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Abstract

The Medieaval period developed the idea of a twofold Book of Nature: a literal book (*Bible*) and a metaphorical book. On the surface, the World Wide Web is pointing to a new *Summa* of knowledge. Enormous projects are underway, which foresee scanning the full texts of over 60 million books within the next fifteen years and to create a World Digital Library. Our story is about further dimensions. At least four developments have begun in parallel and are beginning to converge. First there is scanning, capturing and mapping. Second, there is a wave of reconstructing the world, whereby scholars are reconstructing historical buildings, complexes and even whole cities in various interpretations. Third, there are dramatic developments in technologies for recognizing images. Fourth, there are dramatic developments with respect to embedding objects in the natural word. To date the applications of these four trends have largely been for surveillance, law enforcement and security. But they can equally be applied in the world of knowledge. When we do so, then the physical world and man-made worlds, which were traditionally worlds to be recorded, can become recording worlds.

In these new worlds, there will be two kinds of smart objects: a) physical objects with embedded information and b) digital surrogates in the sense of Industry Foundation Classes, which include various technical specifications as part of their embedded knowledge. In future, such smart design modules need to be imbued with historical and cultural dimensions, reflecting how an object changed both temporally and spatially. If all the world's a sensor, then both the worlds of the past in memory institutions as well as the man-made world and physical worlds around us can serve as combined sources for future design, inspirations and creativity.

The World Wide Web (W3) today focuses on a closed world of born-digital materials. The convergence of capturing, reconstructing, recognition and embedding means that the W3 needs to go beyond its network into the physical and man-made worlds. In future, it needs also to become a system linking various worlds: metaphysical, mental, physical, man-made and social worlds, a Worlds Wide Web (or W5 that tends towards W^n). Technologies for more information are ultimately the easy part. Technologies for more knowledge and especially more viewpoints on that knowledge, technologies which promote wisdom, inspiration and creativity are the true challenge.

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1. Introduction

Many insights come through metaphors, which begin as simple images and then gradually transform our understanding of the world and even our views of knowledge. During the early Middle Ages, the metaphor of the book became a central metaphor in Christianity. God was seen as the author of two books: the Book of God (i.e. the *Bible*) and the Book of Nature.[1] This tradition led to a second metaphor, the notion that Nature was a mirror of God's creation and ultimately a reflection of God himself. Studying the mirror, understanding the correspondences, was thus a key to truth in philosophy and a path to truth in a deeper religious sense. In philosophy, these images have continued to inspire important debates even in recent times.[2]

By way of introduction, we explore some practical consequences of these images of a book of nature and mirror of creation with respect to developments in visual representation, design, architecture and the cultural domain. This leads to a survey of four recent trends which have evolved in parallel: capturing, reconstructing, recognizing and embedding the world. We suggest that a convergence of these four worlds challenges us to rethink the digital revolution and its implications for knowledge, imagination and creativity.

2. Mediaeval and Renaissance Background

Already in Antiquity the images of book and Bible were intimately connected. Etymologically, they stemmed from the same Greek word, *Byblos*. During the mediaeval period the metaphors of book and mirror led in several directions. On the one hand, there was a metaphysical trend, which attempted to link microcosm and macrocosm in a series of increasingly complex diagrams culminating in images such as those of Robert Fludd in the 17th century. On the other hand, there were attempts to record the world in the sense of natural philosophy. These began with verbal descriptions and led increasingly to visual records of the natural world. Already in the early 14th century, Simone Martini was being sent to record images of forts and cities at the boundaries of the Sienese state. Gradually the notion of a mirror became a physical mirror with which one could copy objects and scenes in the external world. Brunelleschi's use of a mirror in his early demonstrations of linear perspective were one of the consequences of this quest to record the world. One obvious result was the advent of realistic images of everyday life by the Limburg brothers that continue to fascinate us today.

For our purposes, however, two unexpected aspects of these developments are of interest. First, the application of perspective was primarily in the context of religious narrative, especially with the Lives of Christ, and the Saints. As a result, beautiful, but also strangely anachronistic paintings emerged, whereby Renaissance towns crept into the backgrounds of scenes connected with the history of Church some 1500 years earlier. Secondly, the quest to record public spaces and piazzas of the major cities directly inspired the rise of stage scenery. Hence, the image of the mirror, which theoretically led to copying the natural world, was also a key to inspiring a new world of creative imagination. Herein, lies a very important lesson as we try to understand recent developments in the digital field.

3. Early Modern Developments

Already in the second century, Ptolemy developed an approach which linked his work on astronomy of the heavens (*Almagest*) and work on the earth (*De Geographia*). The result was

a theoretical framework of projections with a limited number of actual observations. When Renaissance scholars took up these studies anew, observation in the form of surveying and practical astronomy became increasingly a part of geography. Measuring instruments allowed ever more precise recordings of the world. Drawing instruments allowed more accurate transcriptions. Gradually there arose the vision of recording and capturing the world without human intervention. This began with instruments such as the camera obscura, later the camera lucida and the camera. The 18th and 19th centuries brought systematic cartography. The 20th century linked cartography with remote sensing and satellite imagery. The late 20th century introduced Geographical Information Systems (GIS), Geographical Positioning Systems (GPS) and a systematic integration of spatial temporal information through Universal Mobile Telecommunications Systems (UMTS). This is a foundation for the first of four major developments of the past decades.

