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## **Digital Reference Rooms: Access to Historical and Cultural Dimensions of Knowledge**

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1. Introduction
  2. Digital Libraries
  3. Digital Museums
  4. Digital Education
  5. MEDICI Framework
  6. Digital Reference Rooms
  7. Authority Lists
  8. New Search Strategies via Related Terms
  9. New Forms of Meta-Data
  10. Historical and Cultural Dimensions of Knowledge
  11. Interoperability of Contents
  12. Conclusions
- 

### **1. Introduction**

In the United States, the rhetoric about the information superhighway was initially focussed primarily on pipelines: the engineering infrastructure needed for connectivity. In Europe, where there is a goal of an information society, global interoperability of networks has been recognised as one of the fundamental preconditions. This challenge is being addressed at a European level through various R&D and deployment initiatives and at the world level through G8 pilot projects. These are providing the pipelines for high-speed transfer of information. As in the film *Field of Dreams*, there was a general approach of “build it and they (in this case, content) will come,” with an underlying assumption that once there is connectivity the problems are solved and all one needs to do, so to speak, is to pour or ship content down the pipeline.

In addition we need an intellectual framework for interoperability of contents. Important contributions in this direction are being made by the Internet Engineering task Force (IETF) of the Internet Society and the World Wide Web Consortium, particularly through their Resource Description Format (RDF). North American initiatives such as the National Science Foundation in the domains of Digital Libraries and Education; the Coalition of Networked Information; the National Initiative for Networked Cultural Heritage (NINCH) and the Dublin Core in the realm of metadata and ontologies (an American term for *thesauri*) also mark useful steps in this direction. Part one of the paper reviews major initiatives to provide networked access to cultural heritage with respect to libraries, museums and education. These initiatives are introducing some common standards to permit interoperability among distributed collections. A fundamental shortcoming of all these solutions, however, is that they are focussed almost exclusively on contemporary knowledge and as such ignore the historical and cultural dimensions of knowledge organisation.

Data Retrieval for sourcedata	Intelligent Retrieval	Optional Functions	High Definition
Retrieval	Thesaurus	Cover Image Display	ImageData
Hypertext	Keyword Translation	Machine Translation	HDTV
Multimedia data	Hypertext	Keyword Retrieval Logical Expression Retrieval Marking Retrieval using System Hierarchy	Memorandum Service

Figure 1. Schema of key elements in Japan's model for the G7 pilot project on libraries entailing the Electronic Library System (Ariadne).

Part two of the paper suggests that centralised, digital reference rooms offer a new answer to problems of distributed, networked knowledge. Reference rooms are the traditional equivalents of search engines and structuring tools. Indeed the reference rooms of libraries have served as civilisation's cumulative memory concerning search and structure methods through classification systems, dictionaries, encyclopaedias, book catalogues, citation indexes, abstracts and reviews. Digital reference rooms thus offer keys to more comprehensive tools.

The concept of digital reference rooms is part of a larger vision to create an intellectual framework for interoperability of content. This is being developed within the MEDICI framework of the European Commission through a new European Network of Centres of Excellence in Digital Cultural Heritage and ICT<sup>1</sup> based at Maastricht.

## 2. Digital Libraries<sup>1</sup>

In the early phases this process was referred to as library automation or electronic libraries. Now the term digital libraries is most frequently used. At the international level the International Standards Organization has a technical committee on Information and Documentation: Presentation, Identification and Description of Documents (ISO/TC46/SC9)<sup>2</sup> and a standard for Bibliographic References to Electronic Documents (ISO 690-2). There is also G8 pilot project 4: Bibliotheca Universalis which is co-ordinating the author lists of five national libraries (Belgium, Britain, France, Portugal and Spain). Japan<sup>3</sup> has its own approach to this G8 pilot project (figure 1).

In addition G8 pilot project 6: Environmental Natural Resources Management (ENRM) also has a Digital Library Reference System.<sup>4</sup> The United Nations has a Bibliographic Information System (UNBIS).<sup>5</sup> The United Nations Educational, Scientific and Cultural Organisation (UNESCO) has a Memory of the World<sup>6</sup> project and a World Heritage List,<sup>7</sup> which also pertain to museums. A number of international institutions are exploring problems of digital libraries including the International Federation for Information and Documentation (IFID)<sup>8</sup>; International Federation of Library Associations (IFLA); International Research Library Association (IRLA); the International Association of Digital Libraries (IADL), which has a millenium project re: the New World and the International Council on Archives (ICA), which has an Ad Hoc Committee on Descriptive Standards.

At the European level there is a Gateway to European National Libraries (GABRIEL).<sup>9</sup> The European Commission's Telematics for Libraries<sup>10</sup> has projects on a number of themes

<sup>1</sup> Information and Communication Technologies

including: childrens' pages, distance learning, journals, metadata, music libraries, and software. Projects include: Automatic Information Filtering and Profiling (BORGES);<sup>11</sup> Catalogue with Multilingual Natural Language Access/ Linguistic Server (CANAL/LS);<sup>12</sup> a European SR-Z39.50 Gateway (EUROPAGATE);<sup>13</sup> Heritage and Culture through Libraries in Europe (HERCULE);<sup>14</sup> Integrated Library Information Education and Retrieval System (ILIERS);<sup>15</sup> Online Public Access Catalogue for Europe- II (ONE II);<sup>16</sup> Large Scale Demonstrators for Global, Open Distributed Library Services (UNIVERSE)<sup>17</sup> and Virtual library (VILIB).<sup>18</sup> The telematics for research programme is also sponsoring the Development of a European Service for Information on Research and Education (DESIRE),<sup>19</sup> which in turn has links to a British initiative on Resource Organisation and Discovery in Subject Based Services (ROADS). As part of the ESPRIT long term projects the European Research Consortium for Informatics and Mathematics (ERCIM) Digital Library<sup>20</sup> (DELOS) has developed a Semantic Index System and Thesaurus Management System (SIS-TMS) and a Platform Independent and Inter-Platform Multimedia (REFEREED).

In addition there are both ESPRIT and INFO 2000 projects dealing with examples of digital library content ranging from a dictionary of art, palaces and gardens of Europe; great composers; a multilingual multimedia encyclopedia of ecology; a World Electronic Book of Surgery (WEBS) to an information context for biodiversity.<sup>21</sup> There is a European Digital Library Consortium.<sup>22</sup> Another consortium which includes the Oxford Text Archive, the Bibliothèque Nationale and the Consorzio Pisa Ricerche, called Multimedia Electronic MemORIEs At hand (MEMORIA)<sup>23</sup> is devoted to accessing, retrieving, and structuring writing.

The European Commission's Guide to Open Systems Specifications (GOSS)<sup>24</sup> has sections on Information Structure and Representation as well as Library Applications. The World Wide Web Consortium<sup>25</sup> (W3) is concerned with digital libraries. The Research Libraries Group (RLG) has an Archives and Manuscripts Taskforce on Standards. There is a mailing list on International Collaboration on Internet Subject Gateways (IMESH).<sup>26</sup> There is an important Text Encoding Initiative (TEI) based at the Universities of Oxford and Illinois (Chicago). There is also an International Institute for Electronic Library Research (De Montfort University).<sup>27</sup>

At the national level there are many initiatives all over the world. In Australia, for instance, the National Library at Canberra has an Australian Cooperative Digitisation Project 1840-1845.<sup>28</sup> In Canada, the Bureau of Canadian Archivists has a Planning Committee on Descriptive Standards and Rules for Archival Description (RAD). The National Library (Ottawa) has a Canadian Initiative on Digital Libraries<sup>29</sup> (CIDL); Working Groups on Advocacy and Promotional Issues; Creation and Production Issues and Organisational and Access Issues (Metadata); Digital Projects<sup>30</sup> including Early Canadiana Online,<sup>31</sup> a Virtual Canadian Union Catalogue<sup>32</sup> and a Virtual Visit.<sup>33</sup>

In Denmark there is a national project for Denmark's Electronic Research Library (DEF). In France the Bibliothèque Nationale de la France (BNF) affectionately known as the tgb (très grande bibliothèque) is engaged in the MEMORIA consortium (mentioned above) and the Gallica<sup>34</sup> project. In Germany, there is work on a distributed digital research library (Verteilte Digitale Forschungsbibliothek). A federation of five libraries (Berlin, Frankfurt, Göttingen, Munich and Wolfenbüttel) are developing a pilot project for the digitising of all German works (Arbeitsgemeinschaft Sammlung Deutscher Drücke). This includes a Kompetenz Zentrum Digital Library sponsored by the German Research Society (Deutsche Forschungs

Gemeinschaft). Bertelsmann,<sup>35</sup> one of the largest publishers in the world is active on a number of fronts.

