

CITY UNIVERSITY LONDON

**Anticipating the Internet: how the predictions of Paul
Otlet, H.G. Wells and Vannevar Bush shaped the
Digital Information Age**

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Abstract

This is an historical research project that investigates predictions of future information technology made by Paul Otlet, H.G. Wells and Vannevar Bush, specifically those described in the Mundaneum, World Brain and Memex respectively. It is carried out by means of an extended review of the relevant Library and Information Science literature and aims to determine the reasons for their predictions, the relationship (if any) between them, and their influence upon the development of the modern-day Internet. After investigating the work of each figure in turn, further investigation is undertaken through a comparative analysis. It concludes that, although there are differences in approach and emphasis between the predictions, each of them was made in reaction to a common problem – the proliferation of published information – and each of them aimed to solve this problem by applying scientific means to improve the free flow of information throughout society, thus improving it for the benefit of all. Furthermore, their ideas stemmed from the same intellectual traditions of positivism and utopianism, and were expressed through technology, that although advanced for its time, was rapidly superseded by the rise of digital computing during the second half of the twentieth century. Finally, although the technology they used to express their predictions is now obsolete, and had little direct influence on the practical workings of the contemporary Internet, the works, concepts and ideas of Otlet, Wells and Bush remain highly relevant in today's ever-increasingly Digital Age.

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Acknowledgements

Whilst I have stated in the research project design section of this dissertation that this was strictly an individual project, with no external participants in the forms of surveys, interviews, or those techniques that arise from other forms of research methodology, the truth is that it could not have happened without the help and support of a large number of people.

Three years ago from the date of submission, I had a bachelor's degree in history and little idea about what I wanted to do next. Shortly afterwards, I volunteered to work in Durham University Library in order to gain experience within the sector, a decision which led directly to me studying this Master's degree. I must therefore thank my colleagues at Durham, and latterly Coutts Information Services and City University London, for supporting me as I took my first steps in the world of librarianship.

The MSc at City University itself was a tremendously enjoyable experience, due in equal measure to the subject matter on the one hand and the enthusiasm with which it was taught by Professor David Bawden, Dr Lyn Robinson (to whom special thanks must also go for supervising this dissertation), Dr Ernesto Priego, Dr David Haynes and Ludi Price on the other. Moreover, the sense of camaraderie between students on the Library Science and Information Science courses (and some other related ones) has been an excellent incentive to study hard and contribute to an extremely engaging environment. I would like to single out Hannah, Nicola, Sal and Sarah in particular for always being able to find the fun side of LIS.

In the process of completing this dissertation, I have benefited enormously from the efficient and quiet library services run by the British Library, City University London and Durham University, in addition to the help of the staff of the modern-day Mundaneum in Mons, Belgium. Moreover, many people (too numerous to enumerate here) provided me with valuable suggestions and feedback on the nature of my research.

The most important people in this overall process, however, were my family: my parents, Alison and Jeremy, who provided material and emotional support throughout the period when I was starting out in librarianship, and my grandparents – Jack and Alma Gill and the late Richard and Patricia Allington-Smith – whose gifts and legacies enabled me to enrol on this course without any financial concerns. Finally, a special token of gratitude to Hande, for her inexhaustible supply of love and kindness.

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Introduction

This research project aims to investigate the work of three significant figures in the history of information science: Paul Otlet, the Belgian pioneer of the study of documentation; H.G. Wells, the British writer and political activist; and Vannevar Bush, the American computer engineer and scientific administrator. These men are all known for their predictions pertaining to Information and Communications Technologies (ICTs) of the future, and their efforts to achieve these dreams: Otlet's *Mundaneum*, Wells's *World Brain*, and Bush's *Memex*. All of these projects have received a great deal of renewed attention since the emergence of the Internet as a mainstream, publicly-available technology in the early 1990s, and numerous parallels have been identified between their predictions and contemporary reality. There is a particular fascination with the "pre-digital" aspect of these predictions and the constraints of the technological limitations of the time, leading to a general grouping of these concepts together as a form of "analogue internet" (Wright 2014).

This research project therefore rests upon an existing body of research about the work of Otlet, Wells and Bush, and is thus pursued through an historical study of the topic by means of an extended literature review. It builds on this previous research by aiming to situate each individual's work precisely in relation to that of the others, and by updating the contemporary aspect of much of the existing research to include the ongoing development of the Internet, most notably the rise of "Web 2.0", which is typified by its interactive, dynamic and multimedia features (O'Reilly 2005).

Aims and objectives

The overall aim of this research project is to examine and appraise the work of Paul Otlet, H.G. Wells and Vannevar Bush, to compare and contrast them with each other, and to determine their influence on the Internet in terms of both its historical development and its present-day form.

The objectives of this research project are as follows.

1. To identify the predictions about future ICTs made by Otlet, Wells and Bush in turn and analyse them within their broader contexts to determine why they were made (for example, academic or professional background, philosophical beliefs, wider socio-political influences of the time and so forth).
2. To compare and contrast these predictions with one another, determining to what extent each man's ideas influenced the others and analysing them in order to identify if they were part of a collective intellectual tradition, or whether they are in fact significantly different concepts which have been arbitrarily grouped together in retrospect.
3. To ascertain what role their ideas, in both a conceptual and technical sense, influenced the development of the Internet and its associated technology and infrastructure in reality, and whether their importance in this respect in relation to one another has changed as the Internet itself has evolved, such as the relatively recent transition from "Web 1.0" to "Web 2.0" and contemporary debates over issues such as its ownership

and neutrality, in addition to ongoing projects such as the Semantic Web (World Wide Web Consortium (W3C) 2015).

Scope and definition

This research project primarily covers the work of Paul Otlet, H.G. Wells and Vannevar Bush (in terms of primary sources written by them and secondary sources written about them, as outlined more thoroughly in the literature review section below), with a special focus on their predictions on how technology would be used to harness the full power of information, in terms of improving storage, search, retrieval and access. Similar predictions by contemporary figures may also be included in passing as appropriate. A key limitation that I feel is necessary is that the initial predictions should have been made before technological developments made what we would recognise as modern a networked computer system a feasible reality, rather than a distant dream; for this purpose I will use the cut-off year of 1963, the point at which serious work began on ARPANET, which introduced the technologies of packet-switching and the TCP/IP communication protocols that still underlie the contemporary Internet (Isaacson 2014).

To clarify what is meant by the transition between “Web 1.0” and “Web 2.0”, the seminal essay by O’Reilly (2005) is used as a basis.

Preliminary literature review

Prior to the main body of the research being carried out, a preliminary survey of the available literature was carried out in order to verify that the topic was a suitable object of study. As the research project itself consists of an extended literature review, this preliminary outline is necessarily extremely cursory by comparison, and represents a series of “starting-points” for additional research. The initial impression was that a significant, albeit not overwhelming, amount of material has been written on the topics within the remit of the research project, the substantial majority of it focussing on one of Paul Otlet, H.G. Wells and Vannevar Bush whilst mentioning the others in passing.

For Otlet, the first port of call is works by the man himself: his magnum opus is a detailed description of his conception of informative content as a something independent of its physical “carrier”, and how he believes it should be organised through precise documentation by a centralised, international bibliographic authority, including how predicted technologies can be used to achieve this (Otlet 1934b). His idea to create a “world city” of international associations that collect, assimilate and disseminate knowledge is expanded upon in an early work (Otlet 1929), and many shorter essays on similar themes are also available in a translation by Boyd Rayward (Otlet 1990b). The recent Google Cultural Institute Initiative has also resulted in numerous posters, drawings and other visual archive material from the original Mundaneum being made available on the Internet (Google Cultural Institute 2015). Rayward, in addition to translating Otlet’s work, is also his foremost biographer and champion, and has authored a number of works on him; these are variously general (Rayward 1973; 1975), related to specific LIS fields (Rayward 1991; 1997), related to specific aspects of his predictions in relation to ICT (Rayward 1994b), assessing how the importance of his ideas

has subsequently increased over time (Rayward 2003), and also a comparative study that also features Wells (Rayward 1994a). A more recent biography by Wright (2014) has further emphasised Otlet's significance as the Internet has developed, whilst a previous City University postgraduate thesis by So (2004) places Otlet's work (with reference to Wells and Bush as well) in the context of the World Encyclopaedia paradigm and how that has also evolved in line with the development of the Internet. Buckland (1997; 2012) and Day (2014) have also analysed the significance of Otlet's work from different conceptual angles.

Wells' ideas for the future organisation of information in the World Brain are detailed in a book and printed version of a lecture delivered in the late 1930s (Wells 1934; 1938). Its development over the following fifty years is summarised by Goodman (1987). It has since received less critical attention from Library and Information Sciences academics than Otlet's work, but the latter's biographer, Rayward, has also written on the subject of the World Brain, drawing parallels between it and the contemporary emergence of artificial intelligence and the scope for potential government surveillance using ICTs (Rayward 1999; 2008). Wells and Otlet were both somewhat utopian in their outlook, but as a science-fiction writer and activist, Wells was more politically motivated and had a greater understanding of the likely nature of future technology; this is explored in detail by Torres-Vargas (2005).

Vannevar Bush's concept for a future ICT, the Memex, is set out in his famous essay *As We May Think* (Bush 1945a), and expanded upon in a later work (Bush 1967)¹. Bush's predictions have historically been the best well-known of the three, and the Memex influence on the development of the Internet has received a book-length analysis of its own (Nyce & Kahn 1991b). As a prominent computer engineer and senior government scientist, his context within a continuum of such figures, from Charles Babbage and Ada Lovelace, to Tim Berners-Lee and Larry Page, is also well-represented; for a recent example, see Isaacson (2014). Buckland (1992), Rayward (1994b) and So (2004) have additionally used the famous Memex as a starting point to demonstrate similarities with Otlet's own work and predictions of a "scholar's workstation". However, Bush intended the Memex to be a far more personal and individual experience, to be used by academics and professionals rather than the "universal public library" concept of the Mundaneum or World Brain (So 2004). Wright (2015), in an online magazine article that provided the initial inspiration for this research project, brings the subject right up to date at a time when the neutral regulation and continued universal, equal access to the Web is apparently less secure than before, by arguing that although Otlet's and Bush's ideas are utopian, they are both highly structured and require authoritarian control, whilst Bush's work (despite being given impetus by the geopolitical reality of the Cold War) abandoned much of this potential regulation in favour of usability and practical concerns.

This initially identified body of literature was an ideal starting point from which to conduct further research on the subject, and more detailed analysis the works identified form the basis of the finished dissertation.

¹ This primary source dates from later than my self-imposed limit of 1963, but I allow it as it expands upon an earlier idea.

Research project design

Methodology

This research project was carried out through an historical study of the topic by means of an extended literature review. The reasons for this choice are several: most obviously, the project deals with the study of a subject that is in itself historical; it is, moreover, a suitable means of research for in-depth analysis of a relatively narrow subject area which deals with a variety of sources (primary and secondary). It also lends itself well to reaching conclusions based on interpretation and synthesis of written qualitative information, rather than, say, the exhaustive analysis of quantitative data (Pickard 2013). It also requires skills of critical analysis, abstraction and conceptualisation, as well as the ability to formulate a clear written argument based upon the research (Shep 2005); as a trained historian at undergraduate level, such a method of inquiry is therefore well-suited to the author's existing strengths.

It is, however, important to bear in mind that undertaking an extended literature review, whilst relatively simple and economical to carry out, in addition to being free from potentially negative external variables (such as relying upon people to be interviewed or complete a survey), has potential downsides. The quality of the research is itself dependent upon the quality of the sources selected in the first place. Furthermore, although the method is verifiable, in that another researcher could repeat the investigation using the same sources, its reliability and validity (like other forms of qualitative research) are beyond the usual scientific standard of proof (Pickard 2013). It is therefore a highly individual method of research, dependent upon the unique biases (whether explicit or latent), background and perspectives that constitute my individual intellectual framework, and this must be recognised as a potential limitation of the project. Nevertheless, I believe that the advantages of this methodology outweigh its potential for undue subjectivity.

The finished dissertation is structured as follows: for each of the three figures studied, their life and relevant works are outlined, followed by more in-depth analysis of their predictions about future information technologies and the reasons why they were made. This is succeeded by a section of further analysis: first, a comparison of the trio's predictions; second, an investigation into how the changing nature of the Internet itself has affected the historiography of these predictions. After reaching conclusions based on the three original research questions, the research project finishes with a self-evaluation and suggestions for further research that could be carried out on the topic.

Work plan

Due to the methodology outlined above, and the fact that the subject being investigated is relatively complex – in that it compares the predictive work of three different individuals, both to each other and to the current reality – the project did not require an overly-precise work plan. There is neither a reliance upon any external participants, i.e. that which would be required in the case of using a survey or a similar method, nor a precise timeframe in which to collect and analyse a large amount of quantitative data. In addition, due to the exploratory nature of conducting an extended literature review, it was highly likely that I would encounter unexpected and serendipitous connections between the texts consulted, which could easily

in turn disrupt a highly-organised schedule. This prediction was correct: the research process was therefore organic and multi-directional in form.

Nevertheless, a general overall timetable did emerge from the research, in line with that set out in the original research proposal (included in Appendix II and reproduced in part below), based on an overall schedule beginning in late May and concluding in late September that comprised 14 full-time working weeks.

- Week 1: the history and development of the Internet in general; its defining features and current status.
- Weeks 2-4: the work of Paul Otlet in detail.
- Weeks 5-7: the work of H.G. Wells in detail.
- Weeks 8-10: the work of Vannevar Bush in detail.
- Weeks 11-14: comparisons, synthesis, analysis, conclusions etc.

An initial prediction that the process of writing-up the dissertation in the fourth week of the timetable, however, proved somewhat inaccurate, as an increase in the range and volume of the literature consulted (in addition to some extra-curricular considerations) resulted in this part of the work plan not starting until four weeks before the submission deadline. However, I do not believe that this had a significant effect either way on the outcome of the research project.

Resources

The resources needed to carry out this research proposal were minimal: as I lived in London for the majority of the period that it was undertaken, I had ready access to the British Library, which contained all of the relevant information on the subject, mostly primary sources written by Otlet, Wells and Bush, in addition to earlier works by Rayward (1975; Otlet 1990b) that are not yet available online.

During the first weekend in August, I also visited the city of Mons in Belgium, to visit the modern instantiation of the Mundaneum, a museum dedicated to the life, work and legacy of Paul Otlet. This was not strictly necessary for the project, as Otlet's own written works are available through the British Library, and a great deal of visual archive material from the museum is available online through the Google Cultural Institute (2015). However, I believe that it was beneficial to experience a large collection of Otlet's work in a curated, public form similar to how he himself imagined it. The museum first opened in 1998 and re-opened following a refurbishment in June of this year.

