International Journal of Advanced Research in IT and Engineering

ISSN: 2278-6244

AEROSPACE DIGITAL LIBRARIES AND ITS IMPACT ON AEROSPACE SCIENTISTS AND ENGINEERS OF BANGALORE- A RESEARCH SURVEY

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Abstract: *Today academic departments in Universities, libraries, professional associations, research institutions, scholarly and trade publishers, database producers and information industry vendors are all experiencing the effect on Information Technology on Scientific Scholarly Communication. The first change agents included the all-pervading personal computer, the modem and telecommunication networks that supported the growth of on-line databases in the 70's. More recent and current developments like the Internet, electronic periodicals, pre-print databases, digital libraries and the World Wide Web are influencing more profoundly the ways scientists carry out their research and share their findings with others. Digital library technologies are directly applicable to many different manufacturing industries including aerospace, defense, biotech, chemical, automotive, consumer electronics, and healthcare. Indian Aerospace Scientists and Engineers make use of a larger number of Aerospace Digital Libraries for their research work. This questionnaire survey study is restricted to the geographic boundary of the city of Bangalore. The total percentage of responses usable from all the 16 aerospace organizations amounted to 89.7 percent. The major findings that the authors would like to report in this paper are:* ***Analysis of Variance (ANOVA)*** *was applied for testing the significant difference among the 16 mean scores attained from the scientists and engineers of the aerospace organizations for 'Aerospace Digital Libraries'. It is observed that all the 16 aerospace organizations show a significant difference (P < 0.05) in their mean scores viz., 'The Wright Air Development Center / Digital Collection', 'Scientific and Technical Information Network (STINET)', 'NACA Digital Library'* ***except for 'Department of Electronics (DOE) Information Bridge (P=0.054)'.***

Keywords: *Electronic Information Resources, Use Patterns, Aerospace Scientists and Engineers, Aerospace Digital Libraries, Bangalore.*

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I. INTRODUCTION

While developments in science span hundreds of years, developments in digital libraries (DL) as we know them today, in comparison, are very recent. Many consider the DL initiatives launched in the USA in the mid 1990's to have given the major impetus for the development of DL as a field of study and application, and to have engaged worldwide interest in R&D into and the application of DL. DL is therefore just over a decade in age, even younger than the Internet and the Web. Science and DL are interdependent. Within its short period of development, DL has demonstrated its value to scientific progress by enabling improved creation, capture, preservation, organization and dissemination of scientific information. Along with the advent of the Internet, the constant desire of scientists to improve distribution and access to scientific information led many of them to develop path-breaking applications and services, for instance the WWW at CERN, the Mosaic web browser at NCSA and the pre-print distribution system in physics and mathematics at LANL. These developments, combined with initiatives, such as DLI, are showing today the way forward the development of more powerful and advanced DL systems. These systems, many still in demonstration and proof-of-concept stage, are expected to bring about significant improvements in science communication. More importantly, developments in DL are giving rise to new forms of science like e-Science: collaborative research based on shared data not possible through traditional methods of disseminating science information. DL is thus not just improving the way science communication is done, but is also causing a shift in the way science itself is done, **[1].**

A digital library is a library in which in which collections are stored in digital formats (as opposed to print, microform, or other media) and accessible by computers. The digital content may be stored locally, or accessed remotely via computer networks. A digital library is a type of information retrieval system. The DELOS Digital Library Reference Model defines a digital library as: An organization, which might be virtual, that comprehensively collects, manages and preserves for the long term rich digital content, and offers to its user communities specialized functionality on that content, of measurable quality and according to codified policies.

The first use of the term digital library in print may have been in a 1988 report to the Corporation for National Research Initiatives. The term digital libraries were first

popularized by the NSF/DARPA/NASA Digital Libraries Initiative in 1994. These draw heavily on As We May Think by Vannevar Bush in 1945, which set out a vision not in terms of technology, but user experience. The term virtual library was initially used interchangeably with digital library, but is now primarily used for libraries that are virtual in other senses (such as libraries which aggregate distributed content) - (http://en.wikipedia.org/wiki/Digital_library).

