

NDLTD: Encouraging International Collaboration in the Academy

Edward A Fox, Robert Hall, Neill A Kipp, John L Eaton,
Gail McMillan, and Paul Mather *

Abstract

The Networked Digital Library of Theses and Dissertations (NDLTD) is an international effort aimed at ensuring that future scholars are more effectively prepared for the Information Age. The NDLTD also supports present day scholars by providing a forum for more timely, detailed, and effective exchange of information. The NDLTD streamlines the entire thesis process, not only simplifying searching and retrieval, but also making submission and approval easier.

Individual universities play a key role in the development of the NDLTD. Each university establishes a team responsible for local development. Information professionals from the university train students on ETD (Electronic Thesis and Dissertation) submission, and the university network and computer systems provide essential NDLTD infrastructure. University professors play a vital role in ETD quality control, and advise students on publication practices and appropriate digital library access controls.

When a university decides to work towards full participation in the NDLTD, it is most appropriate to engage in pilot efforts. There are several different methods that exist for developing a pilot program. Level of study, discipline, geographic, and administrative groupings are all valid criteria for selecting participants in the pilot initiative. In addition, student volunteers may be invited, thus bringing in innovators and early adopters.

As a result of collaborative activities the NDLTD has been growing rapidly. ETDs in the NDLTD are increasing in number, and are accessed ten to a hundred times more than paper theses. Universities have been joining steadily - twenty during the first year. As more universities join the NDLTD we expect that the materials produced by Virginia Tech will be adapted to varying local situations, allowing the NDLTD to continue to expand rapidly and to facilitate further collaboration.

1. INTRODUCTION

Education is an important force in the advancement of civilisation. Its success depends

upon sharing of information, which is uncovered through worldwide activity. Digital libraries can provide a vehicle for extending collaboration, which is at the heart of the Academy, with the aim of more effective education. This paper focuses on the Networked Digital Library of

* Virginia Tech
Blacksburg, VA 24061-0106 USA

Theses and Dissertations (NDLTD) and its potential to improve education and enhance international collaboration.

1.1 NDLTD

The NDLTD (see <http://www.ndltd.org>) is an international effort aimed at ensuring that future scholars are more effectively prepared for the Information Age by understanding publishing and digital libraries. It is an open initiative, with all educational institutions invited to join and other organisations encouraged to assist as appropriate. While some might prefer to use the term ETD (Electronic Thesis and Dissertation) Initiative, which refers to a broad range of efforts aimed at moving graduate theses into digital formats, due to the openness of NDLTD we will treat the terms interchangeably in this discussion. Similarly, unless precision demands more specific terminology, we use the word thesis to refer to a range of documents including doctoral dissertations, masters theses, bachelors theses, and even the broad range of reports produced in partial fulfilment of degree, course, or research requirements.

The worldwide preparation of theses is one of the largest publishing efforts of items that are book sized or larger. In Canada, about ten thousand doctoral or masters works are written annually. In the United States, about fifty thousand dissertations are prepared each year. While Council of Graduate School records indicate over 350,000 U.S. students per year receive a masters degree, the number of documents they write per year is not known (though it is certainly over 50,000 and is likely to be 150,000 - 200,000, especially if one includes project reports). Based on a 1% sample of data provided by OCLC from their World Cat database, it appears that there are at least 3.5 million theses that have been cataloged in OCLC-affiliated organisations, and that about 100,000 more are added each year. UMI reports that 1.5 million doctoral dissertations have been entered into their database. Clearly, more than 1,00,000 theses of one kind or another are prepared annually worldwide.

Accordingly, NDLTD seeks to involve every interested educational institution in the world in:

- ⊕ helping graduate students learn more about publishing and digital libraries;
- ⊕ ensuring that as many theses as possible are captured and archived electronically;
- ⊕ increasing access to theses through digital library technology.

