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The Making of the Humanities

Volume III:
The Modern Humanities

Edited by
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Jaap Maat and
Thijs Weststeijn

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9.1 Historical Roots of Information Sciences and the Making of E-Humanities

CHARLES VAN DEN HEUVEL

Introduction: The making of library and information sciences

Information scientist Christine Borgman in *Scholarship in the Digital Age* distinguishes between data used by natural scientists, social scientists and humanities scholars and discusses the implications hereof for their research practices. The analysis of these practices in combination with information technology must in her view result in an infrastructure for digital scholarship to facilitate distributed, collaborative, multidisciplinary research and learning that relies on large volumes of digital resources.¹ The distinction in data that Borgman mentioned has been used as one of the arguments to explain why scholars in the humanities and social sciences make less use of digital infrastructures and tools than those in the natural sciences.² However, the roots of library and information sciences that emerged as disciplines from the end of the nineteenth century onward can be found in the humanities and social sciences. Whereas there is a vast bibliography of the history of information science and technology, only recently a research project was set up to uncover the history of computing in the humanities by interviewing prominent members of this scholarly community.³ However, a systematic study of the e-humanities, similar to one of the humanities by Rens Bod or in 'The Making of the Humanities' series of which this publication makes part, still lacks.⁴ It goes beyond the scope of this chapter to write such a study. This chapter focuses on shifts in the relation between the history of the information sciences and of the e-humanities and their common roots.

One of the first historiographical accounts of library science by Henry Evelyn Bliss opens with the line: 'This book should be of interest, we think, to educators, and philosophical readers who recognize the intellectual and the social values of what is termed the organization of knowledge.'⁵ And according to the well-known American philosopher, psychologist, and pedagogue John Dewey,

who wrote the introduction to this historiography: 'It includes questions of psychology concerned with effective, growing assimilation of knowledge and the logical and philosophical questions involved in the problem of unity, interrelations and classifications of science'.⁶ We will demonstrate how in library science by the end of the nineteenth century multidimensional representations of knowledge rooted in humanist disciplines were gradually reduced and translated into more pragmatic terms to serve information retrieval. Furthermore, the impact of methods of the information sciences on the humanities will be discussed. Finally, the renewed interest in the information science and in software development for more inclusive hermeneutic approaches of the humanities will be briefly addressed.

Classification of the sciences

From Bliss's historiographical study it becomes clear that the development of library science at the end of the nineteenth century was shaped by three inter-related debates: debates on the classification of the sciences, on evolution and on atomist theory.⁷ For our analysis of changes in the relationships between the library and information sciences on the one hand and the humanities on the other, we just will briefly touch upon the classification of the sciences. The debate on the classification of the sciences goes back much further in history, but it got a new impetus in nineteenth-century philosophy in reactions to the statements of the positivist thinker Auguste Comte. Comte came up with a hierarchy of sciences, that historically were depending on each other, running from mathematics, astronomy, physics, chemistry, and biology to a new discipline, social physics (sociology), of which he is considered to be one of the founding fathers. Critics such as Herbert Spencer opposed to such a linear and historical sequential representation of the evolution of sciences and argued that sciences are so complex that the relationships can only be explained in a multidimensional way.⁸ The discussion on the evolution of the sciences stood in a wider context of the nineteenth-century debate on (biological and organic) evolution. Studies in the emerging discipline of psychology (Baine, Wundt, Fouillée, Bergson) tried to include the evolution of mental order and explored the internal dimension or 'psyche' of man.

Here, we introduce one of the pioneers of modern knowledge organization, the Belgian Paul Otlet (1868-1940), whose work stands in tradition of positivism and who was a close follower of the ideas of Herbert Spencer and Albert Fouillée. Moreover, the case of Otlet is interesting because it allows us to follow the increasing impact of the natural sciences in library science and classification

at the beginning of the twentieth century, in which the focus from knowledge organization and classification based on philosophical arguments gradually shifted toward information retrieval based on mathematical logic.