The Gesellschaft für Mathematik und Datenverarbeitung (GMD) has an Integrated Publication and Information Systems Institute (IPSI)<sup>36</sup> concerned with Distributed Processing of Multimedia Objects. They are working on a Global Electronic and Multimedia Information Systems for Natural Science and Engineering<sup>37</sup> (GLOBAL-INFO), which includes Physics (PhysDoc), Computer Science (McDoc); Mathematics (MathNet); Natural Sciences and Technology (eprint). Connected with this are the bibliographies on Database Systems and Logic Programming (dblp) (Trier) and on Computer Science (Karlsruhe) and the project on Advanced Retrieval Support for Digital Libraries<sup>38</sup> (DELITE). The Institut für Terminologie und angewandte Wissensforschung (ITAW) in Berlin is exploring full text digitisation and retrieval using SGML. A project called From Text to Hypertext includes at least six partners: Börsenverein des Deutschen Buchhandels, Schlütersche Verlagsanstalt, Olms Verlag, Bertelsmann Club GmbH, Deutscher Bibliotheksverband e.V. and the Zentrum für Kunst und Medientechnologie. The Library at Braunschweig is mapping headings in eight major catalogue systems.<sup>39</sup>

In Italy there is a project for an Intelligent Digital Library (IDL) in Bari and a Biblioteca Italiana Telematica<sup>40</sup> (CIBIT) at the National Research Council site in Pisa. In Japan, there is a Digital Library Network (DLnet) based at the University of Library and Information Science (Tsukuba Science City).<sup>41</sup> In the Netherlands the Digitale Encyclopedie Nederland (DEN) project foresees the creation of a digital encyclopaedia of Netherlandish Cultural Heritage which will cover both library and museum materials. The publisher Elsevier, engaged in the German Global Info project (mentioned above) is also involved in The University Licensing Program<sup>42</sup> (TULIP). The Netherlands is also developing a Dutch Electronic Subject Service (DUTCHESS),<sup>43</sup> based on the Netherlandish Basic Classification, which has links to the European DESIRE project aiming at subject gateways to information.

In the United Kingdom, a number of digital library initiatives are based at the Bath Information and Data Services (BIDS)<sup>44</sup> and the Electronic Library Programme<sup>45</sup> (elib), which entails a range of problems including access to network resources, digitisation, electronic document delivery; electronic journals; on line publishing and quality assurance. The British Library has a Digital Library Research Programme,<sup>46</sup> a Digital Library Programme<sup>47</sup> and a project for Cataloguing and Retrieval of Information Over Networks Applications (CATRIONA). There is also a United Kingdom Pilot Site Licence Initiative (UKPSLI). The Scottish Cultural Resource Access Network<sup>48</sup> (SCRAN) deals with both library and museum resources.

The United States is nominally a member of G8 pilot project 4: Biblioteca Universalis.<sup>49</sup> At home, in the United States, the military is closely connected with digital library initiatives. The Defence Advanced Research Projects Agency (DARPA) has a Research Program on National Scale Information Enterprises and has developed both a Knowledge Query Manipulation Language (KQML)<sup>50</sup> and a Knowledge Interface Format (KIF).<sup>51</sup>

1	Carnegie Mellon University	Infomedia: Digital Video Library <sup>52</sup>
2	Stanford University	Integrative Mechanisms in Heterogeneous Services <sup>53</sup>
3	University of California, Berkeley	Environmental Planning and GIS <sup>54</sup>
4	University of California, S. Barbara	Alexandria Project
		Spatially Referenced Map Information <sup>55</sup>
5	University of Michigan	Intelligent Agents and Information Location <sup>56</sup>
		Advanced User Interface <sup>57</sup>
		Glossary: Terms, Organizations <sup>58</sup>
6	University of Illinois	Federating Repositories of Scientific Literature <sup>59</sup>
		Social Science Team <sup>60</sup>
		Semantic Research <sup>61</sup>
		Interspace Prototype <sup>62</sup>
		Includes CS Quest
		Automatic Indexing
		Concept Space Generation
		Visualisation Fisheye View
		Systems Software Research Group

Figure 2. Key aspects of the Stanford Digital Libraries Project<sup>63</sup> now called Digital Libraries Initiative.<sup>64</sup>

Along with the National Science Foundation (NSF), and the National Aeronautics and Space Administration (NASA),<sup>65</sup> DARPA is active in the Digital Libraries Initiative<sup>66</sup> (figure 2). DARPA funds the new journal D-Lib and along with the National Science Foundation (NSF) recently (1998) announced an International Digital Libraries Collaborative Research<sup>67</sup> which is linked with the British Joint Information Systems Centre (JISC). The National Information Infrastructure (NII) is developing a NII Virtual Library.<sup>68</sup> The Information Infrastructure Task Force (IITF) includes a Linguistic Data Consortium (e.g. BBN, SRI, MIT, CMU) working on a spoken natural language interface to libraries.

Indirectly the military is also active in four projects of the Department of Energy (DOE) in the digital libraries domain: a Comprehensive Epidemiologic Data Resource (CEDR); a Socio-Economic Environmental Demographic Information System (SEEDIS); Carbon-Dioxide Information Analysis Center (CDIAC) and a Data Base of Scientific Mathematical Software. It is also indirectly active in the government's Computer and Information Science and Engineering (CISE) initiative, which has projects on Information and Intelligent Systems (IIS); Advanced Networking Infrastructure and Research (ANIR) and Experimental And Integrative Activities (EIA) entailing nine different areas: 1) Advanced Mass Storage; 2) Electronic Capture of Data; 3) Software for Multimedia Processing; 4) Intelligent Knowledge Processing; 5) User Training; 6) Friendly Interfaces; 7) Collaborative Problem Solving Tools; 8) Standards and Economic issues and 9) Experimental Prototypes.

The U.S. government's Research on Digital Libraries includes a Library Server for Manufacturing Applications at the General Electric R&D Center, Current Economic Statistics and a Guide to Available Mathematical Software (GAMS). Also active are the American Society for Information Science (ASIS),<sup>69</sup> the Center for Networked Information Discovery and Retrieval<sup>70</sup> (CNIDR). There is a Digital Library Integrated Task Environment (DLITE),<sup>71</sup> and a Networked Computer Science Technological Reports Library<sup>72</sup> (NCSTRL). The Committee on Institutional Co-operation (CIC) has a Center for Library Initiatives and a Virtual Electronic Library<sup>73</sup> (VEL). The Digital Preservation Consortium<sup>74</sup> has a Digital

Library Federation<sup>75</sup> (DLF) and a Machine Assisted Realization of the Virtual Electronic Library (MARVEL).

The Library of Congress<sup>76</sup> is the seat of a National Digital Library Program,<sup>77</sup> is co-ordinating the Z39.50 sites<sup>78</sup> (ISO 23950), is engaged in the American Memory<sup>79</sup> project and is one of ten libraries in the Ameritech Digital Library project.<sup>80</sup> They are working on the concept of a Digital Librarian. The University of Illinois which is in the Digital Libraries Initiative (figure 2) has four related Projects: 1) Astronomy Digital Image Lab (ADIL)<sup>81</sup>; 2) Getty Museum Education Site Licensing Project (MESL)<sup>82</sup>; 3) Horizon Project (NASA)<sup>83</sup>; 4) The Daily Planet (TM).<sup>84</sup>

The University of California, Berkeley has a series of projects relating to Digital Library Research and Development<sup>85</sup> including an Advanced Papyrological Information System<sup>86</sup> (APIS); American Heritage; California Heritage;<sup>87</sup> Cheshire II Search Service (which uses the Z39.50 protocol)<sup>88</sup>; Digital Page Imaging and SGML<sup>89</sup>; Electronic Binding DTD (ebind); Encoded Archive Description<sup>90</sup> (EAD); Finding Aids for Archival Collections<sup>91</sup>; Index Morganagus<sup>92</sup>; Full Text Index of Library Related Electronic Journals; Scholarship from California on the Net<sup>93</sup> (SCAN); the Berkeley Multimedia Research Center<sup>94</sup> and the Information People Project<sup>95</sup>

At least four universities (Berkeley, Duke, Stanford and Virginia) are engaged in the American Heritage Project,<sup>96</sup> which includes an American Heritage Virtual Archive Project. Cornell University has a Consortium for University Printing and Information Distribution (CUPID); a project on a Flexible and extensible Digital Object and Repository Architecture<sup>97</sup> (FEDORA) and two projects with the University of Michigan one on the Making of America<sup>98</sup> (MOA), another on an Internet Public Library<sup>99</sup> (IPL). The Universities of San Diego and Southern California (USC) are working on the Alexandria Digital Library.<sup>100</sup>