4. Capturing

Once upon a time, capturing images of the world was an incredibly laborious task. Today satellite cameras are potentially able to read newspapers from space. Countries such as Britain have over 10 million installed security cameras. Meanwhile, there are hundreds of millions of mobile cameras, increasingly linked directly via mobile phones to the Internet. In countries such as Japan, the number of mobile Internet phones is higher than the fixed Internet phones. There are already over 2 billion mobile phones and within the next years over half of these will be Internet enabled. In Europe and North America, it is realistically possible to foresee almost everyone having access to these technologies within the next one or two generations.

In 1978, an innovative project led by MIT produced the Aspen Movie Map. An automobile equipped with special 360 degree cameras took pictures of every street in the small ski resort and introduced a new kind of virtual tour at a distance. In 1993, the Art+Com company (Berlin), in a project called Terravision demonstrated how one could systematically move from a satellite image to the interior of an office in Berlin. This idea soon became part of the marketing ploys of SGI: how one could go “from outer space to right in your face.” In 1994, Art+Com demonstrated this principle via satellite with a conference in Kyoto. Soon afterwards SRI in the US developed their own Terravision linked with the military. NASA also developed an analogous approach called World Wind. In 1998, Al Gore, as Vice-President of the United States, introduced the more dramatic vision of a Digital Earth:

> I believe we need a "Digital Earth". A multi-resolution, three-dimensional representation of the planet, into which we can embed vast quantities of geo-referenced data.
> Imagine, for example, a young child going to a Digital Earth exhibit at a local museum. After donning a head-mounted display, she sees Earth as it appears from space. Using a data glove, she zooms in, using higher and higher levels of resolution, to see continents, then regions, countries, cities, and finally individual houses, trees, and other natural and man-made objects. Having found an area of the planet she is interested in exploring, she takes the equivalent of a "magic carpet ride" through a 3-D visualization of the terrain. Of course, terrain is only one of the many kinds of data with which she can interact. Using the systems' voice recognition capabilities, she is able to request information on land cover, distribution of plant and animal species, real-time weather, roads, political boundaries, and population. She can also visualize the environmental information that she and other students all over the world have collected as part of the GLOBE project. This information can be seamlessly fused with

> the digital map or terrain data. She can get more information on many of the objects she sees by using her data glove to click on a hyperlink. To prepare for her family's vacation to Yellowstone National Park, for example, she plans the perfect hike to the geysers, bison, and bighorn sheep that she has just read about. In fact, she can follow the trail visually from start to finish before she ever leaves the museum in her hometown.
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> She is not limited to moving through space, but can also travel through time. After taking a virtual field-trip to Paris to visit the Louvre, she moves backward in time to learn about French history, perusing digitized maps overlaid on the surface of the Digital Earth, newsreel footage, oral history, newspapers and other primary sources. She sends some of this information to her personal e-mail address to study later. The time-line, which stretches off in the distance, can be set for days, years, centuries, or even geological epochs, for those occasions when she wants to learn more about dinosaurs.
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> Obviously, no one organization in government, industry or academia could undertake such a project. Like the World Wide Web, it would require the grassroots efforts of hundreds of thousands of individuals, companies, university researchers, and government organizations. Although some of the data for the Digital Earth would be in the public domain, it might also become a digital marketplace for companies selling a vast array of commercial imagery and value-added information services. It could also become a "collaboratory"-- a laboratory without walls — for research scientists seeking to understand the complex interaction between humanity and our environment.[3]

One year later, this led to the Beijing Declaration on Digital Earth signed by "some 500 scientists, engineers, educators, managers and industrial entrepreneurs from 20 countries and regions."[4] By 2001, NEC had developed their own version of a Virtual Earth.[5] In early 2004, the US Department of Defense announced that it would construct a 1:1 scale model of the entire earth.[6] By late 2004, this vision also included NASA and the Environmental Protection Agency.[7] In 2005, Microsoft launched their beta version of a Virtual Earth.[8] By 2006, it became clear that Microsoft was working with NASA[9] and also working directly with the US Department of Defense (DOD) in creating their new Virtual Earth.[10]

A preliminary result of these developments is an integration of image capturing devices and mapping devices ranging from satellite images to street views in an approach called Windows Local Live. At present the demos entail only two cities: i.e. Seattle and San Francisco. They show how one can zoom from space to a particular point on a street or sidewalk and then choose between a view from a sports car, a regular automobile or from the viewpoint of a walking pedestrian. In order to achieve this, the idea of the Aspen movie map is being applied to 7,000 cities world-wide using the latest new camera technologies.

Admirers of the system have described it as a Google Maps in 3-D. The effects are often amazing and yet they remain fairly banal at a cognitive or intellectual level. To be sure, these developments have obvious military implications,[11] and clearly have significant applications for security, traffic management, police efforts and many aspects of environmental monitoring. As such, their role is mainly in administration and services. Our interest is how these technologies can be extended to domains of knowledge, design, imagination and creativity. To understand how this might happen we need to consider three other recent developments.