Paul Otlet:

Knowledge organization of ideas and retrieval of facts

Paul Otlet (1868-1940) wanted to bring all the knowledge of the world together in order to create a better society, or in his own words a universal civilization. Aware of the enormous increase of information, he proposed to replace the system of many duplicates of books by microfilms that could be distributed from one central office, The Mundaneum, combining a World Library, a World Museum, a World Archive, World University and a World Headquarters for International Organizations, to smaller units in a global network of documentation. The book in codex form would be gradually replaced by other media, in his time especially radio, that expressed ideas more conveniently. Otlet suggested that scholars all over the world extracted the most valuable information in books and other documents on bibliographic cards. To this end he, and his colleague Henri La Fontaine (1854-1943), founded in 1895 an International Office (later Institute) of Bibliography. Its first aim was to create a bibliographic database, the Universal Bibliographical Repertory. It grew from about 400,000 entries in 1895 to 11,000,000 in 1914 and was soon augmented by a Universal Iconographic Repertory and an Encyclopedic Repertory of Dossiers.⁹ To order these databases, Otlet, together with La Fontaine, developed on the basis of Melvil Dewey's (1851-1931) famous Dewey Decimal Classification (DDC), the Universal Decimal Classification (UDC). Similar to Dewey's classification, the UDC divided all knowledge into ten main classes, numbered from 0-9, instead of using alphabetical orders or letter symbols. This way problems related to semantic differences between natural languages could be avoided. Whereas Dewey had developed his classification as a practical book-shelving system, Otlet and La Fontaine saw it as a way to understand and communicate scientific knowledge: The UDC could form a kind of universal language of numerical codes,

a veritable new language whose [figures] translate ideas absolutely common to the entire scientific world and express them in universally understood signs – numbers. In this twofold way the Decimal Classification actually constitutes an international scientific language, a complete system of symbolization for science.¹⁰

Different from DDC, the ten classes of the UDC had more subdivisions which orders could be changed. Moreover, by using auxiliary signs various relations between concepts could be expressed. The result was a nonlinear classificatory language. In his article 'On the Structure of Classification Numbers,' Otlet wrote that: 'Classification numbers will [...] be complex numerical expressions made up of different factors whose respective meanings when juxtaposed will express a complex idea after the fashion of compound words in spoken languages.'¹¹

In several studies Otlet has been put forward as a forerunner of the World Wide Web. His *reseau universel de documentation* that aimed at connecting all knowledge institutions on a global level has been compared to the Internet, his ideas about knowledge production by scholars to that network has been compared to Web 2.0 and his interpretation of the UDC as a multidimensional, nonlinear classificatory language has been compared to hypertext.¹² There are indeed similarities, but Otlet's ideas on knowledge organization can be better understood within the context of positivism, neoscholasticism, and encyclopedism, which he used in a typical nineteenth-century eclectic way. In Paris he studied the modern philosophies of the Comtean Positivists and was particularly interested in the Synthetic Philosophy of Spencer and Fouillée's synthetic principle of *idée-force*. In his diary Otlet wrote in 1889: 'I believe in the great principles of positivism and evolution: the formation by evolution of things – the relativism of knowledge and the historical formation of concepts.'¹³

However, despite the fact that Otlet's views on knowledge organization and classification are deeply rooted in the nineteenth-century paradigms of the universe of knowledge and the order of sciences, they also express his will to go beyond their metaphorical meaning and to use the sciences as active instruments to order information. Although Otlet adhered as most classificationists of his time to a certain hierarchical order of the sciences – ranging in his case from the general science of being, ontology, to the science of divinity, theology – his interest herein was not just philosophical or theoretical, but foremost instrumental. This becomes clear from Otlet's very early work *Something on Bibliography* (1891-1892) in which he outlines models for bibliographies of law and the social sciences and explains that methods from the natural sciences can be useful for fact finding and formulating scientific laws:

The views of natural scientists on the constitution of man and the world, on the laws of their organization and development, are no less extensive or less imaginative than those of economists and sociologists. But the difference between them is that in the natural sciences speculation and interpretation are secondary and are hardly ever made a-priori. [...] The results of the natural sciences are grounded in millions of carefully observed, analysed, and catalogued facts.¹⁴

In fact Otlet sees in the empirical approach of the natural sciences a means to restore in the future the old scholastic ideal of a vast synthesis of universal knowledge, experience of the human reason and the proper principles of faith that he deemed not possible anymore:

The famous *Summa* of Saint Thomas should be mentioned here as an example. It sets forth a complete exposition of all the questions which the philosophers of the Middle Ages posed and formulated and answered for each question according to the state of knowledge then. *Summae* are no longer possible. The a priori is too far in the past and the empirical method has not yet produced enough facts for us to attempt today a new and definitive synthesis.¹⁵