Ethics and confidentiality

This research project involved individual desk research only. There were no other participants, and so there were no ethical considerations that applied, save for those surrounding academic misconduct and plagiarism on the part of the author. I therefore abided by the Postgraduate School Handbook's guidance on avoiding academic misconduct and plagiarism through proper referencing. There are similarly no confidentiality issues arising from this research project, as it did not involve any work with confidential material: the literature reviewed was either previously published or in the public domain. As stated in

the ethics section above, this project also did not require any external participants in order to be carried out.

I – Paul Otlet

Life and works

Paul Otlet (1868-1944) was a Belgian bibliographer, author and peace activist, who has been described as a “pioneer” (Buckland 1997, p.804) and a “visionary” (Rayward 1975, p.3; 1991) in the research and practice of documentation. Aside from his predictions about future information technologies and conceptual ideas, which form the backbone of this research project, his concrete achievements in the field of library and information science, as listed by Rayward (1975) are numerous: he co-founded the International Institute of Bibliography (IIB) in 1895, a body which remains in existence today as the International Federation for Documentation (FID); he also co-founded the Union of International Associations (UIA); he was closely involved with the establishment of the Committee for International Intellectual Co-operation within the League of Nations after the conclusion of the First World War; and he also co-created the Universal Decimal Classification system, which has since been translated into fifty languages and is currently used to classify approximately 200,000 collections across 130 countries worldwide (UDC Consortium 2015). Most of his work was carried out in close co-operation with his lifelong professional collaborator and personal friend Henri La Fontaine, a Nobel Peace Laureate and long-serving politician in the Belgian national assembly, but his biographers agree that Otlet was the intellectual driving force behind these and his other initiatives (Rayward 1975; Wright 2014). This research project focusses on his theories and ideas about information, which gradually developed from an awareness of the contemporary, late nineteenth-century problem of the proliferation of information, through the development of the “documentary method” to achieve an ideal synthesis of knowledge, to the integration of this method within a wider network of information technology and bibliographic resources, collectively termed the *Mundaneum* (Rayward 1975; 1990; Wright 2014).

Otlet experienced a childhood that was contradictory in many ways, characterised by Rayward (1975, p.10) as “oppressive” yet “charmed”. He was born into a wealthy bourgeois family, whose financial situation was nevertheless obvious uncertain due to his father, Édouard’s, numerous failed business ventures; he enjoyed a close relationship with his family yet had no childhood friends outside it; he went on idyllic holidays and excursions but was later packed off to Jesuit boarding-schools in Paris and Brussels, where he embarked upon his life’s obsession by becoming a student librarian (Wright 2014). He spent much of his time at school and university (in Louvain, with periods in Paris and Brussels) engaged in an introspective and highly personal search for a life goal that somehow combined his shy and nervous temperament with a desire to achieve a great work for the betterment of humanity, further complicated by a crisis of faith that led him to reject the scholasticism of Christianity in favour of the logical positivism favoured by the intellectual class of the period (Rayward 1975). In a diary entry from 1888, he expressed the desire “to unify and synthesise [...] our knowledge in its present state” through “a vast exploitative synthesis of law and political action” (quoted in Rayward 1975, p.16). He qualified as a lawyer two years on the grounds that the profession was the highest form of civic duty that one could aspire to, but abandoned his work as a clerk in the practice of Edmond Picard after only one year, frustrated that his

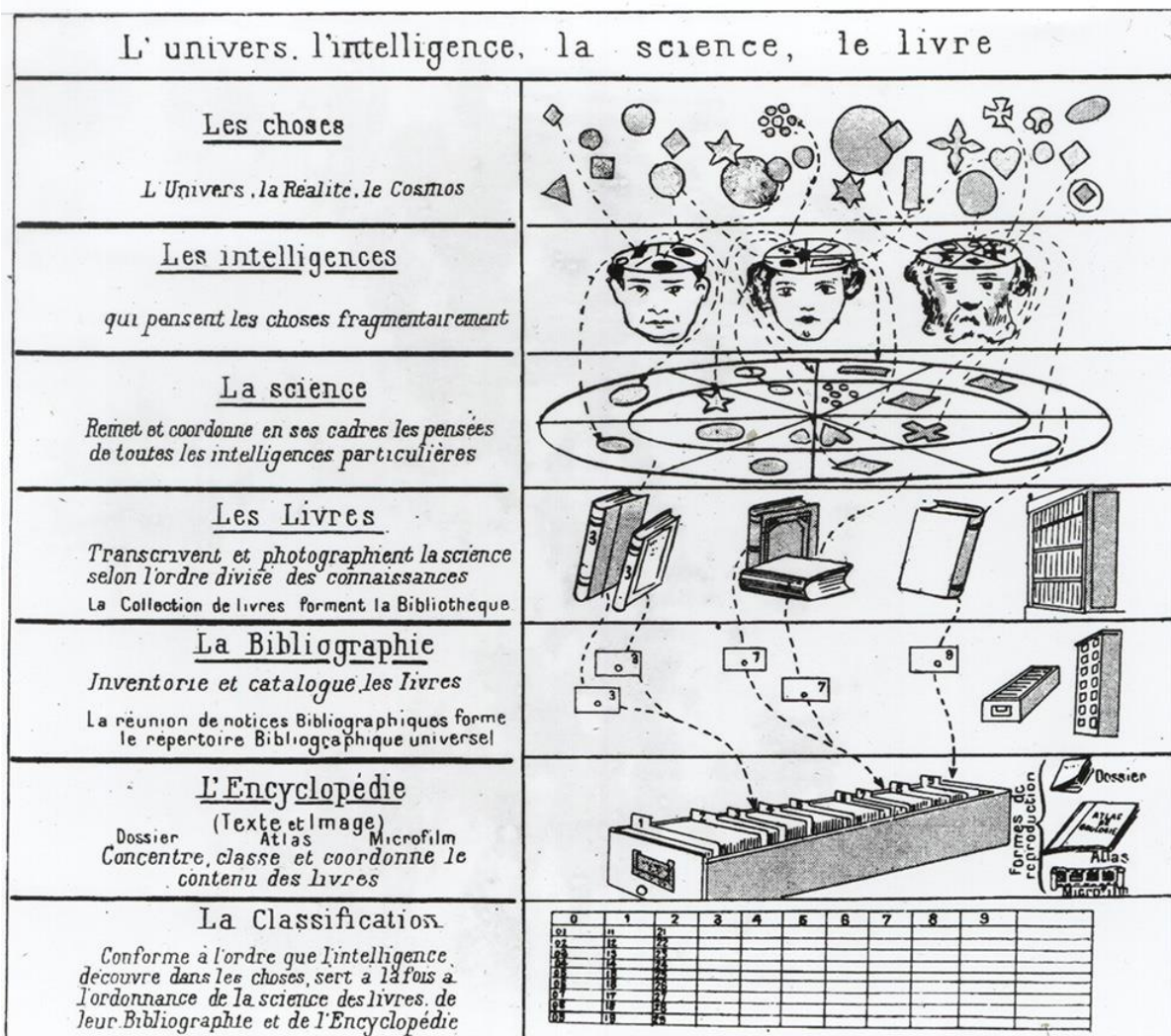


Figure 1 - Otlet's conceptual model of the documentary method. For better access to information, the facts (top section) must transcend the physical limitations of the book, and be incorporated into a card-catalogue repertory from which information can be retrieved by using the Universal Decimal Classification system (Otlet 1934a).

idealistic principles were unfulfilled in favour of having to perform routine acts of judicial and administrative procedure (Rayward 1975; Wright 2014).

Otlet's truncated legal career, however, was not a total loss: he first met La Fontaine as they both worked on compiling Picot's compendium of Belgian law, *Pandectes belges* (Wright 2014), and he was impressed by the degree of information organisation apparent in the legal sector: it was well-served by subject-specific abstracting and indexing journals, and the detailed and precise vocabulary – and even the bureaucratic procedures that Otlet himself detested carrying out – were a useful model for applying the same principles to other disciplinary areas, and indeed on a universal level (Rayward 1975). In an early essay published in 1892, *Un peu de bibliographie* ("Something about bibliography"), Otlet (1990d) first expressed his ideas on the subject: acknowledging an unsustainable proliferation of all types of scientific and academic publication in recent decades, he proposed a new philosophical unity rooted in a grand synthesis of human knowledge. This could only be achieved through a radical repurposing of librarianship and bibliography as it then existed: instead of merely recording bibliographic details such as the author and title of a work, the *documentalist* should break down the informative content within a book, journal article or similar

publication into individual facts, before filing them in a card-catalogue index that should allow for the searching, retrieval and interpolation of such facts to create “a kind of artificial brain” (Otlet 1990d, p.17) or (as expressed in a later 1903 essay) a Universal Book, which, by setting out information in an analytical way with no superficial or extraneous material, would “replace chaos with a cosmos” by “constituting a systematic, complete and current registration of all the facts relating to a particular branch of knowledge” (Otlet 1990f, p.83). Such a monumental undertaking could only be carried out through extensive international co-operation, requiring the establishment of a series of international organisations and a commitment to world peace to facilitate the process (Otlet 1990a). These founding principles form the basis of all of Otlet’s later work, which he also represented in illustrated form (Otlet 1934a, see Figure 1 above; Otlet n.d. *Indexation de publications...*).

The era dating from the 1890s to 1914 consisted of a tumult of activity for Otlet and La Fontaine. In addition to the establishment of the IIB and UIA, plus a plethora of other similar international associations and periodical publications in order to support them (Rayward 1997), they also established the Universal Bibliographical Repertory (RBU), their attempt to create the “artificial brain”, and, having discovered the Decimal Classification devised by Melvil Dewey, adapted it into what was subsequently named the Universal Decimal Classification as the perfect tool for classifying, and thus retrieving, information stored in the RBU (Foskett 1973; Van Den Heuvel 2010). This was a period of triumph for Otlet: the IIB secured backing from the Belgian government and its related exhibits were housed in the Palais du Cinquanteaire in Brussels and named the Palais Mondial; the international associations enjoyed fruitful collaborations with a number of interested partners; regular conferences on bibliographic co-operation and displays constituting international expositions attracted large and enthusiastic audiences; and the RBU (despite widespread scepticism from the bibliographic establishment) contained almost nine million records by 1913, with over a thousand requests made to consult it across the course of the previous year (Rayward 1975). He and La Fontaine also received what they regarded as a symbolic seal of approval for their work when the latter was awarded the Nobel Peace Prize in 1913 (Wright 2014).

This progress, was however, reversed by the outbreak of war in 1914. The ravages of the four-year conflict (including the death of Otlet’s own eldest son (Wright 2014)) and the punitive Treaty of Versailles that concluded it, and the growth of political nationalism and geopolitical polarisation that followed during the inter-war years, shattered the liberal, internationalist outlook under which his work had flourished during the Belle Époque (Rayward 2003). Nevertheless, Otlet’s belief in the need for international co-operation to achieve a new form of information management in the form of a universal repertory remained undimmed. Indeed, he began to envision an even greater degree of intellectual and organisational integration and synthesis: the information tools and technologies should form the basis of an international network supported by the relevant associations and organisations, and crowned by a World City, the plans for which he laid out in some detail (Otlet 1929). The entire infrastructure would be named the Mundaneum, which, in the words of Wright (2014, p.186), forms “both an architectural plan and a metaphor for a new, enlightened form of civilisation”. Again, Otlet also represented the Mundaneum graphically: an example of this is Figure 2 below, which shows the World City (“Civitas Mundaneum”), the

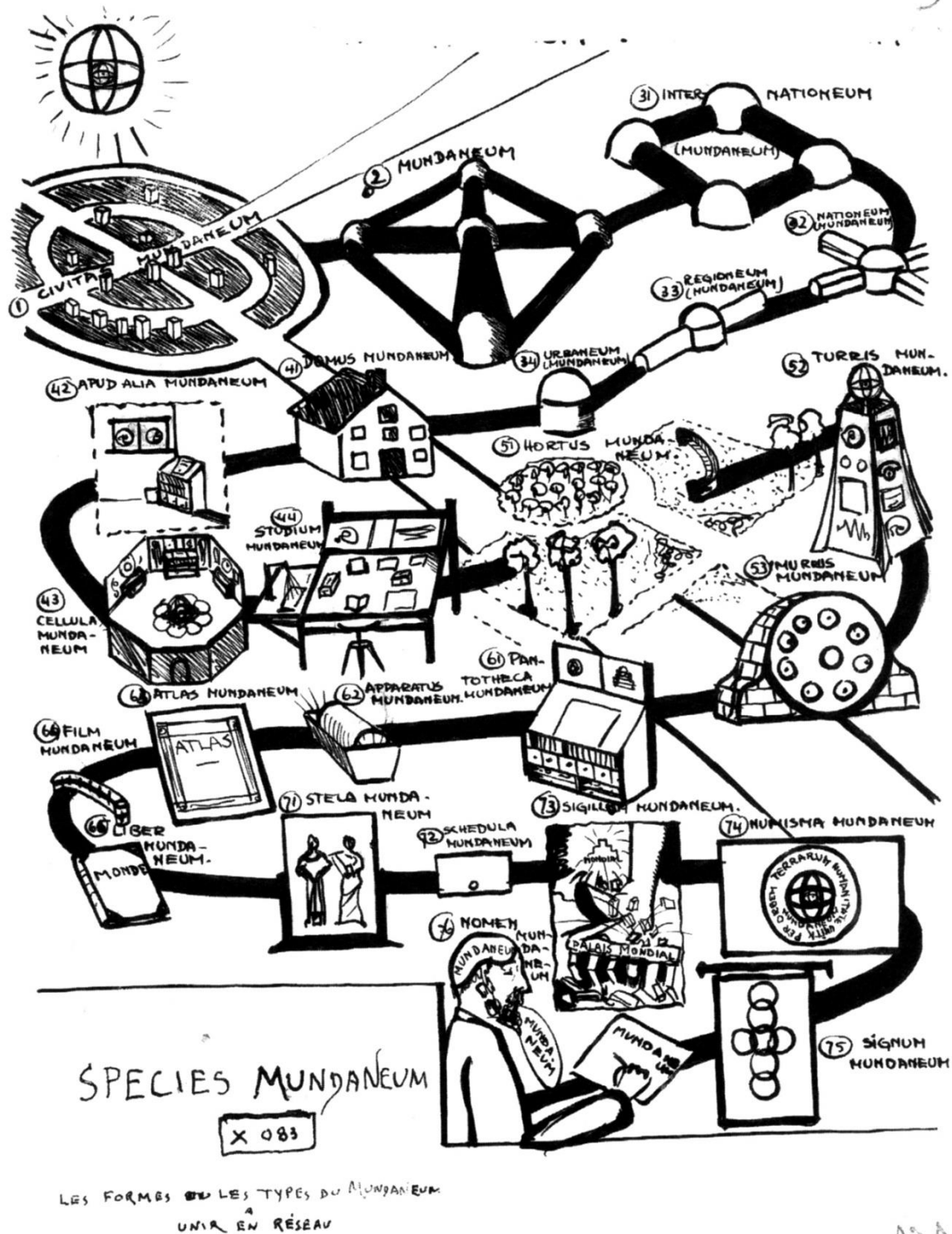


Figure 2 - Otlet conceived the Mundaneum as both a series of institutions and the network that would link them all together. The Mondothèque is number 61 in the scheme (Otlet n.d. *Species Mundaneum*).

central repository of information itself (“Mundaneum”), filtering down into individual people’s homes through different forms of media, including books, atlases, films, microfilm, and speculative technology such as a multimedia work-desk, the Panthotheca Mundaneum

(elsewhere called the Mondotheque; see Figure 3 below). The different instantiations of the Mundaneum are all linked together in a network (Otlet n.d. *Species Mundaneum*).