5. Reconstructing

In 1965, when Ivan Sutherland published his article on *The Ultimate Display,*[12] one of the pioneering article in virtual reality, he was particularly fascinated by the potentials of this new field in helping to visualize things and concepts which would otherwise be invisible to the human eye, thus in a sense continuing the vision of Marey[13] nearly a century earlier. Starting in 1977, James F. Blinn (Caltech) showed the potentials of this approach with his pioneering *Mars Flythrough*.

In 1982, when Autodesk was founded, their AutoCAD software was aimed mainly at various facilities management and engineering applications as well as design for new products especially in architectural design. Initially, the new software was intended to help in dealing with the construction and the constructed world. This quest to represent the constructed world implicitly required the creation of a re-constructed world. During the 1990s, this approach was extended to reconstructions of historical buildings.

Projects such as the NUovo Museo Elettronico (NUME) took this idea to a new level. A series of reconstructions of the inner core of the city of Bologna allow viewers to trace developments within the city in the course of a millennium from 1000 A.D. to the present. This project points a way towards future integration, whereby historical manuscripts in archives, objects in museums, maps, photographs and reconstructions are available in a single system. This system is presently over 7 terabytes and too large to be readily shared if one expects to have one's own copy of the entire database. Even so given recent developments in distributed computing, the possibility of access to precise subsets is a real possibility. A user with a mobile phone could theoretically call up an image of a given monument, house, architectural feature or house.

6. Recognizing

Meanwhile, there has been another parallel development. In 1982, the term active computer vision was coined.[14] During the 1980s, James Bond films introduced the idea of special image recognition systems, which could extract key features and "recognize" the face of some arch-

Capturing and Mapping	Photography, Remote Sensing, GIS, UMTS
Reconstructing	Computer Aided Design (CAD)
Recognizing	Image Recognition, Surveillance, Computer Vision
Embedding	Sensors, Nanotechnology

Figure 1. Four developments and their related fields which are converging.

villain. During the 1990s, this became a recurrent theme in high-tech crime films showing how the "good-guys" in the form of CIA, FBI, or the regular police used these techniques to catch their wanted man. The rise of terrorism as a dimension of daily news provided an enormous impetus to further refinement of these technologies. International agencies are now able to search for the identity of an individual in databases with millions of images. All this is very important qua security, management, administration and everyday services.

Meanwhile, the scope of these developments is expanding through projects such as PRIMA (Perception, recognition and integration for interactive environments).[15] What interests us is how the same technologies, which can recognize a face or a given product can be extended to

recognize cultural monuments, sculptures, paintings, cultural objects, ornaments and images in books. If this is then linked with knowledge bases then photography, which was a passive recording process can be transformed into an active discovery tool.

7. Embedding

The notion of implanting sensors into objects and even into living animals and human beings goes back to the 19th century. The origins of RFID (Radio Frequency Identification) have been traced back to the 1920s,[16] and saw new applications through the Identify Friend or Foe (IFF) systems of the 1940s.[17] Rapid advances in nano-technology during the 1990s meant that sensors, which had typically been a centimetre, could now be reduced to few millimetres. The past decade has seen the idea of combining embedded sensors with RFID technologies. There has also an extension of Local Area Networks (LANs) to Body Area Networks (BAN).

A dark side of these developments is that tracking devices, which were once associated with Alcatraz prisoners in Bruce Willis and Arnold Schwarzenegger films, might soon potentially be applied to everyday citizens. A positive dimension of these technological breakthroughs is that the implants are now so small that they can be inserted into cultural objects and indeed into any object of the environment as if they were non-invasive techniques. In the seventeenth century Shakespeare spoke of:: All the world's a stage. If he were living now , he might in the near future say: All the world's a sensor.[18]

8. Recording Worlds

The implications of this seemingly frivolous phrase are profound. If all the world's a sensor, everyday objects, which were previously passive things that could be recorded, now become active objects, smart objects, which can monitor the world around them and thus become recording worlds themselves. This is exciting per se. Combined with developments in capturing, reconstructing, recognizing and embedding, this opens up a range of new possibilities. The world which was a passive set of objects now becomes an active tool and even potentially a new navigation device. Indeed it can become a new method in searching for knowledge.

By way of illustration, two scenarios will suffice. We are walking in the woods and we see an interesting tree which we do not recognize. We take a picture with our mobile camera-phone, send the image to a digital reference room. A first stage of image recognition determines that this is botany, determines this is a tree, opens a taxonomical database of images of trees; matches the photograph from the mobile phone with the database and determines that this is an *Ilex Aquifoliaceae*. Such image recognition can vary enormously from simple curiosity exercises, to classroom fieldtrips to new tools for botanists exploring possible unknown species in a rain forest. In such cases, where there is no known match in the database, the researcher would be offered nearest samples in the database as a context for classing the new species.