Otlet tried to produce sufficient facts by the involvement of scholars and mechanical extraction of information from multimedia documents. Scholars would work together, assisted by machines, to carry out the complementary operations of analysis and synthesis by means of which these elements could be extracted, recorded on cards, ordered and recombined mechanically. His view of processing information led Otlet to formulate what he called the 'Monographic Principle' according to which documents are dissected into their informative elements. Otlet's search for the smallest particles of knowledge must be seen in relation to developments in the sciences at the end of the nineteenth century and the beginning of the twentieth century. He stood in direct contact with the Nobel Prize winner for chemistry, Wilhelm Ostwald, famous for his atomist debate on the substance of the universe with Ludwig Boltzman. Otlet's Monographical Principle was in fact based on Ostwald's *Monographieprinzip*, which the latter had described as 'the principle of the independent preservation of smaller pieces of thought'.¹⁶

According to Otlet, the form of book did not correspond with the one of ideas. The book was just was just a container of ideas that might be conveyed more efficiently.¹⁷ He envisioned the emergence of a future format of the book in which 'each intellectual element, in corresponding to a physical element, will create a structure such that any combination of ideas, notions and facts will be possible'.¹⁸ Mechanical operations do not only play a role in flexible (re)ordering knowledge, but as well in the retrieval of what we call nowadays data:

Documentation is not limited to recording information but will allow its automatic retrieval at any moment it is required; [documentation is] a vast intellectual mechanism designed to capture and condense fragmentary and scattered information and to disseminate it wherever it is needed.¹⁹

Otlet realized that the reconceptualization of the book also had implications for his classification. In effect, the replacement of the book by a database of cards required new ways of linking related information chunks (or facets) that were dispersed over various cards. The possible links were complex and could in Otlet's view only be organized in multidimensional orders. A poster of April 1916 with the title *Elements de schématique* reveals how Otlet is experimenting with processes of dissecting books and of multidimensional classification to create a semi-mechanical, rotating polygonal card system.²⁰

Otlet is thus describing a new process of flexible information search and retrieval that allows for multiple points of contact between cards and the information inscribed on them, which for him are encoded in the notation and combinatorial processes of the UDC as a nonlinear, multidimensional classificatory language. However, there was also the realization that the sheer amount of possible combinations hindered information retrieval and that the complexity of thought could never be completely captured.²¹

Dimension reduction: Multidimensional thought and one-dimensional search

Otlet's experiments with information retrieval in multidimensional displays of polygonal cards revealed the complexity of search in a nonlinear way. The Indian mathematician Ranganathan, developer of the Colon Classification, another multidimensional faceted classification system, described the problem as follows:

Thought is multi-dimensional. But we are one-dimensional beings – that is, we still prefer all things to be handled to be arranged in one-dimension. [...] This means that classification is essentially a transformation of a many-dimensional universe into a uni-dimensional, uni-directional one. The machine tools are expected to perform this transformation.²²

The solution to this problem was dimension reduction. In his manuscript 'Theorie schématique de la Classification' of 14 December 1908, Otlet describes and visualizes the multidimensional reduction of the content of books to one line [Fig. 27].

Otlet was well aware that the reduction of dimensions had implications for his synthesis. An unpublished manuscript from 1927 in the archives of the Mundaneum in Mons (Belgium) reveals that Otlet was studying the implications of notions of events in time and space (and in space-time) in the work of the philosophers/mathematicians Samuel Alexander, Bertrand Russell and Alfred