Otlet's ambitions were not matched by the reality of the contemporary reality: the Palais Mondial, including the RBU, housed in the Palais du Cinquantaire was partially evicted from the premises in 1924, the year that the word "Mundaneum" first appeared in one of his publications, marking the beginning of a protracted struggle to regain the right to use the space that ended with permanent ejection in 1934 (Rayward 1975). Collaborations with architects Henrik Andersen and Le Corbusier to design his projected World City fell through (Wright 2014), and similar partnerships with like-minded individuals, such as Patrick Geddes and Wilhelm Ostwald, were eventually discontinued due to underlying differences of opinion (Chabard 2008; Wright 2014). He was also effectively side-lined from his work in the IIB in 1932, when it came under the leadership of the more pragmatic Donker Duyvis and repudiated the reasoning behind the RBU in favour of more practical projects (becoming the FID in 1937) (Rayward 1975). Nevertheless, Otlet remained active, pursuing projects such as the creation of an *Encyclopaedia Universalis Mundaneum* on microfilm (Wright 2014), and receiving a warm reception at the World Congress for Universal Documentation, held in Paris in 1937 (Rayward 1975). Now less involved in practical day-to-day projects, he, in the words of Wright (2014, p.225), "increasingly turned his attentions inward, retreating to the intellectual cocoon that had enveloped him in his youth. He began to reflect and refine his conceptions of the ideals he had championed over the years: universal knowledge, world peace, and, most mystically, humanity's potential for transcendent realisation." This was realised through the publication of his magnum opus in the form of a trilogy: *Traité de Documentation* (1934), *Monde* (1935) and *Plan Belgique* (1936) (Otlet 1934b; Otlet 1935; Otlet 1936). His perseverance and defiance were poorly rewarded, however, as in his final years he saw his collections abused by the invading German army before dying during occupation (Wright 2014).

Predictions and analysis

Otlet's predictions about future information technology were shaped by his personal characteristics and philosophy. Rayward (1975, p.11) notes the effect of his isolated childhood and the religious fervour of his formative education on his psyche: "It probably increased and certainly gave direction to his tendency to introspection [...] It seems from his earliest years he was burdened with an almost morbid sensitivity to the problem of finding a goal for his life and of following rules of conduct proper to it and his station." Combined with a contemporary explosion of information, typified by the development of the telegraph (Standage 1999), and the prevailing "Belle Époque" intellectual milieu of a belief in the power of scientific and technological progress in improving the human condition, spread across the world under the aegis of supposedly benevolent European imperialism, this created a powerful impression on the young Otlet: whilst still a young man, his diary entries indicate a conviction in the power of a general, unifying synthesis of knowledge to enhance social and even spiritual development that remained with him for the rest of his life (Rayward 1975). Some fifty years after his first forays into bibliography, he wrote that the ultimate goal of his life's work was to create within humanity "a pure spirit with access to complete and intuitive

knowledge of all things at every moment” (Otlet 1934b, p.427). His philosophical debt to the positivist school of philosophy, in particular the thinking of Auguste Comte, has been much discussed (Frohmann 2008; Day 2014), as has his place in a tradition of would-be universal encyclopaedists reacting to a perceived explosion of available information and the problems that this entails: Wright (2014) links his work back to Conrad Gessner’s *Bibliotheca universalis* of 1545, and So (2004) traces the tradition further back in time, to antiquity. Otlet’s philosophical and moral framework was thus conventional for its time, but his innovation was to integrate the process of factual synthesis, hitherto largely an individual or discrete project (as in a compilation of a single encyclopaedia), into a network of international associations, creating a worldwide bibliographic infrastructure that would ensure permanent accuracy, timeliness, and continual improvement of the information. He advocated the role of international associations as agents for this mission as “these alone were general enough, sufficiently all-embracing in their spheres of activity, and disinterested enough, to achieve the desired goal” (Rayward 1975, p.280). All of these influences, combined his own personality, resulted in what Levie (2008, p.39) characterises as “the Otletian will to reorganise the world”.

Otlet’s philosophy of positivism resulted in his conception of a document as something that was defined by its factual and informative content, not its bibliographic form. Having established the existing problem of the excessive publication of information in *Something About Bibliography* (Otlet 1990d), he argued that the concept of the book was actually a minor node within a hierarchy in his 1903 essay, *The Science of Bibliography and Documentation*: books were a form of printed documents, which were in turn a form of “writings”, which in turn were a form of graphic documents, which only then, combined with other forms of objects, formed the low-level concept of “knowledge and understanding” (Otlet 1990f). This knowledge, separated from the limitations of the book, its physical “carrier”, could be broken down into its component facts, which could then be classified, indexed, interpolated and otherwise manipulated. This feature of Otlet’s thought is known as the Monographic Principle (Rayward 1990; Van Den Heuvel 2010). Thus the carrier of information was removed by several levels of abstraction from the far more important consideration of the informative content itself, which should become the main focus of a new form of science, namely documentation. The purpose of this academic field of study, research and professional practice was to synthesise and systematise knowledge, and to ensure its ready availability (Otlet 1990f). He also advocated the documentary method, which consisted “in having recourse to documents in order to extract facts and information from them for the acquisition of knowledge, for study or for scientific research, and complemented “other methods of investigation: observation, experimentation, deduction” (Otlet 1990g, p.105). The primacy of synthesised knowledge is clearly demonstrated by an illustration displaying it at the apex of a pyramid, supported by encyclopaedias, the catalogue-card index within the RBU, and basic books within a library at the bottom (Otlet n.d. *L’organisation de la documentation*). The identification, synthesis, indexing and retrieval of these facts would be best supported by an infrastructure of bibliographic tools, most obviously the RBU, which would in turn be maintained at their optimum levels of functionality and efficiency by the close co-operation

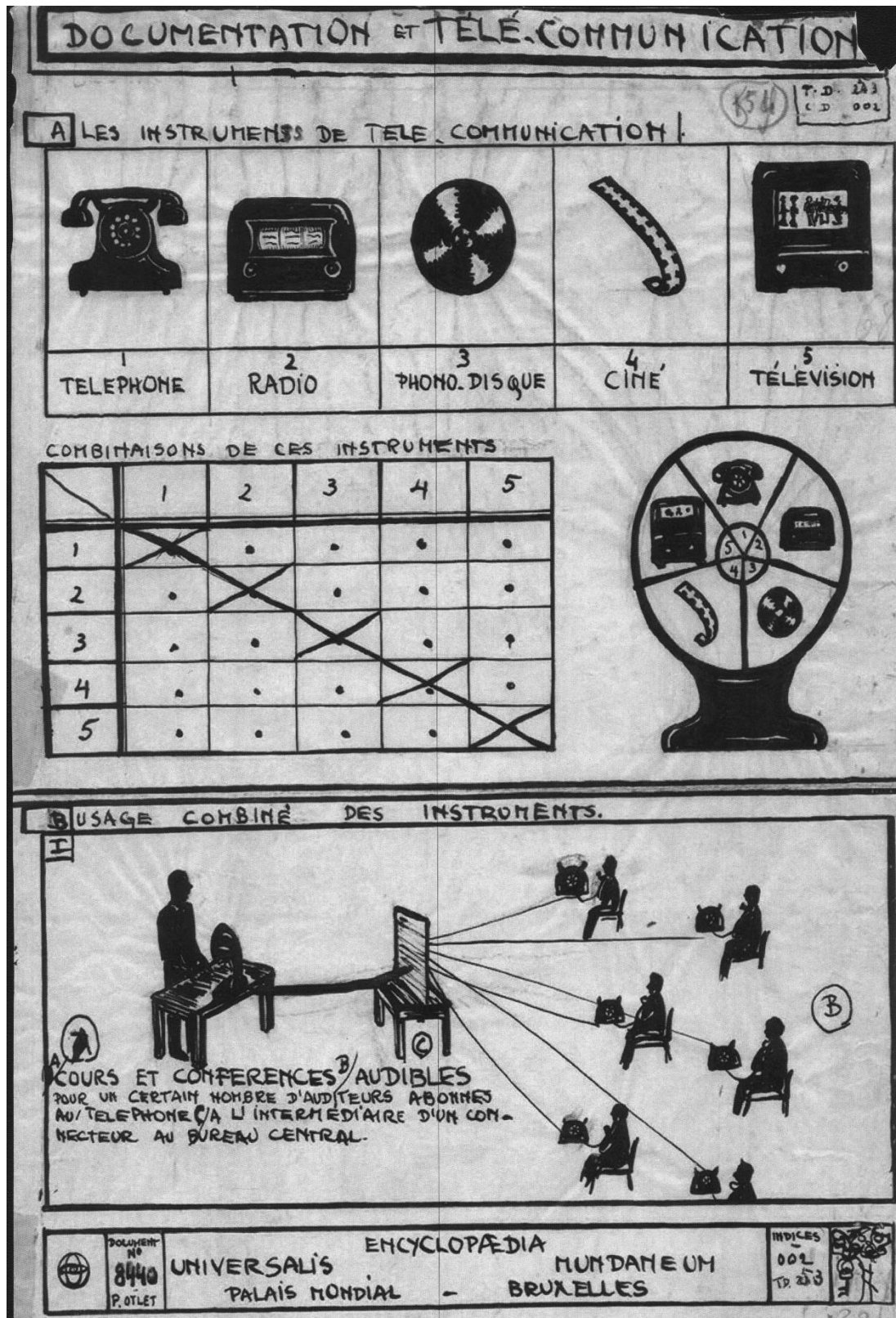


Figure 3 - Otlet was keenly interested in emerging forms of technology, and envisioned a future in which they were synthesised, just as his documentary method synthesised information (Otlet n.d. Documentation et télécommunication).

of a closely linked array of international associations (Otlet 1929; Otlet 1990a; Otlet & La Fontaine 1990; Van Den Heuvel 2010).

Otlet therefore welcomed new forms of technology and media that promised to complement the book, thereby transcending the limitations of a single carrier of information. During a 1908 lecture on the form, function and future of the printed book, Otlet predicted that the book itself would not change, but that information would be conveyed increasingly in a variety of different forms (Otlet 1909; Van Den Heuvel 2010). In particular, he praised radio as having the potential to create “a universal network that would permit the dissemination of knowledge without limitation” (Otlet 1909, p.29); he later heralded the advent of television in much the same way after the War (Otlet 1990e). Recognising the convenience of storing and transporting information miniaturised on microfilm, he wrote on the subject throughout his life, predicting a “Universal Network of Documentation” that would be made possible through a widespread adoption of the medium (Otlet 1990c; Otlet 1990e), and collaborated with his compatriot, Robert Goldschmidt, to improve the technology, before publishing a series of reference works in the medium in the 1920s and 1930s (Rayward 1975; Wright 2014). As part of his desire for an information synthesis, he was a prolific producer of drawings, charts, schemas and other graphical representations of his ideas – suiting his love of an ordered hierarchy of international associations – and was receptive to the opportunities of exhibition spaces in museums, libraries and other public spaces (Day 1997; Buckland 2012; Wright 2014).

However, Otlet’s attempts to realise his ambitions were continually frustrated by both the technological limitations of his time, and as Rayward (1975, p.3) expresses it, the persistent “indifference of governments to problems of co-operation in the dissemination and bibliographic control of information”. His predictions about future information technology were therefore set out most clearly in his late trilogy of utopian, grandiose works, which – unfettered by the need to achieve immediate, practical results – laid out a comprehensive philosophical justification for, and conceptual networked model of international bibliographical associations to facilitate, the free flow of information (Rayward 1975; Wright 2014). These were collectively termed the Mundaneum, which, as Van Den Heuvel (2010, p.216) notes, began as a project for a real building to house the headquarters of these information institutions, but also came to be used as “an architectural metaphor of knowledge organization and dissemination on a global level”. Otlet himself, in *Traité de Documentation*, wrote that “the character of the book, being an ‘architecture of ideas’, of intellectual data, requires the consideration of the enormous revolution [of] architecture itself accomplished in our days” (Otlet 1934b, p.100). His prediction for further events was for the machines themselves to be synthesised, just how this was already done to the informative content itself through the documentary method (see, for example, Figure 3); he proposed a list of functions which these machines must be capable of performing (speech-to-text; unlimited copying of information; permanent links and relationship identifiers for each document; automated classification, filing and retrieval; and “mechanical manipulation at will” to create to combinations, relationships and operations of data), resulting in a “mechanical, collective brain” (Otlet 1934b, p.391).

Developing these ideas, Otlet imagined a future “Universal Book” that could be condensed into a single scholar’s desk for “maximum consultability”. In this way, the information infrastructure represented by the Mundaneum would become “an annexe to the brain, a



Figure 4 - The Mondothèque was drawn as a theoretical device only, but a replica was built for the modern-day Mundaneum museum. Otlet's original sketch hangs above it. (Photo by the author.)

substratum even of memory, an external mechanism and instrument of the mind but so close to it, so apt to its use that it would truly be a sort of appended organ, an exodermic appendage". It would take the form of "a screen connected to a telephone", facilitating the display of requested information instantaneously, and would also be linked to a microphone,

which the user would use to make enquiries of the machine (Otlet 1934b, p.428). In *Monde*, he further expanded on this prediction, envisioning “an instrumentation acting across distance [i.e. networked] which would combine at the same time radio, x-rays, cinema and microscopic photography. All the things of the universe and all those of man would be registered from afar as they were produced. Thus the moving image of the world would be established – its memory, its true duplicate. From afar anyone would be able to read the passage, expanded or limited to the desired subject, that could be projected on his individual screen. Thus, in his armchair, anyone would be able to contemplate the whole of creation or particular parts of it” (Otlet 1935, pp.390–391). Van Den Heuvel (2008) has noted that this armchair analogy is remarkably similar to Tim Berners-Lee’s own idea for the modern Internet: “an armchair to help people to do things in the web of real life” (Berners-Lee & Fischetti 1999, p.178). Otlet also sketched an idea of what such a machine would look like in the present day (allowing for technological limitations): the *Mondothèque* (Figure 4), a form of reference cabinet, contains a personalised section of the RBU, a selection of Mundaneum reference works, including maps and atlases, and multimedia capabilities – a telephone, a radio, a microscope and other devices are integrated into the machine (Otlet 1941; Van Den Heuvel 2010). He also predicted a series of “electric telescopes” that could search documents from afar (Wright 2014, p.8), social media in the form of space for comments surrounding individual documents (Wright 2014, p.9), and a network linking individual devices to the Mundaneum, which he described as a “réseau mondial” (“worldwide network”) and which Van Den Heuvel has characterised as an “analogue World Wide Web” (Van Den Heuvel 2008; 2010). His advocacy of establishing links between documents has also been compared to the later development of hypertext on the Internet (Wright 2014), although Rayward (1994b) concludes that the two are conceptually different: Otlet’s links are based on the relationship of verifiably true facts to one another, whereas modern information retrieval via hypertext is centred on the individual, subjective needs of the user.