In addition there are a number of individual initiatives. Harvard University has an Harvard Information Infrastructure Project<sup>101</sup> (HIIP). The Texas A&M University has a Center for the Study of Digital Libraries.<sup>102</sup> The University of Maryland (College Park) has a Digital Library Research Group (DLRG). The University of North Carolina, Chapel Hill has been working on a Sharium.<sup>103</sup>

Major companies active in digital libraries include Bell Communications Research (Bellcore),<sup>104</sup> IBM,<sup>105</sup> (whose work is focussed on four areas: media and entertainment; higher education<sup>106</sup>; government and cultural institutions); Xerox<sup>107</sup> (whose approach entails four domains: infosphere, workspace, sensemaking tools, document, and superbook) and Lockheed Martin, who are developing a Rapid Access Electronic Library System (RAELS). There are virtual libraries in the Biosciences,<sup>108</sup> Chemistry<sup>109</sup> and Control Engineering.<sup>110</sup> There are also a number of new journals including D-Lib,<sup>111</sup> Digital Library News<sup>112</sup> (DLN), Initiatives in Digital Information (University of Michigan),<sup>113</sup> the International Journal on Digital Libraries (Rutgers University),<sup>114</sup> the Journal of Electronic Publishing (University of Michigan)<sup>115</sup> and the Research Library Group's (RLG) DigiNews,<sup>116</sup> as well as publishers such as High Wire Press<sup>117</sup> (Stanford University).<sup>118</sup>

### 3. Digital Museums

At the international level, digital museums, also called virtual museums,<sup>119</sup> or imaginary museums (a term translated from the French *musée imaginaire* as described by the late

minister of culture Andre Malraux), are covered in one of the eleven pilot projects of the G8, namely Pilot Project 5: Multimedia Access to World Cultural Heritage.<sup>120</sup> The United Nations Educational Scientific and Cultural Organisation (UNESCO) has a number of projects including a World Heritage Information Network, (WHIN)<sup>121</sup> World Heritage Web (WHB),<sup>122</sup> and HERitage NETwork (HERINET)<sup>123</sup> as well as more specialized projects under the Communication, Information and Informatics Sector<sup>124</sup> such as Bibliotheca Alexandrina; International Informatics Programme (IIP); International Program for the Development of Communication (IPDC); Memory of the World Program; World Information Report and World Heritage.

Also interested in these problems are other international institutions such as the International Council of Museums (ICOM)<sup>125</sup> with its numerous committees<sup>126</sup> on conservation, documentation,<sup>127</sup> education, monuments, sites etc and the Comité Internationale d'Histoire de l'Art (CIHA) which set out to create a Thesaurus Artis Universalis (TAU). The Consortium for Computer Interchange of Museum Information (CIMI)<sup>128</sup> has been working on standards and has developed a testbed for museums to share information. The Computer Heritage Information On-Line<sup>129</sup> (CHIO) has developed an Exhibition Catalogue Document Type Description (CHIO DTD)<sup>130</sup> and is working on a standards framework which includes SGML for Cultural Heritage Information<sup>131</sup> and Full Text Document Type Description V4.0<sup>132</sup> (FT DTD). The Council of Europe has a Division for Cultural Heritage.<sup>133</sup> A group based in Berlin is discussing a new Museum of World Cultures, which would probably be located in Strasbourg.

The European Commission has funded many projects including a number specifically intended to establish networks in the field of cultural heritage. These include Remote Access to Museum Archives (RAMA); Multimedia European Network for High Quality Images Registration (MENHIR), which is linked with the commercial enterprise Museums On Line; Network of Art Research Computer Image Systems in Europe (NARCISSE); Sharing Cultural Heritage through Multimedia Telematics (AQUARELLE)<sup>134</sup> and MIDAS Net.<sup>135</sup> There is also an Advanced Communications and Technologies Services (ACTS) project called Virtual Museum International (VISEUM). Museums over States in Virtual Culture<sup>136</sup> (MOSAIC) is part of the Trans European Networks Project (TEN). In the context of INFO2000 there has been Artweb, Mediterranean Multi Media Support Centre for culture and arts (M.Cube);<sup>137</sup> Cultural Heritage of long Standing Legacy in Open Network (CHAMPOLLION) and Cultural Heritage and Arts Information Network (CHAIN). The European Commission's Telematics for Libraries has developed a Visual Arts Network for the Exchange of Cultural Knowledge (VAN EYCK)<sup>138</sup> There are also a number of networks involving pay services namely: Museums On-Line,<sup>139</sup> RMN's<sup>140</sup> Artois, Art Web and in the United States, the Art Museum Image Consortium<sup>141</sup> (AMICO), and Mr. Gates' Corbis.

At the national level, the Canadian Heritage Information Network<sup>142</sup> (CHIN) was the first network to be established for museums, followed by the Marburger Archiv<sup>143</sup> in Germany which developed the Marburger Informations-Dokumentations und Administrations- System (MIDAS). In recent years there have been a number of such national networks including the Scottish Cultural Resources Access Network (SCRAN)<sup>144</sup> and the Australian Cultural Network.<sup>145</sup> Countries such as France have created a general inventory of monuments and artistic treasures,<sup>146</sup> a database of Fine Arts and Decorative Arts (JOCONDE) and a database concerning conservation and restoration (MUSES). The Réunion des Musées Nationaux (RMN)<sup>147</sup> has developed a new network of online museum shops. Italy is developing Cultural Heritage Assisted Analysis Tools (CHAAT). The United Kingdom has an Arts and

Humanities Data Service,<sup>148</sup> Museum Documentation Association<sup>149</sup> (MDA)<sup>150</sup> and a National Council on Archives (NCA) with an Information Technology Standards Working Group (ITSWG) and a Royal Commission on the Historical Monuments of England<sup>151</sup> (RCHME). There is a proposal for a Eurogallery, which will link the National Gallery (London), Réunion des musées nationaux (Paris), Van Gogh Museum (Amsterdam). Under discussion also is a possible European Museum Information Institute (EMII).

In the United States, the American Association of Museums has established a Museum Digital Licensing Consortium<sup>152</sup> (MDLC Inc). National efforts are being led by the President's Committee for the Arts and the Humanities, National Endowment for the Humanities<sup>153</sup> (NEH), the National Initiative for Networked Cultural Heritage<sup>154</sup> (NINCH) and the Coalition for Networked Information.<sup>155</sup> The American Association for State and Local History (AASLH) has been working on a Common Agenda for History Museums. The Getty Trust through its (now abandoned) Getty Information Institute (GII)<sup>156</sup> has produced useful tools such as the Art and Architecture Thesaurus (AAT), a Thesaurus of Geographic Names (TGN) and a Union List of Author Names (ULAN). The Society of American Archivists has a Standards Board<sup>157</sup> with a Working Group on Standards for Archival Description (WGSAD), a Committee on Archival Information Exchange (CAIE) and an Encoded Archival Description Working Group<sup>158</sup> (EADWG). Other significant organizations include the Museum Computer Network<sup>159</sup> (MCN), Archives and Museum Informatics (Pittsburg); the Association of Art Museum Directors (AAMD). The University of California, Berkeley, also has a Museum Informatics Project<sup>160</sup> (MIP).

Major companies in the realm of digital virtual museums include Hitachi (Viewseum<sup>161</sup>); Intel (Virtual Gallery<sup>162</sup>); Sony (Paris, which has a Personal Experience Repository Project<sup>163</sup>); Xerox (Grenoble, which is working on the Campiello Project which is part of the European Commission's i3 or Icube projects).<sup>164</sup> The University of Karlsruhe is developing an Ontobroker.<sup>165</sup>

#### **4. Digital Education**

Similar developments are evident in the fields of education and training. At the global level the International Telecommunications Union is creating a Virtual Training Centre (for Distance Learning)<sup>166</sup> (ITU/BDT). There is a Global Telecommunication University (GTU), a Global Telecommunication Training Institute (GTTI), a Virtual Training Center,<sup>167</sup> a Global Campus<sup>168</sup> (not to be confused with the IBM Global Campus),<sup>169</sup> a Global Learning Consortium<sup>170</sup> (GLC), an International Society for Technology in Education<sup>171</sup> (ISTE), a Federation for Audio-Visual Multimedia in Education (FAME) and a Council of European Informatics Societies<sup>172</sup> (CEPIS) which is producing a European Computer Driving Licence<sup>173</sup> (ECDL). There is also The Association for Computer Based Training<sup>174</sup> (TACT).