1.2 Support of Educational Requirements

Scholars depend on information for their work. Many of their requirements for information can be met in part through ETDs. Some of these requirements include:

Timeliness. For many purposes scholarly information must be timely. Considerable investment is made in obtaining news, state-of-the-art reports, preprints, conference papers, or direct communications from leading researchers. While parts of a thesis may refer to discoveries made several years earlier and reported in a conference, the release of a thesis is usually the first packaging of the full research results of a graduate student. If students, faculty, and university groups allow, an ETD can be made widely available within days of submission.

Detail. Advancing knowledge often depends on having sufficient data and analysis to reach important conclusions. A detailed account may be crucial in the sciences to enable replication, and in the humanities to facilitate corroborating analysis. The hundreds of pages typically present in a thesis may be needed to fully articulate an argument in the social sciences or to give adequate literary rendering in the humanities. Reading a long work is often the best way for a graduate student to master a new subfield, or to understand the depth of investigation needed to prepare his or her own thesis.

Understanding the literature. Many theses have comprehensive bibliographies and careful literature reviews. These help others ensure that they have not missed important background works relevant to their own research, help them develop skills of critical analysis, and provide helpful insights into specialty areas on the borders of their own investigation.

Effective and complete communication. ETDs may include data files, databases, metadata,

spreadsheets, images, audio, video, links, simulations, software, virtual reality representations, interactive applications, and other digital artifacts. These forms may enable readers to more easily comprehend the research reported, may give them a more complete understanding, and may facilitate subsequent follow-on studies.

1.3 Outline

Given the above discussion of NDLTD, theses, and the educational value of ETDs, it is important to consider how the NDLTD can expand and be of even greater benefit. Below we explore how digital libraries in general, and NDLTD in particular, can be developed so as to increase international collaboration. Next we focus on universities, and indicate how the Academy can evince more collaboration. Then we explore types and levels of collaboration that are possible, and report on current collaborations. We conclude by summarising the discussion and point to future work.

2. DIGITAL LIBRARIES AS ENABLERS FOR INTERNATIONAL COLLABORATION

Digital libraries can bring together a community throughout an integrated information life cycle¹ of creation, authoring, refinement, access, reuse, and new discovery. Digital library methods are crucial to allow NDLTD to help advance graduate education and promote worldwide knowledge sharing.

2.1 Formats and Expressive Power

NDLTD focuses not only on retrieval, browsing, access, downloading, and reading of publications but also on their creation, submission, and all related work flow activities. For digital libraries to be cost effective and scale able, it is crucial that appropriate automation be applied, and that use of the digital library fits in with standard community activities.

Communication between researchers in the Information Age can be facilitated, complicated, or limited because of technical considerations. We hope that NDLTD will facilitate communication, increase its volume and spread,

and still provide archiving and preservation services that afford protection into the future. Accordingly, we balance competing pressures, e.g., allowing:

- ⊕ readers to access works as easily as possible
- ⊕ archivists to preserve works at the lowest cost feasible
- ⊕ students to express themselves as precisely and completely as possible, and
- ⊕ faculty to guide their students and carefully check and critique their works

In a 1994 workshop at Virginia Tech involving ten universities, it was decided that NDLTD should establish format standards to achieve a balance of the competing pressures. Where multimedia content was appropriate, conformance to prevalent standards (especially international ones) was encouraged. In addition, the goal was established of having two versions of the body of each document: a fully rendered form supporting electronic books and related images-PDF (Adobe's Portable Document Format), and a tagged representation capturing the structure of the work as well as enabling full-text search-SGML (Standard Generalised Markup Language, ISO 8879). A simple Document Type Definition, ETD-ML (Electronic Thesis and Dissertation Markup Language, see <http://etd.vt.edu/etd-ml/>), was devised that would capture the crucial metadata (e.g., bibliographic information and front matter), references, and high level organisation of the work. To aid authors, tools have been developed to allow conversion to SGML from standard word processors and formatters. To aid readers, a translator from SGML to HTML was constructed that automatically builds a table of contents, adds forward and backward links between chapters, and links the table of multimedia objects to all the separate files involved in representing them.⁹

Since commercially available tools for SGML are relatively expensive, and locally developed tools are in beta testing, most institutions involved in NDLTD have focused on use of PDF. Helping students learn enough to create their ETDs in PDF seems to be a sufficient challenge for most universities, so that has been our focus,

