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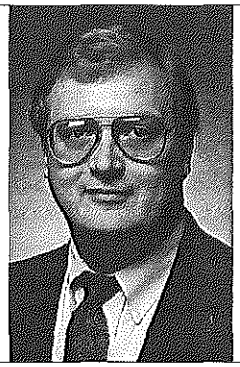
Medieval Faceted Knowledge Classification: Ramon Llull's Trees of Science



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Ramon Llull (1232-1316) wrote many didactic and theoretical works that demonstrate an exhaustive and creative approach to the organization of knowledge. His encyclopedic *Arbre de sciència* (1296) was a multi-volume summation of human knowledge, organized according to a plan that could be applied to other works. Set against a background of Llull's other tree-based works, including the *Libre del gentil e dels tres savis* (1274-89), and the *Arbre de filosofia desiderat* (1294), the *Arbre de sciència* is described and analyzed as a faceted classification system.
(Author)

1. Introduction

> *By divine dispensation it came to pass that in a certain land there lived a Gentile very learned in philosophy, who began to worry about old age, death, and the joys of this world.*

In this way we are introduced to a man who is about to undergo a momentous event: flowering trees of knowledge, a beautiful woman named Intelligence, a Jew, a Christian, and a Muslim will provide him with a detailed system of organizing knowledge that should help him find a path to salvation (1, p. 111). Known in English as *The Book of the Gentile and the Three Wise Men* (*Libre del gentil e dels tres savis*), the tale was written between 1274 and 1276 by Ramon Llull (1232-1316), a medieval mystic from Majorca. In about 1263 Llull, who had up to that time led a cosmopolitan life, is said to have experienced a series of visions during which he was converted to Christianity and persuaded to convert others, especially Muslims and Jews. He became obsessed with a mission to create a great book, "the best in the world, against the errors of unbelievers" (2, vol. 1, p. 15). He left his family, learned Latin and Arabic so that he could communicate his ideas more easily to "those in need," and spent the rest of his life writing, lecturing, and travelling. He wrote poems, novels, treatises on scientific topics, as well as extended philosophical works, many elements of which can be traced to ancient classical and early Christian writers. He was a critic of the Averroists—followers of Averroës (1126-1198), a Muslim philosopher—who held that reason was superior to faith. Among the several sources of biographical information for Llull are Bonner (2, vol. 1, p. 3-52), Carreras y Artau (3, vol. 1, p. 237-271), Platzeck (4, vol. 1, p. 10-59), Hillgarth (5, p. 1-45), and Peers (6). Important Llull bibliographies include those by Bonner (2, vol. 2, p. 1256-1304), Brummer (7), Carreras y Artau (3, vol. 1, p. 272-334), and Platzeck (4, vol. 1, p. 60-72).

The "book" with which he was so preoccupied for most of his post-conversion career is best thought of not as a physical book or a specific work, but rather as a system of ideas that promoted a faith based on reason. Of the three major categories ascribed by one modern scholar, Johnston (8), to Llull's philosophy, the spiritual, metaphysical, and dialectical, it is the third, wherein fundamental methods of logical argumentation are represented in the several manifestations of Llull's system (pedagogical, encyclopedic, and theoretical), that is the primary concern of this study. Llull is of special interest in the history of information science because his system, which is like a theme that weaves through his literary and philosophical works, is a sophisticated system of classifying knowledge. He presented it in forms and languages he thought would appeal to different audiences: didactic fiction in the vernacular—including the tale of the Gentile quoted above—for Catalan lay readers, encyclopedic works in Catalan, Latin, or Arabic for lay and other readers, and theoretical treatises in Latin for the educated leadership of his and other countries. It was a system of organizing knowledge that, when methodically applied to life's problems, was to achieve Llull's goals: to honor God and to unify all religions (that is, to convert to Christianity all non-Christians). In its simplest forms it was a hierarchical system that accommodated pairs of terms; in its most theoretical forms it allowed hierarchical ordering, creation of term pairs, clusters, and faceted relationships and was even hospitable to new subjects. Thus, although it is over seven hundred years old and was not intended for bibliographic control, the system deserves a brief evaluation. A thorough discussion of any one of his works, especially his theoretical representations, would occupy a volume; this article is a mere introduction to Llull's use of the tree as a rhetorical device for expressing his system.