At the European level, there is Ortelius, a database on higher education in Europe;<sup>175</sup> an Educational Multimedia Task Force (EMTF) initiative,<sup>176</sup> a European Schoolnet,<sup>177</sup> and a European Education Partnership (EEP), which is linked with the MEDICI framework.<sup>178</sup> As in the area of culture, the European Commission has produced a Memorandum of Understanding for partnership and standardization in the field of learning technology (MOU Learning)<sup>179</sup> In the United States, the EDUCOM consortium has introduced EDUCAUSE,<sup>180</sup> and working in conjunction with the National Learning Infrastructure Initiative<sup>181</sup> (NLII), is working on an Instructional Management System<sup>182</sup> (IMS) "to enable an open architecture for online learning". IMS, in turn, is co-operating with the IEEE's Learning Technology

Standards Committee<sup>183</sup> (LTSC) and specifically their Technical Standards for Learning Technology. Working Group (P1484.1) to create an "Architecture and Reference Model" of a learning environment. IMS is working with the European Union's project for an Annotatable Retrieval of Information And Database Navigation Environment (ARIADNE) on the development of information content metadata.<sup>184</sup> IMS is also part of the Office of Science and Technology Policy (OSTP), linked with the Department of Defense and the White House,<sup>185</sup> which is developing Advanced Distributed Learning (ADL). IMS is also working with the Aviation Industry CBT Committee<sup>186</sup> (AICC), which is developing recommendations and guidelines for a common learning environment model.

## **5. MEDICI Framework<sup>187</sup>**

To address the problem of how various relevant initiatives can be integrated into a larger framework, the European Commission has recently outlined a First European Community Framework Programme in Support of Culture, Culture 2000.<sup>188</sup> This will integrate existing programs such as Kaleidoscope,<sup>189</sup> Ariane,<sup>190</sup> Raphael,<sup>191</sup> and other relevant initiatives,<sup>192</sup> such that they are all included within a single funding structure.<sup>193</sup> The Fifth Framework Programme of the European Commission will reflect these goals.<sup>194</sup>

As part of this strategy towards integration, the European Commission introduced a Memorandum of Understanding (MOU) for Multimedia Access to European Cultural Heritage (1996). This led (October 1998) to a new framework, MEDICI (Multimedia for EDucation and employment through Integrated Cultural Initiatives).<sup>195</sup> MEDICI has the main goal of promoting the innovative use of ICT and multimedia for access to and exploitation of Europe's cultural heritage. The MEDICI framework is based on the sharing of experiences and co-operation among its participants, which will provide information and specific services in order to facilitate the take-up of advanced ICT services and applications in the cultural heritage sector. Various action lines, such as inter-museum thematic virtual multimedia exhibitions; education, tourism and best practice lists are being defined within MEDICI. The MEDICI secretariat in Milan is developing a web-site, which will contain, among other things, a digital library with information on emerging hardware and software standards, templates for contracts, lists of possible sources for funding, as well as notable examples of products. The MEDICI site serves as an electronic version of a best practice handbook for multimedia in the cultural domain and provides cultural institutions, particularly smaller museums with reliable information about the state of the art, i.e. working solutions which they could not afford to undertake on their own.

An integral part of the MEDICI framework is a European Network of Centres of Excellence in Digital Cultural Heritage and Information Communication Technology (ICT), based at the new Maastricht McLuhan Institute (MMI). This will be linked with the Scuola Normale Superiore in Pisa, the University of Bologna and other centres throughout Europe. One of the basic goals of the network is to create an intellectual infrastructure for interoperability of content. A crucial step in this direction will be provided through the development of digital reference rooms.

## **6. Digital Reference Rooms**

As noted above, all over the world there are immense repositories of knowledge in libraries, museums, archives and other collections. In the past, access to these materials was limited to visiting an individual site, then visiting another and so on. To meet this challenge a spectrum

of solutions evolved. At one extreme, there was a quest to collect everything in a single location. This inspired the Alexandrian Library and inspired more recent efforts such as the British Library (London) and the Bibliothèque Nationale de France (Paris). As the owners of these collections discovered, no single building or complex can contain all the books and materials that exist.

Recently, at another extreme, there was a vision of the Internet as a completely distributed system, the theory being that once the collections are digitised, a new kind of universal access to these materials is possible. In theory, anyone, at anytime, anywhere can have access to these materials, which makes possible an enormous democratisation of access to knowledge. However rhetorically attractive, this is doomed to failure because there is no way of moving efficiently across myriad different naming procedures without standardised names for persons, things, places and times. Digital reference rooms are an intermediate solution between these two extremes: centralized reference materials furnish authority lists to provide standardized access to distributed knowledge.

Traditional reference rooms contain a series of tools for helping readers find books, manuscripts and other materials. These include lists of terms (classifications, thesauri), definitions (dictionaries), explanations (encyclopaedias), titles (library catalogues, book catalogues, publishers catalogues and bibliographies), and partial contents (abstracts and reviews). These combined tools serve as the collective search methods of civilisation.

In such physical reference rooms a single problem may readily take us to dozens or sometimes even hundreds of different sources as we search through multiple definitions of a term, check how the term is handled by different encyclopaedias and then check where books relating to that term are found in different libraries, national book catalogues, publishers catalogues and other specialised collections. Digital reference rooms have an enormous advantage over such traditional reference rooms because we can consult many sources through a single interface.

Some aspects of digital reference rooms are already familiar through the many initiatives in digital libraries, which are typically limited to electronic versions of library catalogues, offering lists of authors, titles, key words and/or subjects and in some cases a standard classification system (figure 3). For instance, the Online Computer Library Center (OCLC) is providing access to information through their Dewey for Windows programme. They are also exploring the possibility of mapping between various systems.

Initial steps in the direction of digital reference rooms can be found on the Internet today. Search engines such as Yahoo and Excite<sup>196</sup> and sites such as Webdata<sup>197</sup> and Link2go<sup>198</sup> have reference sections, which include titles and sometimes contents of dictionaries, directories, encyclopaedias, thesauri and bibliographies as found in reference rooms. The WWW Virtual Library includes such materials under Information Management.<sup>199</sup> The National Center for Supercomputing Applications (NCSA) has a Meta-index of Internet Resources<sup>200</sup>

Form	Content
Authors	Subjects or Key Words
Titles	Classifications and Thesauri
	(Full) Texts, Corpora

Figure 3. Four basic access points to full texts according to traditional library approaches reflected in digital libraries projects.

The University of California at Berkeley is working on webliographies.<sup>201</sup> The University of Strathclyde has created BUBL (originally an acronym for Bulletin Board for Libraries), which has a significant reference section and allows one to search using the Dewey Decimal Classification (DDC).<sup>202</sup> The University of California at Irvine has a Virtual Reference Collection.<sup>203</sup> The University of Sussex has a useful list of subject resources for the arts, social sciences and sciences.<sup>204</sup> Gerry McKiernan at Iowa State has a list of on-line classification systems and controlled vocabularies.<sup>205</sup> Professor Beard at Bucknell University has made a list of some 800 dictionaries<sup>206</sup> and some 150 grammars.<sup>207</sup> The Bayerische Staatsbibliothek is scanning in standard German encyclopaedias such as Adelung and Zedler. General reference tools such as the International Bibliography of Periodical Literature (*Internationale Bibliographie der Zeitschriftenliteratur aus allen Gebieten des Wissens* or *IBZ*) are already available on CD-ROM. The Oxford English Dictionary is scheduled to be available on line in October 1999.<sup>208</sup>

A series of universities have created prototypes of virtual reference rooms. For instance, the Scholes Library at Alfred University has an Electronic Reference Desk.<sup>209</sup> Carnegie Mellon has On-line reference works.<sup>210</sup> Tsukuba University has a Tsukuba Library Digitized Information Public Service (TULIPS).<sup>211</sup> The University of Arkansas has a Virtual Reference Desk.<sup>212</sup> The University of California at San Diego (UCSD) has a Libraries Reference Desk.<sup>213</sup> The American Communications Association (ACA) has a Virtual Reference Desk<sup>214</sup> as does Galaxy.<sup>215</sup> Most of these are limited to titles of reference works rather than their full contents. A personal equivalent of such approaches is at a site called My Virtual Reference Desk.<sup>216</sup> Meanwhile there are companies such as Silverplatter,<sup>217</sup> Dialog<sup>218</sup> and Knight-Ridder,<sup>219</sup> which are offering commercially what have traditionally been public services.

The challenge is to take such sporadic examples and combine them to create a digital reference room. This electronic reference room will begin as a personal digital desktop with a handful of standard reference works in electronic form and gradually expand its repertoire of sources to deal with local problems of students and experts, then at a national and an international level. Eventually it will provide an electronic equivalent of the combined reference materials available in the world's great libraries such as the Bibliothèque Nationale, the British Library, Library of Congress, the Herzog August Bibliothek and the Vatican. Using methods such as the Resource Description Format (RDF) of the W3 Consortium the quality and the level of acceptance of these sources can also be built into the system.