Nevertheless, it is widely agreed that Otlet’s work is of significant importance in predicting the development of the Internet age and its underlying technology, in addition to his more general views on documentation and international associations (Rayward 2003; Van Den Heuvel 2010). Wright (2014) in particular argues that he deserves more attention as an Internet pioneer than he receives in the standard Anglo-American historiography of the subject. It is clear that his predictions about future information technology were based on a personal philosophy that he abided by consistently throughout his life: information improves society, so having quick, easy access to accurate and trustworthy factual material is imperative in an age when people are affected by a proliferation of scholarly publications. This idealism combined with his natural capacity for organising, synthesising and systematising published material, developed to an extremely high standard during his career as a bibliographer and documentalist, enabled him to develop an overall, lifelong project that encompassed the technical, social and philosophical aspects of information organisation, and also for him to make predictions in terms of not just the bibliographic processes and individual scholars’ research tools of the future, but also how these contributed to the greater good of the continuing intellectual development of humanity.

II – H.G. Wells

Life and works

Herbert George Wells (1866-1946) was an English writer, journalist and political activist, who is best-known today for his pioneering works of science fiction such as *The Time Machine* (1895), *The Invisible Man* (1897) and *The War of the Worlds* (1898) (Sherborne 2010). Along with his elder French contemporary Jules Verne, he has been described as “the father of science fiction” (Roberts 2000, p.48). However, his total literary output was much wider, spanning the late nineteenth century to the year of his death, and covering other genres of fiction, non-fiction works of social criticism and journalism, and also scientific textbooks (Rayward 1999). Haynes (1980, p.1) describes him as “the most prolific author of any stature in his generation, and certainly the most widely read of his contemporaries”, as well as a profound influence on younger writers, the first wave of whom used him as a model to attack the socio-political establishment, before later generations themselves reacted against him. Although his work immediately within the scope of this research project, a collection of essays and lectures published in a single volume entitled *World Brain* (1938), produced late in life and forming only a small part of his oeuvre, it represented the culmination of much of his earlier thinking: a synthesis of modernism, utopianism, and social progress through scientific and technological developments facilitated by access to information (Rayward 1999). Rayward (2008, p.223) also states that Wells “epitomises [the] conjunction of modernism and the information society”.

From a working-class family, Wells was unsuccessfully apprenticed to a draper and then as a chemist’s assistant as a teenager. His love of literature began when he perused the private library at the country house, Uppark, where his mother was a domestic servant. The collection included classic utopian works such as *The Republic* by Plato and *Utopia* by Thomas More, which were Wells’s first contact with the genre (Sherborne 2010). After the failure of his apprenticeships, he was able to return to education, sporadically at first, as a pupil-teacher (an older student who supervised his younger classmates) at a National School in Somerset and then Midhurst Grammar School, before winning a scholarship to the Normal School of Science in London in 1884, where he studied biology under the tutelage of Thomas Henry Huxley, the noted advocate of Charles Darwin’s evolutionary theories; notions of biological science and evolution played in an important role in his later theories of social development, culminating in *World Brain* (Kemp 1996). He also, through the School’s debating society, developed a socialist political outlook by associating with the Fabian Society. Reaching the conclusion that the contemporary geopolitical situation would inevitably lead to wars and civil strife between nations, he developed a belief in the advancement of humanity through the creation of a single world state – first referenced in the 1901 work, *Anticipations* – which remained consistent for the duration of his life (Partington 2003). In the early twentieth century, he produced a number of utopian novels, most famously *A Modern Utopia* (1905), which explored themes that he was to develop over the coming decades (Sherborne 2010). He further developed these ideas in *The Open Conspiracy* (1928), in which he called upon thinking people across the world to pool their expertise and knowledge into a common

infrastructure which could impose a benevolent new world order, governed by technocrats according to scientific principles for the benefit of all (Wells 2002).

After the conclusion of the First World War, Wells, who had become frustrated with the obsolescences and petty nationalisms of contemporary education systems which limited international co-operation and restricted the free flow of information necessary to advance humanity through scientific progress and the creation of a new world order (Partington 2003), authored a series of works which were grandiose in scope, popular in appeal, and intended to form a trilogy illustrating the universal principle linking universal biological development with human social and economic history (Rayward 1999). Beginning with *The Outline of History* (1920), he continued with *The Science of Life* (1930) and *The Work, Wealth and Happiness of Mankind* (1931) (Sherborne 2010), a trilogy whose forward-looking, anticipatory nature was complemented by his contemporary novel, *The Shape of Things to Come* (1933) (Rayward 1999). These sweeping, general works allowed Wells to develop and combine his ideas into a synthesis in which biology, history and society were all governed by the same evolutionary imperative to progress or face destruction, either from internal forces or external forces (Kemp 1996; Partington 2003). In *The Science of Life*, he described human social life as being the latest and greatest product of biological evolution, and the rapid and ongoing improvement of the individual's mental faculties through various forms of documentation to aid memory and form a collective knowledge bank as the latest form of humanity's social development in turn (Rayward 1999). In *The Work, Wealth and Happiness of Mankind*, which Wells (1938, p.1) himself described as "the only attempt to bring human ecology into one correlated survey", he listed the ongoing achievements of humanity, from the early development of agriculture and materials science to the contemporary and ongoing "abolition of distance", the eradication of hunger and many forms of disease, and the mechanisation of labour, yet also noted that its capacity to manage and access its published information was not yet up to the same standard; he therefore proposed a form of "World Encyclopaedia" in concrete terms for the first time (Partington 2003).

Wells focussed on this aspect of his research for *World Brain*, published seven years later from a collection of essays written and lectures given shortly beforehand (Rayward 1999). He was also influenced by attending the 1937 World Congress for Universal Documentation in Paris, where Paul Otlet was also present (Rayward 1975; Wright 2014), and by meeting with British librarians Alan Pollard and Samuel Bradford, who acquainted him with the technological possibilities for his project that were offered by the development of microfilm (Rayward 1999). The main argument in the collection is that the problem of rapid change in human society has not been matched by its intellectual apparatus or its educational system; therefore, the rapid establishment of one through universal international co-operation is necessary to construct the eponymous "World Brain" and thus avoid destruction through conflict and war (Wells 1938), the sense of which was heightened by the deterioration in international relations that was taking place at the time and would soon lead to the Second World War, which Wells had long warned would occur without fundamental changes to global governance (Partington 2003). By this stage of his life, however, Wells – although still internationally admired and respected as a writer and thinker – was now somewhat out-of-step with the prevailing intellectual climate: his utopian ideals, held since the Belle Époque

era of his youth, were frequently treated with indulgence, whilst his political tendencies towards socialism within a universal polity attracted suspicion in a world which had just undergone the ravages of wars caused by the actions of an authoritarian state, and which was increasingly polarised between capitalism and communism immediately afterwards (Sherborne 2010). In his final decade of life, as many people believed and as George Orwell remarked, “Wells is too sane to understand the modern world” (Orwell 1941).

Predictions and analysis

Wells’s first detailed exploration of his World Encyclopaedia concept in the magisterial *The Work, Wealth and Happiness of Mankind* (1931), a grand survey of human social and economic development that explicitly mirrored the biological “progress” of evolution discussed earlier in *The Science of Life* (1930) (Partington 2003). The book is presented as a series of humanity’s achievements over natural obstacles: for example, how the invention and development of agriculture has eliminated famine (in the well-developed countries at least), and how the development of medicine has eradicated many often fatal and previously widespread diseases; near the end of the volume, Wells covered the history of education and noted its shortcomings, observing that there was a general lack of order and coherency in how information was published and incorporated into the collective knowledge of the world (Wells 1934; Rayward 1999). He therefore proposed a theoretical World Encyclopaedia, based on global co-operation and for the benefit of all. It would be “prepared and kept by an endowed organisation employing thousands of workers permanently, spending and recovering millions of pounds yearly, mediating between the original thinker, the scientific investigator, the statistician, the creative worker and the reporter of ideas on the one hand and the general intelligence of the public on the other”. He also imagined it as the centrepiece of a common curriculum, replacing the outdated and “loose-knit” world university system currently in use, receiving state funding and also featuring “a series of informative and demonstrative museums” (Wells 1934, p.795). Conceptually, he envisioned the World Encyclopaedia, and its use as a pedagogical tool, as an intermediary between the expert “sources” of knowledge who would contribute to, and edit, the encyclopaedia entries, and the “general mind” which would collectively benefit from its existence (Wells 1934, p.799). After outlining the general conceptual index of such an encyclopaedia, he made a clear and overt appeal for why such an intellectual apparatus should be constructed: “It would become the central ganglion, as it were, of the collective human brain. It would keep the thought of the world in a perpetually lively interchange. It would be the living source of a true Outline of History, instead of the poor sketch the world buys today, of a lucid Science of Life, of an understandable summary of the business of the world. It would sustain the common ideology of mankind. It would be the world origin of our correlated activities” (Wells 1934, p.802). His desire for a common platform of knowledge as a means of achieving world unity and peace through mutual co-operation and understanding is clearly evident in his writing.

Beginning with an address to the Royal Institution in 1936 on the collective World Encyclopaedia, the following years saw a concentration of Wells’s activity on the subject as he continued to explore his ideas (Rayward 1999). In August 1937, Wells lectured at the World Congress for Universal Documentation in Paris, which enabled him to experience first-

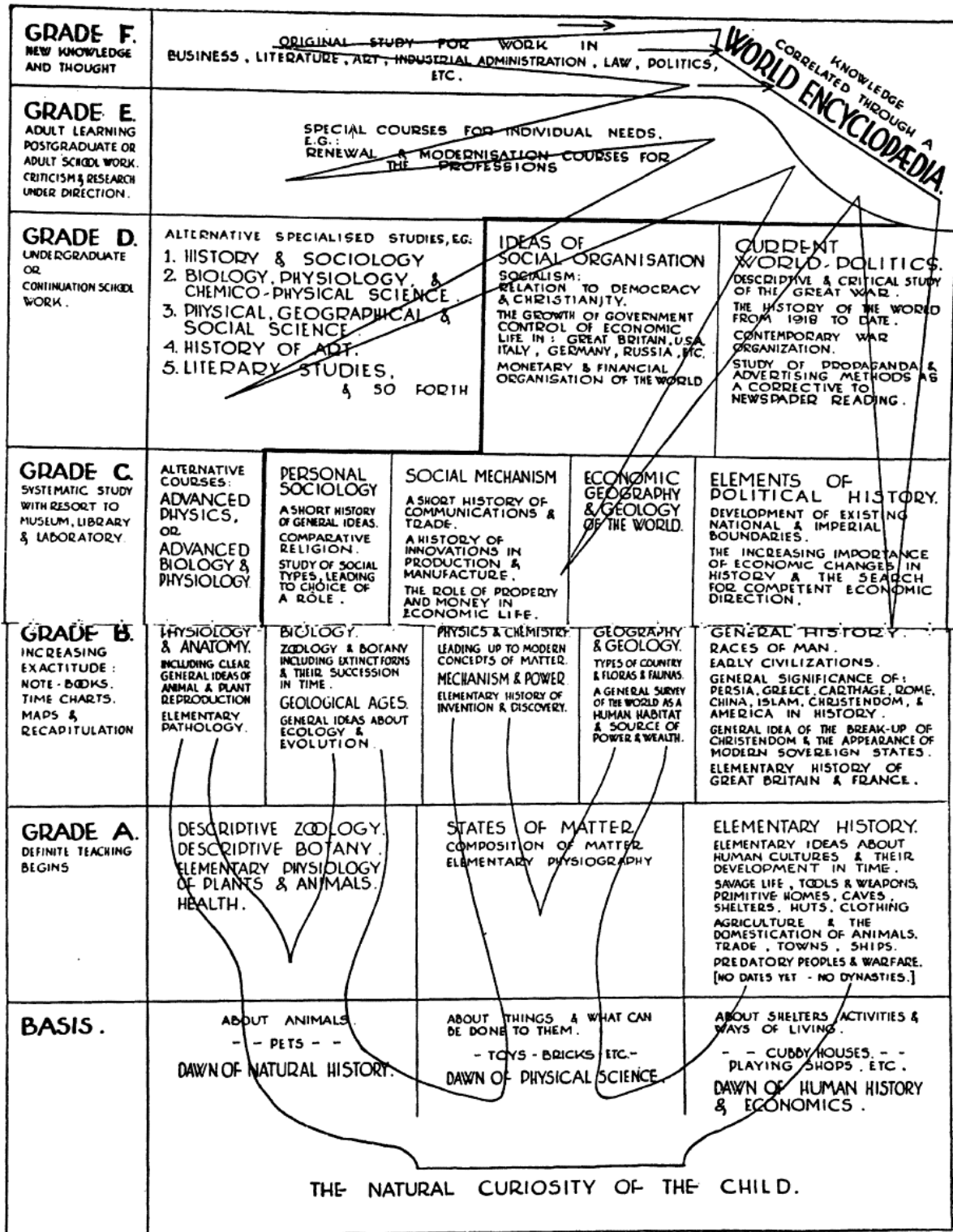


Figure 5 - Wells's diagram illustrating his proposals for a new, global form of education, a strict hierarchy of related subjects and concepts that would all be supported by the background information infrastructure of the World Brain (in this case, the "World Encyclopaedia") (Wells 1938, pp.72-73).

hand the kind of bibliographic technologies, standards and practices that could facilitate the achievement of his ideas (Wells 1938, p.54; Rayward 1975; Wright 2014). In October of the same year, he journeyed to the United States in order to lecture on "The Brain Organisation of the Modern World"; this and other similar lectures, articles and letters which developed

the ideas first expressed in *The Work, Wealth and Happiness of Mankind* were published together in *World Brain* (1938) (Hammond 1999). Through extensive use of the biological analogy of an individual human's body representing the entirety of human society, as influenced by his scientific background, he reached the conclusion that a total reform, even a revolution, of humanity's intellectual organisation was required (Kemp 1996; Rayward 1999). The central argument of this collection is that modern human society has evolved beyond the capabilities of "natural man", and that "he has to be educated systematically for his social role" (Wells 1938, p.vii) through the "raising and unifying, and so implementing and making more effective, the general intelligence services of the world", thus forming "a universal organisation and clarification of knowledge and ideas, in a closer synthesis of university and educational activities" (Wells 1938, pp.xiii–xiv).