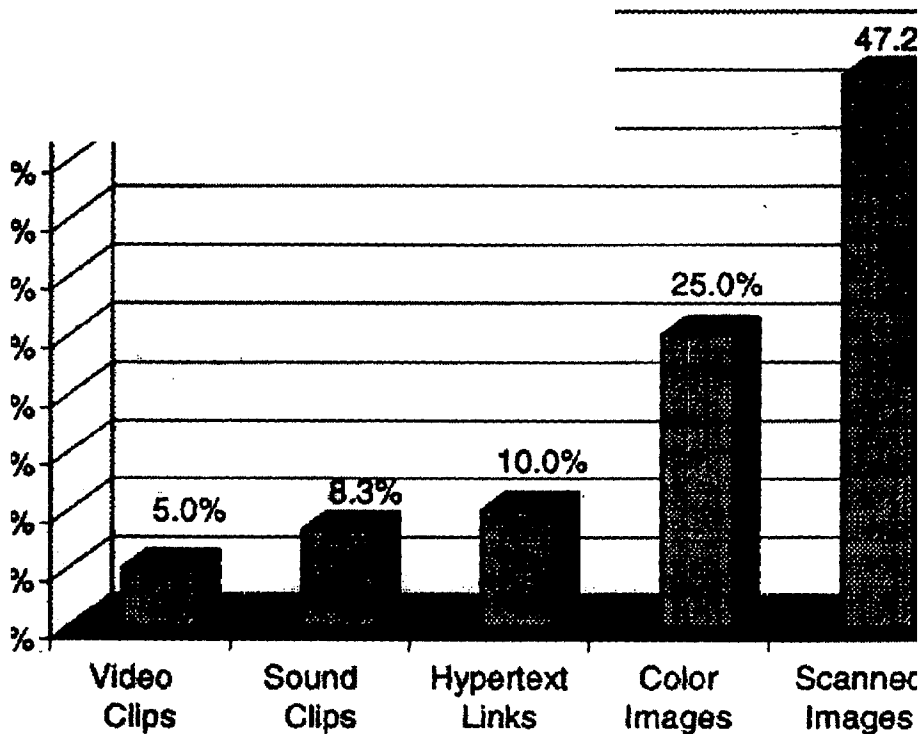


Figure 1 (a) Planned Multimedia Use

ML submission is still viewed as in the long term. Ultimately, if n create their ETDs in both PDF and will have learned a great deal about document preparation, and archivists assured that preservation will be

veyed students about their plans for multimedia in their ETDs. Nearly rrs planned to use images in the body of their thesis. Only one planned to use digital video in their (Figure 1a). Indeed, nearly half used s in their ETDs (Figure 1 b). As more we expect a general increase in the multimedia objects.

all number of cases, special formats r Ware, Director) are used that will solete in a few years, but those are lied in situations where the study requires use of those representations the authors are aware that parts of sion will be difficult to preserve in form. In general, students seem with the range of formats led, are exciting about the

expressive potential afforded by can easily access the multimedia v by others.

2.2 Support Software

Supporting scholarship in the A digital libraries requires a base software systems. While many are distributed information technologie WAIS, and SQL, only in recent y packaging of even more comprehe for scholars into digital libraries be goal and realistic possibility.

A number of corporate doi supported development of ND provided copies of Acrobat softw: supplied preparation of SGML froi OCLC donated Site Search to supp package for access to MARC rec ETDs. OCLC also provided PURL allow association of persistent nar with current URLs, and the Corporation for National Research Initiatives is assisting with 'handle' software for the same purpose.^{6,13}

The ND LTD support team at Virginia Tech has developed a variety of tools to help authors

