A Multipurpose Indian Gateway for Aerospace Information

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Abstract

Aerospace Science and Technology encompasses the work carried in good number of branches of Engineering, Physical, Chemical, Material and other sciences. Electronic publishing is order of the day and aerospace S&T falls in line. This paper identifies various types of aerospace information generated in a variety of media and different access mechanisms. Few aerospace virtual libraries and library sites attached to aerospace institutions world over provide links to relevant sources. However Indian National Aerospace Laboratories' portal 'AeroInfo' (www.aeroinfo.org.in) designed, developed and maintained by its Information Center (ICAST) is unique Aerospace Information Gateway in many respects. More than 50,000 web sources have been indexed under various headings including General Categories like- associations, organizations, space agencies, education, research and museums; Interdependent Subjects like- physics, chemistry, materials, mechanical engineering, electronics and composites; NASA Subject Categories like- aeronautics, aerodynamics, avionics, wind tunnels, composites, materials, etc; and Aviation Categories like- aircraft, airlines, air shows, airports, helicopters, etc. Indian Aerospace sources are covered exhaustively and are indexed separately using many subject headings and further grouped under four main categories- Aviation, Space S&T, Associations / Organisations and General. Links have been given to different servers for searching and downloading different types of aerospace documents like technical reports, journals, patents, regulatory information, conferences and news.

ICAST also creates its own digital content including news clippings in aerospace, table of contents of 280 journals it subscribes, OPAC of library with >3,00,000 records, union catalogue of journals subscribed in 40 CSIR and 25 aerospace libraries, proceedings of conference on Knowledge Management and full text of NAL technical reports. Based on these resources a number of value added web/e-mail based information services are provided for the benefit of aerospace community within and outside NAL. The portal has been evaluated and indexed by many search engines and aerospace portals maintained by world aerospace leaders.

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1. Introduction:

Since centuries, man has been recording, presenting and preserving information using various media like clay tablets, stones, palm leaves, leather etc. The invention of paper and the printing press provided an important media for recording and storing information. Later micro documents, audio and video cassettes also arrived on the scene. The 20th century witnessed a revolution in the form of computers for storing and retrieving information. Compact Disc read only Memory (CD-ROM) due to its enormous storage capacity brought a revolution in information storage and delivery mechanism there by setting a revolutionary trend in the information industry. DVD with high storage capacity further revolutionized the information delivery mechanism. INTERNET with its world wide web converged the whole world into an information village. The information going electronic, knowledge storage and retrieval has become dynamic with the help of powerful retrieval engines irrespective of the storage media used, be it CD-ROM, Online or Internet.

The 1980's saw the exponential growth in the information storage and retrieval systems including online retrieval of information from bibliographic, full text, numeric, multimedia databases through remote hosts like DIALOG, STN, CSA-IDS and many other data base vendors. The knowledge economy boosted by the rapid developments in information

and communication technologies especially the networking power of Internet, Intranets and Extranets have resulted in a remarkable expansion in the ability to generate, process, and disseminate digital information ultimately paving a way for paradigm shift in the information seeking behavior of researchers and knowledge workers. Slowly the static and paper-based library will be replaced by dynamic virtual libraries with flexible and efficient mechanisms for producing, organizing, locating, repackaging and accessing the information, which is extraordinarily dynamic, context sensitive and growing geometrically. The flexibility and interactive nature of the Web facilitates the information to be tailor made to suit its target audience. The growing acceptance of digital media has resulted in libraries *inter alia* gaining much more experience of their management. Many libraries have gained experience with aspects of digital resource management. Some with public access to the Internet, many with networked CD-ROMs, and others with scanning publications and managing images.

2. Digital Resources by Type

The five basic formats of information are text, image, sound, motion pictures and data. Aerospace digital resources by type as in any other subject are as listed in Table 1.

Table 1

Resource Types	Description
Conferences	A prearranged meeting for consultation or exchange of information or discussion. Meetings, Exhibitions, Trade shows and Fairs.
Guides	That offers basic information, tutorials and manuals.
Discussion groups	Any system that supports group messaging, e.g. a shared mailbox, Usenet, bulleting board system.
Electronic journals	Full text and Table of contents of online journals.
Patents	Official document of invention rights
Theses and dissertations	A lengthy, formal treatise for the doctoral degree at a university.
Abstracting and indexing databases	Secondary sources of information those index and abstract the primary literature like Journal articles.
Digital collections	Images, audio and video.
Product catalogues	Aircraft, Satellite products and spare parts, services and information
Library catalogues	Bibliographic databases of library holdings.

