Chapter 2
About Theory of Knowledge Organization

2.1 On Theory

To understand the importance of theory in the development of scientific thought one has to rely on a thorough comprehension of the tools and paradigms of research. At the most basic level, theory is a frequently-tested (and thereby affirmed) statement of the interacting requirements of a phenomenon. In empirical research, theory is both the accumulated wisdom of the paradigm from which hypotheses are cast and the constant reaccumulation that occurs as each hypothesis is tested. The essence of empirical theory is the notion that probability theory allows us to state with great precision the degree to which our statements likely mirror reality. In other domains theories have more the aura of accumulated statements that describe positions within a system. In sum, the presence of a theoretical basis in a domain, whether a single theory or a system of theoretical statements, implies not just the cleverness of the actors in the domain, but rather their scientific productivity. Theory exists in domains where a large quantity of research has been very productive at generating workable explanations and also at identifying inadequate or erroneous statements.

So if there were to be a theory of knowledge organization what would it look like? Obviously it would have to include operational definitions of both of the key terms—knowledge, and organization. It would have to supply environmental parameters within which the two phenomena interact. And it would have to describe the manner in which these phenomena interact. In essence, a theory of knowledge organization would have to explain the impact of the organization of knowledge on those for whom it is operationalized, whether animate or not.

There are, in fact, several theoretical contributions that seek to explain knowledge organization. I will review four discrete points of view in this essay, in order to

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arrive at an overview that will help us consider how current research is contributing to theory in the domain. Dahlberg (2006) was the founder of the domain as we now know it. In particular she was the founder of the International Society for Knowledge Organization. Her point of view lays the groundwork for a particular approach to empirical analysis using the term "concept theoretic." I will begin with her ideas, because in many ways they are the most concise.

But we must look also at three different and all influential points of view. Patrick Wilson posed the backdrop of a bibliographical universe of texts in which various approaches to ordering might be found. He gave us a theoretical yardstick for evaluating the efficacy of all approaches—he called this exploitative power. If it is working it is powerfully driving the evolution of new knowledge, and that has important social consequences. More recently Elaine Svenonius attempted an explanation of the totality of organization of knowledge, by using a linguistic metaphor and designating a set-theoretic. Falling chronologically between the two we find Birger Hjørland's application of activity theory as an explanation for the phenomena of knowledge organization. I will first review the major thrust of these three texts, and then look at two articles of my own in which I attempted a summary of empirical evidence, and two articles by Hjørland that helped move Dahlberg's theoretic closer to fruition.

2.2 Dahlberg

It takes some bravery to put your ideas before the critical eyes of peers, and it often ends with difficulty. Peers see what they want to see, and often miss critical points, no matter how carefully crafted. So it is a testimony to Dahlberg that she sought to turn the mostly rationalist/pragmatist act of classification into the science of the order of knowledge. There are several earlier papers that established her goals, but in 2006 she offered the paper cited here for publication to help explain some of the most basic (and most misunderstood) tenets of knowledge organization. Let us consider it her epistle to the post-modern ISKO domain. In this paper she answered all of our theoretical questions. To wit (Dahlberg 2006, 12):

knowledge = the known
organization = the activity of constructing something according to a plan.

To elucidate what she means by knowledge, she explains further that knowledge may be transferred in space and time, and is dependent on language. Note that this is an utterly social definition, which restricts knowledge to the human dimension. In this theory, knowledge is a commodity of humans that is shared with purpose, and therefore is not raw, nor is it unattached to a human thought, nor is it unutterable. For Dahlberg, knowledge exists only in the dimension of human perception. She says there are four ways in which it can be perceived:

- Knowledge elements (characteristics of concepts);
- Knowledge units (concepts);

– Larger knowledge units (concept combinations); and,
– Knowledge systems (knowledge units arranged in a planned, cohesive structure).

For example, the temperature is high, flames are leaping about, matter is being consumed—these are elements of the knowledge of fire, which is a concept. Pistons work, fuel is consumed, wheels turn, firemen ride—these are characteristics of the engine of a fire department. We may combine these knowledge units, or concepts—of fire, and engine—into a concept combination (or a term) "fire engine." Furthermore, we can create a small hierarchy with two classes and a rule of synthesis, such that:

1: Fire: high temperature, flames, consumption of matter
2: Engine: pistons, fuel, firemen, wheels, ride

Add any *n* to any other *n* in natural linguistic sequence if a sensical result ensues

1-2: Fire engine

In this manner we have created a knowledge organization system (the ubiquitous KOS), by the use of deliberate planning, and cohesive structure.