If digital reference rooms only provided some of the contents of physical reference rooms in digital form, they would be of limited interest. Potentially digital reference rooms offer much more: they provide further resources for authority lists; new search strategies via related terms; new forms of meta-data, keys to historical and cultural dimensions of knowledge and thus serve as an important basis for an intellectual framework for interoperability of content. Digital reference rooms are therefore much more than a key to digital libraries and museums. They offer a new approach to the organisation of knowledge.

## **7. Authority Lists**

In searching for authors or titles, library catalogues offer an obvious point of departure. But such catalogues are limited to the authors and titles, which happen to be in that particular library. Networks of library catalogues such as the Online Public Access Catalogue for

Europe- II (ONE II)<sup>220</sup> or that of the Research Libraries Information Network (RLIN) have greatly expanded such lists of authors and titles.

Reference rooms contain many other resources, which can help in creating comprehensive lists of authors and titles. These resources include biographical dictionaries, encyclopaedias, book catalogues, and bibliographies. Authority lists provide us with standard spellings of names. Reference works such as the *Allgemeine Künstler Lexikon* provide us with numerous variants of those standard spellings. When we move to full text searches, these variants become new elements for searching. Thus digital reference rooms increase greatly the potential number of authors and titles to be searched.

As noted above, museums and galleries are already creating digital versions of their collections, including their reference works. We can therefore use existing digital versions of reference works (e.g. classification systems, dictionaries, encyclopaedias, catalogues, bibliographies, reviews and abstracts) to create new authority lists of persons (Who?), things (What?), places (Where?), times (When?), processes (How?) and causes or reasons (Why?). Some of these lists have been produced by publishers of standard reference works (e.g. Saur). Publishers will find it useful to co-operate in this venture in order to provide new links to their materials, which can be licensed within the system.

## 8. New Search Strategies via Related Terms

As noted above (figure 1), digital libraries are typically limited to two types of questions: Who? (Authors) and What? (Titles, Subjects and Classifications), thus four points of access. Some libraries such as the Herzog August Bibliothek (Wolfenbüttel) also offer access via two further questions: Where? (in terms of place of publication) and When? (in terms of date of publication).

Digital reference rooms potentially offer a much richer set of entry points to information. The authority lists of authors' names can be linked with corresponding names in (biographical) dictionaries, encyclopaedias, bibliographies, partial contents and full contents. Similarly the subject terms can be linked with classification systems and in turn with dictionaries, encyclopaedias and the like. This will have two fundamental consequences.

First it will help to contextualise knowledge concerning a person or subject. If I encounter a name and am uncertain whether this is an individual who interests me, I need only check a short description in a biographical dictionary or a longer entry in an encyclopaedia in order to ensure that this is the person I am seeking.

			WHO	WHAT	WHERE	WHEN
1	Names, Terms	Classifications	Authors	Subjects	Places	Periods
2	Definitions	Dictionaries	“ “	“ “	“ “	“ “
3	Explanations	Encyclopaedias	“ “	“ “	“ “	“ “
4	Titles	Catalogues	“ “	“ “	“ “	“ “
5	Partial Contents	Abstracts	“ “	“ “	“ “	“ “
6	Full Contents	Texts, Corpora	“ “	“ “	“ “	“ “

Figure 4. Different levels of knowledge in the digital reference room (1-5) coupled with four basic questions to produce a matrix of twenty different access points into existing corpora.

Second, this process of contextualisation will, at the same time, provide me with a wealth of new material, which can potentially be crucial to my searching. For example, when I look where a given word occurs in a classification system, I am given all the related terms around it. This provides me a vocabulary for further searches. Similarly when I go from the name of a given author to a biographical dictionary, I find the names of the key persons connected with the individual who interests me. These names can, in turn, provide me with further information about the individual in question. Taken to its logical conclusions this approach provides me with at least twenty points of entry into the contents found in full texts or corpora (figure 4).

Standard classification systems such as the Dewey system provide limited moves between broader and narrower terms. Technically this is a form of subsumption, which constitutes one of a number of relations among terms. The past generation has seen a dramatic rise in new kinds of thesauri, which differ from earlier classification systems in that they establish a number of relations among concepts. Perrault, in a seminal article introduced a method of integrating these systematically within the Universal Decimal Classification (UDC). The Medical Subject Headings (MESH) has five kinds of relations. Systems such as Dewey are too primitive to allow a full range of relations. Nonetheless, if there were mappings to link LC and DDC to UDC, then one could use the relations of UDC as a starting point for links to other systems. These same reference works can be used to generate an enormous amount of related terms in the form of alternatives, associations, complementaries, duals, identicals (synonyms), and opposites (antonyms).

Categories under which titles of books are listed are not limited to classification systems and thesauri. National book catalogues (such as *Books in Print* in the United States and the United Kingdom, *Kayser* in Germany, *Lorenz* in France and *Pagliaini* in Italy), publishers catalogues and bibliographies provide a wealth of further categories. These also change over time. Hence we need to take a given title, trace the various headings under which it is listed, in order to arrive at the equivalent of an etymology of categories. If we combine this with the basic titles in historical bibliographies we can develop new ways of tracing both the evolution of a field and the changing array of subjects connected therewith.

## **9. New Forms of Meta-Data**

Meta-data, one of the new buzzwords of digital library initiatives, typically serves as summary data about data, in order to provide a first clue about the author(s) or subject(s) of an electronic document or database. Digital reference rooms introduce the possibility of new forms of metadata.

In the case of an individual such as Leonardo da Vinci I want to know not only the standard and variant spellings of his name but also want a standard list of his paintings, drawings, and manuscripts. Hence a meta-data package on Leonardo will give me the key information on what he produced. At the same time it will provide me with both regular and variant spellings. Hence whether I type in *Mona Lisa* or *La Gioconda* it will take me to the same painting in the Louvre and draw my attention to copies and versions elsewhere.

## 10. Historical and Cultural Dimensions of Knowledge

At present the Internet is focussed primarily on the latest news as if it were a kind of electronic newspaper. The creators of search engines assume that isolated keywords in the form of natural language and translated into different languages will solve all our problems. Natural language does not account for variant spellings. More importantly it does not account for historical and cultural shifts in the meanings of terms.

We cannot reach a deeper understanding of an individual or a subject until we recognise just to what extent knowledge itself is an historical phenomenon. Today a Leonardo expert such as Pedretti lists over forty writings by Leonardo. In 1600, 1800 or even 1900 the number of known manuscripts by Leonardo was considerably different. The same holds true of his paintings. Hence the meta-data about Leonardo will eventually be much more than the titles found in a current *catalogues raisonnée* or in standard works. It will include lists, which change in size with time.

In the case of particularly complex authors such as Aristotle, this temporally changing meta-data will vary enormously. The corpus of Aristotle's works as provided in the Ross edition is very different from the works known at Charlemagne's court in 800, in Paris in 1275 at the time of Thomas Aquinas' death or in Marburg in 1527 when Melanchthon founded the university there.

In the case of countries, the problem of authority lists is more complex still and present day search engines ignore the problem entirely. If, for instance, I ask for Poland in Yahoo or Altavista, it is assumed I mean contemporary Poland. Historically, however, not only does the name of a country change with time, its boundaries also change. If I ask about Poland in the fourteenth century, I am asking about a much greater area of land than in 1998. Such information exists in historical atlases in reference rooms and the reference sections of map rooms. This needs to be added to the meta-data lists of our knowledge concerning place names.

Not only do basic names, terms and places change with time, so too do the concepts and structures with which we organize and class our knowledge. It is no secret that science today is very different than it was six hundred years ago. The English term, *science*, is easily translated into Latin *scientia*. But if we search using this term *scientia* in fourteenth century sources we find references to *knowledge*. At the time, *science* was classed under *philosophia naturalis*. The efforts of the Online Computer Center (OCLC) to use the Dewey classification system for searching the latest materials in libraries and on the Internet are important for finding subjects according to today's categories but do not help in historical searches.

Throughout the Internet community and even in the museum and library world, there is a general assumption that, if only we had "proper" natural language interfaces, combined with faster computers, which could potentially do comprehensive full text searches, all our searching problems would be over. This scenario may be tempting but it is fundamentally wrong. Simply applying the principle of number crunching to word crunching is not a solution. Unless we understand the historical dimension of knowledge we shall not even know where to begin with our searches. We may find the latest news from the standpoint of one culture but miss finding the richness and complexity of knowledge as a whole. Here again the digital reference room offers a solution precisely because reference rooms include earlier classification systems and multiple definitions of terms.