Museum, Archives	Artifacts, Paintings, documents
Virtual libraries	Multiple resource types on various subjects
Reference sources	Dictionaries, encyclopedias, biographies, abbreviations, thesauri, handbooks
Employment	Career sources, advertisements
Libraries	School, College, Universities and other Libraries
Organizations	Schools, Research institutes, Associations and Societies.
Companies	Manufacturers and industries
Directories	Various search engines with subject directories

3. The Web and the Library Services

Realizing the dynamic nature of the web more and more libraries have been engaged in creating their own web sites and have been providing innovative services. Through intranet/internet one can provide basic information like library hours, contact persons for various services, quality manuals, calendars and give links to remote information covering bibliographic and full text databases, library catalogues, electronic books, etc hosted on thousands of servers all over the world. Libraries can provide platform independent access to CD-ROM databases through Intranet. Library sites can also facilitate document acquisition activity by providing links to publishers catalogues; book databases and online shops and creating online document suggestion form on their own site. One can generate a number of push-based services like Current Awareness Service and profile based services such as SDI, Journal Table of Contents, e-mail delivery, etc. The interactive home pages facilitate the transactions in the counter and reservation of library material. We can make surveys and get feed back about library services apart from providing ILL service.

4. Virtual Libraries

The virtual library acquires, processes, organizes, stores and provides access to information primarily in electronic form. For the purpose of this presentation the terms gateways, portals and virtual libraries are referred synonymously. These systems facilitate the users usually in a specific area of interest to access information residing solely in digital form in distributed network systems without respect to physical location of the information. The Internet described as 'information chaos' does not follow standardized organizational structure or defined format. In spite of the availability of valuable information, finding it quickly and efficiently is time consuming and many a times futile job. This is where virtual libraries play a major role giving guided and faster access to required information. There are no limits on the size, format, content or value of data in a virtual library. Virtual libraries provide links to meta-indexes either going

through the metadata or directly to full text electronic information stacks.   Gateways are the means to bring together the resources of various libraries and information services both internal and external all in one place.

5. Aerospace Science and Technology

The Aerospace Science and Technology, a branch of Engineering applies the principles of physical and mathematical sciences to the development, design, construction, testing and operations of flight vehicles operating within and beyond the earth's atmosphere. The principal technologies encompassed by aerospace engineering are those of aerodynamics, propulsion, structures and flight stability & control.   The aerospace industry is the complex of manufacturing concerns engaged in the production of flight vehicles, including powered gliders and sailplanes, lighter than aircraft, ground-effect machines, heavier than air aircraft of both fixed wing and rotary wing varieties , military missiles, space-launch vehicles, and manned or unmanned spacecrafts; propulsion systems or other thrusting devices; ground based support equipment; etc.

6. Indian Aerospace Scenario

India, though a developing country has contributed enormously in the area of aerospace. The major bodies responsible for the development of Aerospace include Dept. of Space, Defense establishments, National Aerospace Laboratories, Aeronautical Engineering Departments of few Centers of learning.   India began its space program with the establishment of the Space Commission and Department of Space 1972. Since then India has made steady progress in the development of launch vehicles and satellites. The first Indian satellite was *Aryabhata*, which was launched by a Soviet rocket on 19th April 1975. With the successful launch of the SLV-3 on 18th July 1980 when a 35kg satellite called *Rohini* was placed in LEO, India became only the seventh nation in the world to achieve space orbit capability. The 1990' s saw major achievements in the form of Space transportation systems, Indian Remote Sensing Satellites (IRS), medium and long range missiles, helicopters and all-composite trainer aircraft. The new millennium attributed to the maiden test flight of Light Combat Aircraft and the most recent successful launch of Geosynchronous Space Launch Vehicle (GSLV). Some of the web resources covering the Indian aerospace scene are listed in Table 2.