A second scenario entails the man-made world with applications ranging from tourism to archaeology. Projects such as Archeoguide have demonstrated how an augmented reality reconstruction of a no longer extant building can be superimposed on a physical landscape that we see in front of us. Projects such as the NUovo Museo Elettronico (NUME) have linked a reconstruction of an historical centre of a city, Bologna, with various kinds of materials in memory institutions.

Meanwhile, projects such as Microsoft's Live Local Virtual Earth show how small subsets from enormous databases can be used to show specific views one at a time. In future, such a Virtual Earth demo could be co-ordinated with historical reconstructions such that one can see how a given square or specific building looked like in the 15th, 18th, 19th centuries indeed at any time in its history. This becomes especially useful in the case of famous buildings which have been continually re-adapted for other purposes such as Hagia Sophia, which began as a Christian Church, became a Muslim Mosque and is now a museum. In a world of embedded objects at the micro-scale and the nano-scale, historical buildings could have a series of tiny sensors that trigger local stories on portable pen-type computers, potentially in combination with audio-guides.

This approach applies equally at the level specific statues, architectural details and ornaments. Today a typical tourist photographs items of interest and pastes them in an album or posts them on an internet site. In future, such images can become a starting point for further study when one has returned home. We send the image to a virtual reference room, which identifies the item, and traces its origins back to the symbol for Mother Earth as Ninhursag. We then receive a series of other examples. The extent to which we pursue this depends on the depth of our interest.

Such examples show how the new technologies allow us to take the power of reference rooms and the collective memory of memory institutions into the fields, streets and indeed all walks of everyday life. The corollary is that the we can equally take imagery of the everyday world into our studies within libraries or within our homes. In the past, we could consult an atlas. In the past years Google Earth has pointed the way to a new approach. Soon we shall be able to consult any place on earth at different at different scales from views in space to 1:1 scale imagery and potentially also at the microscopic level. Today these maps simply show us maps and photographs. In future these can be linked with services and with various levels of specific knowledge about objects and environments.

For tourism this has enormous potentials. Scholarship is, of course, about much more than simply identifying isolated decorations, objects, buildings or places. It is also about exploring contexts, versions of stories, traditions, possible reasons for events. In memory institutions of the future, where image recognition techniques are used to search for copies, versions and related iconographical materials whole new chapters of studying our past and present are imaginable. In the traditional paradigm, scholars sometimes retreated from the world to record their thoughts; sometimes went into the world and recorded thoughts. The products of their efforts were recorded knowledge, which became part of a cumulative corpus in memory institutions. Hence, these memory institutions were primarily the end-station of the knowledge process, even if their reading rooms provided new inputs for a subsequent cycle of knowledge. In the new paradigm, these corpora of the past can become one input for new creativity.

9. Animation, Film, Post-Production and Deisgn.

The 1980s did more than revolutionize the fields of facilities management, construction and architectural design. In 1982, the same year that AutoCAD was founded, Walt Disney produced Tron,[19] one of the the first large scale animated films. 1983, saw the founding of Alias, which aimed at realistic 3D video animation for the advertising industry and post-production houses.[20] 1984 saw the foundation of Wavefront which became Alias-Wavefront

in 1995. 1984, also saw the founding of BUF,[21] a French company which began with some of the first animated clips for television and their personnel have gone on to produce the electronic sets for major films ranging from *Shrek* to *Alexander the Great*. Meanwhile, by the time of SIGGRAPH (1989) in Boston, Autodesk unveiled a new PC based animation package called Autodesk Animator[22]

Without attempting either a history of television, film and the design industries, we can see that the same technologies being used to approach anew the physical and the man-made world are also transforming our approach to the world of imagination, phantasy and the creativity. Indeed, the trends towards digital production factories entail a convergence of technologies affecting many disciplines ranging from engineering and architecture to film and television. One consequence of these developments has been the rise of visions for a World Digital Library.

10. World Digital Library

In 1997, NEC announced the world's first virtual library: the Universal Digital Library.[23] In 2000, the US also had a vision for "a Universal Library starting with a free-to-read, searchable collection of one million books available to everyone over the Internet by the year 2008.[24] By 2004, the *Wired* version of that vision by Kevin Kelly was even more dramatic:

> The universal library should include a copy of every painting, photograph, film and piece of music produced by all artists, present and past. Still more, it should include all radio and television broadcasts. Commercials too. … the billions of dead Web pages no longer online and the tens of millions of blog posts now gone — the ephemeral literature of our time. In short, the entire works of humankind, from the beginning of recorded history, in all languages, available to all people, all the time.[25]

Since then a number of projects have emerged around the world. Google's announcement to scan the full text of 10 million books is the most publicized, but there are a series of such projects around the world ranging from the Library of Congress and UNESCO to India and China. Together these projects plan to scan the full texts of over 50 million books in the next 15 years.[26] By the year 2020, the British Library plans to be entirely digital. The banal version of these developments insight would state that everything is becoming digital. What interests us is that the structures we have for preserving and studying the products of these different fields still reflect old models.