1	reference room in digital form
2	basis for more comprehensive authority lists
3	network of connections among terms in classification systems, dictionaries, encyclopaedias, which will permit both speedier and more complex search strategies
4	set of meta-data knowledge packages for authors, concepts, subjects and places which epitomises what we know and the sources of knowledge regarding individual items; a map of all our systems knowledge, such as periodical tables, the human genome, the classes of the animal, mineral and vegetable kingdoms, complete with all the links pertaining to these
5	historical dimensions of knowledge
6	cultural dimensions of understanding.

Figure 5. Six functions for a Digital or Virtual Reference Room.

On the Internet there are recent developments such as the Hotsauce software of Apple which shows a basic term surrounded by all the links at the next level, an approach that has been rendered in three-dimensional form through Stuart Card's *Cone Tree* and Matthias Hemmje's *Lyberworld*. In future we need a new kind of etymology of terms which will show us the changing constellations of its related concepts over time. This is another fundamental dimension where digital reference rooms can provide an essential contribution. They can help to trace the history of terms (etymologies) and changing structures of enduring knowledge through catalogue headings, classification systems, thesauri and other reference materials. A digital reference room will thus add an historical dimension to Internet techniques.

Closely related to the above are cultural dimensions of knowledge. These dimensions which change over space are often somewhat more subtle than interpretations which change over time historically. Poland may officially change size over the ages. But even at a given time, the size of Poland according to the Poles may vary considerably from the size of Poland according to the Germans, Ukrainians or the Russians.

This applies not only to definitions of size but applies especially to perceptions of meaning or importance. The significance of Siena according to the Sieneese is quite different than the significance of Siena according to the Florentines. Eventually we need meta-data, which will help us see the same persons, objects, events through the eyes of different cultures, in order to understand how something that seems wonderful to one person can be a perfect horror for others; how the same colour (white), which means purity in one culture can mean death in another. Only thus will we slowly have a framework for a new level of international understanding and, it is hoped, tolerance. From the above it is evident that Digital Reference Rooms (DRR) entail at least six interrelated functions (figure 5).

## 11. Intellectual Framework for Interoperability of Contents

The interrelated functions of the Digital Reference Room outlined above mark a first step towards an intellectual framework for interoperability of contents. The Maastricht McLuhan Institute (MMI), a European Centre for Digital Culture, Knowledge Organisation and Learning Technologies, will combine a prototype of such a digital reference room with new interfaces through a System for Universal Multi-Media Access (SUMMA). In the big picture, a number of other elements are needed for a comprehensive intellectual framework for interoperability of content. These include problems of conservation and restoration, of

reconstruction; more detailed study in the realms of multicultural, historical terminology and classification; accepted versus emerging concepts; as well as dynamic vs. static knowledge.

The new Network of Centres of Excellence in Digital Cultural Heritage will focus on creating this intellectual infrastructure. The network as a whole, will have six other functions, namely, to: 1) serve as arbiters of quality; 2) develop a multimedia Masters and Ph.D. programmes on a European scale (a postgraduate form of the ERASMUS concept); 3) promote fundamental research; 4) articulate directions for cultural policy; 5) share and create content;<sup>221</sup> and 6) encourage international dissemination.<sup>222</sup>

The links with museums and libraries can thus ensure new sources for European culture through better access to its cumulative memory of creative traditions. The MOU for Multimedia Access to Europe's Cultural Heritage was developed in parallel with the original aims of G8 pilot project 5: Multimedia Access to World Cultural Heritage. The challenge remains of ensuring that European experiences are properly seen in the context of culture around the world. For this reason links with international bodies such as UNESCO and ICOM are being established.

## 12. Conclusions

Global interoperability of networks has rightly been recognised as a fundamental prerequisite for an information society and a knowledge society. In addition to such pipelines, the exchange of information and knowledge requires an intellectual infrastructure for interoperability of content. Part one of the paper reviewed major projects at the international and national levels in the realms of digital libraries, museums and education. This revealed that a myriad of useful attempts are underway in these fields, often alas, unaware of efforts elsewhere. It also brought to light a fundamental shortcoming of all these solutions. They are focussed almost exclusively on contemporary knowledge and as such ignore the historical and cultural dimensions of knowledge organisation.

In response to a profound need for a whole that is greater than the sum of its parts, the European Union is developing a more systematic approach. The Fifth Framework Programme reflects this goal in the context of Information Society Technologies as a whole. In the realm of culture, this goal is reflected by the MEDICI framework.

Within the MEDICI framework, the European Commission is developing a new Network of Centres of Excellence in Digital Cultural Heritage based at the new Maastricht McLuhan Institute (MMI). It is proposed that reference rooms serve as the historical equivalents of search engines for the collective memory of civilisation. Digital reference rooms therefore offer a new key to the challenge of integrating historical and cultural dimensions of knowledge. This will serve as a first step towards an intellectual framework for interoperability of content. Initially the network includes European centres. The goal is to expand this such that MEDICI's efforts for Multimedia Access to Europe's Cultural Heritage can lead to a larger goal of Multimedia Access to World Cultural Heritage.

At the heart of this quest lies an interesting paradox. To create a truly global network of information and knowledge we need coherent standards: common rules for recording, storing, transporting and accessing knowledge. But the result of this homogenisation of forms must be a diversification of contents, a fundamental increase in awareness of the uniqueness of each local area. McLuhan's *global village* referred to an emerging reality whereby persons all around the world are linked electronically as if they were in a village. It must not come to

mean that we are all reduced to a single undistinguishable and undistinguished mass. The new technologies must increase our awareness of individual uniqueness. That is why historical and cultural dimensions of knowledge provided by digital reference rooms are not a luxury. Digital reference rooms are a key to more than digital libraries and museums. In addition, they may well be our only hope of realising the deeper goals of the Internet as a whole: creating a world wide web of knowledge that makes us richer as individuals.

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## Notes

- <sup>1</sup> See: <http://www.dlib.org/projects.html>
- <sup>2</sup> See: <http://www.nlc.bnc.ca/iso/tc46sc9/index.htm>
- <sup>3</sup> See: <http://www.mpt.go.jp/g7web/Electronic-Libraries/Electronic-Library.html>  
<http://www.mpt.go.jp/g7web/Electronic-Libraries/images/Electronic-lib-org.gif>
- <sup>4</sup> Info via Christine Maxwell
- <sup>5</sup> See: <http://www.un.org>
- <sup>6</sup> See: <http://www.unesco.org:80/cii/memory/menupage.htm>
- <sup>7</sup> See: <http://www.unesco.org/whc/heritage.htm>
- <sup>8</sup> See: <http://fid.conicyt.cl:8000/>
- <sup>9</sup> See: <http://www.konbib.nl/gabriel>
- <sup>10</sup> See: <http://www2.echo.lu/libraries/en/libraries.html>
- <sup>11</sup> See: <http://www2.echo.lu/libraries/en/projects/borges.html>
- <sup>12</sup> See: <http://www2.echo.lu/libraries/en/projects/canal.html>
- <sup>13</sup> See: <http://www2.echo.lu/libraries/en/projects/europaga.html>
- <sup>14</sup> See: <http://www2.echo.lu/libraries/en/projects/hercule.html>
- <sup>15</sup> See: <http://www2.echo.lu/libraries/en/projects/iliers.htm>
- <sup>16</sup> See: <http://www2.echo.lu/libraries/en/projects/one2.html>
- <sup>17</sup> See: <http://www2.echo.lu/libraries/en/projects/universe.html>
- <sup>18</sup> See: <http://www2.echo.lu/libraries/en/projects/vilib.html>
- <sup>19</sup> See: <http://www.ukoln.ac.uk/metadata/DESIRE/overview>
- <sup>20</sup> See: <http://www-ercim.inria.fr/activity/delos.html>
- <sup>21</sup> See: <http://www.uia.org/projects/i2000rep.htm>
- <sup>22</sup> See: <http://www-ercim.inria.fr/>
- <sup>23</sup> See: <http://guagua.echo.lu/langeng/en/mlap94/memo.html>
- <sup>24</sup> See: <http://www.ewos.be/goss/top.htm>
- <sup>25</sup> See: <http://www.dlib.org/dlib/november96/11miller.html>
- <sup>26</sup> See: <http://www.ilrt.bris.ac.uk/discovery/imesh>
- <sup>27</sup> See: <http://ford.mk.dmu.ac.uk>
- <sup>28</sup> See: <http://www.nla.gov.au/ferg/fergproj.html>
- <sup>29</sup> See: <http://www.nlc-bnc.ca/cidl>
- <sup>30</sup> See: <http://www.nlc-bnc.ca/digiproj/edigiact.htm>
- <sup>31</sup> See: <http://www.nlc-bnc.ca/cihm/ecol>
- <sup>32</sup> See: <http://www.nlc-bnc.ca/resource/vcuc/index.html>
- <sup>33</sup> See: <http://142.78.40.7/vtour/fvtour.htm>
- <sup>34</sup> See: <http://gallica.bnf.fr>
- <sup>35</sup> See: <http://www.fachinformation.bertelsmann.de/>
- <sup>36</sup> See: <http://www.darmstadt.gmd.de/IPSI>
- <sup>37</sup> See: <http://www.global-info.org>
- <sup>38</sup> See: <http://delite.darmstadt.gmd.de/delite/Projects/>
- <sup>39</sup> Bernhard Eversberg, *Was sind und was sollen Bibliothekarische Datenformate*, Braunschweig, Universitätsbibliothek, Technische Universität Braunschweig, 1994.