Table 2

Web Sources on Indian Aerospace

Indian Space Research Organization (ISRO)	http://www.isro.org/
National Aerospace Laboratories (NAL)	http://www.nal.res.in/
Centre for Space Science and Technology Education in the Asia Pacific region (CSSTE- AP)	http://www.cssteap.org/
Defense Research & Develop. Organization (DRDO)	http://www.drdo.org/
Aerospace in India	http://home.att.net/~sprasad/aero_india.html
Department of Aeronautical Engineering, IISc, Bangalore	www.aero.iisc.ernet.in/aeronow/dev.html home.att.net/~s-prasad/aero_india.html
Department of Aeronautical Engineering, IIT, Mumbai	www.iitb.ernet.in/~aero/
Aero India 2001	www.aeroindia2001.com/
Department of Aeronautical Engineering, IIT, Chennai	www.aero.iitm.ernet.in/

7. Aeroinformatics:

The field of aerospace science and technology being inter-disciplinary in nature, quite a good number of branches from engineering and other disciplines like physics, chemistry, materials, etc contribute for its growth. NASA's Scientific and Technical Information (STI) program is a world leader in archiving and disseminating aerospace information. STI contribution by subject (Table 3) gives an idea about contribution of different disciplines for the growth of information in aerospace science and technology. The information thus generated gets into various forms like books, conference proceedings, journal articles, technical reports, standards and patents and is being made available

through different media including online, CD-ROM and Internet.   More than 350 CD titles   cover aerospace literature of various types.   The prominent bibliographic titles include Aerospace Database, NTIS, Compendex Plus, INSPEC, Metadex, Move-SAE, and FLUIDEX. Important databases on conferences, regulatory information, patents and standards include AIAA, ANSI, HIS, ISO, ASTM, ASME, ARINC, BSI, DIN, Defense Standards, FAR, JAR and Derwent Aerospace.   Jane's Directories provide detailed information covering military and civil aviation. Most of these databases now have been made available on Internet. Aerospace community also need other kind of information like aerospace agencies, associations and organizations, corporate bodies, museums, library and information centers, news groups, aviation authorities, airports, airlines, training facilities, weather, etc.

Table 3

NASA's STI Contribution by Subject

Engineering	25%
Aeronautics	18%
Chemistry & Materials	16%
Astronautics	13%
Geosciences	10%
Space Science	8%
Physics	7%
Mathematics and Comp..Sci.	1%
Social Science	1%
Biological Science	1%
General	3%

8. Aerospace Web Sources

A casual *Google* search on Internet for Aerospace related subject terms and few leading organizations doing aerospace related works showed thousands of hits (Table 4 and 5).

Table 4

Aerospace Resources on Internet
(Google Search)

Subject Terms

Keyword	Basic Term	Basic Term + India
Aerodynamics	1,95,000	5,900
Aeronautics	5,63,000	25,600
Aerospace	1.8 million	1,32,000
Aircraft	7.41 million	3,14,000
Astrodynamics	8,000	364
Astronautics	4,37,000	16,600
Aviation	5.83 million	2,63,000
Avionics	3,22,000	10,700
Airports	9.31 m	0.47 m
Helicopters	1.39 million	78,300
Propulsion	0.63 million	25,200
Air shows	127,000	2800
Missiles	0.96 million	111,000
Rockets	2.73 million	1,05,000
Satellites	7.25 million	4,03,000
Spacecraft	1.14 million	33,00
Airfoils	25,400	676

Table 5
Institutions

NASA	5.68 m
ESA	202,000
NAL(Japan)	75,800
DLR	49,000
ONERA	11.300

ISRO	11,100
DRDO(India)	17,400
NAL(India)	34,600

Even if we assume that only 10% of these hits are useful for the aerospace community still the task of indexing and making available these web sources through a gateway is a huge task. Many organizations have hosted aerospace information sources either through their own home pages or by creating tailor made portals by cataloging and providing links to world over Internet sources. More than 30 Virtual Libraries and Indexes serve as information sources specifically for aerospace science and technology. In spite of this, aerospace community spends lot of time and energy in searching required information and some times get lost in the ocean of Internet. Table 6 gives select list virtual libraries and aerospace agencies providing information as well hyper links to the sites mostly from developed world.

Table 6

Aerospace Virtual Libraries and Indexes

International Aerospace Information Network (IAIN)	http://www.dtic.mil/iain/main.html
The World-wide Virtual Library: Aerospace	http://macwww.db.erau.edu/www_virtual_lib/aeronautics.html
The World-wide Virtual Library: Aviation	http://macwww.db.erau.edu/www_virtual_lib/aviation.html
AIAA Aerospace-Related Links	http://www.aiaa.org/information/links/index.html
Yahoo's Index of Space Resources	http://www.yahoo.com/science/space/
Internet AeroLinks	http://www.galcit.caltech.edu/~padam/htmls/AeroLinks.html
Aerolink.com	http://www.aerolink.com/links.html
Space Russia	http://www.conveyor.com/space_russia/
Lunacity Space Links	http://www.LunaCity.com/space.html
Aerospace Engineering Resources Via ICE	http://www.englib.cornell.edu/ice/lists/aerospace-engineering.html
Index of National Space Soc.	http://www.nss.org/