Although the literature about Llull is quite large, most is to be found in fields other than library and information science. Perhaps it has been the system's bewildering complexity that has concealed Llull's importance in classi-

fication theory. Neither Richardson (9) nor Flint (10) mention it as a theoretical classification system. However, it has received some attention by Dahlberg (11, in the context of the history of word classification and linguistic thesauri), by both Perreault (12) and Colomer i Pous (13) in terms of its relationship to computer and information science, and by Salsano (14, 15) in connection with a discussion of the history of encyclopedias.

2. The Arbre de sciència

In his biography of Llull, Peers (6, p. 269) states that the *Arbre de sciència* (*Tree of Science*, 1296) is "an immense production . . . containing a large proportion of didactic matter which in these days can be of interest to very few." He continues: "no part of it is more attractive than its evidently autobiographical opening, which promises a book of great delight, — a promise unfortunately not fulfilled". It is indeed immense (three large volumes in the modern Catalan edition) and while the "evidently autobiographical" introduction does serve its literary purpose most elegantly, it tells no more about Llull than is already known from other sources: that he wrote this work to popularize his system by making it easier to comprehend. And despite Peer's comment, the "didactic matter" is fascinating enough to have inspired (along with similar material from other Llull works) the Renaissance movement known as Llullism as well as several scholarly careers of the present century. Most important for this analysis is the structure rather than the content of this work.

Concerned that his system or aspects of it may not have been understood, Llull often resorted to rhetorical devices, which could also be called disguises or user/system interfaces. Among them were the combinatory trees of *The Gentile*. On a larger scale, and by means of hierarchies and combinatorics, he again tried the image of trees, this time producing an encyclopedic *Tree of Science*. For the purposes of this very complex work, Llull found it necessary to present human knowledge in sixteen trees, actually a "grove" of knowledge. The first fourteen trees each represent one grade of a "scale of being," which is the first and most fundamental hierarchy of the system, and which comprises of trees of the Elements, Plants, the Senses, Imagination, Man, Morality, Government, (Christian) Theology, the Heavens, Angels, Eschatology, the Virgin Mary, Christ, and God. Two additional "meta-trees" are concerned with parables and proverbs related to the first fourteen trees as well as with a lengthy but methodical application of term combinations and principles to a wide variety of questions. Each tree has several parts (roots, trunk, boughs, branches, leaves, flowers, and fruits — a second ordering system) which in turn are associated with from one to 137 terms, usually arranged in a logical order.

The roots of each tree represent groups of related terms upon which everything above ground can be built; each root term can be combined with or can govern the terms above ground. The Elemental Tree (Fig. 1) grows from roots that are representative of those of the other trees: Goodness, Greatness, Eternity, Power, Wisdom, Will, Virtue, Truth, Glory, Difference, Concordance, Contrariety, Beginning, Middle, End, Majority, Equality, and Minority (16, vol. 11, p. 10-23). The first nine are the divine attributes used by Llull in many other works (but not always numbering nine) and the second nine (three groups of three) represent certain relative principles, which like the divine attributes, are used in combining terms to explore subjects and to answer questions. These eighteen terms and the concepts for which they stand surface in many Llull works and are discussed by several modern writers, including Carreras y Artau (3), Platzeck (4), Yates (17, 18), and Bonner (2).

The trunks unify the terms or kinds of terms on each tree. Just as trunks supply water and nourishment to their trees, these trunks also serve as conduits between the root terms and those of the rest of the trees. In the Elemental Tree, for instance, the trunk represents Chaos, out of which were created the four basic elements: water, earth, air, and fire, represented by the boughs (16, p. 23-26).