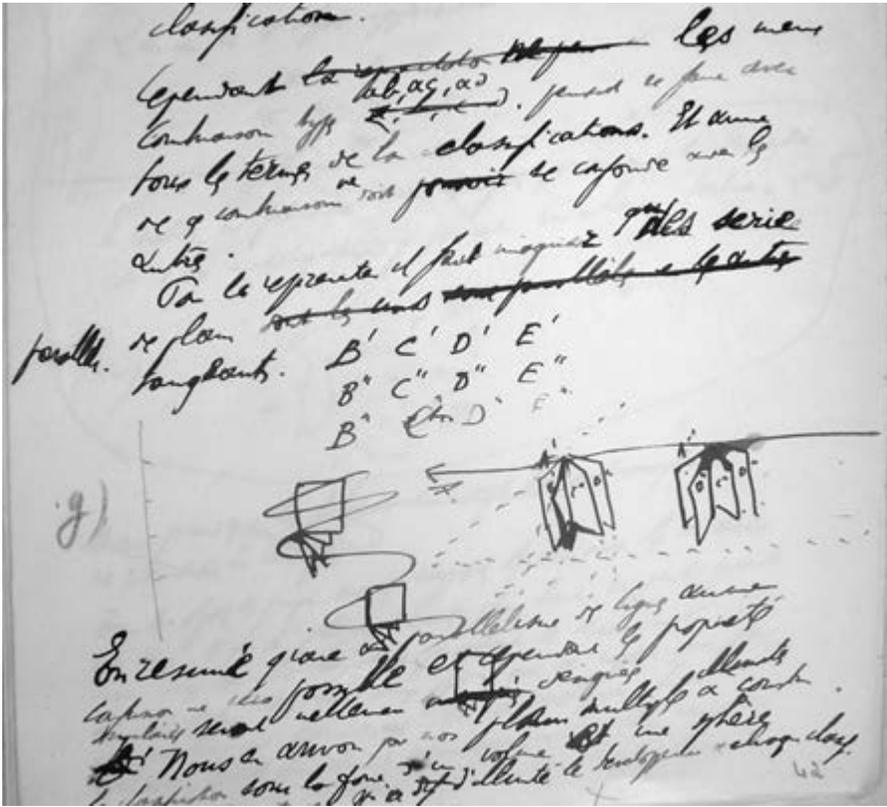


Fig. 27: Visualization from Paul Otlet's manuscript *Theorie schématique de la classification*, 14 December 1908

North Whitehead for a synthesis of the knowledge. It was clear to him that the universe of ideas and the universe of documents could not be fully integrated yet in one synthetic classification.²³ This might be the reason why Otlet outlined in 1928 a kind of shadow classification of knowledge 'Structure and Classification of Knowledge: General Considerations and Synoptic Table' in which he differentiated between objects, beings, ideas and facts. The distinction between the universe of ideas and of documents becomes apparent when he describes the purpose of the table. Otlet does not want to include this classification of knowledge in the UDC, or 'documentary classification' as he calls it in this context, but it could be used in 'preparation of its revision'.²⁴

Despite the fact that Otlet realized that vast developments in the sciences hindered a synthesis of knowledge, he never gave up his universalist ideals. In fact, he believed that the sciences, in particular mathematics, would not just be

instrumental to reach higher levels of abstractions, but would become: 'a producer of concepts that allow us to reason about unperceivable objects and that will spiritualize us unceasingly and free us from our senses, to get higher and further'.²⁵ In short, Otlet was not just interested in mathematical methods of dimension reduction to cope with the complexity of his knowledge representations, but believed that one day mathematics would liberate the human spirit in order to create an universal civilization.

Denial of philosophical conceptions of classification

The most important biographer of Paul Otlet, Boyd Rayward, rightly warned not to overestimate the influence of philosophy on Otlet's work.²⁶ Otlet was certainly no philosopher and very eclectic in the combination of theories and ideas. However, he strongly believed in the need to understand the principles of science underlying his classification to come to a synthesis of knowledge. From that perspective, the explicitly nonphilosophical interpretation of the UDC by one of Otlet's closest collaborators and leading experts of this classification comes somehow as a surprise.²⁷ In his article 'UDC, What It Is and What It Is Not', Frits Donker Duyvis (1894-1961) argued that Otlet had been eager to give full credit to Dewey as the source of the UDC, but that he had changed it fundamentally. Those changes to the concept of DDC implied according to Donker Duyvis 'that no philosophical or scientific system could longer be recognized as underpinning the UDC'.²⁸ In fact, Donker Duyvis ignored that important characteristics of this classification of knowledge, such as universality, multidimensionality, hierarchy, dynamics were not just practical, but were underpinned by theoretical, sometimes philosophical arguments, based on Otlet's views on universalist thought and the unity of the sciences. Otlet, as we observed, had studied the texts of Comte and Spencer on the hierarchical order and evolution of sciences; he had studied the ideas of Russell and Whitehead on events in time and space and had tried to assess their implications for a synthesis of universal knowledge.