SciCentral Aerospace Engg.	http://www.scicentral.com/E-aerosp.html
Valid Space Related Links-Fast	http://advicom.net/~hal5/space-links.shtml

All NASA Technical Information Centers, few Libraries attached to leading aerospace agencies in the world, AIAA Library simply open Pandora boxes for aerospace information. More than 50% of Aerospace R & D communications are in the form of technical reports. NASA Technical Reports Server at *http://techreports.larc.nasa.gov/cgi-bin/ntrs* is a rich source for both bibliographic and full text information on reports. Apart from one hundred e-journals in Aerospace, more than 1000 titles in the areas of Mechanical Engineering, Astronomy and Astrophysics, Materials Science, Physics, Chemistry, Electronics, Computer Science and Composites cover aerospace research papers partially. The Web sites of AIAA, ESA, RAS and Embry-Riddle Aeronautical University list various Aerospace associations and organizations. The Yahoo site at http://dir.yahoo.com/business_and_economy/business_to_business/aerospace/ lists aerospace companies arranged under sectors like avionics, consulting, development, publications, etc. FAA and CAA sites are good sources for regulatory information.

9. The Indian Gateway 'AeroInfo'

9.1 Need for 'AeroInfo"

Few Gateways cover exhaustively the aerospace information with exclusive coverage on civil aviation, commercial airliners, airports, pilot sources, climatology & meteorology etc. generated in US, Europe, Canada and few other developed countries with a meager coverage of information from developing countries like India. Most of these portals index web sources in a very general way many a times without a search engine. Indian web sources listed in Table 4 cover mostly the information concerned to respective organizations. Considering these lacunae, the Information Centre (ICAST) of National Aerospace Laboratories (NAL), Bangalore, India launched a multipurpose Gateway **'AeroInfo'**, a WWW Virtual Library for Aerospace. (Figure 1, URL: *http://www.aeroinfo.org.in*).

Figure 1

Many search engines and directories like *Yahoo, AltaVista, Google, HotBot, InfoSeek, Aeroseek* and a host of Virtual Libraries and Indexes meant for aerospace and aviation have indexed this unique portal after proper evaluation.

9.2 *The Host ICAST*

The ICAST, the information center of Indian National Aerospace laboratories caters to the information requirements of the aerospace community in particular and the engineering and technical personnel in general. The center is well known for its aerospace collections of books, journals and specifically technical reports from NASA, DLR, ONERA, NLR, ARL and UTIAS. The center has created a portal 'AeroInfo', the first of its kind in the country and serves as one window information search facility for the aerospace community in the world in general and India in particular. It provides value added web and e-mail based information services to it's users.

9.3 Contents Planning and Organization

The Gateway gives access to both contents created in-house at the host center as well innumerable number of sources available on Internet.

9.3.1 *Links to External Sources*

Unlike in many aerospace virtual libraries, contents of AeroInfo are indexed by multiple categories, so that visitor is driven one way or the other to the required source. The approach could be a general category, subject, document types like patents, technical reports, news, etc.

a) General Categories

Links have been provided exhaustively under this general categories like associations, books, companies, conferences, education, research, museums, clubs, software, weather, women, etc.

b) NASA Subject Categories

NASA subject categories are used world over to classify the documents. Interestingly none of the virtual libraries and other web sites including NASA sites have used to classify and index web sources in aerospace. AeroInfo uses these categories along with other ones (Table 5).

c) Aviation

More than 100 subcategories like aircraft, airports, air cargo, airlines, helicopter, skydiving, ultra lights, etc are used to give access to thousands of aviation sources.

d) Interdependent Subjects

Links have been given to a good number of interdependent subjects like astronomy and astrophysics, avionics, composites, computer science, material science, mechanical engineering, etc considering their relation with aerospace area.

e) Indian Aerospace Sources

Considering the fact that Indian sources have not been indexed exhaustively by most of the virtual libraries, special care is taken in this regard. Sources have been indexed under four main headings viz. Aviation / Aeronautics Space S&T Associations/ Organisations. Sub-headings under each of these headings facilitate to searcher in visiting the specific site of his interest.

f) Information by Source Types

Aerospace researchers, developers and practitioners usually look for various kinds of information available in documents like journals, technical reports, patents, regulatory information and news and other sources like conferences, virtual libraries. The portal facilitates the visitor to jump to any kind of sources of their interest given on the top of all pages.