Grouped by type or in sequence, the boughs are large groups of terms. Those on the Tree of Man represent two types of concepts: corporal (of the four elements, of the vegetative functions, of the senses, and of the mind) and spiritual (of Memory, Intellect, and Will) (16, p. 117-125). One half of the Tree of Morality has boughs representing the seven sins. They appear singly and in all the twenty-one possible binary combinations with each other. Llull adds a twenty-second bough containing many "consequent vices" such as Indiscretion and Frivolity (16, p. 276-292). The other half of the tree naturally has boughs of the seven Virtues.

Of the remaining tree parts, the branches and flowers generally represent states of being or activities of their respective subjects. The leaves can also stand for activities, as on the Tree of Man where they cover eighteen areas from farming and horsemanship to music and medicine (16, p. 206-225), but normally they function as a means of describing the fourteen major subjects in terms of characteristics such as the following: quantity, quality, relation, activity (hence the eighteen human activities above), situation, time, and location. As can be imagined, the tree's fruits represent final products or goals of the various large subjects. Despite the imagery there need not be a large number of fruits on each tree. The Elemental Tree has a very large number while the Tree of Morality contains an unspecified number of fruits in two varieties: forms of reward and punishment.

One could attempt to itemize the contents of the different trees and their parts in order to arrive at an hierarchical outline of Llull's classification system. This has been done for many other encyclopedic and bibliographical systems. Simply listing Llull's subjects alone, however, would be misleading unless two special cross-relationships or classifying devices used between different subject levels in each tree and similar structures of subject levels across the first fourteen trees were emphasized: Llull's combinatorics, or use of term pairs, and his introduction of standard facets into a classification system. The combinations appear in several different trees and at different levels. The facets are