In the past, architecture was about the static man-man world, film was about motion pictures of the physical and man-made world. The plans of architecture were records and became part of memory institutions such as libraries, archives or museums and could be studied by future generations. The results of film and television were part of the recording industry and ended up in specialized archives. The political rules for managing the products of these so-called creative industries were kept very separate from the rules in more traditional disciplines. In the case of architectural records there was a tradition of adapting elements, quoting from earlier masters. In the creative tradition, there were and still are no ready tools in place to make the equivalents of "quotes" or allusions from films or moving pictures. In terms of politics, we need a new vision of copyright which extends the idea of fair use to all media: audio, visual, as well as verbal.

In terms of memory institutions, this points to a widening of the scope of what they store to include all new media, and a deepening in their methods of bibliographical control such that we

can search more systematically not just for quotes from books but also the equivalents of quotes from images, videos, films and databases

11. Virtual Agora

During the 1990s companies such as AutoDesk formed a world wide consortium to create Industry Foundation Classes (IFC) with a view to creating smart objects in the sense of individual components such as windows and doors. The idea was simple. In the past, one had to draw each window every time one designed a new plan. If one could store all the information qua shape and requirements re: a window in a database, then an architect designing a new skyscraper would immediately have access to the right kind of window, complete with structural specifications. This vision is becoming a reality. The good news was that some of the daily routine of architects became much easier. The bad news was that if everyone has access to the same images, there is a danger that engineers and architects will all build the same objects. When this exercise began in the mid 1990s, SGI machines used an image of a particular kind of bridge. All over the world, examples of such a kind of bridge emerged.

Seen from a larger historical viewpoint, the roots of Industry Foundation Classes go back to the Middle Ages when architects such as Villard De Honnecourt made Sketchbooks which evolved into a category of literature called Pattern Books (*Musterbücher*). The mediaeval architects were also interested in components such as columns or rose windows. Significantly, however, they did not use these examples to copy precisely. The patterns were used as starting points for original designs. Christopher Alexander[27] had a precedent. As a result, the idea of combining wood and stucco, became a standard element of building design (*Fachwerk*) and yet every town produced its own unique versions. This is one of the secrets of diversity and why European towns and cities are so rich in their variety.

Needed is a modern equivalent of this process. This requires at least two steps. First, in terms of organization it means that we need to add an historical dimension to our ideas of smart objects and foundation classes. A future database of windows should give us access not just to cottage windows and skyscraper windows, but potentially to the history of each window. This may sound excessive, but if we can manage to label every object that we use for daily consumption in our supermarkets, then surely the labelling of everything we build and recording its history is fully possible. Enormous amounts of this description of the objects and monuments has been done. Needed is an integration of materials from the enduing knowledge of our memory institutions, with industry databases of products and with design databases.

Second, we need new ways of sharing and storing cumulatively this knowledge and information. When the Internet began there was an assumption that it would focus on enduring knowledge. In practice, the Internet has brought into focus an explosion in sharing of personal "knowledge" and collaborative knowledge. The monumental growth in instant messaging, e-mail, web-blogs, Skype and related techniques. An interim challenge will be more efficient and reliable methods of storing this new corpus, with a appropriate distinctions between public and private. In the realm of physics and other sciences, we see the emergence of collaboratories, networks of scientists of a like-mind, effectively sharing ideas complete with access to pre-prints of their latest work. In the realms of design and architecture, we need something similar. As noted earlier, at the software level there has been a convergence of tools for engineering, architecture, design, video, film, post-production and advertising. We need a new framework, where designers and architects have access to both the enduring knowledge of memory

institutions as well as emerging personal and collaborative knowledge. We need a Virtual Agora. We need an extension of our notion of what the World Wide Web can do.

12. Towards a Worlds Wide Web

This going beyond the World Wide Web entails various dimensions. The rise of the Internet seemed at first sight to signal the creation of a new World Wide Web of knowledge, which was effectively autonomous and separate from the rest of reality. It appeared that one would need a simple scanning process from printed to digital media so that materials from outdated print could be "translated" into the new form. Accordingly, computer scientists emphasized the rise of born-digital materials as a world apart, typically represented as a cloud detached from surrounding things.

Just as printing had unexpected "side-effects", the rise of digital technologies is bringing a series of unforeseen developments, which are increasingly linking the born-digital cloud with the physical world. The International Telecommunications Union (ITU) recently published an important report called *The Internet of Things* (2005).[28] Their point was that the enormous rise of sensors was expanding greatly the scope of World Wide Web beyond connections in a closed network, into objects with embedded devices everywhere in our environment. This consequence of embedding is a significant and profound development. Our point is that even this is a small part of what is actually happening because embedding is part of a larger convergence that includes capturing, reconstructing and recognizing (figure 1).

At a practical level, this means that what began as an Internet among a few scientists and expanded to a World Wide Web involving millions and now over 1 billion persons is no longer about a closed network of terminals, databases and connecting networks. The new, new thing, as the Americans would say, is that these networks extend beyond it, into objects, every thing and potentially every idea. This means that a semantic web of the future cannot simply be about reliable addresses in the form of URLs, URNs or URIs. To verify the truth of things we need to go back to the sources (*ad fontes*) in a new sense. We need connections back to the objects and things. Here, Robert Kahn's important idea of Digital Object Identifiers (DOIs), is an excellent first step in addressing the problem, But this solution from DARPA, is ultimately a military approach, which views everything and everyone as objects to be identified for potential "hits" in multiple sense.