'A digital library service as an assemblage of digital computing, storage, and communications machinery together with the software needed to reproduce, emulate, and extend the services provided by conventional libraries based on paper and other material means of collecting, storing, cataloguing, finding, and disseminating information', **[2].**

'Digital Libraries are a set of electronic resources and associated technical capabilities for creating, searching and using information…they are an extension and enhancements of information storage and retrieval systems that manipulate digital data in any medium (text, images, sounds, static or dynamic images) and exist in distributed networks', **[3a, b].**

Digital libraries are becoming an integral part of digital learning environments. At the same time, the notion of "digital library" is subject to a broad range of definitions. Different audiences associated with a digital library have different interpretations; they evaluate a digital library differently and use different terminologies. On one end of the range, DLs are considered to be related to physical libraries performing similar functions, thus creating a hybrid library (combining traditional and electronic resources). On the other end, DLs are considered to be knowledge repositories, and services, organized as complex information systems, **[1].**

"Digital libraries are organized collections of digital information. They combine the structure and gathering of information which libraries and archives have always done with the digital representation that computers have made possible", **[1].**

As a bridge between research and practicing communities, "Digital libraries are a set of electronic resources and associated technical capabilities for creating, searching, and using information; they are an extension and enhancement of information storage and retrieval systems that manipulate digital data in any medium. The content of digital libraries includes data and metadata. Digital libraries are constructed, collected, and organized by (and for) a

community of users and their functional capabilities support the information needs and uses of that community" [**1].**

The frequency of usage of aerospace digital libraries by the aerospace scientists and engineers are presented in table 5.81. The mean scores of the other organizations for the frequency of usage of Aerospace Digital Libraries are shown in table 5.81.

II. THE AEROSPACE INDUSTRY

The Aerospace industry is a high-tech industry and the industry is a powerful driver of innovation in the economy as a whole. Competition drives innovation in the Aerospace industry. The Aerospace industry is not a homogenous industry but it consists of several sub industries: the civilian aerospace industry, the defence or military aerospace industry and the space industry. Each of these industries faces a different industrial structure, a different innovation system and faces different major challenges.

Aircraft development and production is by far the largest component of the industry. The Aerospace industry is characterized by strong knowledge cumulativeness. Knowledge production in the Aerospace industry is paramount: The Aerospace sector is highly R&D intensive and levels of competition are high. More competition acts an innovation driver in Aerospace. Aerospace is dominated by Strategic innovators, firms which drive innovation performance in the sector directly but also indirectly as they are the source of many innovative products and processes that are adopted by other firms throughout their domestic economy and internationally. The Aerospace industry is one of the few sectors where it may be claimed that military purposes are still a driver for technological development **[4].**

III. AEROSPACE DIGITAL LIBRARIES

The aerospace community is made up of Universities, Research Centres, Enterprises, Experts, Authorities, etc.. Most importantly, the aerospace domain there is huge amount of data to handle i.e. project data, aerospace system data, experimental/numerical campaign data, commercial and technical data, business data, historical process and product data. This large heterogeneous amount of data is spread over several storage resources and is often not accessible to its users. The main aim of an Aerospace Digital Library is to capitalize all the available heterogeneous amount of data to set up a mechanism to automate processes and workflows within the Aerospace Community in order to foster synergies. **[5].**

IV. REVIEW OF LITERATURE

Vakkari [6], interalia says that the number of and variety of different sorts of databases ranging from journal databases to reference databases to fact databases are increasingly accessible from scholar's desktops,

Chang [7], examines the research and development of digital library user studies and points out the 3 stages of American based digital libraries development and the three approaches to studying those digital libraries.

Kudashev [8], in his article reviews the experience of the development of digital library for the problems in organization of state-of-the-art education in remote sensing for environmental research. Information-education resources are installed on the Web-Server of Space Research Institute. Web Server was organized in the form the Remote Sensing Data Server, and Metadata Server on the base of digital catalogues with satellite imagery.

Yitzhaki, et al. [9], in his paper opines that effective R&D organization draws information from a complex system of sources and channels. Clearly, the widespread use of the Internet is affecting how R&D researchers communicate, collect data, publish reports, and conduct their research. Thus, in an information world radically transformed by the Internet, and given the recent changes in information accessibility and delivery, it is considered essential to conduct new studies to get a fresh look at the ways R&D research is conducted in a more digital environment. Also, scientists and engineers have the complex task of choosing from numerous and diversified information sources and making effective use of the source chosen. The various techniques of information seeking and use are an essential part of scientific and technological progress. By providing new possibilities of locating, collecting, and disseminating information, electronic technology has revolutionized the entire concept of communication for R&D in the fields of science and technology.