The denial of the philosophical argument and the reduction of conceptualizations of human thought to one dimensional, linear methods in information retrieval became more and more apparent in library science, but was also criticized. The early guru of human computer interaction Joseph Licklider observed in his *Libraries of the Future* that most studies of topological and metric space analogies (for the greater part written in the domain of information retrieval) had focused so far on linear methods, and 'have little or no consensus even about the dimensionality, much less about the identities of the dimensions, of any such thing as "information space" or "semantic space" or the "space of knowledge"'.²⁹

This dimension reduction in the information sciences did not only affect library and information sciences, but would also have an impact on the humanities, especially when computer-assisted methods were introduced, and philosophical arguments gradually made place for more pragmatic ones.

Dimension reduction in the humanities

After the computer had proved its capacity in the sciences to analyze large quantities of information and to make complex calculations in a couple of seconds, it also gradually made its way in those disciplines in the humanities that were looking for meaningful patterns in texts or were trying to support their observations with quantitative and statistical methods. The Jesuit priest Roberto Busa, convinced IBM's director Thomas J. Watson in 1949 to produce a machine readable corpus and concordance, the Index Thomisticus, of the work of St. Thomas Aquinas that could be searched using punch cards.³⁰ This way the pioneer of computational linguistics fulfilled to some extent the old dream of the pioneer of knowledge organization, Paul Otlet, to create a machine-readable *Summae* on cards. In history, quantitative and statistical methods were especially used in historic-demographic research and socio-economic history.

Historiographical accounts of these disciplines that became known as historic informatics or cliometrics often open with a famous quote from a 1968 essay by the French historian Emmanuel Le Roy Ladurie: 'Dans ce domain au moins l'historien de demain sera programmeur ou il ne sera plus'.³¹ Although many promoters of the digital humanities indeed claim nowadays that practitioners in these disciplines should be trained in xml code and other software languages, Le Roy Ladurie's prediction did not come true. Right from the start of the use of computers for quantitative research in history there was severe resistance. The well-known historian Carl Bridenbaugh, for instance, formulated in his presidential address to the American Historical Association in 1963 his dislike of quantitative approaches in history: 'The finest historians will not be those who succumb to the dehumanizing methods of social sciences. [...] Nor will the historian worship at the shrine of that Bitch goddess, QUANTIFICATION'.³² But twenty years later even a supporter of computer-assisted history, Bernard Bailyn, lamented the fact that historians had forsaken the general goals of history for 'severely vision-limiting' technical problem solving.³³

Resistance of historians against the use of computers was followed by pleas of practitioners of computer-assisted historical research not to resist any longer against the hard methodologies of the sciences. This development is, for instance, recognizable in changing attitudes toward the use of geographical information systems in historical research. Kemp and Mostern proposed that users of Geo-

graphic Information Systems (GIS) in historical research followed the example of environmental modeling by 'asking scholars to change their methods to suit technology, rather than making the technology work for them'.³⁴ Jack Owens turned the question regarding the demands of technology around by asking, 'What do historians want from GIS?', but still recommended that historians experiment with the use of algorithms and fuzzy logic. By doing so, they would acquire more rigor in their methods to handle the ambiguity and uncertainty in historical records.³⁵ In a more recent study on the use of GIS in future humanities scholarship, David Bodenhamer seeks for the enhancement of this technology with spatial multimedia and gaming tools. Such changes in technology would allow: 'for an open postmodern scholarship, an alternate construction of history and culture that embraces multiplicity, simultaneity, complexity, and subjectivity'.³⁶ Book artist and digital humanities expert Johanna Drucker suggests that humanist scholars give up the visualization techniques borrowed from the natural and social sciences all together and develop their own graphic language.³⁷

Epilogue: Digital hermeneutics and the making of e-humanities

Technology-driven quantitative methods of computational humanities are more and more complemented by computer-assisted qualitative approaches that are inclusive and embrace complexity, subjectivity, ambiguity and uncertainty as typical characteristics of humanities research. After historic informatics and cliometrics with their statistical and quantitative methods, we are entering a phase in digital history with a comprehensive approach that is labeled as digital hermeneutics. It is hardly surprising that this shift is supported by digital historians as becomes clear from the digital-born initiative: *Writing History in the Digital Age*.³⁸ However, digital hermeneutics does not only belong to the domain of the e-humanities or e-history; it is also making its way into the theory and practice of information and communications technology. One of the most important advocates of digital hermeneutics, the information scientist Rafael Capurro, tries to raise the attention of IT researchers for hermeneutics, which in his view has both theoretical and practical relevance. Digital hermeneutics answers, according to Capurro,

to the call of the digital by making explicit its ontological presuppositions. As a philosophic discipline it does not place itself outside history but tries to understand the factual present situation in which human existence and human thinking is located. It looks for a radicalization of the process of self-understanding of human societies that interact with natural and technical networks and construct complex hybrid living systems.³⁹