9.3.2 Access to In house Contents

The host center has created a good number of aerospace related digital contents and made available both through 'AeroInfo', the gateway under discussion and the Library Web site at *www.icast.org.in*. Journal table of contents of about 280 titles are scanned and some times captured from some sources on the net and are made available systematically for the benefit of aerospace community. Aerospace news items from 12 dailies are being digitized for the last 3 years and one can use the search engine for retrieving the news items of interest. The union catalogue of journals subscribed by 40 CSIR libraries and 20 aerospace organizations has been compiled and made available for facilitating document delivery service. The Web OPAC with more than 3 lakh bibliographic records of the holdings of the host center ICAST covering books, technical reports, standards, patents and conference papers serves as rich resource for inter library lending in the country. The proceedings of the conference on ' Media Convergence and Knowledge Management' hosted by the center are other highlights. The center has begun the digitization of more than 10,000 in house technical reports and contents will be made available in appropriate time.

9.4 *Gateway Management and other Facilities*

Links have been given to well known Internet search engines to help visitors use the search engine/s of their choice directly. A dedicated team of information professionals does the planning, sourcing, generating and organizing information content for disseminating through this portal. The contents are updated regularly. As already mentioned above, multiple access facility has been provided in organizing the sources in three different ways. The target visitors to this Portal being aerospace community, the NASA subject categories have been used to group the sources. The advanced search features with Boolean logic, site maps and directories have been provided to facilitate information seekers world over to access specific information exhaustively, expeditiously and easily, regardless of its physical location.

10. *Conclusion:*

In the midst of a data explosion, we find ourselves victims of information poverty – unable to find useful information. It is obvious that the aerospace field is rich in Online,

CD-ROM and Internet resources and offer different levels of access… some more helpful than others. It is equally evident that it is difficult to know what information exists, what format it is available in and where to look for it. Many search engine, directories and virtual libraries facilitate retrieving information required from web sources. More than 30 virtual libraries facilitate the Aerospace information searching. The portal 'AeroInfo' – a WWW Virtual Library for Aeroinformatics is one such an attempt. The unique contents planning and organization aided by site search engines has made searching much more easier, meaningful and relevant.

7. References:

http://www.cmmacs.ernet.in/nal/icast
http://www.nasa.sti.org
http://home.att.net/~sprasad/aero_india.html