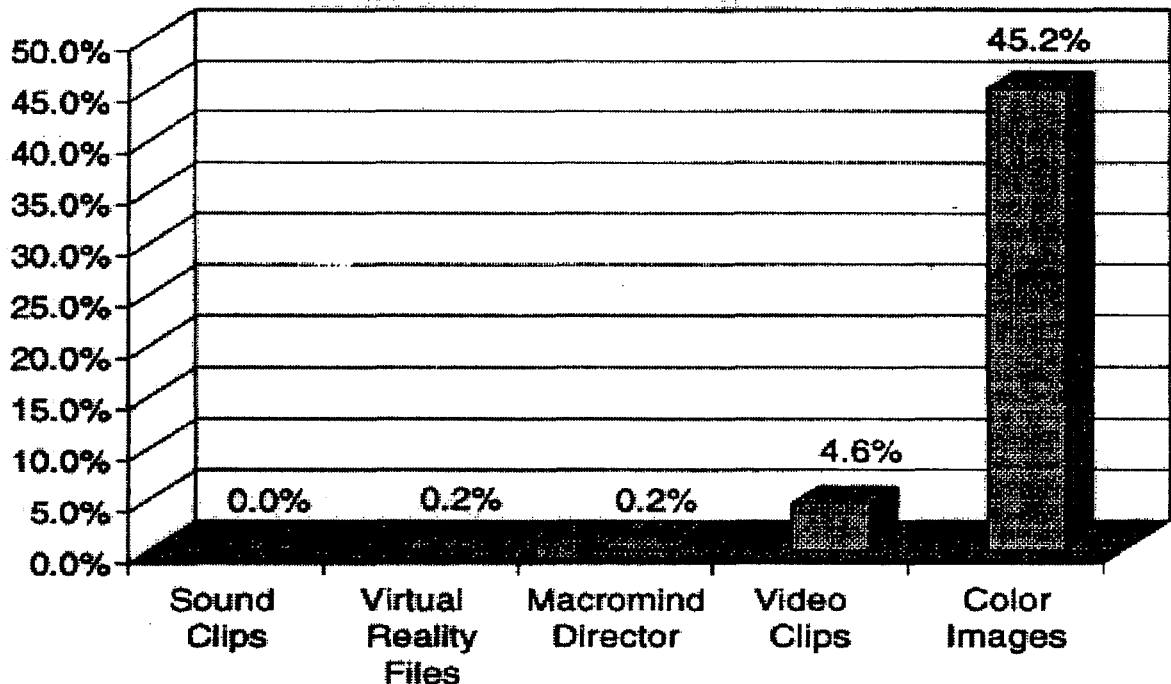


Figure 1(b) Actual Multimedia Use

create works, enhance them with hypertext and multimedia capabilities, submit them to campus servers, and then automate subsequent processing by Graduate School and Library staff. In addition, they have constructed a database record keeping system, provided an up-to-the-hour mirroring of submitted works on a separate computer, added log analysis and reporting tools, and prepared analysis tools for a variety of survey instruments. Another database keeps track of ND LTD member universities. All general interest materials are managed through WWW tools on a single physical server with multiple URLs: <http://www.ndltd.org/> (about the project), <http://etd.vt.edu/> (local instructions to aid with authoring and submission), and <http://www.theses.org/> (leading to the collection).^{8, 10}

The collection at Virginia Tech is indexed and made accessible for searching using Open Text software. Another mode of access is supported with the Dienst protocol that underlies the Networked Computer Science Technical Report Library (NCSTRL, at <http://www.ncstrl.org>); an improved version of that software developed at the University of Virginia has been prepared to support federated

searching. The Site Search system from OCLC will support Z39.50 access. IBM's Digital Library system also will support searching, initially on text or metadata values, where needed for multilingual texts, later on image content, and eventually in federated fashion. These search systems, building upon the standardisation of representation discussed in Section 2.1 above, will enable a variety of approaches to constructing and accessing a large, distributed, international collection of ETDs.

2.3 Role of Information Professionals

For significant numbers of graduate students to learn about publishing and digital libraries, a serious educational initiative is required. The ND LTD support team at Virginia Tech has prepared extensive online information, including a number of multimedia training programs, available through the above-mentioned WWW sites. In addition, several writing projects are underway to reach others interested through a how-to booklet for students; a source book for students, faculty, publishers, and other interested parties; and a compendium to be drawn from talks by those slated to speak in a symposium series on ETDs.