It is probably this complex understanding of human societies that drive large companies to include the inclusive, hermeneutic approaches in their software designs. Steve Jobs wrote: “[T]echnology alone is not enough. It is technology married with the liberal arts, married with humanities, that yields us the result that makes our hearts sing.”⁴⁰

And IBM started recently a collaboration with the Royal Netherlands Academy of Arts and Sciences (KNAW), the University of Amsterdam and the VU University Amsterdam for the creation of a Center for Humanities and Technology (CHAT) that “combines a set of major challenges in the fields of digital humanities and cognitive computing into an ambitious public-private research agenda. Its goal, briefly put, is to develop a new generation of computer technology that is able to truly ‘understand’ products of the human mind, and past and present human activities.”⁴¹

To conclude, classificationists and other early practitioners of library and information sciences had rooted their theories in the humanities and social sciences. When technical information retrieval methods became predominant, philosophical and social arguments became less prominent or were even silenced. Humanities scholars collaborating with information and communications specialists, especially in the early computer era, were gently persuaded to follow the rigorous, often exclusive methods from the sciences. Only recently have e-humanities researchers questioned reductionist approaches of the sciences and pleaded for the development of holistic methodologies standing in a hermeneutic tradition in e-humanities research. At the same time large players in ICT development try to incorporate the complexity, ambiguity and uncertainty of humanities data, methods, and practices in their software designs. Both will contribute to the use of digital methods and new interpretations in the humanities. It is a prelude of a new phase in the making of the humanities, recently described as Humanities 3.0.⁴²

Notes

- 1 Christine Borgman, *Scholarship in the Digital Age: Information, Infrastructure and the Internet* (Cambridge, MA, London: MIT Press, 2007), 31 and 179-226.
- 2 See, for instance, American Council of Learned Societies Commission on Cyberinfrastructure for the Humanities and Social Sciences, *Our Cultural Commonwealth* (2006). Available at URL: <http://www.acls.org/cyberinfrastructure/OurCulturalCommonwealth.pdf>.
- 3 Julianne Nyhan and Anne Welsh, ‘Uncovering the “Hidden Histories” of Computing in the Humanities, 1949-1980: Findings and Reflections on the Pilot Project’, in *Digital Humanities 2013: Conference Abstracts University of Nebraska-Lincoln, 16-17 July 2013* (Center for Digital Research in the Humanities, 2013), 326-329. Available online at URL: <http://dh2013.unl.edu>.