The W3 Consortium is focussing on the truth of addresses and the logic of claims within the web. At least three more things are needed. First, we need to add the truth and the reliability of links back to original objects. Anyone can talk about *Mona Lisa*. Anyone who takes us directly back to the Louvre's version is more to be trusted than someone who shows us images of images many generations removed from the original. Second, this extension beyond the web needs to go not only to objects but also to the claims about objects. What Pliny or Newton or Einstein said may or may not be true, but unless we have access to the original statements we cannot study, judge and ultimately decide. In law, there is a quest for the truth, and nothing but the truth, In the worlds of culture, which includes the worlds of design, imagination, and creativity, the possible and the impossible, we need something more. (*Die Wahrheit aber nicht nur Sie* as the Stipendiaten in Wolfenbüttel used to say). We need true links to claims, even when, or especially when we doubt their veracity. In simple terms, we ultimately need true links beyond the web, to maintain a sense of truth in the digital world within the web.

The third thing needed is to beyond the notion of physical objects as currently assumed by DOIs .The world of design is not just about doing and making "things". The majority of

designs and plans are never built. In a some cases, the obvious reason was that the designs were poor or incompetent. In most cases, the reasons were more complex. Leonardo's designs of buildings that were never constructed, Bramante's designs for Saint Peter's remain very important sources of inspiration even if there was no "product" at the time. The World Wide Web today is about a digital network which assumes we are focussed on a physical world of "things". There are also metaphysical worlds, mental worlds, man-made worlds, social worlds. Historically there has been discussion of 3, 4, 7, 31 or even 33 such worlds. Most of the great microcosm-microcosm analogies are based on systematic links between/among these various worlds.

The same convergence that is taking the World Wide Web beyond the born digital world of electronic networks into the physical world, calls for a further extension into and integration between different worlds. A designer needs not just plans of what exists but also what could exist. We have developed wonderful GIS, GPS and UMTS in the physical and man-made worlds. We need the equivalent for the other worlds. We need a GIS, GPS and UMTS of the metaphysical, mental and potentially social worlds. Of course, we cannot hope to record every thought that ever existed. But we can strive to gain access to those thoughts which were recorded and which have managed to survive the many dangers from natural decay to natural disasters and man made catastrophes. We need a worlds wide web. If we start with the notion of 5 worlds, perhaps we shall see how the WWW (W3) becomes W5 in this larger sense.

To continue with the scenarios outlined above. This will mean that in future the W5 will do more than allow us to use maps to "Google" down the Vatican. It will allow us to see a) conservation materials about how it has been restored; b) reconstructions of how it looked earlier; c) hypothetical reconstructions of how it looked earlier (not just Ranke's *wie es eigentlich gewesen*, but also other hypotheses) and d) various plans about how it might have looked. This is a Utopian web in a positive sense, for in those possible worlds, the ones that might have been, lie sees for future vision. The way to creativity is the path of the not yet and its reality can be very important even if there is no physical product. Marketing managers think they require more, but this is the path of lesser dreams. True dreams are those where less physical is more mental and metaphysical. If we want a W5 that is more than a glorified reporter of what is "finished," then we need to explore this paradox.

13. New Book of Nature

Implicit in these developments is something much more fundamental than a simple translation process from a born-physical to a born-digital or more accurately to re-born digital world. As noted earlier, in the Mediaeval period, the metaphor of a book of nature was actually about two books, one via the *Bible* was a world of belief and the other was a world of knowledge (*scientia*). As this vision of *scientia* moved towards science, it became increasingly focussed on domains that were visible and measurable. The visible was a key to the invisible. In many cases, the vision of knowledge as encompassing a universe of studies (*universitas studiorum* as Bologna still calls itself), gradually narrowed to exclude Why? questions and increasingly even How?, Where?, When? and Who? questions to focus strictly on What? Knowledge seemed to be reduced to the knowledge of (invisible) subsumptive relations about objects (assumed to visible) in the physical world. Aristotle's larger vision of ten accidents that addressed determinative and ordinal relations seemed to be passé.[29]

The 20th century confronted us with scientific developments the philosophical consequences of which we are still digesting. Heisenberg's indeterminacy principle implied that everything we study is changed by the very act of study. Polanyi's *Personal Knowledge*, Lorenz's *Behind the Mirror*, Popper's *Objective Knowledge* were attempts to rescue a framework. Now another chapter is in progress. The Internet began with buzzwords of interactivity and is leading, as we have outlined to a new convergence that links the electronic world back to a physical world that is often embedded. We foresee that this will increasingly go further to link with other worlds to include: metaphysical, mental, physical, man made and social worlds.