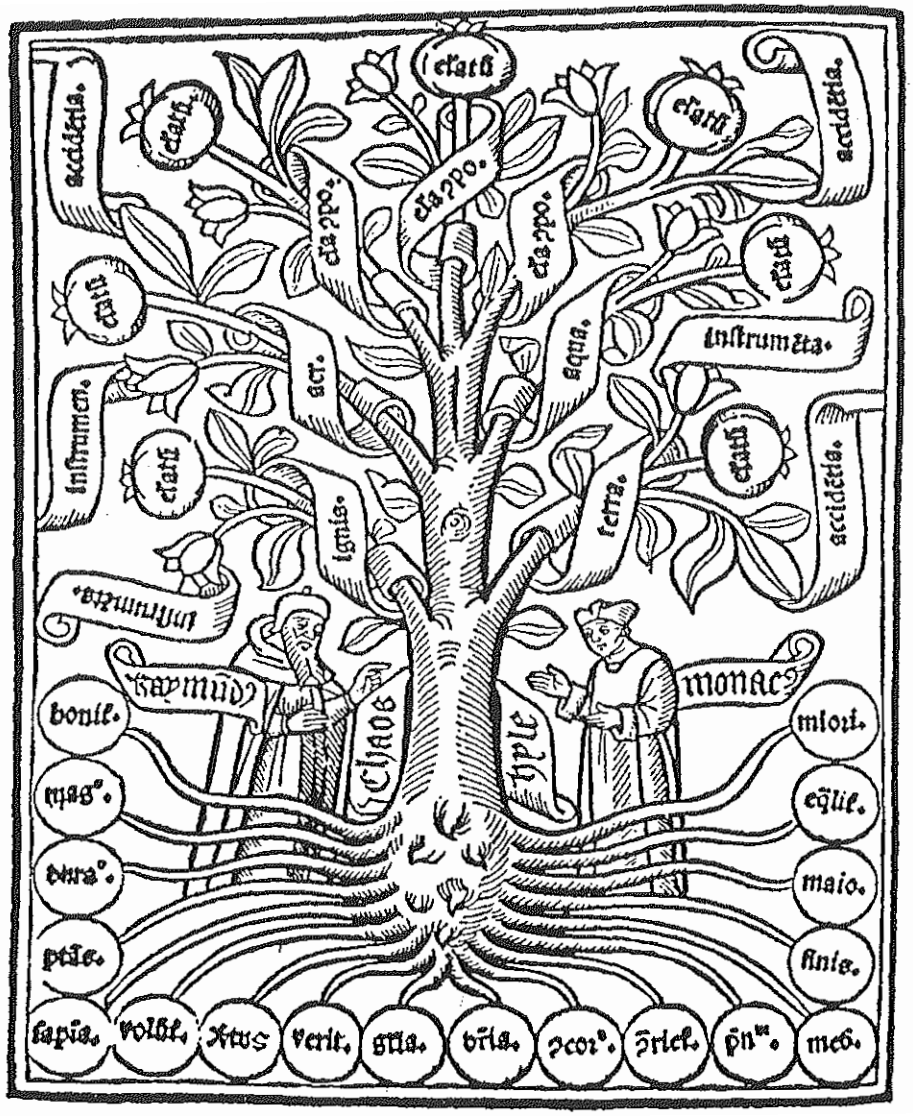

Figure 1: "Elemental Tree" from Arbre de sciència (16)

not as systematically developed as in later forms of Llull's system, but they can be seen especially in the unifying trunks (the "trunk" facet) and in the roots of each tree (the "root" facet), where the dignities and relative principles support and can be applied to each tree. In other words, the facets add dimensions to the tree system's combinatory capabilities by enhancing the combined sets of term pairs with various qualities or characteristics. An example is the "leaf" facet which applies the characteristics of quality, quantity, time, etc. (what Llull in later works calls "principles") to the relative subjects of each tree. In his *Logica nova* (19), Llull proposes a Natural and Logical Tree (*Arbor naturalis et logicalis*), which purports to increase the reader's knowledge in a systematic way in order to increase the reader's logical abilities. Here, Llull combines aspects of the scale of being, the structure of a tree, questions (or rules), and a set of variables used to represent terms in the work's combinations. For a detailed treatment of *Logica nova*, including a discussion of the tree, see Johnston (8); see Hernández (20) and Yates (17) for more on the *Arbre de sciència*.

3. The Trees of *Libre del gentil e dels tres savis*

One of the most comprehensible versions of the system is expressed in *The Gentile*. In the same forest in which the Gentile mentioned above was wandering, three amiable wise men, a Jew, a Christian, and a Saracen (a Muslim of the period of the Crusades), came upon five unusual trees watered by a spring, next to which was sitting a beautiful lady known as Intelligence. They asked her to explain the nature of the trees and the writing on each of their flowers. She replied:

The first tree, on which you see twenty-one flowers, represents God and His essential, uncreated virtues, which virtues are written on the flowers, as you can see. This tree has, among others, two conditions. One is that one must always attribute to and recognize in God the greatest nobility in essence, in virtues, and in action; the other condition is that the flowers not be contrary to one another, nor one be less than another. Without knowledge of these two conditions, one cannot have knowledge of the tree, of its virtues, or of its works. (1, vol. 1, p. 114)

Twenty-one flowers bear a combination of two concepts each, in this case the divine attributes: Goodness, Greatness, Eternity, Power, Wisdom, Love, and Perfection. Intelligence continues by describing the second tree, which bears forty-nine flowers, each of which combines one of the dignities and one of the "seven created virtues" (Faith, Hope, Charity, Justice, Prudence, Fortitude, and Temperance) and which are also governed by at least two conditions: that the created virtues be created when they symbolize the uncreated virtues and that the two types of virtues not be contrary to one another. Likewise, the third tree bears forty-nine flowers, combines the concepts of the divine attributes with the seven vices (Gluttony, Lust, Avarice, Sloth, Pride, Envy, and Ire), and operates under at least two conditions: that the divine attributes not be concordant with the vices and that the relationships be used "to better represent God to human understanding," provided that neither conflict with the conditions of the other trees. The fourth tree bears twenty-one flowers that combine in pairs the seven created virtues; its conditions

