organized on two-dimensional graph on the basis two qualities: level of representation and level of specificity. If a symbol is more representational, or looks more like the thing it represents, it is positioned on the right side of the graph. If it represents a more specific thing as opposed to a generic, categorical concept, it rests in the bottom portion of the graph. When placing human Isotype symbols within this model, it was interesting to notice that there were two general methods of building specificity. The two yellow lines below illustrate this. The left line shows how meaning is built through the layering of additional information, yet keeping the level of abstraction relatively consistent. The right line, however, demonstrates an alternative approach. Meaning is built by adding details, objects, and gestures to the symbols, increasing the level of representation. For instance, specific military symbols can either be created by including more attire detail or by layering their identifying symbols (Figure 7a and 7b).

While this model may provide a straightforward framework for the discussion of symbol categorization, the placement of symbols on this graph can seem very arbitrary and subjective. It is unlikely that two people using this model will demonstrate the same results.

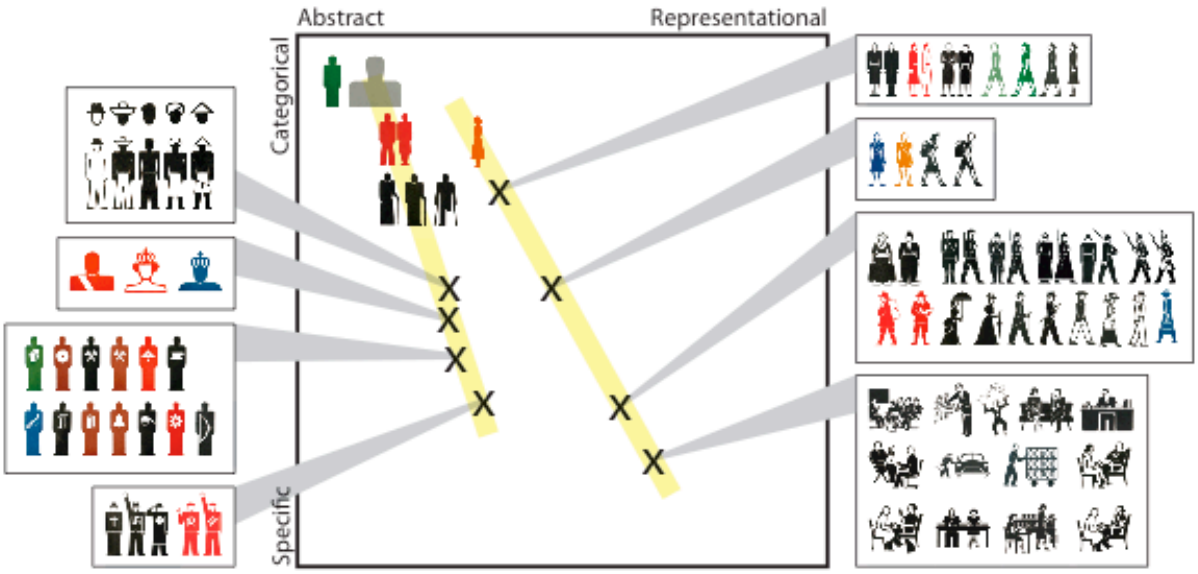

Figure 6. Specificity / Representation Level Model

Figure 7a.
Specificity created primarily by layering symbols

Figure 7b.
Specificity created by including more detail from uniform

5. Application of Taxonomies

Arguably, a taxonomy should provide a useful means for both analyzing what exists and for guiding new developments. Each of the taxonomies discussed above is useful for analysis in a different way. The Arnheim Model for considering the function of symbols, the Pierce Model for understanding formal graphic characteristics and drawing style, the Specificity / Representation Model for considering symbols in a continuum rather than discrete categories. Placing Isotype symbols in the Arnheim Model results in a dominant cluster in a single region. This is interesting in that it suggests consistency of approach but not particularly helpful in that little insight is gained into how the system might be meaningfully expanded to convey a fuller range of symbol functions. Placing Isotype symbols in the Pierce Model results in greater distribution of symbols in various categories suggesting less consistency while hinting that variations in graphic characteristic and drawing style could be informative for improving the system to clarify its meaning. For example, one could infer that more abstract symbols are read more conceptually and that conversely more representational symbols are read to represent discrete individual instances. Placing Isotype symbols in the Specificity / Representation Model results in well dispersed clusters that suggest the relationship of drawing style to conceptual level. While this Model gains strength from a continuum approach to categorization, it exhibits weakness in that the blurred categories do lend themselves to clearly defined taxonomic labels such as icon, pictogram, and sign.

As noted above, a taxonomy should also provide means to guide new directions. A practical application for this work is the design of symbols for the *Hablamos Juntos* project, a collaborative effort to create public information symbols for use in the medical environment with the goal of improving patient-provider communication for Latinos [6]. This project involves the partnership of five American universities as they create and test additional symbols to be incorporated into a future comprehensive visual language system. Applied to this project, these taxonomies might serve in the following ways. The Arnheim Model is useful for guiding the design of symbols to cover the full range of conceptual functions. Using the *Hablamos Juntos* project as a real-world example, this taxonomy would allow for a discussion of the possible interaction of multiple symbols within a single symbol to communicate a comprehensive idea. For instance, when is it essential to combine a picture of a nurse with a picture of a syringe with the cross sign? This taxonomy provides a channel for conversation about the interaction of the different symbol functions. The Pierce model is useful for guiding the application of various graphic and drawing styles. This could be useful for the *Hablamos Juntos* project by providing specific parameters for the classification icon, index, and sign, while highlighting sections of consistency and inconsistency in the amount of conceptual information used. It also may shed light on instances where more representation within the symbol system could be useful. The Specificity / Representation Model lacks clear categorical definitions but represents the continuous range of possibilities in conceptual level and drawing style. Using this taxonomy for the *Hablamos Juntos* might provide insight into how much detail may be needed or allowed to communicate a more specific concept in contrast to a more broad/categorical symbol. For example, if done systematically, it may prove useful to provide more representational detail when representing a specific surgical procedure than when representing general surgery. This model could provide a visualization of the variety of ways specificity is achieved within this system, and allow for discussion in how this can be done more consistently or efficiently.

6. Conclusion

While none of the proposed models have been explored sufficiently to recommend them as a standard for adoption to analyze and guide the development of symbol systems, it is our belief that this preliminary study of taxonomies both confirms the need for symbol taxonomies and the useful role such taxonomies might play in guiding the design of symbol systems. Other fields such as medicine have benefitted from shared vocabularies with agreed upon definitions: the Unified Medical Language System (ULMS) and related Medical Subject Headings (MeSH). These schemes in medicine show that common frameworks need not unnecessarily restrict variety and meaningful differences, indeed, the ULMS integrates many individual vocabularies from different domains, but global advancements in medical science would not be possible without shared terms and meaningful taxonomies of concepts. If design is to advance significantly as a discipline, taxonomies of shared concepts and vocabularies to embody them are an essential first step.

6. Citations

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