We suggested a need for a GIS of the mental and metaphysical worlds. Ultimately we need much more: a new approach to the book of God as well as the book of nature. This could easily launch us into a theological treatise or even a *Summa* in the tradition of Thomas Aquinas which would take us infinitely beyond the limits of this paper. To draw attention to the deeper challenges it is useful to quote a paragraph from Sheldon's five volume *History of the Christian Church* (1895):

> The religion of the Germans appears to have been a polytheism, in which the gods stood in close relation with the powers of nature. Cæsar calls attention to this feature in his remark that the Germans acknowledge only such gods as are visible, and whose might renders a perceptible aid, such as manifest themselves through the orbs of heaven and the element of fire. 1 Bella Gallorum, vi. 21. In their worship of the gods, they were accustomed to discard for the most part both temples and images. Sacred groves took the place of the former, and symbols of the latter. This absence of images, as Wilhelm Müller judges, betokens not so much an approach to high spiritual conceptions, as the stage of indefiniteness in the growth of polytheism. The Scandinavians in later times used images, and their employment seems to have been on the increase among the German tribes when Christianity came across the natural development of their polytheism. 2 Geschichte und System der Altdeutschen Religion.[30]

Protestantism, especially in its Calvinist versions, is famous for its iconoclasm that launched a *Bildersturms* across Europe in the 16th century. This passage is remarkable because it confirms that already in Roman times, Caesar had identified how the Germans both a) linked their belief with visible nature and b) avoided representation of that belief with visible images. The Nabateans who chose to represent their divinities only as regular stones without a visible image are another example of an analogous mentality. A quick answer to these kinds of differences would remind us that some cultures are iconoclastic and avoid icons while and others are iconophile and have icons. Roman Christians would quickly note that they have images but abhor idols in the tradition of a golden calf. Orthodox Christians would insist strongly that kissing an icon is profoundly different from worshipping idols. Clearly there are a whole gamut of relations between man and the world beyond: some mental, some verbal, some via images with a range of levels of "identity".

With respect to who is right, these are profound theological questions which, it is hoped, theologians will explain and resolve. Our concern, in terms of the new book of nature, is a more practical one. What do we do with this complex range of "identity relationships'" where one culture thinks God "is a", others depict that God "is a" or God "has a" while others insist that even to write G_D is already bordering on the limits of the acceptable? Caesar saw the problem. If Caesar had been a computer scientist how would he have created a system that reflected both the German way as well as his own?

These problems apply equally to philosophy. The Hindu tradition, for instance created six main schools. The one sentence summary of the classic two volume survey by Renou and Filiozat (1947-)[31] would be that there profoundly different approaches, some emphasizing logic (*Nyaya*), others emphasizing metaphysical via a physical body (*Yoga*) while others were closer to a philosophical approach qua exploring categories (*Vedanta*). Some schools saw relations between ideas and visible characteristics (fire, water, planets etc); while others described relations among series of levels of consciousness. Again there is a practical question behind which lurk deep theoretical challenges of method. Clearly any attempt to reduce these alternative philosophies to a single set of "is a" statements, to a single ontology as the jargon of the day would say, is ironically to fall back into precisely the kind of mental colonialism, that the computer science community so fervently attempts to sidestep, avoid and deny through their use of multiple ontologies – which alas all use one logic.

Our concern here is to bring into focus on challenges, not to offer a quick solution. In terms of basic objects in the physical world; in terms of business transactions, subsumptive relations (is a, has a) are necessary and often even sufficient. In more complex cases, we need also to add ordinal relations (when, where, how) and determinative relations (why and partly how). In terms of historical treatment of the physical and man-made world; in terms of religion and philosophy, we need much more. We need frameworks which allow for different approaches to the same evidence. This is something much more than a glib Kuhnian statement about different paradigms. Nyaya and Vedanta have co-existed for at least two thousand and some would insist much longer than that.

In the West, there is a catch phrase that seeing is believing. We dismiss its extreme version with jests about doubting Thomases, forgetting that the Apostle Thomas is reported to have gone to India in c. 56 A.D[32] where he avidly converted Indians to Christianity. Visualization is very important but how do we convey different approaches to the visual? How do we create systems to help persons see things and ideas on a screen and also convey different senses of abstraction, different senses of aesthetic and other distance to what is on display? If we are not very careful retrospective conversion in the digital world could have more senses than "is a" allows. To read the new book of nature we need more than glasses or a computer; we need different ways of seeing and ways of learning to see some bits, and not visualize other bits. We need to convey how the Greeks for a time preferred tactile metaphors while the Romans preferred visual metaphors. We need an approach to knowledge that shows more than just names of different schools. We need different knowledges, recognizing that this is different in each language. French distinguishes between multiple *savoirs* a single *connaissance;* Italian between *concoscenza* and *sapere;* the Dutch have *Wetenschap* which is quite different than German *Wissenschaft*. How do we create systems that do nor reduce everything to the equivalent of an ASCII file and instead reveal how cultures use very different approaches to what they think, say and "spell out"?

In the case of the natural and man-made worlds the challenges may be more subtle but are no less profound. Imagine a world in a generation or two where the convergence of capturing, reconstructing, recognizing and embedding is effectively "complete." We now have in our hands a W5 generation cellphone-camera- OCR- computer device. Anything it "sees" can be identified at different levels of complexity: "this is an oleander tree" for the schoolchild ; "this is the complete taxonomy" for a botanist. Voice recognition will have advanced to the level that we speak to our computer the way we now speak to our friends. The distinction between this is a phone message and a this is the person who leaves the phone message will become ever more elusive.