For Dahlberg, this process is the essence of knowledge organization. The process is constrained by human experience and bounded by linguistic borders. The process is semiotically dynamic, and can be repeated infinitely until everything is contained in one or more systems and all systems are linked. In fact, to ground the process, Dahlberg also identifies three approaches to the designation of concepts (Dahlberg 2006, 13):

Mathematical-statistical: cluster analysis of terms;
Mathematical-conceptual: lattice theory for visual graphing of relationships;
Concept-theoretical: analyses the contents of concepts.

Notice that the latter approach is not explained. We can imagine use of co-word analysis (mathematical statistical) or of multi-dimensional scaling (mathematical-conceptual), and in fact, bibliometric methods use these techniques to generate taxonomies that describe the axes of domains. But, the final approach, which is the key to Dahlberg's science, is the most elusive. We will hold this thought while we turn back to Wilson's bibliographical universe. It will be Hjørland's appeal to activity theory that will flesh out an operational plan for concept-theoretic.

2.3 Wilson

Two Kinds of Power is an immensely influential book (see Smiraglia 2007), that has fueled more than a generation of research in knowledge organization, and in information retrieval. In it, Wilson elucidated the dichotomous goals of controlling recorded knowledge as over against the creation of new knowledge. His theoretical

construct was presented in the form of a philosophical bibliographical essay. The citations are far-ranging and the footnotes entertainingly expressive. He captured the frustration of scholars attempting to interact with the known universe of fact, even as they themselves create new, frustratingly complex, material. The power of this theoretical explanation is its universality and its presentation in natural language. But make no mistake, his terms are operational and have been used for decades to generate research (see for example Mai 2011, 2013; Smiraglia and van den Heuvel 2013).

2.3.1 The Bibliographical Universe

The central part of Wilson's theory is his conception of the bibliographical universe as a concept space wherein one might find in orbit or transit all exemplars of recorded knowledge. Wilson at once sets his sights only on recorded knowledge—this sets his notion apart from some aspects of Dahlberg's, because nothing is included that has not been recorded (recorded texts, therefore, can be retrieved). To wit (Wilson 1968, 6): "The totality of things over which bibliographical control is or might be exercised, consists of writings and recorded sayings." Of course, the physical universe is full of knowledge that is recorded in DNA and molecular structures and other sources, but these are not necessarily accessible to humans, being literate merely in their own tongues. Wilson frees the bibliographical apparatus from the linear existence it had up to this point. Instead of a vast index or card file, Wilson sees points in this universe orbiting and clustering and crossing the bibliographical macrocosm, in concert with each other according to specifiable (if so far unspecified) relationship patterns. Just as the physical universe reels with gravity and physical forces that propel, impel, and compel planets, stars, asteroids and other bodies to exist in relation to each other, so Wilson sees the bibliographical universe as a multi- dimensional, relational system. His mystical explanation goes no farther, but was inspiring enough to lead decades of scholars to seek explanations that might further describe his universe.

In Wilson's universe there are two domains or concept spaces (he calls them powers or controls; we might also think of them as dimensions)—which he calls descriptive and exploitative. The descriptive domain is the dimension where people labor to make indexes and catalogs of all of the texts of knowledge that they know to be extant. The exploitative domain is where scholars toil to create new knowledge by synthesizing that which already is known. It is very difficult to explain this differential. To librarians or archivists (especially catalogers) it seems he is referring to the cataloging department on the one hand and the users on the other. But he really means it in quite a different way. The descriptive domain is that place where what is known and already has been synthesized is described—so this includes not just indexes and catalogs, but also encyclopedias, textbooks, databases, the memories of scholars, and everything that in some way records that which already is known and

synthesized. This is no simple list of raw documents. Rather it is the entirety of what is known, in the form in which it has been filtered by scholars and cultures through the ages and passed to us to curate. And, the exploitative domain is not just a place where users pose queries. Rather, it is that place where, in order to arrive at the best solution, the scholar must find bits of knowledge that are related in a fundamental way but that are so disjoint that they might never appear to be similar at all.

Every scholar has these moments, and often refers to them as serendipity. These are the moments when, after toiling over a text for months, one goes to the farmer's market, and the color of the apples suddenly reminds one of something that reminds one of something else that reminds one to go ask another question, and the answer to that question leads in a new direction where—bingo, one finds an amazing connection that now brings together two heretofore unrelated senses. That is what the exploitative domain is all about. Wilson is trying to say that catalogs and indexes are all very nice, and so are encyclopedias (and even mentor's memories), but, what scholars really need is some way to make the process less haphazard. If the bibliographic universe has bodies spinning in concert according to bibliographical laws, then let us describe all of those entities—the bodies and the laws—sufficiently that we might be able to predict relationships with accuracy.