Ultimately, however, there must be substantive involvement of information professionals in supporting the education of students regarding NDLTD. We believe that if graduate students are to be prepared adequately for the information age, they should have competence in preparing electronic documents (which can be demonstrated by preparing their ETD), knowledge about the world of publishing (copyright, intellectual property rights, derivative works, agreements with publishers, inter library loan, and related economic issues), and ability to use digital libraries (e.g., from accessing the NDLTD collection).

Besides reading materials about NDLTD, students should attend local training sessions carried out by campus information professionals. For complex ETDs, they should be supported as needed by experts in the various electronic publishing and multimedia capture tools required. At Virginia Tech, the New Media Center has a number of professionals helping with scanning and other special tasks, while the local ETD team handles email, phone, and in-person requests for assistance.^{4,5}

3. ROLE OF UNIVERSITIES

Supporting NDLTD thus calls for involvement of local information professionals at each university, in the context of an overall educational initiative organised by personnel in the Graduate School, Library, Computing/Information Technology, etc. Efforts by a team at each university are crucial for scalability of the ETD Initiative.

3.1 Infrastructure

NDLTD builds upon distributed information system technology in the context of the Internet and WWW. Typically, universities have a LAN, WWW servers, an online public access catalog, systems to store several gigabytes of information (since a gigabyte is roughly the space required for 500 new theses), search software, scanners, multimedia capture labs, database management systems, and other basic facilities needed for distributed digital libraries. Students may have their own computers and the university is likely to have computers in labs, the Graduate School, Library Automation, Cataloging, and for general access.

Of key importance for NDLTD are the Acrobat tools available from Adobe. Students or campus personnel can buy the inexpensive package needed for authoring; anyone can obtain the free Reader directly from Adobe that suffices to read works in NDLTD. Most client systems have built-in or freely available plug-ins that can handle multimedia works.

A few specialised services round out the local infrastructure. First, Virginia Tech or other centers involved in NDLTD can run PURL and 'handle' servers, so that each new ETD is assigned a unique identifier (Uniform Resource Name-URN) that can junction instead of a less persistent URL. These URNS can go into the 856 field of a MARC record, to be managed by the local catalog, so individuals searching the library catalog can view the record and click on the URN (or paste it into a WWW browser to gain access to the ETD). Second, universities should have an electronic archiving operation to secure and preserve their ETDs, or else have an arrangement with a large organisation capable of providing such permanent services (e.g., OCLC or UMI).

3.2 Unlocking Resources

With the help of information professionals (see Section 2.3) and building upon a satisfactory infrastructure (see Section 3.1), universities are in position to participate actively in NDLTD. While gopher and WWW have encouraged universities to make general information available, there is little coordination among universities to share their intellectual output on a systematic basis. Some provide access to online course ware (e.g., the Computer Science materials at <http://ei.cs.vt.edu> which have had over 6 million accesses), but many others either have little that is online or else restrict access to what they have prepared. In selected domains, like Computer Science, there is free sharing of technical reports by services like NCSTRL. However, many disciplines are not oriented toward reports. ETDs, on the other hand, are available for all fields, and seem to be something that many universities have thought of as a genre for sharing with other institutions.

Contributing to NDLTD allows students' works to be more widely known, which may

add to the prestige of a university as well as bring credit to its graduates. As collections of ETDs accumulate at each university, researchers at other institutions can learn about the activities of research groups, facilitating collaboration between such groups.

Since an average size university can produce something in the range of 100-1000 ETDs per year, there is a substantial base of works per year upon which to discover and develop collaboration, of much larger scale than the number of reports in a particular discipline. While collaboration based on ETDs begins with the student author, it can extend to others in the research group, including faculty involved, as well as to any future places of employment of the student. If students elect to publicise their ETDs or parts thereof before completion,¹² the collaboration can begin early in a research investigation, allowing refinement or reshaping of ideas based on feedback from others interested in similar topics.