Bordogna Joseph [10], in his paper states that the spread of digital libraries; the onset of virtual collaboratives; the capacity to mine data with alacrity; the assurance of high-confidence systems for privacy, security, and reliability; and the creation of knowledge-on-demand pedagogies have ushered in a promising new era of discovery, innovation, and progress. This presents the engineering community with the opportunity--and the responsibility--to sustain and expand the connections to learning and creativity that Academus launched with his gift to Plato 2 millennia ago.

Kaplan and Nelson [11], attempt to assess the publication impact of a digital library (DL) of aerospace scientific and technical information (STI). The Langley Technical Report Server (LTRS) is a digital library of over 1,400 electronic publications authored by NASA Langley Research Center personnel or contractors and has been available in its current World Wide Web (WWW) form since 1994. In this article, the authors examine the calendar year 1997 usage statistics of LTRS and the Center for Aerospace Information (CASI), a facility that archives and distributes hard copies of NASA and aerospace information. They also perform a citation analysis on some of the top publications distributed by LTRS. While their investigation fails to establish a relationship between LTRS and increased citations and raises at least as many questions as it answers, the authors hope that it will serve as an invitation to, and guide for, further research in the use of Digital Libraries.

Bartolo et al. [12], in their paper mention that digital repositories can be catalysts for new knowledge by providing information space and tools to facilitate the work of students, educators, or scientists. The authors discuss the NSF NSDL Materials Digital Library (MatDL) which is adapting existing open source "tools", such as an image gallery and a version control system, to meet the needs of users within the materials science community. In their conclusion, the authors point out that a critical challenge in the development and sustainability of digital repositories is fostering ongoing participant involvement within digital communities. To encourage contributions and broaden participation, MatDL is investigating the integration of its submission process into adapted tools as part of the user's workflow. Finally, they advocate that by integrating submissions into users' workflow and increasing submissions from students, educators, and researchers, digital libraries can act as catalysts for interaction between research and education.

O'Flaherty [13], in his paper talks about, EURILIA, which is part of the Commission of the European Communities (CEC) Libraries Programme. It aims to enhance the libraries' research, development and education process which underpins the aerospace sector by establishing a new service based on a standardized pan-European system for information access, retrieval, image browsing and document delivery. This will, in turn, extend the access and availability of major aerospace collections. The paper outlines work undertaken on the information needs of aerospace engineers and scientists. Also the development of the EURILIA system for OPAC searching and document delivery is described.

Houghton et al. [14], in their paper examine changing research practices in the digital environment. A review of the literature and their own field research in Australia suggest that there is a new mode of knowledge production emerging, changing research practices and bringing new information access and dissemination needs. Adjustments will be required to accommodate these changes, but new opportunities are emerging for more cost-effective and sustainable information access and dissemination. It will be necessary, however, to take a holistic approach and treat the creation, production and distribution of scholarly information, the management of information rights and access, systems of review and evaluation and the underlying infrastructure as parts of a single research information and scholarly communication system.

Koremath et al. [15], in their paper examine how digital libraries (DL) may be integrated into the learning resources of engineering students. They add that advent of digital libraries has opened revolutionary opportunities in engineering education. The diversity of resources offers rich opportunities to enhance engineering education, providing access to data, codes, problems and information that are far beyond what each individual teacher has time to develop. However, students are largely unaware of the DL resources, as well as the most efficient manner to utilize them. This paper lays out the problems and provides initial results on how students are accessing internet-based material in engineering courses, as well as ideas for improving their ability to reach the best problem-solving resources.

V. CSIR-NATIONAL AEROSPACE LABORATORIES, BANGALORE

The National Aerospace Laboratories is India's premier civil aviation R&D aerospace research organization in the country. Its main mandate is the 'Development of aerospace technologies with strong science content and with a view on their practical application to the design and construction of flight vehicles'. NAL is also required 'to use its aerospace technology base for general industrial applications'. 'Technology' would be its core engine-driver for the future. NAL is also best known for its main sophisticated aerospace R&D testing facilities which are not only unique for this country but also comparable to similar facilities elsewhere in the world.