- 4 Rens Bod, *A New History of the Humanities: The Search for Principles and Patterns from Antiquity to the Present* (Oxford: Oxford University Press, 2013).
- 5 Henry Evelyn Bliss, *The Organization of Knowledge and the System of the Sciences* (New York: H. Holt and Co., 1929), preface, xi.
- 6 *Ibid.*, introduction, vii.
- 7 For relations between library and information science and atomist theory, see Charles van den Heuvel and Richard Smiraglia, 'Concepts as Particles: Metaphors for the Universe of Knowledge', in C. Gnoli and F. Mazzocchi (eds.), *Paradigms and Conceptual Systems in Knowledge Organization: Proceedings of the Eleventh International ISKO Conference, 23-26 February 2010* (Rome, 2010), 50-56; Richard Smiraglia and Charles van den Heuvel, 'Interactions between Elementary Structures in Universes of Knowledge', in *Proceedings of the International UDC Seminar Classification and Ontology: Formal Approaches and Access to Knowledge* (The Hague, 2011), 25-40.
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- 9 W. Boyd Rayward (ed.), *International Organisation and Dissemination of Knowledge: Selected Essays of Paul Otlet* (Amsterdam, New York, Oxford, Tokyo: Elsevier, 1990), 3-4.
- 10 Henri La Fontaine and Paul Otlet, 'Creation of a Universal Bibliographic Repertory: A Preliminary Note, 34', in W. Boyd Rayward (ed.), *International Organisation and Dissemination of Knowledge: Selected Essays of Paul Otlet* (Amsterdam, New York, Oxford, Tokyo: Elsevier, 1990), 25-50. Originally published as 'Création d'un Répertoire Bibliographique Universel: note préliminaire', *IBB Bulletin* 1 (1895-1896), 15-38.
- 11 Paul Otlet, 'On the Structure of Classification Numbers', in W. Boyd Rayward (ed.), *International Organisation and Dissemination of Knowledge: Selected Essays of Paul Otlet* (Amsterdam, New York, Oxford, Tokyo: Elsevier, 1990), 51-62, esp. 52. Originally published as 'Sur la structure des nombres classificateurs', *IIB Bulletin* 1 (1895-1896), 244-249.
- 12 W. Boyd Rayward, 'Visions of Xanadu and Hypertext', *Journal of the American Society for Information Science* 45 (1994), 235-50; C. van den Heuvel, 'Building Society, Constructing Knowledge, Weaving the Web: Otlet's Visualizations of a Global Information Society and His Concept of a Universal Civilization', in W. Boyd Rayward (ed.), *European Modernism and the Information Society* (London: Ashgate Publishers, 2008), 127-153; Charles van den Heuvel, 'Web 2.0 and the Semantic Web in Research from a Historical Perspective: The Designs of Paul Otlet (1868-1944) for Telecommunication and Machine Readable Documentation to Organize Research and Society', *Knowledge Organization* 36.4 (2009), 214-226.
- 13 W. Boyd Rayward, *The Universe of Information: The Work of Paul Otlet for Documentation and International Organisation*, FID 520 (Moscow: VINITI, 1975), 20.
- 14 Paul Otlet, 'Something about Bibliography', in W. Boyd Rayward (ed.), *International Organisation and Dissemination of Knowledge: Selected Essays of Paul Otlet* (Amsterdam, New York, Oxford, Tokyo: Elsevier, 1990), 11-24, esp. 11. Originally published as 'Un peu de bibliographie', *Palais* (1891-1892), 254-271.
- 15 Paul Otlet, 'Something on Bibliography', 18.
- 16 Thomas Hapke, Wilhelm Ostwald, 'The 'Brücke', and Connections to Other Bibliographic Activities at the Beginning of the Twentieth Century', in M.E. Bowden, T. Bellardo Hahn, and R.V. Williams (eds.), *Proceedings of the 1998 Conference on the History and Heritage of Science Information Systems* (Medford, NY: Information Today), 139-147.
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- 18 Paul Otlet, 'L'Avenir du Livre et de la Bibliographie', *IIB Bulletin* 16 (1911), 275-296, esp. 291.
- 19 Paul Otlet, 'Documentation', *IIB Bulletin* 12 (1907), 11.
- 20 Charles van den Heuvel, 'Multidimensional Classifications: Past and Future Conceptualizations and Visualizations', *Knowledge Organization* 39.6 (2012), 446-460.
- 21 Compare: 'Indeed there is divergence, inexactness, and incompleteness. [...] The Mind does not know everything, language does not express everything and the document does not register everything. But they intend to do, or should to do so' (Paul Otlet, *Monde. Essai d'Universalisme. Connaissance du Monde. Sentiment du Monde. Action organisée et Plan du monde* [Brussels: Editions Mundaneum 1935], xxii).
- 22 Shiyali R. Ranganathan, 'Colon Classification and Its Approach to Documentation', in J.H. Shera and M.E. Egan (eds.), *Bibliographic Organization: Papers Presented before the Fifteenth Annual Conference of the Graduate Library School, July 24-29, 1950* (Chicago: University of Chicago Press, 1951), 94-105, esp. 96.
- 23 Mons, Mundaneum, EUM Farde 9 N 63, 'Relations fondamentales', 9 April 1928.
- 24 The Hague, National Library, Archives of FID, Box 95, 'Andere classificatiesystemen', MD 25.49, Paul Otlet Note 2197.
- 25 Otlet, *Monde*, 31.
- 26 Rayward, *The Universe of Information*, 27.
- 27 Charles van den Heuvel, 'The Dutch Connection: Donker Duyvis and Perceptions of American and European Decimal Classification Systems in the First Half of the Twentieth Century', in T. Carbo and T. Bellardo Hahn (eds.), *International Perspectives on the History of Information Science and Technology: Proceedings of the ASIS&T 2012 Preconference on the History of ASIS&T and Information Science and Technology* (Medford, NJ: Information Today, 2012), 174-186.
- 28 Frits Donker Duyvis, 'The UDC: What It Is and What It Is Not', *Review of Documentation* 18.2 (1951), 99-105; esp. 100.
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