The key to Wilson's theory is the concept of efficacy. Anything descriptive that makes exploitation possible is efficacious. That which is not efficacious is creating bibliographical drag on the system and should be expunged. This philosophical yardstick has been operationalized in many ways by researchers over the past four decades in order to justify the evolution of the bibliographical apparatus that we have today.

Oh yes, the bibliographical apparatus. Well, I have already described that as the product of the descriptive domain. Except, Wilson points out, the apparatus has rather the character of a *deus ex machina* (my interpretation, not Wilson's, by the way), which is to say, it is like a great big machine with certain cogs working perfectly and others rusted shut. One way of repairing the apparatus, according to Wilson, is by tending to the specifications of the various bibliographical instruments, and it is here that he attends to the pitfalls and joys of specific tools—indexes, bibliographies, catalogs, abstracts, and so forth. Notice that (p. 55): "Any text that refers in any way to any other text or copy of some text might be considered a potential bibliographical instrument." Even a simple citation, then, is a bibliographical instrument, much like a road sign.

Finally, Wilson excels in pointing out the linguistic disadvantages of conceptual systems. Subject analysis is fraught with phenomenological peril, and its product leads to various habits of hunting in order to couple appropriate references. It is not a pretty picture, as he points out the futility of a system built on assumptions about relevance, which (he says) does not really exist. He devotes an entire (the penultimate) chapter to the concept of reliability, foreshadowing another major work (Wilson 1983), *Second-hand knowledge: an inquiry into cognitive authority*. It is here, in his discussion of reliability, that he fleshes out the extension of what I have called efficacy (my word, not Wilson's). It is here that he points out the fact that no

matter how elegant the apparatus, the true test is exploitative power, and there are few ways to measure such a thing with reliability. He says (p. 131):

> An estimate of power is an estimate of what one could do if one tried, of what success would be achieved in different attempts. The existence of multitudes of cases in which success cannot be recognized with certainty, or in which the very notion of success is of doubtful applicability, added to the obvious difficulties of estimating a power on the basis of a sample set of trials, effectively prevent such estimates, in the bibliographical case, from claiming exactitude or finality.

In the end, with what today seems a surprising bit of futuristic imagination, Wilson petitions a revelatory "Supreme Bibliographical Council," which will be able to decide which things known by what scholars when, might actually be related to each other and to a contemporary scholar's query. He suggests, and then rejects, the creation of a bibliographical policy that would collocate all results (a la Otlet's universal bibliographic control), in favor of a bibliographical policy for the rationalization (p. 144) of work of all sorts. If the test of a theoretical construct were simply its power to explain, the number of citations to Wilson's work (Smiraglia 2007) would be sufficient testimony. But the true test of a theoretical construct is its power to inspire—thus see the papers by Buckland and Shaw (2008) or Mai (2011, 2013) or the nascent work by Zherebchevsky et al. (2008)—we see at the remove of forty years from the introduction of Wilson's ideas and the beginning of the third generation of scholars to make reference to it (led, in these two cases by Wilson's contemporary Buckland (see Bates 2004), and Smiraglia, a disciple from the 1980s (see for example Smiraglia 1985), the power of this notion of rationalizing what is known to create better efficacy for the generation of new and necessary knowledge.

In the decades immediately following the publication of *Two Kinds of Power* two distinct research streams developed inspired by Wilson's vision. Information scientists, such as Belkin, Saracevic, Van Rijsbergen, Swanson and Bookstein (Smiraglia 2007, 11) sought to find answers to the first of Wilson's bibliographical policies—how can we collocate all like results? Another research stream developed around the problems of controlling that which is known in order to generate a better bibliographical apparatus. This stream has at its forefront Svenonius, Hjørland, and White. White, together with his Drexel University colleague Kathryn McCain, created the complex of techniques for extensive bibliometric analysis of domains; we will look at their work when we turn to informetrics and domain analysis in a subsequent chapter. But both Svenonius and Hjørland taught generations of new scholars, and both generated their own, more pragmatic, theoretical constructs for knowledge organization. We will look at both, working chronologically.