Figure 1
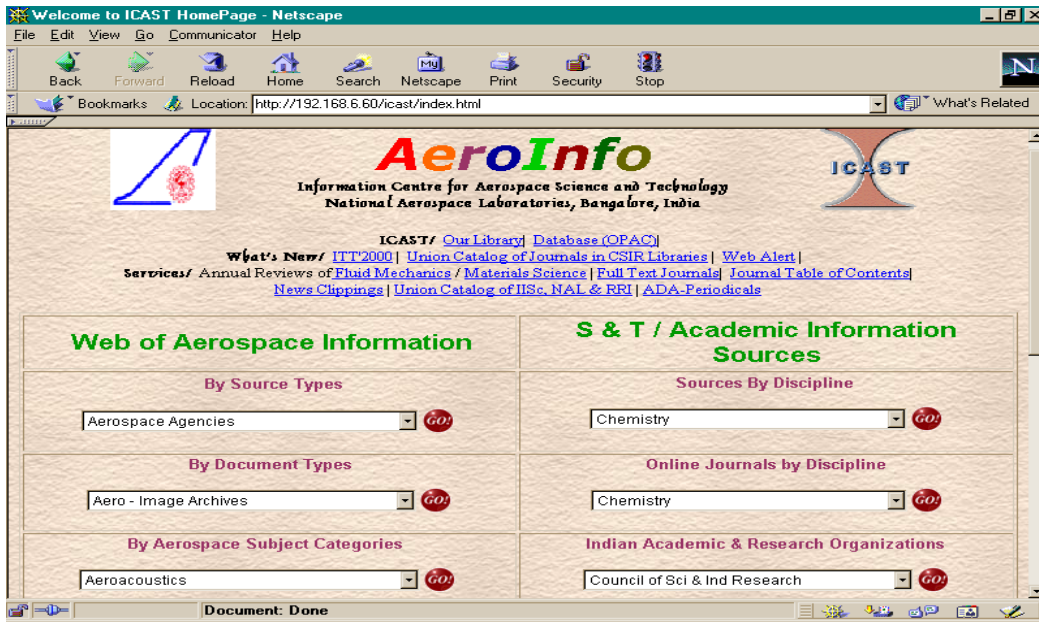
Figure 2
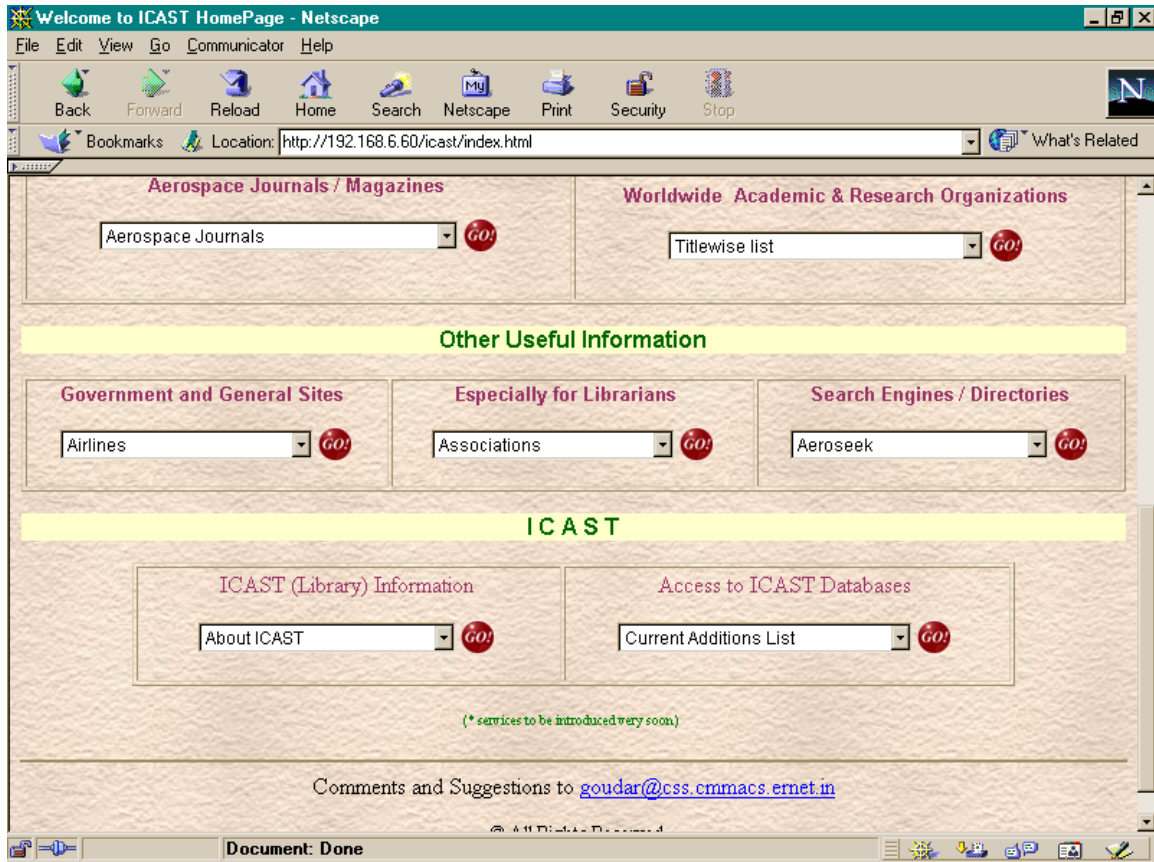
Table 5

NASA Subject Categories used in 'AeroInfo'

Aeroacoustics	Avionics
Aerodynamics	Communication & Navigation
Aerothermodynamics	Composites
Aerospace Materials	Fatigue, Fracture & Failure Analysis

Aerospace Medicine	Fluid Mechanics
Aerospace Structures	Material Science
Astrodynamics	Mechanical Engineering
Astronautics	Meteorology & Climatology
Astronomy & Astrophysics	Missiles
Aircraft Design & Testing	Propulsion & Power
Aircraft Instrumentation	Rockets
Aircraft Profiles	Rotordynamics
Aircraft Stability & Control	Satellites
Aircraft Structures	Space Craft Design & Testing
Airfoils	Space Sciences
Air Transportation, Safety & Certification	Space Transportation
Atmospheric Science	Space Vehicles
Aviation General	Surface Engineering
Aviation History	Wind Tunnels