As universities unlock these important results of graduate study and research, collaboration can extend even beyond the Academy. Companies involved in technology transfer, scholars in government or corporate research facilities, and a wide variety of others interested in new discoveries all can gain access to materials previously difficult or expensive to obtain.

3.3 Quality Control and Access Control

Universities play a key role not only in knowledge generation but also in quality control regarding research. Faculty serve as editors and reviewers of all types of publications, and often develop considerable skill in training students to present their works effectively. It is likely that, as ETDs become more common and more widely read, faculty will ensure that the quality of ETDs goes up. That can take place without a great deal of additional effort, especially if spell checkers and other automated tools are employed to help.³

Fundamentally, however, it is not necessary that ETDs differ radically from the theses and dissertations that have been prepared for decades. Their main roles remain: (1) marking

completion of, and (2) recording the content of a student's graduate work. On the quality side, they are usually fairly good, having passed scrutiny of a faculty committee. On the length side, they tend to be long and sometimes verbose, typically representing the first book-length writing activity of the student. On the detail side, they tend to be comprehensive, giving specifics often recorded nowhere else. In this genre there is often a large bibliography, a careful literature review, a clear problem statement, a long discussion of approach, and a short statement of future plans.

It seems likely that ETDs will co-exist with paper theses for a number of years, and that this well-established genre will co-exist harmoniously with other types of publications. There continue to be a large number of genre that serve to complement each other. ETDs fall into the class of gray literature, though on the high-end of quality, since faculty committees certify the works; in contrast, conventional publications have peer review. ETDs are a type of electronic publication, and so will grow to be more flexible in using multimedia, but for a while are likely to remain mostly text, appearing as electronic versions of paper books. It seems extremely unlikely that ETDs will dislocate or reduce demand for conference or journal papers, research monographs, textbooks, or other types of publications commonly used by the scholarly community.

Consequently, we argue that ETDs should be made freely available, and encourage publishers not to force authors to place restrictions on access. Though dissertations have been available on demand from UMI for decades, and UMI is well known as the publisher of record for most US dissertations, publishers of related books or papers have not considered such distribution to count as prior publication. We hope this view can extend to ETDs. At the very least, we hope that after a fixed number of years since completion, e.g., no more than 3-5 years, all ETDs will be fully accessible worldwide to provide an important scholarly record of our civilisation for the future.

While publishers learn about ND LTD, and consider these matters, digital library technology allows enforcement of a variety of access

options regarding ETDs. Table 1 summarises those options, gives reasons for choosing each, and provides numbers to show a typical sequence of broadening access. Thus, in the last row, a work that relates to a patent application may be locked up completely while the patent application is prepared (step 1). Next (step 2), part of the work, that relates to the patent disclosure, may remain locked up during patent review, while the rest (e.g., literature review, bibliography) may be released worldwide. Finally (step 3), after the patent is granted, the entire work may be released worldwide since the patent is in the public record.

Reason for Restriction	No Access	Campus Access	Unlimited Access
None			Step 1
Wish to publish separately		Step 1	Step 2
Wish to delay dissemination		Step 1	Step 2
Proprietary agreements	Step 1	Step 2	Step 3
Patent application	Step 1	Step 2	Step 3

Table 1: Access Options

Though we hope widespread access will become the norm, it may take time for that view to evolve. since diverse cultures are involved in this matter.

3.4 Bridging Cultures

The word 'university' indicates that a variety of viewpoints are represented. Since ETDs will be produced by each part of each university, tremendous diversity of opinion is sure to surround issues relating to them. Inside a university, there are differing views depending on level (bachelor, masters, doctoral), area (topic, research group, department), and college (engineering, arts, sciences, business,...).

In some cases the student is the sole author, while in other cases part of the work was done by a research team (whose members' names should be appropriately credited in an ETD). Depending on the discipline, the valuation of an ETD relative to a conference or journal paper, or to a monograph on the same topic, may vary. Having seen that ETDs serve the needs of the entire Academy, and so can act as a bridge for all sectors to move forward into electronic publishing and digital libraries, we turn our attention to focus on sources of variation that have appeared for ETD pilot efforts.