2.4 Svenonius

Elaine Svenonius was one of the twentieth century's most respected researchers in knowledge organization. A graduate of the empiricist school at the University of Chicago, her research was always tightly controlled and therefore highly reliable

scientifically. In 2000 *The Intellectual Foundations of Information Organization* was published, containing her meta-construct for theory of knowledge organization. That the title of her book uses the phrase "information organization" instead of the term we are using (knowledge organization) is a sign of the imprecision of definitions within the discipline of information science and the sub-disciplines (or domains) that work within it. This is not the place to discuss the merits of these terms. Suffice it to say that both terms certainly are used, and with the same meaning, which is the organization of that which is known in order that it might be the product of the process of information retrieval.

Svenonius' framework begins with an outline of her intellectual foundation (p. 1), which includes an ideology of purposes and principles, the formalization of processes, research design, and key problems in need of resolution (Svenonius 2000). This is followed at once with an extensive historical analysis, which provides a precise set of parameters for the extension of the concept space in which she intends to work. That is, this is not the entire history of knowledge organization but it is the history of the precedents that yield Svenonius' theoretical construct. The second chapter is an analysis of bibliographic objectives, in which she clearly focuses her effort on the record of written knowledge to be found in bibliographical entities. And these bibliographical entities are the subject of the third chapter.

2.4.1 Set Theoretic

The first major element of her theoretical construct is her set theoretic, which is introduced almost accidentally within the discussion of entity types. She writes that (p. 35):

> Individual documents can be collected into *sets*, which themselves are bibliographic entities. Sets represent equivalence clusterings of documents. The individual members of a given set are equivalent with respect to the attributes they have in common. Potentially any attribute or collection of attributes can be used as a specification for set formation.

In this manner she maps a group of bibliographic typologies (about which more in a subsequent chapter)—categories that overlap and therefore are not mutually exclusive. Membership in any one category implies only clustering on the basis of the stated equivalence measure. Thus it is theoretically possible to isolate the attributes of a given bibliographic condition (my word, not hers) such as "origin" or "subject" the better to define the intension of each set over against the intensions of the other sets. Just as one might want a dress that also is red (thus borrowing from two types: clothing and color) so one might want a French translation of *Bleak House* (thus borrowing from two of Svenonius' sets: edition and superwork). Here are the five most important sets, which (she says) are mandated explicitly by the collocating objective (p. 35):

The set of all documents sharing essentially the same information (work)
The set of all documents sharing the same information (edition)

The set of all documents descended from a common origin (superwork)
The set of all documents by a given author
The set of all documents on a given subject.

In the next several chapters, Svenonius uses this set theoretic to describe how to operationalize bibliographical terminology. So, where Wilson had posed difficult questions and described the fuzziness of terminology, Svenonius now tries to supply a means for separating the intermingled attributes of entities so that they might be explicitly described. Potentially, this is a major step forward for research in knowledge organization. Unfortunately she does not continue to use the theoretic beyond this point in her text. Instead she turns to a set of linguistic metaphors.

2.4.2 Bibliographical Languages

The other major component of Svenonius' theoretical construct is itself a collocating device. Remember that to collocate is not only to draw things together, but to do so in order to disambiguate. Thus she suggests considering the domain of knowledge organization as a set of vocabularies with overlapping semantics, each of which might be considered its own language. The set of languages is (p. 54):

Work language
Author language
Title language
Edition language
Subject language
Classification language
Index language
Document language
Production language
Carrier language
Location language

Notice that she divides all Gaul into two parts—works and documents. This acknowledges the essential distinction between inventory control (document language) and intellectual access (work language), and it makes all aspects of intellectual access subordinate to the concept of the work. It is a quintessentially bibliographical point of view about the order of things, that all queries must eventually lead to "a work." Languages then have vocabulary, syntax, semantics, pragmatic uses, and rules. It is under "rules" that we find a partial (but telling) list of bibliographical standards. Here Svenonius has collocated the practice of bibliographical control—Wilson's bibliographical apparatus—as a pragmatic consequence of a post-modern Babel. Oh but that we all might speak one language!

The rest of Svenonius' book contains in-depth explanations of the set of languages in the list above. She attempts to broach this metaphorical Tower of Babel by clarifying the contents and the consequences of the plethora of bibliographical

languages that constitute the bibliographical apparatus. While this book ends essentially without a conclusion—her "Afterword" is essentially a research agenda—we still have a concrete step forward in the statement of theory for knowledge organization. Svenonius' conception of the concept space, like Wilson's, is exclusively bibliographical and therefore the province of that which is known, synthesized, *and* recorded. The space is considered pragmatically from two perspectives, which might be thought to parallel Wilson's describing and exploiting. Specifically, Svenonius tells us to limit describing to document inventory, much of which can be automatic, and to focus instead on exploiting by expanding our conception of works and their attributes. She gives us two tools—a set theoretic, and a linguistic metaphor—with which to tackle this giant problem.