state that none of the virtues be contrary to another and the "whatever enhances them or causes man to have greater merit," must be true, and the opposite must be false, provided that neither conflict with the conditions of the other trees. The fifth tree combines the seven virtues and the seven vices in pairs upon forty-nine flowers. Its conditions state that the virtues and vices not be concordant with one another and that the virtues most contrary to the vices be most "lovable," and the vices most contrary to the virtues be most "detestable." The ten conditions of the first tree are governed in turn by two conditions: all are to be directed toward a single goal and they are not to be contrary to this goal, namely to "love, know, fear, and serve God" (1, vol. I, p. 113-115).

On closer inspection, it is possible to see the structure on which it *The Gentile* is built and what is probably the most easily understandable aspect of Llull's ultimate system: the combinatorial method of classifying concepts. The author supplies five trees. The first allows him to combine seven terms of equal value (the dignities, or D), two at a time, resulting in 21 pairs. The second allows him to pair those seven terms with seven others (the virtues, or V1), and in the third with yet another set of seven (the vices, or V2), each resulting in 49 combinations (7 x 7 = 49). The V1 terms appear again in the fourth tree, this time in combination with themselves (21 pairs). The theoretically possible tree representing the combinations of the vices with themselves would also have borne 21. The fifth tree combines the virtues and the vices in 49 pairs. Including all the represented and theoretical combinations of two, there are 210 pairs. (The number of ways these three sets can be combined two at a time with themselves and the others (without regard for order) is 3! (or 6) sets of pairs: D/D, D/V1, D/V2, V1/V1, (V2/V2), V1/V2; the number of combinations of each set: 21+49+49+21+(21)+49=210.) To each of the five sets of combinations (to each tree) are attached at least two conditions which cannot contradict conditions of other sets of combinations; two conditions, in turn, govern these ten conditions. The whole is a system of terms that can be used only in pairs, and only according to certain rules.

How can these pairs be used? The Gentile who has meanwhile met the three wise men. He is impressed by them. He has never heard of, nor believes in, God or life after death, but nevertheless implores the wise men to convince him of God's existence and human resurrection in order to "banish the pain and sorrow" from his heart. The three wise men agree that they should follow the instructions of Intelligence, prove their beliefs one by one using the five trees, and allow the Gentile to make up his own mind.

One of the wise men begins by explaining eleven (out of a possible twenty-one) binary combinations of terms of the first tree, starting with the first, Goodness/Greatness. The other wise men in turn explain selected pairs from the four remaining trees, and thereby prepare the Gentile for the soon-to-follow and more complicated proofs by acquainting him with the system of classification and logic. Each then in turn explains the articles of his faith, buttressing his arguments with the truths of the trees. It is worth noting that the three religions are represented, that their similarities are stressed, and that although the Gentile is convinced in the end of the existence of God, he does not choose any one faith.

4. The Trees of the *Arbre de filosofia desiderat*

Two years before the *Arbre de sciència*, Llull wrote the *Arbre de filosofia desiderat* (21). Here, he adopted the imagery of a tree and introduces a letter notation and rotating wheel which will become of utmost importance in Llull's later works. The tree, like others he has proposed, has roots and branches with associated terms. Letters at the ends of the branches serve as notations for concepts represented on the tree. Each letter represents two or three ideas, singly and in combination with others as explained in the work. The first section of the work explains the terms and letters in broad terms. The first chapter explains the terms of the tree and a set of rotating rings, each with letters representing the concepts. This latter device facilitates the systematic combination of terms.