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- See: <http://www.biblio.tu-bs.de/acwww25/formate/formate.html>.
- 40 See: <http://www.ilc.pi.cnr.it/dbt/index.htm>
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- 43 See: <http://www.konbib.nl/dutchess/>
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- 47 See: <http://portico.bl.uk>
- 48 See: <http://www.scran.ac.uk>
- 49 See: [http://nii.nist.gov/g7/04\\_elec.lib.html](http://nii.nist.gov/g7/04_elec.lib.html)
- 50 See: <http://cs.umbc.edu/kqml>
- 51 See: <http://logic.stanford.edu/kif/kif.html>
- 52 See: <http://www.infomedia.cs.cmu.edu>
- 53 See: <http://walrus.stanford.edu/diglib>
- 54 See: <http://elib.cs.berkeley.edu>
- 55 See: <http://alexandria.sdc.ucsb.edu/>
- 56 See: <http://www.si.umich.edu/UMDL/>
- 57 See: <http://www.si.umich.edu/UMDL/au>
- 58 See: <http://www-personal.engin.umich.edu/~cerebus/glossary/glossary.html>
- 59 See: <http://dli.grainger.uiuc.edu/testbed.htm>
- 60 See: [http://dli.grainger.uiuc.edu/dlisoc/socsci\\_site/index.html](http://dli.grainger.uiuc.edu/dlisoc/socsci_site/index.html)
- 61 See: <http://ai.bpa.arizona.edu>
- 62 See: <http://csl.ncsa.uiuc/interspace.html>
- 63 See: <http://www-diglib.stanford.edu/>
- 64 See: <http://dli.grainger.uiuc.edu/national.htm>
- 65 See: M.O.W.B., "The Stanford Digital Libraries Project," *Web Techniques*, San Francisco, vol. 2, issue 5, May 1997, p.44.
- 66 See: <http://dli.grainger.uiuc.edu/national.htm>
- 67 See: <http://www.nsf.gov/pubs/1999/nsf996/nsf996.htm>
- 68 See: <http://nii.nist.gov>
- 69 See: <http://cpmcnet.columbia.edu/www/asis>. This has a special interest group for Classification Research.
- Another branch of the same site, namely
- <http://cpmcnet.columbia.edu/www/asis/interest.html>
- 70 See: <http://www.cnidr.org>
- 71 See: <http://www-diglib.stanford.edu/diglib/cousins/dlite>
- 72 See: <http://www.ncstrl.org>
- 73 See: <http://ntx2.cso.uiuc.edu/cic/cli.html>
- 74 See: <http://www.nlc-bnc.ca/ifla/documents/libraries/net/dpc.txt>
- 75 See: <http://palimpsest.stanford.edu/cpa/newsletter/cpaal80.html>
- 76 See: <http://lcweb.loc.gov/homepage/lchp.html>
- 77 See: <http://lcweb.loc.gov/ndl/per.html>
- 78 See: <http://ds.internic.net/z3950/z3950.html>. Cf the Canadian National Library's Directory of Z39.50 targets.
- See: <http://novanet.ns.c/vCucdm.html> and
- <http://www.nlc-bnc.ca/resource/vcuc/z3950.htm>.
- 79 See: <http://lc2web.loc.gov/ammem>
- 80 See: Mike Snider, "Research Archives in Cyberspace," *USA Today*, 10 April 1997, p. 60.

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- 81 See: <http://imagelab.ncsa.uiuc.edu/imagelib>
- 82 See: <http://images.grainger.uiuc.edu/mesl/mesl.htm>
- 83 See: <http://www.atmos.uiuc.edu/horizon>
- 84 See: <http://www.atmos.uiuc.edu>
- 85 See: <http://sunsite.berkeley.edu/R+D/>
- 86 See: <http://sunsite.berkeley.edu/APIs>
- 87 See: <http://sunsite.berkeley.edu/CalHeritage>
- 88 See: <http://128.32.224.173/cheshire/form.html>
- 89 See: <http://sunsite.berkeley.edu/Ebind>
- 90 See: <http://sunsite.berkeley.edu/ead/>
- 91 See: <http://sunsite.berkeley.edu/FindingAids/>
- 92 See: <http://sunsite.berkeley.edu/~emorgan/morganagus>
- 93 See: <http://www-ucpress.berkeley.edu/scan>
- 94 See: <http://www.bmrc.berkeley.edu>
- 95 See: <http://www.lib.berkeley.edu:8000/>
- 96 See: <http://sunsite.berkeley.edu/amher/>
- 97 See: <http://www2.cs.cornell.edu/payette/papers/ECDL98/FEDORA-IDL.html>
- 98 See: <http://moa.cit.cornell.edu/MOA/moa-main-page.html>
- 99 See: <http://www.ipl.org>
- 100 See: <http://www.alexandria.ucsb.edu>
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- 102 See: <http://www.cSDL.tamu.edu>
- 103 See: <http://www.glue.umd.edu/~march/NALtalk/tsld010.htm>
- 104 See: <http://community.bellcore.com/lesk/diglib.html>
- 105 See: <http://www.software.ibm.com/is/dig-lib/dlib.htm>. For an article See: Henry M. Gladney, "Towards On-line Worldwide", IBM Systems Journal, vol. 32, n.3, 1993.  
Cf. <http://www.ibm.com/features/library/manuscript.html>
- 106 See: <http://www.newdeal.org>
- 107 See: Ramana Rao, Jan O. Pedersen, Marti A. Hearst, Jock D. Mackinlay, Stuart K. Card, Larry Masinter, Per-Kristian Halvorsen and George C. Robertson, "Rich Interaction in the Digital Library," *Communications of the ACM*, New York, April 1995, vol. 38, no. 4, pp. 29-39. See: <http://www.dlib.org/dlib/june96/hearst/06hearst.html>  
cf. <http://www.parc.xerox.com/istl/projects/dlib>.
- 108 See: <http://golgi.harvard.edu/biopages.html>
- 109 See: <http://www.chem.ucla.edu/chempointers.htm>
- 110 See: [http://www.cds.caltech.edu/extras/Virtual\\_Library/Control\\_VL.html](http://www.cds.caltech.edu/extras/Virtual_Library/Control_VL.html)
- 111 See: <http://www.dlib.org>
- 112 See: <http://civic.rutgers.edu/~ieeedln/>
- 113 See: <http://www.lib.umich.edu/libhome/IDINews>
- 114 See: <http://civic3.rutgers.edu/jodl>
- 115 See: <http://www.press.umich.edu/jep/>
- 116 See: <http://www.rlg.org/toc.html>
- 117 See: <http://highwire.stanford.edu>
- 118 For further reading See: : Christos Nikolaou, Constantine Stephanides, ed., *Research and Advanced Technology for Digital Libraries. Second European Conference ECDL '98*, Berlin: Springer 1998; Michael Spring, *The Virtual Library, Explorations in Information Space*.  
See: <http://www.lis.pitt.edu/~spring/papers/vl.ps.Z>); The Document Processing Revolution,

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See: <http://www.lis.pitt.edu/~spring/papers/dpr.ps>); *Towards the Digital Library*, ed. Leona Carpenter et al., London: British Library, 1997; George P. Landow, *Hyper/text/theory*, Baltimore: Johns Hopkins Press, 1984.

119 See: <http://www.tagish.co.uk/ethosub/lit5/9a42.htm>

120 See: <http://www.ispo.cec.be/g7/projects/g7pr5.html>. This is co-ordinated by the Istituto Centrale per il Catalogo e la Documentazione<sup>120</sup> (ICCD).

See: <http://www.iccd.beniculturali.it>.