VI. CSIR'S PIONEERING ROLE IN PROMOTING E-RESOURCES USAGE AMONGST ITS SCIENTISTS ENGINEERS AND TECHNOLOGISTS (AS PART OF THE CSIR-NISCAIR-DST-NKRC CONSORTIA)

Today, every CSIR-NAL scientist has access to online electronic scholarly information right at their desktops. This has been possible with the help of setting up of the 'The National Knowledge Resource Consortium (NKRC) jointly established by CSIR and DST with the 'National Institute of Science Communication and Information Resources (NISCAIR), a sister CSIR Laboratories as its apex body. With the setting up of the 'National Knowledge Resource Consortium', it has been possible for every NAL scientist and engineer to access almost 5,000+ e-journals by typing up with almost 23 reputed international journal publishers. This facility enables any CSIR scientist to access, browse, search and download 'full-text' journal articles from any computer system connected to the campus wide network. This greatly facilitates every NAL Scientist and Engineer to keep pace with global R&D.

VII. OBJECTIVES OF THE STUDY

- To determine the use patterns of 'Aerospace Digital Libraries' amongst the aerospace scientists and engineers of Bangalore.
- To ascertain whether the percentage of preference of the Use Patterns of 'Aerospace Digital Libraries' by the aerospace engineers and scientists are approximately the same.
- To study whether similar patterns exists (homogeneity) of use of 'Aerospace Digital Libraries' amongst these aerospace scientists and engineers of the 16 aerospace organizations in Bangalore.

VIII. NULL HYPOTHESES

- There is no significant difference in the mean scores of 'Aerospace Digital Libraries' amongst the aerospace scientists and engineers of the selected 16 aerospace organizations of Bangalore.

IX. MATERIALS AND METHODS

The present study is restricted to the selected 16 prominent aerospace organizations in Bangalore. A total number of 650 survey questionnaires were distributed amongst the aerospace scientists and engineers belonging to these 16 aerospace organizations. A total

number of 612 questionnaires were received back finally 583 (89.7%) were selected for the study which were found suitable for the study.

A survey questionnaire has been used to conduct this research study. The total population size of this research study is restricted to the 1220 aerospace scientists and engineers in Bangalore. The distribution of Source Data is indicated in *Table 1*. Random sampling technique has been used for selection of the sample size.

Table 2. shows the 'Frequency of Use of Aerospace Digital Libraries' graded on a scale of 0-4. The frequency of usage of Aerospace Digital Services by the Aerospace Scientists and Engineers of Bangalore is indicated in *Table 3.*

Table 4. highlights some selected Aerospace Digital Libraries URLs for the benefit of the readers as an immediate e-reference source.

X. RESULTS AND DISCUSSION

- The summary of total scores obtained with regard to 'Frequency of Usage of Aerospace Digital Libraries' is as follows: The highest mean score of 0.61(CV=177.08) is reflected by the respondents of 'NACA Digital Library'. This is followed by a mean score of 0.53(CV=186.67) by the respondents of 'Scientific and Technical Information Network (STINET)'. A mean score of 0.48(CV=213.65) is accrued by the respondents of 'The Wright Air Development Center / Digital Collection'. Finally, the lowest mean score of 0.42(CV=218.41) is accrued by the respondents of 'DOE Information Bridge'.
- Analysis of Variance (ANOVA) Analysis of Variance (ANOVA) was applied for testing the significant difference among the 16 mean scores attained from the scientists and engineers of the aerospace organizations for 'Frequency of Usage of Aerospace Related Digital Libraries'. It is observed that all the 16 aerospace organizations how a significant difference ($P < 0.05$) in their mean scores viz., 'The Wright Air Development Center / Digital Collection', 'Scientific and Technical Information Network (STINET)', 'NACA Digital Library' ***except for 'Department of Electronics (DOE) Information Bridge (P=0.054)'.***

XI. FINDING AEROSPACE RESOURCES ON THE INTERNET

There are a larger number of web resources on 'Aerospace Digital Libraries'. Few of the selected resources which the authors felt would be of useful and ready reference to the

aerospace scientists and engineers are listed below in *Table 4.* These web resources offer searching capabilities, and access to full-text e-resources.

XII. CONCLUSIONS

The creation and management of digital libraries is a multidisciplinary activity, requiring cooperation among a whole range of specialists from computer engineers, psychologists, librarians, etc. All of them have their roles to play.