Acknowledging that the modern world requires intelligence and awareness from its citizens, Wells described the World Encyclopaedia in easy-to-understand, even mundane terms, as: "a row of [20-40] volumes in [a] home or in some neighbourhood or in a convenient public library or in any school or college, and in this row of volumes [the enquirer] would, without any great toil or difficulty, find in clear understandable language, and kept up to date, the ruling concepts of our social order, the outlines and main particulars in all fields of knowledge, an exact and reasonably detailed picture of our universe, a general history of the world, and if by chance he wanted to pursue a question into its ultimate detail, a trustworthy and complete system of reference to primary sources of knowledge" (Wells 1938, p.13). Existing in an existing form, a written encyclopaedia in volumes, its familiarity would ensure its rapid adoption and ubiquitous use; the real difference from its predecessors would be the quality and accuracy of its informative content. Its content would be extremely similar to Otlet's RBU on a conceptual level, consisting "of selections, extracts, quotations, very carefully assembled with the approval of outstanding authorities in each subject, carefully collated and edited and critically presented. It would not be a miscellany, but a concentration, a clarification and a synthesis" (Wells 1938, pp.13–14), and through regular updating and reissuing of its volumes, and organised across a global network, it "would hold the world together mentally" (Wells 1938, p.14), thus achieving his ultimate goals of socialism (i.e. global unity and co-operation) and world peace (Wells 1938, p.x). He did not have any detailed technical or organisational plans, but suggested the formation of advocacy groups, and also postulated that such a project would become self-funding as it achieved a monopoly on useful knowledge. The collection also contains a great deal of advocacy for specific areas education reform using the World Brain, of which Figure 5 (showing a hypothetical curriculum) is an example (Wells 1938, pp.72–73).

Wells's conception of a World Brain was the natural culmination of his intellectual life; a demonstration of his continual and unwavering commitment to the achievement of social and economic progress through scientific, technocratic means, and the unification of the world's information organisation in order to achieve a shared intellectual polity and thus avoid the wars and conflicts that had punctuated his own life (Partington 2003). Haynes (1980, p.6) notes that he was particularly aware of "the necessity for intelligent control over the progress of technology", as indicated by his numerous comparisons of humanity's collective shortcomings in organising its information when compared to its achievements in other areas,

as laid out clearly and in great detail in *The Work, Wealth and Happiness of Mankind*, and that this would ideally be achieved through a close marriage of science with government. His desire for a universal world order based on a shared intellectual foundation, which the World Brain would assist in achieving, is particularly apparent; as Wells himself wrote in *World Brain*, “my particular line of country has always been generalisation and synthesis [...] I like my world as coherent and consistent as possible” (Wells 1938, p.1). The World Brain also represents a continuation of his Open Conspiracy concept, as he explicitly states that the project is an intermediary between the experts who would benefit society by sharing their knowledge within the apparatus of the World Brain, and society itself as a whole. Rayward (1999) also notes that, although *World Brain* is short on practical ideas on how to turn the concept into a reality, Wells’s contemporary novel *The Shape of Things to Come* features a future society in which the scientists, technocrats and other experts instituted a similar revolution by involving themselves in politics *en masse*. As a scientist by education, a mostly science-fiction writer by vocation and a political activist by interest, it is therefore unsurprising that the World Brain represents a coming-together of all these aspects: the achievement of a utopian state by the application of scientific understanding and principles to disseminate the subjective truth to the world’s populace, skilfully imagined in vivid and inspiring prose. It is equally unsurprising that his vision is glaringly short on technical details and practical organisational suggestions, as he did not have a background in what is known today as information management: his investigations in this area, such as the possibilities of convenient information storage and retrieval offered by microfilm, were guided by those already in the sector (Rayward 1999; Wright 2014).

Wells’s vision of a World Brain, especially its clear biological analogy with our own central nervous systems, has proved to be extremely compelling, and “has been taken to be emblematic of the modern information society as represented by the Internet and the World Wide Web”, with many subsequent projects, Internet-based or otherwise, using similar terminology and rhetoric (Rayward 2008, p.236). So (2004) and Wright (2014) both trace the development of the concept of the world encyclopaedia, focussing on Otlet but also linking numerous later projects directly back to Wells, up to the present day. However, Rayward (1999; 2008) presents Wells as being a cautionary tale in addition to an inspiring figure due to his tendencies towards authoritarianism. Wells’s belief in the power of science to improve science was predicated upon the positive principle of objective, scientific knowledge: the World Brain would include the one true version of human knowledge, perhaps with no room for dissenting opinions. It has also been noted that the World Brain is part of a much larger information apparatus, for example a registry of all the world’s population, first introduced in *A Modern Utopia* (1905), that would enable an authentication system to be integrated within the wider information apparatus (Torres-Vargas 2005; Rayward 2008). Wells was also an advocate of policies which, although apparently for the greater good in logical, scientific terms, are now viewed as chillingly authoritarian and unacceptable in modern society, most obviously eugenics, but also transportation and exile of prisoners (Rayward 2008). Even though Wells himself argued that “we do not want dictators, we do not want oligarchic parties or class rule, we want a widespread world intelligence conscious of itself” (Wells 1938, p.xiv) and that the World Brain’s function would be “knitting all the intellectual workers of the world

through a common interest and common medium of expression into a more and more conscious co-operating unity and a growing sense of their own dignity, informing without pressure or propaganda, directing without tyranny” (Wells 1938, p.23), his belief that improved access to and dissemination of information would automatically result in total unity and agreement seems hopelessly naïve by modern standards. Moreover, his arguments that the World Brain organisation would constitute a kind of “clearing-house” for facts in which people would be compelled to agree upon the one objective truth (Wells 1938, p.15), and that a universal encyclopaedia is by definition universal in terms of admitted opinions (Wells 1938, p.55), seem somewhat disingenuous in the context of his prevailing theme of intellectual unity. It should, however, be borne in mind that the authoritarian states that were establishing themselves in the 1930s were founded on the restriction and censorship of information, and therefore Wells believed that an authoritarian state aiming to achieve the opposite was still desirable. Nevertheless, the legacy of Wells’s World Brain ideology remains mixed, as although the desire for universal access to useful information is generally lauded, the level of control proposed has actually been totally rejected in the case of the decentralised, anarchic modern Internet (Rayward 1999; Wright 2014). Regardless, Wells’s work on the subject remains an extremely important part of the futurology of the contemporary digital age, as the global scope, timeliness of information and spirit of international co-operation and progress that underpins his work closely resembles the Internet of today.

III – Vannevar Bush

Life and works

Vannevar Bush (1890-1974) was an American engineer, inventor and scientific administrator who was one of the leading figures in the emerging field of computer science from the 1920s onwards. An electrical engineer by training, he joined the Massachusetts Institute of Technology (MIT) shortly after graduating, where he worked on the differential analyser, a form of analogue computer, for much of the inter-war period, also co-founding the American Appliance Company (now Raytheon) in 1922. By the close of 1930s, he had served as Dean of the Engineering Department and was already engaged in several national institutional roles; the outbreak of the Second World War compelled him to suggest the creation of a new government agency, the National Defense Research Committee, to President Franklin D. Roosevelt, a proposal which was immediately accepted with Bush as its chairman, before he was appointed Director of the newly-formed Office of Scientific Research and Development in 1941. Following the United States' entry into the Second World War later in the year, the nation's scientific research experienced an unprecedented level of government financial support and public interest, with Bush at its epicentre (Isaacson 2014). In this mood of optimism over the country's potential scientific development, and need for superiority of this development against potential future threats, Bush published his seminal essay, *As We May Think*, in the August 1945 issue of *The Atlantic* magazine, in which he introduced his idea for a device that he termed the Memory Extender, or *Memex* for short (Bush 1945a; Nyce & Kahn 1991a; Isaacson 2014). This essay has been extremely influential in the historiography of the modern computer and the Internet: Wright (2014, p.254) notes that "most contemporary accounts of Web history trace its conceptual origins" to it; Isaacson (2014, pp.221, 263) states that Bush was "the first person who "envisioned [...] the idea of a *personal* computer"; and Nyce and Kahn (1991a) judge that out of all his works and achievements, *As We May Think* is his most important legacy. Bush subsequently lost his national prominence, and his achievements with analogue computers were rapidly rendered obsolete by improvements in digital technology, but as a respected elder statesman within the field, he continued to explore and defend the idea of the Memex throughout his later life (Bush 1967; 1991a; 1991b; Burke 1991; Kahn & Nyce 1991; Owens 1991; Isaacson 2014).

Bush, the son of a Christian Universalist pastor, was a Massachusetts native who attended Tufts College (now University). Pursuing a bachelor's and master's degree simultaneously, he invented the "Profile Tracer" for his thesis: a mechanised device for surveying, which, in the words of Owens (1991, p.29), consisted of "an arrangement of gears, shafts, and servo-driven pens which translated mechanical motion into graphical mathematics", or in other words, essentially a prototype of the analogue computers using automated mechanical means to perform mathematical calculations and functions that he would build later in life. He secured a patent for his machine – the first of 49 that he registered during his career – but was unable to secure a manufacturer to build it in large quantities sufficient for commerce (Owens 1991; Isaacson 2014). Owens (1991) has noticed the influence of recently-completed educational reforms initiated by the work of Gardner C. Anthony in the field of engineering mathematics – favouring signs, graphs and other forms of graphical representation – on Bush's initial years

as an electrical engineer, and his lifelong preference for analogue, rather than digital, technology and computers, as the older technology, as the computations carried out by an analogue device are visible and thus of greater pedagogical benefit, rather than the abstractions carried out within the circuitry of their digital counterparts. After a brief stint working for General Electric and teaching at his old college, he enrolled at MIT, from which (jointly with Harvard) he was awarded his doctorate in engineering in 1916. Joining the faculty of the Electrical Engineering department immediately afterwards, he remained with the university for the next twenty years, rising through the administration and also pursuing numerous business interests (Isaacson 2014).

During this period, Bush's main project – and the one that would occupy him for much of his life – was the development of the differential analyser, a mechanical analogue computer designed to solve differential equations by integration. Although this project drew upon an intellectual history spanning over one hundred years, dating back to Charles Babbage and Ada Lovelace's work on a "difference engine" in the 1820s, the differential analyser conceived and designed by Bush and his colleagues was the first such machine to be realised in a practical, physical form (Wildes & Lindgren 1985; Isaacson 2014). This machine was gradually developed, evolving through later forms such as the Rapid Selector and featuring sponsorship from institutes such as the Rockefeller Foundation, over the course of the 1930s, as Bush became increasingly prominent within the American academic community. He was appointed to several senior administrative roles in the expanding "New Deal" federal government (or organisations closely linked with the government) of President Roosevelt, including President of the Carnegie Institution of Washington, and Vice-Chairman of the National Advisory Committee for Aeronautics (Burke 1991; Isaacson 2014). The most important new technology that was incorporated into the differential analyser was the addition of a photoelectric microfilm selector, the miniaturisation of the medium and improvements in camera technology facilitating the machine's potential use in information retrieval. Although the Russian-Jewish, German-based scientist, Emanuel Goldberg, had already invented such a device (his existing patent preventing Bush from obtaining one himself), Bush's improvements to the design and integration within the differential analyser again resulted in it becoming the first functional machine of its type (Buckland 1992).

By the time of the outbreak of war in Europe, Bush's position as a bridge between the new and exciting field of computer science and the government, in addition to his business acumen, made him the ideal candidate to forge the enduring partnership between the American military, industrial and academic sectors that has underpinned much of the country's scientific and technological development since, including the creation and development of the modern Internet (Isaacson 2014). His prominent positions on the newly-created National Defense Research Committee and Office of Scientific Research and Development gave him the opportunity to heavily influence government funding and public opinion alike. The differential analyser also benefitted from massive government investment and the opening up of potential military uses during the war, but its career was decidedly mixed and it had been comprehensively eclipsed by digital computers by 1960 (Burke 1991). Indeed, Owens (1991) argues that the sudden and significant increase in funding and state interest was wholly unsuited for what had begun as a small-scale project of limited academic

interest, and it was therefore unlikely to succeed in any case. Bush's proposal for a post-war National Science Foundation, despite passing through Congress, was vetoed by President Harry S. Truman, was also a personal blow, although he remained closely involved in governmental and military scientific bodies, and respected as a senior figure in scientific administration, he was gradually marginalised in the development of computer science by a new generation of computer scientists, spearheaded by proponents of digital technology (some of whom were his former students) such as Claude Shannon, J.C.R. Licklider and Douglas Engelbart (Isaacson 2014).

Predictions and analysis

Bush's continued advocacy of analogue technology in computers, which was the preferred technology during his initial invention and development of the differential analyser, yet gradually rendered obsolete by subsequent improvements in technology, and his increasing involvement in the nation's political life, form the contextual framework within which his predictions of future information technology are situated. Bush's early publications were dry, scholarly and limited to technical matters, as one would expect from an electrical engineer. However, an important development in his thinking is illustrated by an essay he published in 1933: *The Inscrutable 'Thirties* (Bush 1991c), a whimsical satire written from the point-of-view of a writer who lives thirty years in the future which marks the shift of his writing from purely scientific to predictive as well (Nyce & Kahn 1991a). Nyce and Kahn (1991a) also note that this shift was a continuation of two contemporary intellectual traditions: first, the general positivist belief in social progress through technological development using the scientific method; second, a particularly American version of this conviction which is focussed specifically on the combination of technology, structures and machines, which they date back to the publication of *Looking Backward 2000-1887* by Edward Bellamy in 1887. Charles Ammi Cutter, an influential figure in American librarianship during the latter half of the nineteenth century, also published such a predictive work – *The Buffalo Public Library in 1983* – one hundred years before the year to which the predictions pertain (Cutter 1883). Bush's essay observed the enormous technological changes affecting all areas of current life, as did the imperfections and imprecisions of contemporary technology, and made numerous predictions, including a reader who would have access to "the contents of a thousand volumes located in a couple of cubic feet in a desk, so that by depressing a few keys one could have a given page instantly projected before him" (Bush 1991c, p.126); Nyce and Kahn (1991a) speculate that he wrote it when his work on the differential analyser first encountered the serious obstacles of contemporary technological shortcomings. Bush's later predictive works on the Memex expand on ideas first expounded in this initial exploration of future technology.