121 See: <http://www.unesco.org/whin>

122 See: <http://www.unesco.org/whcform.htm>

cf. <http://www.unesco.org/whc/nwhc/pages/home/pages/homepage.htm>

123 See: <http://www.aec2000.it/aec2000/projects/herinet/herinet.htm>

124 See: <http://firewall.unesco.org/webworld/en/>

cf. <http://firewall.unesco.org/webworld/en/accueil.html>

125 See: <http://www.icom.org>

<http://palimpsest.stanford.edu/icom>

126 See: <http://www.cs.rdg.ac.uk/icom/officers.html>

127 See: <http://www.konbib.nl/rkd/engpubl/mmwg/home.htm>

128 See: <http://www.cimi.org>

129 See: <http://www.cimi.org/CHIO.html>

130 See: [http://www.cimi.org/Project\\_Chio\\_DTD.html](http://www.cimi.org/Project_Chio_DTD.html)

131 See: [http://www.cimi.org/SGML\\_for\\_CHI.html](http://www.cimi.org/SGML_for_CHI.html)

132 See: [ftp://ftp.cimi.org/pub/cimi/CIMI\\_SGML/cimi4.dtd.rtf](ftp://ftp.cimi.org/pub/cimi/CIMI_SGML/cimi4.dtd.rtf)

133 See: <http://neon.coe.fr>

134 See: <http://www2.echo.lu/info2000/en/mm-projects>

135 See: <http://www2.echo.lu/info2000/midas/activities.html>

136 See: <http://mosaic.infobyte.it>

137 See: <http://www.mcube.fr>

[mcube@gemlr.org](mailto:mcube@gemlr.org)

138 See: <http://www2.echo.lu/libraries/en/projects/vaneyck.html>

139 See: <http://www.museums-online.com/site/>

140 Cf. <http://www.rmn.fr/vpc/fvpc.html>

141 See: <http://www.amn.org/AMICO/background.html>

142 See: <http://www.chin.gc.ca>

143 See: <http://fotomr.uni-marburg.de/for.htm>

144 See: <http://www.scran.ac.uk/>

145 See: <http://www.can.net.au>

146 Inventaire général des monuments et des richesses artistiques de la France:

See: <http://www.culture.fr/culture/inventai/presenta/invent.htm>.

147 See: <http://www.louvre.edu>

148 See: <http://www.ahds.ac.uk>

149 See: <http://www.open.gov.uk/mdoassn>

150 See: <http://www.comlab.ox.ac.uk/archive/other/museums/mda>

151 See: <http://www.rchme.gov.uk>

152 See: <http://www.museumlicensing.org>

153 See: <http://www.arts.endow.gov/sitemap/index.html>

154 See: <http://www.ninch.org>

155 See: <http://www.cni.org>

156 See: <http://www.ahip.getty.edu/>

157 See: <http://www.archivists.org>

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- 158 See: <http://sunsite.berkeley.edu/FindingAids/EAD/eadwg.html>
- 159 See: <http://world.std.com/~mcn>  
cf. <http://world.std.com/%7Emcn/index.html>
- 160 See: <http://www.mip.berkeley.edu>
- 161 See: [http://www.cmg.hitachi.com/fine\\_art/art\\_main.html](http://www.cmg.hitachi.com/fine_art/art_main.html)
- 162 See: <http://www.intel.com/english/art/>
- 163 See: <http://www.csl.sony.co.jp/person/chisato.html>
- 164 A doctoral thesis on Museums and Multimedia is being prepared by Benoit de Wael ([Benoitdw@hotmail.com](mailto:Benoitdw@hotmail.com)).
- 165 See: <http://www.aifb.uni-karlsruhe.de/WBS/broker>
- 166 See: <http://info.itu.ch/VTC/>
- 167 See: [http://www.unesco.org/webworld/tunis/tunis97/com\\_64/com\\_64.html](http://www.unesco.org/webworld/tunis/tunis97/com_64/com_64.html)
- 168 See: <http://estrella.acs.calpoly.edu/~delta/>
- 169 See: <http://ike.engr.washington.edu:81/igc/>
- 170 See: <http://www.eun.org/launch/programme.htm>
- 171 See: <http://www.iste.org/>
- 172 See: <http://www.cepis.org/>
- 173 See: <http://www.ocg.or.at/ecdleu.html>
- 174 See: <http://www.tact.org.uk/default.htm>
- 175 See: <http://ortelius.unifi.it>
- 176 See: <http://www2.echo.lu/emtf/>
- 177 See: <http://www.eun.org/>
- 178 See: <http://www.eep-edu.org/>
- 179 See: <http://www2.echo.lu/emtf/currentnewsemf.html>
- 180 See: <http://www.educause.edu>
- 181 See: <http://www.educause.edu/nlii/>
- 182 See: <http://imsproject.org/>
- 183 See: <http://www.manta.ieee.org/p1484/>
- 184 See: <http://tina.lancs.ac.uk/computing/research/cseg/projects/ariadne/>
- 185 See: [http://www.ott.navy.mil/1\\_4/adl/index.htm](http://www.ott.navy.mil/1_4/adl/index.htm)
- 186 See: <http://www.aicc.org>
- 187 For further information please contact:  
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- 188 See: [http://europa.eu.int/en/comm/dg10/culture/program-2000\\_en.htm](http://europa.eu.int/en/comm/dg10/culture/program-2000_en.htm)
- 189 See: <http://europa.eu.int/en/comm/dg10/culture/en/action/kaleidos-gen.html>
- 190 See: <http://europa.eu.int/en/comm/dg10/culture/en/action/ariane-gen.html>
- 191 See: <http://europa.eu.int/comm/dg10/culture/raphael/index.html>
- 192 See: <http://europa.eu.int/comm/dg10/avpolicy/media/en/home-m2.html>
- 193 For further literature on these trends see the European Commission staff working paper: Culture, the Cultural Industries and Employment (SEC (98)837:  
See: [http://europa.eu.int/en/comm/dg10/culture/emploi-culture-intro\\_en.html](http://europa.eu.int/en/comm/dg10/culture/emploi-culture-intro_en.html)); the 1st Report on the Consideration of Cultural Aspects in European Community Action.  
See: <http://europa.eu.int/en/comm/dg10/culture/cult-asp/en/index.html>);  
Marcelino Oreja, Culture and European Integration. Foundations of the European Community's cultural activities, Vienna, 6th March 1997.

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See: <http://europa.eu.int/en/comm/dg10/oreja/0603en.html>); and Sally Jane Norman, Culture and the New Media Technologies, Intergovernmental Conference on Cultural Policies for Development, Preparatory Paper IX

See: <http://www.unesco-sweden.org/Conference/Papers/Paper9.htm>). On the question of cultural heritage and EC funding

See: [http://www.medicif.org/Dig\\_library/ECdocs/default.htm](http://www.medicif.org/Dig_library/ECdocs/default.htm) or <http://inf2.pira.co.uk/pub/ecwebsite97.html>.

194 See: <http://www.cordis.lu/ist>

195 See: <http://www.medicif.org>

196 See: <http://www.excite.com/education/reference/>

197 See: <http://ie3.webdata.com/main.htm>

198 See: <http://www.links2go.com/>

199 See: <http://vlib.stanford.edu/Overview.html>

200 See: <http://www.ncsa.uiuc.edu/SDG/Software/Mosaic/MetaIndex.html>

201 See: <http://www.lib.berkeley.edu/TrainingLib/Guides/Internet/BeyondWeb.html>

202 See: <http://bubl.ac.uk/link/a/>

203 See: <http://www.lib.uci.edu/rraz/genref.html>

204 See: <http://www.sussex.ac.uk/library/pier/subjects.dir/subjbase.html>

205 See: <http://www.public.iastate.edu/~CYBERSTACKS/CTW.htm>

206 See: <http://www.facstaff.bucknell.edu/rbeard/diction.html>

207 See: <http://www.facstaff.bucknell.edu/rbeard/grammars.html>

208 See: <http://www.oed.com/inside/revision.htm>

209 See: <http://scholes.alfred.edu/Ref.html>

210 See: <http://www.cs.cmu.edu/references.html>

211 See: <http://www.tulips.tsukuba.ac.jp/welcome.english.html>

212 See: <http://cavern.uark.edu/libinfo/reference/>

213 See: <http://sshl.ucsd.edu/refshelf/>

214 See: <http://www.americancomm.org/~aca/electref.html>

215 See: <http://galaxy.einet.net/galaxy.html>

216 See: <http://www.refdesk.com/>

217 See: <http://www.silverplatter.com>

218 See: <http://library.dialog.com/essentials.html>

219 See: <http://www.kri.com/>

220 See: <http://www2.echo.lu/libraries/en/projects/one2.html>

221 It is foreseen that there will be links with other networks for film and television schools.

See: [http://europa.eu.int/comm/dg10/avpolicy/index\\_en.html](http://europa.eu.int/comm/dg10/avpolicy/index_en.html)).

222 Here two approaches are under discussion: demonstration rooms and dissemination by television and film.