Scientists and engineers have the complex task of choosing from numerous and diversified information sources and making effective use of the source chosen. The various techniques of information seeking and use are an essential part of scientific and technological progress. By providing new possibilities of locating, collecting, and disseminating information, electronic technology has revolutionized the entire concept of communication for R&D in the fields of science and technology.

Over the last decade or so, Digital Libraries has demonstrated its value to scientific progress by enabling improved creation, capture, preservation, organization and dissemination of scientific information.

One of the main purposes of an Aerospace Digital Library is to capitalize all the available heterogeneous amount of data to set up a mechanism to automate processes and workflows within the Aerospace Community in order to foster synergies.

More importantly, developments in Digital Libraries are giving rise to new forms of science like e-Science: collaborative research based on shared data not possible through traditional methods of disseminating science information. Hence, Digital Libraries are thus not just improving the way science communication is done, but is also causing a paradigm shift in the way science itself is done.

The main conclusions that the authors would like to infer in this paper are:

- **Analysis of Variance (ANOVA) Analysis of Variance (ANOVA)** was applied for testing the significant difference among the 16 mean scores attained from the scientists and engineers of the aerospace organizations for 'Frequency of Usage of Aerospace Digital Libraries'. It is observed that all the 16 aerospace organizations show a significant difference ($P < 0.05$) in their mean scores viz. 'The Wright Air Development Center / Digital Collection', 'Scientific and Technical Information Network (STINET)', 'NACA Digital Library' ***except for 'Department of***

Electronics (DOE) Information Bridge (P=0.054)'.

- It implies that the percentage of preference of the Use Patterns of 'Aerospace Digital Libraries' by the aerospace engineers and scientists are not approximately the same, ***except for 'Department of Electronics (DOE) Information Bridge (P=0.054)'.***
- The study also reveals that there is heterogeneity in the Use Patterns of 'Aerospace Digital Libraries'**, *except for 'Department of Electronics (DOE) Information Bridge (P=0.054)'.*** among the aerospace scientists and engineers of Bangalore of the selected 16 aerospace organizations taken for the study.

XIII. ACKNOWLEDGEMENTS

The authors would like to express their deep gratitude and thankfulness to Mr. Shyam Chetty, Director, CSIR-NAL, Bangalore for his unconditional support towards use of electronic information resources for aerospace research at NAL and permitting to publish the paper. The authors are also very grateful to Head, KTMD for all the encouragement and support.

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Tables and Figures

Table-1: Distribution of Source Data (Sample Size)

Sl.No.	Organizations	No. of Questionnaires distributed	No. of Questionnaires received	No. of usable questionnaires usable
1.	ADA	67	63	58
2.	AFTC	19	16	15
3.	ADE	14	12	12
4.	ASTE	33	30	29
5.	CABS	16	15	14
6.	CEMILAC	33	30	29
7.	C-MMACS	8	6	6
8.	DARE	11	9	9
9.	LRDE	5	3	2
10.	GTRE	24	22	21
11.	HAL	144	140	134
12.	IAM	40	36	33
13.	ISRO-ISTRAC	25	24	22
14.	IISc	38	37	34
15.	JNCASR	5	3	1
16.	NAL	168	166	164
Total		**650**	**612**	**583 (89.7%)**

Geographical Boundary of the Study (16 Prominent Aerospace Organizations of Bangalore, INDIA).

Key: **ADA**=Aeronautical Development Agency, **AFTC**=Air Force Technical College, **ADE**=Aeronautical Development Establishment, **ASTE**=Aircraft Systems Testing Establishment, **CABS**=Centre for Airborne Systems, **CEMILAC**=Centre for Military Airworthiness and Certification, **C-MMACS**=Centre for Mathematical Modeling and Computer Simulation, **DARE**=Defense Avionics Research Establishment, **LRDE**=Electronics and Radar Development Establishment, **GTRE**=Gas Turbine Research Establishment, **HAL**=Hindustan Aeronautics Limited, **IAM**=Institute of Aerospace Medicine, **ISRO-ISTRAC**=Indian Space Research Organization, **IISc**=Indian Institute of Science, **JNCASR**=Jawaharlal Nehru Centre for Advanced Scientific Research, **NAL**=National Aerospace Laboratories.