The second chapter explains ten rules or questions, each in turn composed of several sub-rules, based on the Aristotelian categories. The similarity of these rules to Aristotle's categories has been discussed by several writers, most notably by Platzeck (4). According to Bonner (2), these rules first appeared in the *Taula general* of 1293-94, shortly afterward in *Arbre de filosofia desiderat*, and in every subsequent work concerned with the system. The third chapter discusses the binary combinations of each of the letters explained in the first and second chapters. It is notable that they are not simply combinations of single letters into pairs, as could easily be applied to several parts of the *Arbre de sciència*, but also combinations of two or three terms per letter with corresponding terms of the other letters. Chapter four poses problems and proposes answers using combinations of terms in a way very similar to that of the *Ars brevis*, perhaps Llull's most influential theoretical work.

5. Other Respresentations of the System

Llull was a prolific writer and keenly aware of his potential audiences. As indicated above, he tried reaching lay readers by means of the vernacular and by offering palatable literary forms. Less immediately approachable than his novels or the *Arbre de sciència*, yet easier to understand than his fully-developed theoretical treatises, is the *Liber de ascensu et descensu intellectu* (*Book of the Ascent and Descent of the Intellect*, 22). Here, Llull projects his ideas onto a ladder (or stairway) whose rungs each represent different states of being from which the medieval universe can be viewed. It introduces two devices not found in *Arbre de sciència*: variable letter notation of terms and a rotating wheel to assist in the combining of terms. As in the other manifestations of Llull's method, the ladder, too, is based on a combinatory principle. Llull's conception of the divine attributes are paired with the rungs of the ladder of being, allowing the method of knowledge classification to

be worked out at successive levels (upward or downward) and applied to different subjects.

On several occasions, and with the intention of persuading the more educated and powerful leaders of his day, Llull explained his ideas of classification in theoretical terms. Perhaps the two most representative examples from the middle two periods of his creative life are the *Ars demonstrativa* (23) and the *Ars brevis* (24), both prime specimens of the *ars combinatoria* (combinatory art) for which Llull is notorious. These and other theoretical works featured sets of rotating wheels that allow terms — or letter codes, which function as variables — to be systematically combined in pairs or larger groups. Llull explicitly required that users commit to memory the entire system; the graphic design of the individual circular and tabular figures was an attempt at simplifying the process. For a thorough discussion of the *Ars brevis*, see Artus (25) and Carreras y Artau (3).

6. The Universality of Llull's Method

Llull saw his system as a rational approach to salvation. By systematically applying his rules of investigation, he maintained that it would be possible to answer any question, sacred or mundane, and therefore ultimately, to prove the existence of God and the truth of Christianity. At different points in his post-revelation career, Llull tried different methods of expounding his plan. In some of his smaller non-theoretical works he expectedly applied the system to divine problems. In several of the general, non-theoretical manifestations of the system, such as the *Arbre de sciència*, he applied it to almost every aspect of human experience. Llull's first major attempt to unify the applications of the system into one comprehensive theoretical work was his *Ars demonstrativa*. It presented the longest list of dignities, the virtues and the vices, many qualities and conditions present in non-theoretical and later theoretical works, truth, falsehood, plus treatments of three exemplary subject areas: Theology, Philosophy, and Law. He also covered biology, physics, mathematics, music, and other fields. Not surprisingly, this work was probably his most cumbersome and intimidating. At the opposite extreme, in his relatively compact and elegant *Ars brevis*, he was no less confident that his system was truly a universal system:

> *Everything that exists is implicit in the principles of this figure, for everything is either good or great, etc., as God and angels, which are good, great, etc. Therefore, whatever exists is reducible to the above-mentioned principles.* (24, vol. 1, p. 583)

It is perhaps because this version of his system is so theoretical and tightly-knit, that it can be applied to other subjects so easily. Llull does just this in a number of related works. While they may not explore every subject, they do demonstrate a fundamental feature of the system and it seems that, except for the conversion of non-Christians, this is what mattered most to the author. However, he did expect a great deal of initiative on the part of the user, in terms of both the memorization and the application of the system to the user's own experiences and questions:

> *In this way the intellect is made more universal and, by means of the solutions to the questions posed and given here, is enabled to solve other questions, each in its own way.* (24, vol. 1, p. 626)

Specifically, Llull wrote extended works on law, medicine, philosophy, and theology, all of which have their own "figures" and all of which may be tied into his overall system. Taking the treatise on medicine as an example (26), Llull suggests as a model the figure of the "Tree of the Principles and Degrees of Medicine" whose roots are composed of a wheel representing the four humors (melancholy, choler, blood, and phlegm) and their various degrees. Although this root system is slightly different from those of the *Arbre de sciència* and *Arbre de filosophia*, it is not difficult to conceptualize. The branch on the left bears "things contrary to nature," "non-natural things," and "natural and related things." The middle branch contains four characteristics, heat, dryness, moisture, and cold, each associated with four "herbs." A third branch contains groups of elements used by Llull before, either in lists or in conjunction with geometric shapes: perfection, being, defect, privation; beginning, middle, end; difference, concordance, contrariety; majority, equality, minority. As usual, Llull requires the memorization of these basic concepts, for "whoever does not know them cannot understand the Art" (p. 1123). Furthermore he instructs us that,

> *Whoever wants to know or understand this Art should learn the above alphabet, and should transfer the flowers of the tree onto other movable and inscribed flowers so that he can, for purposes of demonstration, mix, give form to, equalize, increase, or diminish one with the other.* (p. 1123)

As he does in other theoretical and non-theoretical works, Llull then discusses conditions of the system and presents questions and answers based on them. The actions mentioned in the last part of the quote above summarize the purposes of Llull's facets in all of his logic systems. Terms may be combined with each other, but need not represent facets themselves; however, they may be combined with terms representing facets that affect the results of logical exercises by coloring them in some way or by allowing them to be examined in connection with groups of like concepts. It would, for example, be possible to examine aspects of medicine or law (represented by pairs of medical or legal terms) in the light of time (beginning, middle, end), of God (goodness, greatness, eternity, power, wisdom, will, virtue, truth, glory, perfection, justice, generosity, simplicity, nobility, mercy, dominion), of the intellective soul (memory, intellect, will, remembering, forgetting, knowing, not knowing, loving, hating), or of the virtues and vices. The facets are categories that are expectedly foreign to us today and correspond only superficially to Ran-

ganathan's facets of Personality, Matter, Energy, Space, and Time. Unlike bibliographic information systems, which can provide means of retrieving records or items based on relationships among terms, Llull's logic systems provide for systematic discussions of problems involving groups of concepts that are mechanically manipulated in order to address them systematically.

Llull thus covered a great many subjects and aimed to perfect a tool for exploring still others. Although it may have been easier to master a greater percentage of the available knowledge in his day than it would be today, he made no claim to a lawyer's knowledge of law, a musician's knowledge of music, or a doctor's knowledge of medicine. His mission in life was "the conversion of unbelievers by means of a method based on the general principles that govern the natural order of the universe" (2, vol. 1, p. 55). It was by exploring some of the major sciences that he tried to demonstrate the applicability of his universal system. A Llullist of the sixteenth century, Heinrich Cornelius Agrippa von Nettesheim, summed up the universality of the system:

> *The Art contains nothing trivial, it does not deal with specific objects; precisely for this reason it is to be regarded as the queen of all arts, an easy and sure guide to all sciences and all doctrines. (It) is characterized by its universal applicability and certainty; aided only by this Art, men will be able, without being required to possess any other knowledge, to eliminate all possibility of error and to find "de omni re scibili veritatem et scientiam." The arguments of the Art are infallible and irrefutable; the principles and theorems of each particular science are illuminated by it and derive their validity from it; finally, because it embraces every science, the Art has the task of ordering every facet of human knowledge.* (2, vol. 1, p. 81)