In 1939, Bush wrote another, far more serious essay entitled *Mechanisation and the Record*. Now involved in national scientific administration, he was more aware than ever before of the limitations inherent in contemporary information management, rhetorically asking how one could mechanically improve the book when all other aspects of life were undergoing profound change. Noting that the quantity of scientific literature being published was "expanding faster than man's ability to understand, let alone control, it" (quoted in Nyce &

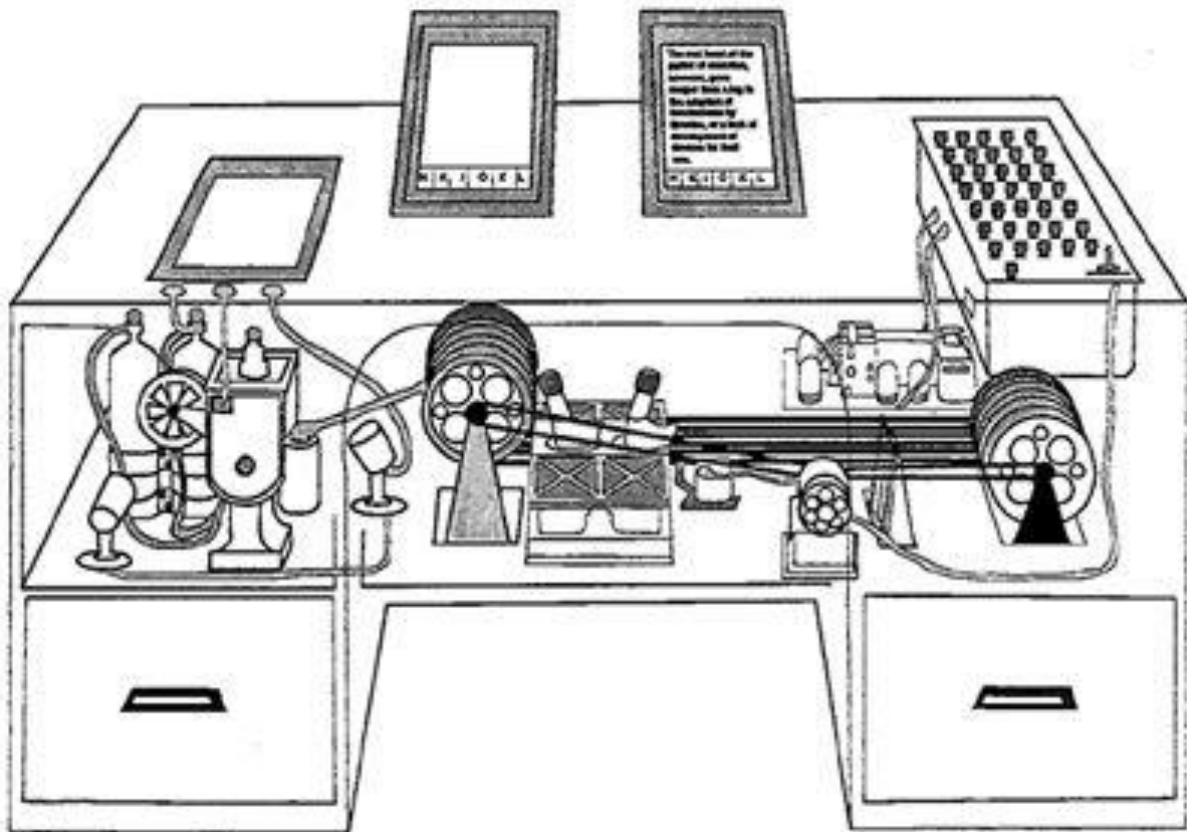


Figure 6 - Bush's *As We May Think* essay was subsequently printed (abridged) in *LIFE* magazine, with an illustration of the Memex by Alfred D. Crimi, drawn from its description in the text and approved by Bush (Bush 1945b). Similarities with Otlet's *Mondothèque* are immediate and obvious, even if the integrated technology is significantly more advanced.

Kahn 1991a, p.42), he divided the progress of humanity into four stages. The initial stages are beneficial: first, one must control one's physical environment (through continued and incremental developments in agriculture, architecture, infrastructure and so forth); second, one must control one's own biological processes (healthcare and medicine). However, the third and current stage – improving the effectiveness of warfare – is extremely dangerous, with a high risk of complete destruction (as proved by the impending nuclear standoff during the Cold War). Humanity's salvation therefore must lie in increasing and improving its collective processes of thought, thus applying science for the benefit of all, rather than its total annihilation (Bush 1967; Nyce & Kahn 1991a, p.52). As most clearly expressed in a later essay, he came to the conclusion that information retrieval was hopelessly outdated compared to other areas of engineering, because not only was human language complex and difficult to translate into a machine-readable form, but also the records used to store information were still based on an increasingly outdated world of handwriting and penmanship that was equally unsuitable for the advantages in speed and efficiency offered by automated processes (Bush 1967). By the end of the Second World War, Bush had developed his thoughts to propose a practical machine – the Memex, short for **Memory Extender** – the purpose of which was to contribute to this necessary and worthy goal. Although the hypothetical device – which has never been constructed, either by Bush or

anyone else² – was essentially a combination of existing combinations that “represents a middle ground between evolution and revolution in design” (Nyce & Kahn 1991a, p.45), it has proved to be an extremely influential idea in the field of computer science, and is widely hailed as the conceptual forerunner of the personal computer (Isaacson 2014; Wright 2014).

The Memex, as illustrated in Figure 6 above, was, in terms of its mechanics, a system of existing technologies integrated within a single unit the size and shape of a scholar’s desk. It was a direct conceptual child of the rapid selector, and utilised similar technology to mechanise repetitive and mundane tasks in order to assist its human user in completing more complicated ones, as explained by Nyce and Kahn (1991a, p.44): “In the rapid selector, low-level mechanisms for transporting 35mm film, photo-sensors to detect coded dot patterns, and precise timing mechanisms combined to support the high-order task of information selection. In Memex, microfilm, photo-optic selection devices, keyboard controls, and dry photography would be combined to create a high-order machine that mirrored and supported the process of the human mind”. Its function was to allow rapid access to a collection of documents held in the user’s microfilm library or repository based on pre-assigned metadata, a coding system, or through an index; then to display selected documents on screens in front of the user, and finally to allow him or her to create links, connections, or, as Bush described it, “associative trails” between them (Bush 1945a). Indeed, Bush made his case for the Memex precisely because it was explicitly a mechanical reproduction of how he believed the human brain worked: by the association of items based on shared characteristics, rather than the existing mechanical system of indexing, whether by using a classification scheme or otherwise, that was extremely slow and cumbersome by comparison (Bush 1945a; Bush 1967; Nyce & Kahn 1991a). Although the Memex was not a networked machine, intended for purely personal academic use without any semblance of a wider hierarchy of information – Nyce and Kahn (1991a) attribute this to the contemporary popularity of the field of information management, which was primarily concerned with the generic, even mundane issues faced by corporations and institutions – Bush also envisioned a scenario in which encyclopaedias and similar reference works would be produced and sold on microfilm with “pre-laid” trails for incorporation into individual machines, and the possibility of colleagues exchanging their personal trails with one another, thus integrating the Memex to some extent within a wider intellectual polity of co-operation (Bush 1945a; Wright 2014).

Despite the immediate and ongoing appeal of the Memex as an idea, first as a realistic prediction of technology likely to manifest itself within the fairly near future, and then as a conceptual forerunner of the similar technology that did emerge later on, it is neither as revolutionary or visionary in its specifics as one might expect, the superficial similarity of the desk console to a personal computer or the list of associative trails to hypertext. Nyce and Kahn (1991a) observe that although Bush’s associative trails undoubtedly influenced the later hypertext model of linking Web documents to one another, in practice this was realised by

² An annotated animation of the Memex in action, complete with voiceover extracts from *As We May Think*, was produced for a conference on Bush’s predictions held fifty years after the essay’s publication (Adelman & Kahn 1995).

the links being set by the creators of Web pages, not their readers; the intensely personal nature of the Memex made its technology inherently unsuitable for a large-scale network. In the field of information retrieval, later Internet pioneer Theodore “Ted” Nelson noted as far back as 1973 that the Memex “runs counter to virtually all work being pursued under the name of information retrieval today” (Nelson 1973), as practical efforts soon resulted in the mechanical indexing of documents according to content to enable mechanical search and retrieval on a universal basis; such projects continue in the form of present-day search engines. The rapid obsolescence of the Memex in terms of the practical application of its specifics stems from the facts that it was essentially a collection of existing technology (albeit in a revolutionary and inspiring way) that is firmly rooted in the analogue computing era of the 1930s that had already seen its inventor produce the differential analyser and rapid selector upon which it was based. Finally, although Bush (1967, p.98) did predict that the successful adoption of the Memex would result in “each generation [receiving] from its predecessor, not a conglomerate mass of discrete facts and theories, but an interconnected web which covers all that the race has so far attained”, each example of the machine was fundamentally an isolated unit, dependent on its user manually adding content to its existing repository, thus rendering it unsuitable for a global network of instantaneous access to newly-available information (Wright 2014). Bush was thus rapidly left behind in the latter decades of his life; although he maintained his predictions of the Memex throughout later essays on the subject, continuing to co-opt contemporary technological developments (such as the storage capacity and erasability of magnetic tape), his final word on the subject was that it remained a dream of the future, albeit a less distant one (Bush 1967). This was a reaction due to both the uneven progress in scientific and technological development since his original prediction, and his continuing relative lack of expertise in digital computing compared to the analogue technology upon which the Memex was founded (Kahn & Nyce 1991). Nevertheless, the machine’s influence at a conceptual level – a personal computer with an enormous memory and the concept of creating dynamic, permanent links between documents – upon Bush’s contemporaries and successors who developed the modern Internet is unquestionable (Kahn & Nyce 1991; Nyce & Kahn 1991a; Isaacson 2014; Wright 2014).

Further analysis

Comparison of predictions

Having completed the individual surveys of the life and works of Paul Otlet, H.G. Wells and Vannevar Bush, and their predictions about future information technologies, there now follows a comparative analysis of these predictions. Before embarking upon a detailed study, however, it is first necessary to see if there is any evidence of these three men directly influencing each other. It is beyond dispute that both Otlet and Wells attended the 1937 World Congress for Universal Documentation in Paris, at which they also gave lectures on their pet projects, the Mundaneum and World Brain respectively (Rayward 1975; Wright 2014). In his earliest published biography of Otlet, based on his doctoral thesis, Rayward (1975, p.356) states that “Otlet met Wells and made ‘magnificent improvisations’”; however, in a later preface to a collection of Otlet’s essays translated into English, he now notes that there is no evidence that they in fact met in person (Rayward 1990). Nevertheless, it is clear that the two men were aware of one another’s ideas and were mutually appreciative: prior to attending the conference, Wells met with British librarians Alan Pollard and Samuel Bradford and the American Watson Davis (all of whom were acquainted with Otlet), who familiarised him with current projects involving microfilm (Rayward 1999). This occurred at the same time that Otlet was pursuing microfilm-based projects such as the *Encyclopaedia Universalis Mundaneum*; it seems extremely likely that Wells was made aware of these projects and was perhaps able to view them using a reader or projector. Whatever the case, Wells paid tribute to the work of trained librarians and bibliographers in pursuing such technologies in his address to the Congress, referring to outsiders like himself as “lay observers” by comparison (Wells 1938, p.63). In a similar acknowledgement, Otlet (1934b, p.428) noted that “Wells certainly would have liked this idea” when writing about his vision of a future desk console connected to the intellectual infrastructure of the Mundaneum in a passage from *Traité de Documentation*. The links between these two figures and Bush are harder to pin down: there is no direct evidence that Bush was influenced by either of them, but it has been noted that he was known for not citing his sources, even when he was aware of similar work that had been carried out previously – most notably, Goldenberg’s inventions that had denied him a patent for the Rapid Selector (Buckland 1992). It is also likely that Davis, an influential figure in American librarianship and computer science, would have acquainted him the work of the two Europeans (Wright 2014).

Regardless of the actual direct influence of the ideas of Otlet, Wells and Bush upon one another, it is obvious that they share much in common. First and foremost, they are nearly identical in their conceptual origin, purpose and eventual aim. At a fundamental level, they all realised during the course of their professional lives that humanity’s collective information management had not advanced at the same rate as other technological improvements (most worryingly, the ability to wage war and sow destruction), and that an overhaul of existing systems, processes and technologies was needed in order to rectify the situation. Otlet’s bibliographic inclinations from a young age, and his early working-life experiences with legal information, impressed upon him the limitations of the book as a physical form and led him to propose his Monographic Principle: that the informative content within a book was more

important than its physical instantiation, and that it could be classified, catalogued, retrieved and reproduced in a multitude of documentary forms. His personal positivist philosophy, typical of the intellectual milieu of his youth, led him to believe that the improvement in communicating and disseminating knowledge that would result from collecting, organising and synthesising this knowledge through a global, hierarchical organisation, would inevitably improve society. The chief obstacle to this utopian vision of world co-operation and harmony was the spectre (and often, during his lifetime, reality) of warfare: thus he was a committed pacifist who believed that the best way to achieve his goals was through the creation and promotion of an array of international associations (Rayward 1975; Wright 2014). Similarly, Wells, having completed his magisterial surveys of biological and human history, came to the similar conclusion that contemporary intellectual organisation was not up to the required standard to avoid destruction through war, warning that humanity risked becoming “the great ape that was clever – but not clever enough. It could escape from most things but not from its own mental confusion” (Wells 1938, p.25). A close contemporary of Otlet, he came to the similar conclusion that the dissemination of objective, true, factual information through a global, networked organisation was the best course of action to prevent this eventuality (Rayward 1999; Wright 2014). Bush, a scientist by vocation who was thus familiar with the limitations of communicating scholarly information, also saw his predicted machine as a solution to the problem of valuable factual content becoming lost, citing the case of Gregor Mendel’s seminal works on genetics becoming lost for a generation as a typical instance of the present malaise, and concluding that “a revolution must be wrought in the ways in which we make, store, and consult the record of accomplishment” in order to improve “how creative men think, and what can be done to make them think” through achieving “compact storage of desired material and swift selective access to it” (Bush 1967, pp.75–76). He also outlined a scheme of human social history similar to that of Wells, with humanity’s salvation from its increased destructive capabilities only achievable through “increasing and improving processes of thought” (Nyce & Kahn 1991a, p.52). Thus each individual’s prediction was a common solution to a common problem.