Table – 2: How frequently do you use the following aerospace related digital libraries for your scientific work?

4 – daily, 3 – weekly, 2 – fortnightly, 1 – monthly, 0 – Never						
DIGITAL LIBRARIES	**Name of the Digital Libraries**	**4**	**3**	**2**	**1**	**0**
	(1) The Wright Air Development Center / Digital Collection	4	3	2	1	0
	(2) Scientific and Technical Information Network (STINET)	4	3	2	1	0
	(3) DOE Information Bridge	4	3	2	1	0
	(4) NACA Digital Library	4	3	2	1	0

Table-3: Frequency of Usage of Aerospace Digital Libraries

S. N.	Organizations	Mean and CV	Frequency of Usage			
			The Wright Air Development Center/Digital Collection	Scientific and Technical Information Network (STINET)	DOE Information Bridge	NACA Digital Library
1	ADA	Mean	0.66	0.76	0.47	0.64
		CV	184.30	144.63	198.01	167.91
2	AFTC	Mean	0.93	0.47	0.53	0.27
		CV	142.98	178.67	171.65	222.61
3	ADE	Mean	0.67	0.92	0.58	1.50
		CV	184.64	127.04	212.59	96.40
4	ASTE	Mean	0.14	0.34	0.24	0.38
		CV	538.52	312.68	378.00	276.63
5	CABS	Mean	0.43	0.50	0.36	0.43
		CV	218.78	218.39	302.91	198.71
6	CEMILAC	Mean	1.17	0.59	0.90	0.45
		CV	134.99	201.42	147.08	202.94
7	C-MMACS	Mean	0.17	0.17	0.17	0.17
		CV	244.95	244.95	244.95	244.95
8	DARE	Mean	1.33	1.22	1.11	1.33
		CV	118.59	121.20	130.77	118.59
9	LRDE	Mean	1.00	1.00	1.00	0.50
		CV	141.42	141.42	141.42	141.42
10	GTRE	Mean	0.71	1.10	0.76	1.10
		CV	160.50	122.17	137.06	95.35
11	HAL	Mean	0.36	0.42	0.37	0.39
		CV	235.70	208.11	231.62	211.77
12	IAM	Mean	0.61	0.48	0.45	0.39
		CV	197.57	179.52	220.62	228.28
13	ISRO-ISTRAC	Mean	0.09	0.18	0.09	0.32
		CV	323.67	275.59	469.04	245.11
14	IISc	Mean	0.18	0.21	0.18	0.41
		CV	326.29	287.46	326.29	232.46
15	JNCASR	Mean	0.00	0.00	0.00	0.00
		CV	0.00	0.00	0.00	0.00
16	NAL	Mean	0.44	0.58	0.40	0.89
		CV	223.11	177.32	221.16	147.23
Total Mean Scores of Usage of Aerospace Related Digital Libraries		Mean	0.48	0.53	0.42	0.61
		CV	213.65	186.67	218.41	177.08
P Values			0.001	0.026	0.054	0.000

Table-4: Web Resources of Digital Libraries With Specific References to Aerospace Engineering