7. Conclusion

Llull's system in its various forms superficially resembles common rhetorical devices such as trees (of knowledge) and circles (en-*cyclo*-pedias). Why should the modern world be interested in Llull's system? To begin with, there are similarities between some of Llull's techniques and modern information retrieval: use of hierarchical systems of terms, the combination of term pairs, the establishment of formal links between terms, the formation of strings, and the application of facets. Additionally, a direct connection between Llull's work and the *ars combinatoria* of Leibniz has been well established (3, 1939; 2). At least two modern writers have recognized the similarities between Llull's system, particularly as presented in the *Ars brevis* and *Ars generalis ultima*, and modern symbolic logic and computer science. Perreault (12) has credited Llull as the first person to recognize the possibility of the union of combinatory logic and a mechanical means of utilizing such a logic. The same author suggests that Llull's use of questions in the late theoretical works is of "the very sort a cataloger or indexer might consider" (12, p. 15-16). Llull's work has at least twice been seen as constructing one of the seminal ideas in the history of combinatory logic and computer science (12, 13). Additionally, Dahlberg (11), in her study of universal classification systems, ascribes importance to Llull in terms of word classification. Although she recognizes the potential of Llull's theories in the area of knowledge classification, she emphasizes their value as very early precursors to the linguistic thesauri of John Wilkins and Peter Mark Roget. These appraisals of Llull's worth today may well be accurate, but they do not tell the whole story. Of even more direct interest to information scientists is Llull's introduction of a theoretically flexible universal classification system which in many ways was not duplicated until the twentieth century and the works of S.R. Ranganathan. Despite their different purposes, the systems are remarkable similar.

In Chapter XH of his *Prolegomena to Library Classification*, Ranganathan (27) has the following to say about formalization of classification:

> *The culmination of classification schemes and classifying practices in abstract classification is but in keeping with the familiar tendency of all intellectual disciplines to increase formalization. This has happened in mathematics and logic. Each of them amounts to a calculus. Classification too amounts to a calculus. Formalization leads to the use of symbols, sooner or later. . . . Classification too, particularly abstract classification, will have to resort to symbolization of its own. This is inevitable in any discipline of a high level of abstraction dealing with methodology in abstract. There are reasons for this.* (27, p. 577)

As to the reasons, primary of which is the Law of Parsimony (The preferred alternative is to be the one that is most economical), it seems that Ranganathan and Llull would not be in disagreement. It was chiefly for reasons of efficiency and clarity that Llull developed his *Ars brevis*. This final version of Llull's system is a formalization of a classification system that occupied him for over thirty-five years; with its trees, ladders, and combinatory wheels, it does indeed "amount to a calculus." Also, Llull's formalization certainly leads to the use of symbols. Llull's adoption of trees as rhetorical devices, his attention to faceted classification, his application of a sorting device, and his use of symbols or codes — all present in the works of Ranganathan, could lead to a worthwhile comparative study.

Llull's theories of knowledge classification are not merely historical novelties. His system deserves more attention because at a very early date it ventured away from exclusively hierarchical systems and developed into what might be called a "modern" system. He did use hierarchical systems in the forms of trees and ladders to reach lay readers, but even while using such imagery, he eventually found it necessary to introduce additional models to his structural conceptions of knowledge. His theories may not have been intended for bibliographical organization, yet their fundamentals strongly foreshadow — by several hundred years — prominent modern classification sys-

tems that have been regarded as strikingly original. Further study of relationships between Llull's systems and modern ones and of Llull's many works as models of classification theory may well bear fruit.

References

Catalog numbers from the three standard bibliographic surveys of Llull's works have been included in some of the following entries in order to uniquely identify works and to lead readers to additional bibliographical information. The catalogs are identified by abbreviations, Bonner, CA, and Platzeck, which stand for Bonner (2), Carreras y Artau (3), and Platzeck (4).

(1) Llull, R.: Libre del gentil e dels tres savis (1274-76). Bonner II.A.4; CA 71; Platzeck 6. English translation in Bonner (2, vol. 1, p. 110-304).

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