The common intellectual heritage shared by each of Otlet, Wells and Bush is their persistent use of the analogy of the human brain in relation to the free and unrestricted flow of information within society, and how their predictions would result in an external information infrastructure which complemented the internal workings of the mind. This is most obvious in Wells’s World Brain project, which makes explicit use of the parallels between the human brain and his envisioned system of disseminating knowledge, drawing upon his background in biology and evolutionary science (Wells 1938; Haynes 1980; Rayward 1999). Otlet also used the same analogy, the phrase “a kind of artificial brain” – referring to his system of bibliographic control and synthesis – first appearing in his 1892 essay, *Un peu de bibliographie* (Otlet 1990d, p.17). He used the analogy again over forty years later in *Traité de Documentation*, and also deliberately paid homage to Wells’s work with a separate poster that compared the functioning of international associations during peacetime to a healthy body, and the collapse of these functions during war to the ravages of disease and disability (Otlet 1934b; Wright 2014). Bush also explicitly linked his Memex to the workings of the brain, as the whole concept of creating an associative trail through a series of documents was

directly based on how the human consciousness works; the eventual desired result would be the rapidity of the human mind combined with the permanence of a machine to compensate for the frailties of the human memory (Bush 1945a; Bush 1967; Nyce & Kahn 1991a). This shared biological metaphor of the brain for their predicted information infrastructures was also a manifestation of their common belief in how information should transcend the physical limitations of its traditional bibliographic form. Otlet's proposed new science of documentation was founded upon the principle of separating the fact, or "Biblion" from the effective prison of its containing book, assigning it a classification number and metadata and filing it a universal repertory for easy and universal retrieval, and the ability to reproduce it in a wide form of documentation covering different media types (Rayward 1975; Otlet 1990f). Wells likewise railed against the inadequacies of contemporary universities, encyclopaedias and other pedagogical methods, whereas the synthesis and order of the World Brain would ensure an "intellectual authority sufficient to control and direct our collective life" (Wells 1938, p.48). Bush was similarly aware of the limitations of the traditional book and the inadequacies of existing mechanical methods of information retrieval (Bush 1945a; Bush 1967; Nyce & Kahn 1991a). Thus their solutions aimed to improve the workings of the human brain by effectively creating a much larger external, mechanical version of it, in order to aid the thinking process as efficiently as possible by creating a sort of synchronicity of method.

Otlet and Wells's predictions are particularly similar – they were both pacifists and believers in a form of new world order based around a central World City (Otlet) or World State (Wells). With scientific backgrounds rooted in the positivism of the late nineteenth-century, they also both believed unquestioningly in the existence of a single set of true, objective facts that could be used to advance knowledge and therefore drive the progress of human society. The Mundaneum and World Brain are also similar in many respects – they rely on a bibliographic synthesis of these facts, compiled and edited by experts, disseminated through a global network that, through strong, hierarchical administrative support and continual revision, would ensure timely and universal access to desired knowledge – in effect an extension, albeit a revolutionary one in terms of underlying philosophy and method – of the traditional encyclopaedia (Wright 2014). Both were also keenly interested in new technologies to facilitate their projects, in particular microfilm: Otlet was involved in numerous projects with the medium throughout the twentieth century, whilst Wells, introduced to its possibilities in terms of miniaturisation and for information retrieval shortly before the 1937 World Congress, hailed it as "foreshadow[ing] a real intellectual unification of our race. The whole human memory can be, and probably in a short time will be, made accessible to every individual" (Wells 1938, p.1961). Both have also been criticised subsequently for the authoritarian political tendencies that their projects entail (Rayward 1999; Wright 2014). Nevertheless, there are some significant differences between them, most obviously the fact that Otlet's vision of the Mundaneum was grounded in precise programmes and projects, most notably the creation of a bespoke classification system and an attempt to maintain a universal bibliography repertory, not to mention the multitude of international associations that he and Henri La Fontaine were instrumental in establishing; Wells, without this detailed technical knowledge and experience, was limited to more general pronouncements and declarations, even if the World Brain did represent the culmination of his own previous

intellectual endeavours (Rayward 1999; Partington 2003). On the other hand, he was undoubtedly more astute and imaginative at predicting the social effects of his technological predictions on wider society, given his background in authoring works of imaginative science-fiction and extensive studies of social and economic history (Sherborne 2010). Furthermore, Torres-Vargas (2005) argues that the Mundaneum, with its focus on creating a centralised repository of documentation above all else is more traditional in concept than the World Brain, which anticipates modern digital libraries more closely by concentrating on the dissemination of information through the network, with less importance given to the physical documents themselves and more to the means of distribution. Overall, however, this represents a subtle change of emphasis: the Mundaneum and the World Brain are fundamentally based on the same principles and the same enabling technologies, with the differences that do exist caused by the different professional backgrounds of their progenitors.

The differences between the predictions of Otlet and Bush on the one hand, and Bush on the other, are significantly more pronounced. In the historiography of the proto-Internet, Bush – one generation younger than the others and based in a separate continent during a time when the world was less interconnected than it is today – is usually presented as belonging to a newer wave of figures in the technology’s history. Whereas Otlet and Wells supposedly are the amongst the last people to use purely analogue means to predict the future in this respect, Bush’s vocation as an senior and influential electrical – and later specifically computer – engineer at time when this area of technology was in its infancy, and undoubted influence on his successors, and the relative fame of the Memex compared to the Mundaneum and the World Brain, mean that he is often presented as the father of a new, pioneering digital age (Isaacson 2014; Wright 2014). Nevertheless, it has already been observed that the technology of the Memex was not revolutionary (nor Bush’s love of microfilm, another obvious similarity), merely its assembly, and neither was the concept of its purpose, due to the similarities of Otlet, Wells and Bush’s thought explored above (Burke 1991; Nyce & Kahn 1991a; Owens 1991; Wright 2014). Nevertheless, the Memex differs from the Mundaneum and the World Brain in two key respects. First, it is not inherently a networked device, instead resembling a computer without an Internet connection, depending upon the manual insertion of additional information by its user to determine its content (Wright 2014). Related to this is the second difference: Bush’s writings contain a noticeable lack of a universal, global controlling authority that governs and regulates the workings of the associative trails; instead, the whole infrastructure of the Memex is based upon the personal preferences of its individual users, and even commercialised (for example, he suggests that there may be professional “trailblazers” who create and sell useful associative links (Bush 1967). By extension, he does not mention anything to do with creating a universal, ultimate record of objective factual content – a significant difference in focus from the writings of Otlet and Wells. The Memex also lacks the multimedia functionality of the Mondotheque, its conceptual cousin, including the integrated communication devices, atlases and maps, and Universal Decimal Classification system to organise the resources in such a way that the device can be used by anyone in the same manner (Wright 2014).

Despite these differences in emphasis and approach, caused by the different professions and thus strengths in knowledge and expertise of the three subjects of this research project, it is clear that they all represent a continuation of the same intellectual tradition – to improve human society through improved access to information facilitated by the development of technology and through scientific principles.

Influence on the creation and development of the Internet

The above sections have amply demonstrated how many of the predictions for future information technology made by Otlet, Wells and Bush have been fulfilled, in whole or in part. Otlet's vision of a "réseau mondial", under the auspices of the Mundaneum, and Wells's prediction of a networked brain have been realised through the existence of the Internet, which allows almost instantaneous communication of, and access to, information worldwide. Moreover, the concept of the structure of Web pages and their connections through hypertext was also predicted by both Otlet and Bush (Nyce & Kahn 1991a; Rayward 1994b); Otlet's *Monothèque* and Bush's *Memex* also bear close resemblance to the modern personal computer in terms of facilitating private study through an enormous amount of documentation, whether supplied through the bibliographic controls and revisions of the Mundaneum or an internal repository of microfilm chosen according to the user's wishes (Isaacson 2014; Wright 2014). Yet there are also clear differences between their predictions and the resulting reality: the Internet is based on digital computing, not the analogue mechanisms at the cutting-edge of technology in the early-to-mid twentieth century; although the communication protocols of the Internet are standardised and controlled by a central agency, and other technical details such as Web domain names strictly regulated, the structure of the Internet itself in terms of its use and content are chaotic and anarchic in comparison to the visions of Otlet and Wells in particular, with little in the way of expert moderation of information and widespread anonymity (Rayward 1999; Wright 2014): Wright (2015) in particular contrasts the "flat and open web" of the modern Internet with Otlet's vision of the information infrastructure of the Mundaneum, reliant upon a high level of bibliographic control by trained specialists. Another crucial difference is that of information search and retrieval: modern search engines use indexing techniques and complex automated algorithms involving page views and word occurrences to retrieve results, unlike Otlet's *Universal Bibliographical Repertory*, which was again founded on the assignment of bibliographic metadata and a *Universal Decimal Classification* number based upon its factual content, and Bush's inherently personal trails of association (Nyce & Kahn 1991a; Wright 2014; 2015). What, then, is the influence of Otlet, Wells and Bush on the development of the contemporary Internet?

It is first worth noting the legacy of each man's work. Otlet, although admired for his work in co-founding what is now the *International Federation for Information and Documentation* and co-devising the *UDC*, was largely forgotten for several decades after his death until his work on the science of documentation and bibliography was rediscovered and championed by Boyd Rayward from 1973 onwards (Rayward 1973; 1975; Wright 2014). He has remained a comparatively obscure figure, although his profile has recently been raised by a wide-ranging partnership between the modern Mundaneum and the modern Internet giant,

Google, which was first announced in 2012 (Wright 2014). Wells's legacy, boosted by the fact that he remains a significantly more famous world figure due to his literary output, has survived in a steady stream of "World Brain" projects that continue to the present day, which have come closer than ever before to being realised thanks to the possibilities offered by the Internet (Goodman 1987; So 2004; Wright 2014). The most complete realisation of the universal world encyclopaedia concept expounded by both Otlet and Wells is the Web-based encyclopaedia Wikipedia, which is universal in scope, far larger and complete than its predecessors, and freely licensed. However, although there are a myriad of rules and guidelines in place, it is operated entirely differently: by (usually anonymous) volunteers, and it exists as a registered charity, independent of any direct governmental or existing international association support and influence. In short, it is based on trust rather than expert authority, and can be considered a perfect demonstration of how the larger Internet as a whole differs from the predictions of Otlet and Wells (Reagle 2008; Wright 2014). Bush, by contrast, has had an undoubted influence on the development of the Internet, as many of his protégés and other people who were influenced by *As We May Think* have openly acknowledged the inspiring quality of the essay (Kahn & Nyce 1991; Isaacson 2014). However, it has already been established that the Memex was based on technology that was rapidly becoming obsolete in favour of digital computers, and even that the associative trails that influenced hypertext turned out to be unsuited in practice (Nelson 1973; Nyce & Kahn 1991a). It must therefore be concluded that, due to the technological limitations of the era, the work of Otlet, Wells and Bush has proved most influential on a conceptual level that continues to inspire the current generation of Internet technology developers, rather than the now antiquated practical methods.

This being the case, the current research project concludes with an exploration of a number of ways in which the ideas of Otlet, Wells and Bush have influenced the development of the Internet since its mass adoption in 1993, and how they could continue to influence its future progress. First, one of the most important developments in the history of the Internet whilst it has been in use is the transition to the so-called "Web 2.0" in the mid-2000s (O'Reilly 2005). This has seen a shift in how users interact with the Web: from what were essentially a static series of electronic forms of textual documents with hyperlinks, to far more dynamic, personalised and participatory content, exemplified by the rise of social media (Wright 2014). O'Reilly (2005) identifies the development of the Web as a platform rather than an application or single piece of software, allowing a base from which multimedia content can be shared, tasks can be crowdsourced, and the free exchange of data allows for further degrees of collaboration, creating a virtuous circle of creativity and innovation. This contemporary reality appears to mirror both the pervasive networks of Otlet and Wells that extended beyond simple tools and technologies to influence education, business and human life in general (Wright 2014), whilst the personal nature of social media – the ability to publish personal material and receive content in the form of a "stream" of information tailored to the information – is more than a little reminiscent of Bush's creation of personal associative trails in the Memex. Indeed, Gelernter's (2013) recent predictions of the future Internet resembling a "world stream" is not only an extension of this increasing personalisation, but also a realisation of the global integration forecast by Otlet and Wells (Wright 2014). The

expansion of Internet technology into devices other than computers (“The Internet of Things”) can also be said to fulfil this universalist vision. Finally, although the current Internet is generally chaotic and disordered, it can be argued that the Semantic Web project – which aims to promote common data formats and exchange protocols – is an attempt to establish a measure of bibliographic control over the contents of the Internet, along the lines of that envisioned by Otlet and Wells, and later developed by Ted Nelson’s proposed Xanadu system of hypertext (Rayward 1994b; Van Den Heuvel 2010; Wright 2015). As concluded by Wright (2014) in his biography of Otlet, the issues of power, control and freedom in society relating to the collection, synthesis and dissemination of information raised by Otlet, Wells and Bush, are of continuing, and perhaps even increasing, importance, as their predictions, partially realised through the Internet, become ever more pervasive and ubiquitous in our everyday lives.

Conclusions

Answers to research questions

The objectives of this research project, and the answers to them, as best determined through the course of the preceding analysis, are as follows.

- 1. To identify the predictions about future ICTs made by Otlet, Wells and Bush in turn and analyse them within their broader contexts to determine why they were made (for example, academic or professional background, philosophical beliefs, wider socio-political influences of the time and so forth).**

The predictions made by Otlet, Wells and Bush were firmly rooted in their professional backgrounds, personal philosophical beliefs, and wider societal influences of their era, in particular their shared belief in advancing humanity through applying scientific processes to the collection, validation, synthesis and dissemination of information. They each therefore came up with their own solutions to the common problem of a rapidly increasing proliferation of published information: Otlet envisioned a intricate and over-arching network of bibliographic control through cataloguing, classification and co-operation through the creation of international associations; Wells predicted the reform of the world's educational system through the constitution of a single world state network of information, expressed through biological and evolutionary metaphors; and Bush strove to create a computing device that would combine the rapid ability of the human brain to retrieve information through association with the permanence of machine memory.

- 2. To compare and contrast these predictions with one another, determining to what extent each man's ideas influenced the others and analysing them in order to identify if they were part of a collective intellectual tradition, or whether they are in fact significantly different concepts which have been arbitrarily grouped together in retrospect.**

It is difficult to determine the level of direct influence between these three men (especially in the case of whether or not Bush was aware of the works of Otlet or Wells), but it is clear that they were each trying to solve a common problem through a scientific solution rooted in positivist and utopian ideals, and thus part of the same intellectual tradition. The differences in the practical solutions proposed are due to differences in each man's character, profession and expertise, and are comparatively trivial when considered in the continuum of the history of Library and Information Science as a whole – humanity's pressing and never-ending need and desire to organise its information effectively.

- 3. To ascertain what role their ideas, in both a conceptual and technical sense, influenced the development of the Internet and its associated technology and infrastructure in reality, and whether their importance in this respect in relation to one another has changed as the Internet itself has evolved, such as the relatively recent transition from "Web 1.0" to "Web 2.0" and contemporary debates over issues such as its ownership and neutrality, in addition to ongoing projects such as the Semantic Web (World Wide Web Consortium (W3C) 2015).**

Although the precise practical technologies of the predictions made by Otlet, Wells and Bush proved to be less suitable than the digital computing technology that underlies the modern Internet, their ideas and concepts have been profoundly influential and will continue to do so as the Web continues to develop and becomes an increasingly integral and diverse part of human civilisation.