University Libraries	On-line Publication Archives: specific servers	U.S. Government Information Centers	Information Centers Overseas
Georgia Tech Electronic Library www.library.gatech.edu	JSTOR:Journals on-line http://www.jstor.org	United States Government Printing Office http://www.access.gpo.gov/	Korea Research Information Center http://www.kric.ac.kr/english/english_index.htm
Aalborg University Library (English version) http://www.aub.auc.dk/english.htm	National Academy Press www.nap.edu	United States Library of Congress http://lcweb.loc.gov/	The British library http://portico.bl.uk/
OCLC: On-line Computer Library Center www.oclc.org	NASA Technical Reports Server www.nasa.gov/techinfo.html	Interactive Citizens' Handbook http://www1.whitehouse.gov/WH/html/handbook.html	CERN: European Laboratory for Particle Physics Library http://alice.cern.ch/
University of Michigan Digital Libraries Project www.si.umich.edu/UMDL/intro.html	OCLC Inter-Cat: Catalog of Internet Resources http://orc.rsch.oclc.org:6990/	GILS: Global Information Locator Service http://www.gils.net/index.html	Bibliotheque nationale de France: http://www.bnf.fr/
Stanford Integrated Digital Library Project www-dglib.stanford.edu	NASA Scientifc and Technical Information Program: NASA Center for AeroSpace Information (CASI) http://www.sti.nasa.gov/	National Library of Medicine http://www.nlm.nih.gov/	The library of the Institut Pasteur (English version) http://www.pasteur.fr/units/biblio/english/english.htm
University of Illinois Digital Libraries at Urbana-Champaign http://dli.grainger.uiuc.edu	NACA Digital Library: Scanned Reports back to 1959 http://naca.larc.nasa.gov/	National Oceanic and Amospheric Administration (NOAA) http://www.noaa.gov	ISO: International Standards Organization http://www.iso.ch/infoe/catinfo.html
University of California at Santa-Barbara http://www.alexandria.ucsb.edu/index.html	D-Lib Magazine www.dlib.org	Library of Congress: http://www.loc.gov/	
Carnegie-Mellon University Digital Library	CMU: Internet Connections for Engineering: http://www.englib.cornell.edu/ice/ice-index.html	National Archival Information Locator: National Archives& Records Administration http://www.nara.gov/nara/nail.html	
University Libraries	**On-line Publication Archives: specific servers**	**U.S. Government Information Centers**	**Information Centers Overseas**
University of California at Berkeley http://elib.cs.berkeley.edu	Engineering Connections at NASA: http://arioch.gsfc.nasa.gov/wwwvl/engineering.html	Defense Technical Information Center http://www.dtic.mil/	
Cambridge University	Aerospace Worldwide	Smithsonian Institution	

Library http://www.lib.cam.ac.uk/	Web Virtual Library at Embry-Riddle Aeronautical University: http://macwww.db.erau.edu/www_virtual_lib/aerospace.html	http://www.si.edu/newstart.htm	
Cranfield University Library http://www.cranfield.ac.uk/cils/library/libinfo/	ASEE List of Engineering Libraries: Cornell U. http://www.englib.cornell.edu/eld/libraries.html	National Air and Space Museum http://www.nasm.si.edu/	
The Open University Library http://oulib1.open.ac.uk/lib/		DoD Libraries: http://www.defenselink.mil/other_info/libraries.html	
Royal Institute of Technology Library, Stockholm http://www.lib.kth.se/kthbeng/kthb.html	Physical Constants: NIST database http://physics.nist.gov/cuu/Constants/index.html?/codata86.html		
Georgia Tech Civil Engineering Virtual Library: http://www.ce.gatech.edu/WWW-CE/home.html	IBM's Patent Network http://www.patents.ibm.com/		
Edinburgh Engineering Virtual Library: http://www.eevl.ac.uk/			
OTHER USEFUL AEROSPACE RELATED DIGITAL LIBRARY RESOURCES			
Resource URL	**Type of Resources**	**Contact Information**	**Remarks**
http://www.digital-librarian.com/astronomy.html	Astronomy and Aerospace	Margaret Vail Anderson, Librarian in Cortland, New York	URL consists of large number of Aerospace Resources
http://store.sae.org/digitallibrary.htm	SAE Standards, e-Books, Technical Papers		SAE International is your one-stop resource for standards development, events, and technical information and expertise used in designing, building, maintaining and operating self-propelled vehicles for use on land or sea, in air or space.
http://spec.lib.vt.edu/aerosp/	Archives of American Aerospace Exploration		The Archives of American Aerospace Exploration (AAAE) were established by the Special Collections Department at University Libraries, Virginia Polytechnic Institute and State University, in April 1986. The purpose of

			the AAAE is to preserve and make available materials (collections of correspondence, notes, photographs, written or recorded reminiscences, memorabilia, oral histories, as well as illustrations and publications) documenting American aeronautical and space history.
Resource URL	**Type of Resources**	**Contact Information**	**Remarks**
http://guides.library.tamu.edu/content.php?pid=223918&sid=1857192	Resources related to Aerospace Engineering		
http://catalog.hathitrust.org/Record/000635496	Aerospace Safety		Hathi Trust is a partnership of major research institutions and libraries working to ensure that the cultural record is preserved and accessible long into the future. The Digital Library is a digital preservation repository and highly functional access platform. It provides long-term preservation and access services for public domain and in copyright content from a variety of sources, including Google, the Internet Archive, Microsoft, and in-house partner institution initiatives.

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