Meanwhile, if we have sensors at both ends of the systems then machines can take information without anyone needing to press the button. This already happens in space exploration and spy satellites and closer to home with traffic cameras and CCTV. The world which used to be recorded will now also be self recording. We will be various steps closer to a world where terms such as autonomous computing are more than metaphors. The dangers of all this have been sung by a series of male versions of Cassandra ranging from Norbert Wiener to Grant Fjermedal[33] and a series of science fiction writers. Doom and gloom aside there are profound philosophical questions that loom.

In a world with billions of sensors are constantly recording data and their attendant computers are sifting through this to produce information and knowledge, what then do we call knowledge? In the past a learned man was assumed to have read everything and a wise man was thought to have understood nearly everything. Already today with an estimated 7 million new web pages daily only the wisest seeker of knowledge can hope to avoid getting hopelessly lost.

So what is knowledge in such a world? An obvious answer is awareness of the problems of method in sifting through, assessing and gaining insights from these cumulative masses of knowledge. But which methods? How do we ensure that they reflect sufficiently other great traditions. Washington may assume it is their version of English. But if only numbers count then we should all be learning Chinese, Hindu, Arabic and Spanish. There are extremely interesting times ahead, a term which the Chinese also see as a curse. Pessimists aside, it should be clear that the knowledge revolution, which was taunted as beginning in the 1970s has hardly begun. Or from another viewpoint if we are in the midst of a knowledge revolution, then the even profounder changes of a Knowledges Revolution await us in the decades to come.

14. Conclusions

Antiquity invented the idea of a book (*Byblos*). In the Latin West, the Medieaval period developed the idea of a Book of Nature: a twofold book: one a literal book of the Bible with the visible words of an invisible God; the other the visible world of Nature as a metaphorical book with which God's purpose could be studied. By the 13th century, great thinkers such as Thomas Aquinas believed they could write a summary, a *Summa*, of all recorded knowledge. In the 18th Century Diderot and D'Álembert attempted a layman's equivalent.

On the surface, the Internet and the World Wide Web are pointing to a new *Summa* of knowledge. Enormous projects are underway which foresee scanning the full texts of over 55 million books within the next fifteen years. There are plans to create a World Digital Library. There are visions of a Distributed Electronic European Resource (DEER) and World Online Networked Digital Electronic Resource (WONDER). The processes of scanning whereby the recorded worlds of print, film and other media are translated as re-born digital knowledge are well underway. There are quibbles whether Google[34] will do all and own all, or whether the great memory institutions of the past will continue their processes of collecting recorded knowledge. In the case of the British Library, for instance, there is a clear announcement that they will be fully digital by the year 2020.

There are a number of obvious technical challenges which have not been our concern. There are over 6,500 languages in the world. Major systems such as the New York Public Library now already address some 3000 of those languages. Optimists would not that we are almost 50% of the way there. There are questions of speed of connection, size of servers etc. Salesman will

insist that these are developing faster than ever. More sober users will note the paradox that the needs of leading projects such as CERN are now at least 100 times greater than the largest supercomputer available. Even so these are technical challenges which will almost certainly be overcome.

Our story has been about further dimensions. At least four developments have begun in parallel and are beginning to converge. First there is scanning, capturing and mapping. Second, there is a wave of reconstructing the world, whereby scholars are reconstructing historical buildings, complexes and even whole cities in various interpretations. Third, there are dramatic developments in technologies for recognizing images. Fourth, there are dramatic developments with respect to embedding objects in the natural word. To date the applications of these four have largely been for surveillance, law enforcement and security. But they can equally be applied in the world of knowledge. When we do so, then the physical world and man-made worlds, which were traditionally recorded worlds can become recording worlds.

In this new world there will be two kinds of smart objects: physical objects with embedded information and digital surrogates in the sense of Industry Foundation Classes, which include various technical specifications as part of their embedded knowledge. In future, such smart design modules need to be imbued with historical and cultural dimensions, reflecting how an object changed both temporally and spatially. If all the world's a sensor, then both the worlds of the past in memory institutions as well as the man-made world and physical worlds around us can serve as combined sources for future design, inspirations and creativity.

A profound consequences of these developments is that the Internet which became a World Wide Web needs to be much more than a closed cloud of born-digital information. As the ITU has noted the Internet is becoming an Internet of things. Even this is only a first step in a much more wide-ranging change whereby the World Wide Web (W3) will become a system linking various worlds: metaphysical, mental, physical, man-made and social worlds, a Worlds Wide Web (or W5 that tends towards W^n). Technologies for more information are ultimately the easy part. Technologies for more knowledge and especially more viewpoints on that knowledge, technologies which promote wisdom, inspiration and creativity are the true challenge.

Notes

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For a further discussion of these themes see the author's: Understanding New Media: Augmented Knowledge and Culture, University of Calgary Press, 2006 and see also the online version at www.sumscorp.com .