Evaluation of research project

This research project was carried out through an historical study of the topic by means of an extended literature review, and it is worth reiterating the points made in the introductory section above. It must be remembered that the quality of the research is itself dependent upon the quality of the sources selected in the first place. Furthermore, although the method is verifiable, in that another researcher could repeat the investigation using the same sources, its reliability and validity (like other forms of qualitative research) are beyond the usual scientific standard of proof (Pickard 2013). It is therefore a highly individual method of research, dependent upon the unique biases (whether explicit or latent), background and perspectives that constitute my individual intellectual framework, and this must be recognised as a potential limitation of the project. Nevertheless, I believe that the advantages of this methodology outweigh its potential for undue subjectivity. Ideally, future research into this or a similar topic would validate it by reaching similar conclusions.

I believe that the findings of this research project have significant value to academic research into the history of the Internet, and the futurology of Library and Information Science, as they tie together and amplify the results of previous research that has largely been carried out into solely one of the three subjects. There is little obvious value to LIS practitioners, but I do also believe that having an historical and background appreciation of the subject that underpins one's profession is inherently beneficial.

Suggestions for further research

As argued in the main body of this research project, the predictions of Otlet, Wells and Bush are of continuing relevance and this will continue to evolve in tandem with the ongoing evolution of the modern Internet. It is therefore not unreasonable to say that the exact same topic could be revisited every few years in order to keep up-to-date with changes that have occurred in the interim period.

As also noted in the text, it was difficult to establish whether there was any direct relationship between Otlet and Wells on the one hand, and Bush on the other. A more in-depth project on Bush's life and work in this context, with a greater number of interdisciplinary and primary sources consulted, would therefore also be of value.

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Appendix I – Reflection

Writing this dissertation has proved to be a mixture of emotions for me. On the one hand, it was highly enjoyable to research, as I deliberately chose a topic which particularly interested me when I came across it during the taught part of the Library Science course. I found it fascinating to delve deeper into the works of Paul Otlet, H.G. Wells and Vannevar Bush and what has been subsequently written about them. My visit to the Mundaneum in Mons to conduct further research into Otlet's lifetime project (and, to be honest, just to enjoy the artefacts of his work collected in one place, with the shelves of the remnants of the RBU still filled with their original catalogue cards). I had no problems with finding any of my desired sources and references, and deriving answers to the questions in my original research proposal was straightforward. I have always enjoyed reading, researching and learning about new things, exploring interesting avenues of thought, and building up a coherent mental picture of the issue at hand.

On the other hand, getting all of my thoughts set on paper was more of a challenge, and I am extremely glad that it is all over now. My main problem was that I believe that this research project, in retrospect, was possibly slightly too broad in scope. When reading the finished text, therefore, I am under the impression that I have not written nearly as much as I have found out, in the interests of not making the dissertation far longer than required. I feel as if I have just scratched the surface of the topic – I hope that this is just a vindication of my editing and summarising skills, to produce a synthesis of which my subjects would be proud! Realistically, though, my experience of academia, as both an undergraduate and a postgraduate, in addition to family members and friends who have gone onto higher-level qualifications and even careers in the sector, has taught me that wanting to conduct further research into one's chosen topic is the default state of mind for any self-respecting academic, so perhaps it is only natural to feel like I could have done more.

I believe that I have gained a great deal from undertaking and completing this research project. In terms of academic writing, it is by far the longest and most detailed that I have carried out. I have therefore had to extend my existing skills of historical research and synthesis over a much wider area. On a more practical level, the sheer length of time that I have spent researching the subject and writing it up has improved my personal discipline and, target-setting and time-management skills, which should serve me well in the library jobs for which this degree has prepared me.

Dominic Allington-Smith
September 2015

Appendix II – Original research proposal

Working title

Anticipating the Internet: how the predictions of Paul Otlet, H.G. Wells and Vannevar Bush have shaped the Digital Information Age.

Introduction

This research project aims to investigate the work of three significant figures in the history of information science: Paul Otlet, the Belgian pioneer of the study of documentation; H.G. Wells, the British writer and political activist; and Vannevar Bush, the American computer engineer and scientific administrator. These men are all known for their predictions pertaining to Information and Communications Technologies (ICTs) of the future, and their efforts to achieve these dreams: Otlet's *Mundaneum*, Wells's *World Brain*, and Bush's *Memex*. All of these projects have received a great deal of renewed attention since the emergence of the Internet as a mainstream, publicly-available technology in the early 1990s, and numerous parallels have been identified between their predictions and contemporary reality. There is a particular fascination with the "pre-digital" aspect of these predictions and the constraints of the technological limitations of the time, leading to a general grouping of these concepts together as a form of "analogue internet" (Wright 2014).

This research project therefore rests upon an existing body of research about the work of Otlet, Wells and Bush, and will be pursued through an historical study of the topic by means of an extended literature review. It builds on this previous research by aiming to situate each individual's work precisely in relation to that of the others, and by updating the contemporary aspect of much of the existing research to include the development of Web 2.0, which is typified by its interactive, dynamic and multimedia features.

Aims and objectives

The overall aim of this research project is to examine and appraise the work of Paul Otlet, H.G. Wells and Vannevar Bush, to compare and contrast them with each other, and to determine their influence on the current Internet.

The objectives of this research project are as follows:

4. to identify the predictions about future ICTs made by Otlet, Wells and Bush in turn and analyse them within their broader contexts to determine why they were made (for example, academic or professional background, philosophical beliefs, wider socio-political influences of the time and so forth);
5. to compare and contrast these predictions with one another, determining to what extent each man's ideas influenced the others and answering the question: "are they fundamentally the same with superficial differences, or are they in fact significantly different and have been grouped together arbitrarily?"; and
6. to ascertain what role their ideas, in both a conceptual and technical sense, influenced the development of the Internet and its associated technology and infrastructure in

reality, and whether their importance in this respect in relation to one another has changed as the Internet itself has evolved, such as the recent transition from “Web 1.0” to “Web 2.0” and debates over issues including the Semantic Web and its ownership.

Scope and definition

This research project primarily covers the work of Paul Otlet, H.G. Wells and Vannevar Bush (in terms of primary sources written by them and secondary sources written about them, as outlined more thoroughly in the literature review section below), with a special focus on their predictions on how technology would be used to harness the full power of information, in terms of improving storage, search, retrieval and access. Similar predictions by contemporary figures may also be included in passing as appropriate. A key limitation that I feel is necessary is that the initial predictions should have been made before technological developments made what we would recognise as modern a networked computer system a feasible reality, rather than a distant dream; for this purpose I will use the cut-off year of 1963, the point at which serious work began on ARPANET, which introduced the technologies of packet-switching and the TCP/IP communication protocols that still underlie the contemporary Internet (Isaacson 2014).

To clarify what is meant by the transition between “Web 1.0” and “Web 2.0”, the seminal essay by O’Reilly (2005) is used as a basis.

Literature review

As the research project itself consists of an extended literature review, this preliminary survey is necessarily extremely cursory by comparison, and represents a series of “starting-points” for additional research. A great deal has been written on the topics within the remit of the research project, the overwhelming majority of it focussing on one of Paul Otlet, H.G. Wells and Vannevar Bush whilst mentioning the others in passing.

For Otlet, the first port of call is works by the man himself: his magnum opus is a detailed description of his conception of informative content as a something independent of its physical “carrier”, and how he believes it should be organised through precise documentation by a centralised, international bibliographic authority, including how predicted technologies can be used to achieve this (Otlet 1934b). His idea to create a “world city” of international associations that collect, assimilate and disseminate knowledge is expanded upon in an early work (Otlet 1929), and many shorter essays on similar themes are also available in a translation by Boyd Rayward (Otlet 1990b). The recent Google Cultural Institute Initiative has also resulted in numerous posters, drawings and other visual archive material from the original Mundaneum being made available on the Internet (Google Cultural Institute 2015). Rayward, in addition to translating Otlet’s work, is also his foremost biographer and champion, and has authored a number of works on him; these are variously general (Rayward 1973; 1975), related to specific LIS fields (Rayward 1991; 1997), related to specific aspects of his predictions in relation to ICT (Rayward 1994b), assessing how the importance of his ideas has subsequently increased over time (Rayward 2003), and also a comparative study that also

features Wells (Rayward 1994a). A more recent biography by Wright (2014) has further emphasised Otlet's significance as the Internet has developed, whilst a previous City University Master's dissertation by So (2004) places Otlet's work (with reference to Wells and Bush as well) in the context of the World Encyclopaedia paradigm and how that has also evolved in line with the development of the Internet. Buckland (1997; 2012) and Day (2014) have also analysed the significance of Otlet's work from different conceptual angles.

Wells' ideas for the future organisation of information in the World Brain are detailed in a book and printed version of a lecture delivered in the late 1930s (Wells 1934; 1938). Its development over the following fifty years is summarised by Goodman (1987). It has since received less critical attention from Library and Information Sciences academics than Otlet's work, but the latter's biographer, Rayward, has also written on the subject of the World Brain, drawing parallels between it and the contemporary emergence of artificial intelligence and the scope for potential government surveillance using ICTs (Rayward 1999; 2008). Wells and Otlet were both somewhat utopian in their outlook, but as a science-fiction writer and activist, Wells was more politically motivated and had a greater understanding of the likely nature of future technology; this is explored in detail by Torres-Vargas (2005).

Vannevar Bush's concept for a future ICT, the Memex, is set out in his famous essay *As We May Think* (Bush 1945a), and expanded upon in a later work (Bush 1967)³. Bush's predictions have historically been the best well-known of the three, and the Memex influence on the development of the Internet has received a book-length analysis of its own (Nyce & Kahn 1991b). As a prominent computer engineer and senior government scientist, his context within a continuum of such figures, from Charles Babbage and Ada Lovelace, to Tim Berners-Lee and Larry Page, is also well-represented; for a recent example, see Isaacson (2014). Buckland (1992), Rayward (1994b) and So (2004) have additionally used the famous Memex as a starting point to demonstrate similarities with Otlet's own work and predictions of a "scholar's workstation". However, Bush intended the Memex to be a far more personal and individual experience, to be used by academics and professionals rather than the "universal public library" concept of the Mundaneum or World Brain (So 2004). Wright (2015), in an online magazine article that provided the initial inspiration for this research project, brings the subject right up to date at a time when the neutral regulation and continued universal, equal access to the Web is apparently less secure than before, by arguing that although Otlet's and Bush's ideas are utopian, they are both highly structured and require authoritarian control, whilst Bush's work (despite being given impetus by the geopolitical reality of the Cold War) abandoned much of this potential regulation in favour of usability and practical concerns.

I believe that this identified body of literature provides me with an ideal starting point from which to conduct further research on the subject.

³ This primary source dates from later than my self-imposed limit of 1963, but I allow it as it expands upon an earlier idea.

Methodology

This research project will be carried out through an historical study of the topic by means of an extended literature review. This is most obviously because it deals with the study of a subject that is in itself historical, but it is also a suitable means of research for in-depth analysis of a relatively narrow subject area, dealing with a variety of sources (primary and secondary), and lends itself well to reaching conclusions based on interpretation and synthesis, rather than, say, the exhaustive analysis of quantitative data (Pickard 2013). It also requires skills of critical analysis, abstraction and conceptualisation, as well as the ability to formulate a clear written argument based upon the research (Shep 2005); as a trained historian at undergraduate level, such a method of inquiry should therefore be well-suited to my existing strengths.

It is, however, important to bear in mind that using an extended literature review, whilst relatively simple and economical to carry out, in addition to being free from potentially negative external variables (such as relying upon people to be interviewed or complete a survey), it is also dependent upon the quality of the sources selected in the first place. Furthermore, although the method is verifiable, in that another researcher could repeat the investigation using the same sources, its reliability and validity (like other forms of qualitative research) are beyond the usual scientific standard of proof (Pickard 2013). It is therefore a highly individual method of research, dependent upon the unique biases (whether explicit or latent), background and perspectives that constitute my individual intellectual framework, and this must be recognised as a potential limitation of the project. Nevertheless, I believe that the advantages of this methodology outweigh its potential for undue subjectivity.

Work plan

Due to the methodology outlined above, and the fact that the subject being investigated is relatively complex – in that it compares the predictive work of three different individuals, both to each other and to the current reality – the project does not require an overly-precise work plan. There is neither a reliance upon any external participants, i.e. that required by using a survey or a similar method, nor a precise timeframe in which to collect and analyse a large amount of quantitative data. In addition, due to the exploratory nature of conducting an extended literature review, it is highly likely that I will encounter unexpected (hopefully serendipitous) connections between the texts that I consult, which could easily in turn disrupt a highly-organised schedule.

I therefore think that it is most appropriate to maintain a relatively vague work plan at this stage in the research process, in order to accommodate the potentially unpredictable and creative trains of thought that may emerge. However, based on an overall schedule beginning in late May and concluding in late September that comprises 14 full-time working weeks (allowing for part-time work, holidays and other social events, and a planned house move in early September), a rough work plan for the project, in terms of areas of research, is as follows:

- Week 1: the history and development of the Internet in general; its defining features and current status.
- Weeks 2-4: the work of Paul Otlet in detail.
- Weeks 5-7: the work of H.G. Wells in detail.
- Weeks 8-10: the work of Vannevar Bush in detail.
- Weeks 11-14: comparisons, synthesis, analysis, conclusions etc.

I envision that writing the dissertation will begin in the fourth week, as I write up my findings in the literature at the end of each broad section in the anticipated structure implied above, and that this aspect of the work plan will gradually increase until the final draft is completed, especially from week 11 onwards.

Resources

The resources needed to carry out this research proposal are minimal: as I live in London, I have ready access to the British Library, which will most likely contain all of the relevant information on the subject that I am not able to obtain online.

I am considering a trip to Mons, Belgium, to visit the modern instantiation of the Mundaneum, a museum dedicated to the life, work and legacy of Paul Otlet. This would not be strictly necessary for the project, as Otlet's own written works are available through the British Library, and a great deal of visual archive material from the museum is available online through the Google Cultural Institute (2015). However, I believe it would be beneficial to experience a large collection of Otlet's work in a curated, public form similar to how he himself imagined it. The museum, which first opened in 1998, is currently undergoing refurbishment for an expansion, and is set to re-open on June 27 of this year (Mundaneum 2015), which is conveniently in the middle of the timetable for this project.

Ethics

After reviewing the Research Ethics Checklist for projects carried out in fulfilment of the requirements for Bachelor's and Master's degrees awarded by the School of Informatics within City University London, I can state that my answers to questions 1-3 are all "yes", and "no" for questions 4-6; an application to the Informatics Research Ethics Committee for permission to proceed is not required.

This research project involves individual desk research only. There will be no other participants, and so there are no ethical considerations that apply, save for those surrounding academic misconduct and plagiarism on my part. I will therefore abide by the Postgraduate School Handbook's guidance on avoiding academic misconduct and plagiarism through proper referencing, as I have done for the assignments that I have already completed for this course.

Confidentiality

I do not foresee any confidentiality issues arising from this research project, as it does not involve any work with confidential material: the literature reviewed will all either have been published or be readily accessible to me as a university student. As stated in the ethics section above, this project does not require any external participants in order to be carried out.

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