2.5 Hjørland

Birger Hjørland is arguably the most-cited author of theoretical work in the field of knowledge organization. His name frequently is found near or alongside Svenonius' in visualizations of the domain. And, again arguably, Hjørland has contributed the most directly usable applications analyses for the advance of knowledge organization. That is, his pragmatic writing urges authors in the domain to step aside from the pragmatic and to consider other epistemological perspectives. In 1997 his theoretical construct took form in the book *Information seeking and subject representation: an activity-theoretical approach to information science*. Here we see an appeal to understand documents not by their content but rather by the uses to which they are (or might be) put. This is not a new idea, for decades bibliographers (see Krummel 1976) have appealed to the notion that the actual physical form of documents is dictated by the marketplace and therefore the intellectual content also is molded by such considerations. This is an important principle for bibliography because it tells us to look beyond title pages for the clues to significant identification of specific documents as artifacts.

Here the thrust is different. Hjørland attempts to give an overview of information science based on the principle that information seeking is the key problem, over and against document representation. Thus his theoretical construct takes place entirely in Wilson's exploitative domain, leaving the descriptive domain for another day (or another author). His major thrust is subject searching and its requisite impact on the structure of information retrieval systems. Information seeking is presented from the point of view of "behavioral ecology," and he makes distinctions between documents and non-documents, and between known-item and unknown-item retrieval. Where Wilson posed a universe of writings, and Svenonius focused on documents only, Hjørland broadens the scope of the discipline to entities that record knowledge but that are not documents *per se*. Activity theory is clearly presented as a motivating factor in the metaphorical search for mushrooms (see p. 12 ff.), which draws convincing parallels. If we really want mushrooms we should be looking for the place with the best selection of mushrooms and not just the first batch we find under a tree. So, therefore, should searchers be locating their work according to the activity

that drives it, in the best locations for good results. The anti-Google, we might call this. Knowledge organization is explicitly addressed in chapter 3, in relation to subject analysis. And the chapter after that outlines his reliance on epistemology.

2.5.1 Some Fundamentals

In 2003 Hjørland laid out some explicit marching orders for the domain of knowledge organization. Of particular importance was the new extension of the domain that he offered by extending it beyond the purview even of information science (as it traditionally has been understood) to the impact of the social division of labor and of social institutions. Principle actors in the domain are identified as knowledge producers and knowledge users. It is their two sets of activity that generate the dimensions of this universe. He is interested not just in indexing or document retrieval, but now also in scientific communication, the social roles of information, the epistemological stance of knowledge providers, and the impact of social semiotics. Hjørland's bibliographical universe is much broader than any we have seen before, and therefore the methodological requirements for research are all the less adequate.

2.6 Smiraglia, Hjørland

Is there a theory of knowledge organization? Not yet. There is, however, quite a lot of progress. In two papers, Smiraglia (2002a, b) used the tools of meta-analysis to suggest areas where empirical research has reached the level of theory. These are:

Author productivity and the distribution of name headings
The phenomenon of instantiation; and,
External validity.

The first two categories make liberal use of Lotka's Law to show that after several decades of empirical research it now is possible to predict the distribution of bibliographic phenomena in KOS if we know the bibliographic-demographic parameters of a set of documents (such as a library collection). The third category relies on the same bodies of research, to demonstrate that the bibliographic-demographics tell us that most libraries are, in fact, not just in supposition, alike. Thus research carried out in one library catalog, so long as the bibliographic-demographics are explicitly reported, can be generalized to other collections. There is potential theoretical predictive power in these results. The dimensions of the bibliographical universe can be not only comprehended but also recorded for exploitation. And with the wide comprehension of instantiation we see real evidence of what Svenonius' called the "Work language" and its impact on information retrieval. The extension of Lotka's Law from its original narrow use as predictor of author productivity to a new capability for demonstrating the extension of the bibliographic domain is also a major theoretical leap forward.

Hjørland (2008) brings our discussion full circle by acknowledging both broad and narrow definitions of the term knowledge organization. The narrow meaning is document description, the broad meaning is the social division of mental labor, the actual structure of that which is known and how it is conveyed in society. Thus we have Wilson's two powers—describing and exploiting—now defined as the extension of two dimensions of the power and use of knowledge. The impact of Dahlberg's concept-theoretic is its *use* in different domains.

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