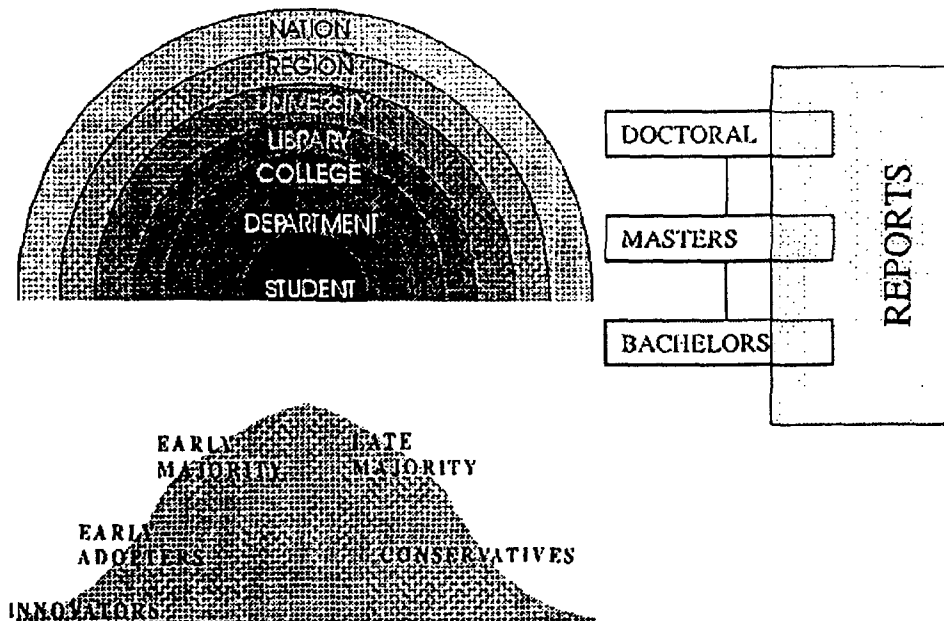


Figure 2 Pilot Taxonomies

4. TYPES OF PILOT INITIATIVES

At the time a university decides to work toward full participation in NDLTD, it is most appropriate to engage in pilot efforts so the campus can understand issues likely to emerge when the whole campus is involved. Following the lead of those tracking technology transfer, one may divide groups based on their reaction to technology and acceptance thereof. Alternately, one may distinguish populations according to a variety of other schemes. See Figure 2 and the subsections below for details on such divisions.

4.1 By Level or Discipline

One type of variation deals with discipline. In some disciplines, such as the sciences, the type of related publication most commonly considered is that of journal articles. In the humanities, on the other hand, a manuscript is more common.

Disciplines vary in terms of their use of mathematics, figures, tables, and multimedia. That leads to variations in preferred tools, like word processor or a separate equation processor. Many disciplines have different styles for format, especially regarding footnotes or end notes, citations, and entries in the bibliography. Some expect a thesis to tell a story of discovery not yet reported, while others expect that students will have obtained outside certification and publicity regarding their discoveries through published papers.

Since disciplines often relate to one or more commercial publishers and one or more associations, there also are aspects of them relating to the lead associations. For example, publishers in some fields are known for conservatism regarding electronic publishing, while others are in the vanguard of technology application. Similarly some publishers focus on serving a particular nation or region only.

4.2 By Region

Universities exist in a variety of contexts. Virginia Tech is in the Southeast of the U.S., and so is part of the Southeastern Universities Research Association (SURA). The University of Illinois, on the other hand, is in the Big 10, with

administrative coordination through the CIC. Regional university associations also are paralleled by other types of regional groups.

Thus, among libraries there is the Southeastern Library Network (SOLINET). Similarly, among graduate schools there is the Conference of Southern Graduate Schools (CSGS). Serving mostly North America is the Council of Graduate Schools (CGS).

Efforts in regard to NDLTD have had strong support from CGS, CSGS, SOLINET, and SURA. There is also interest in the CIC. Additional groupings relating to NDLTD rest on other types of association.

4.3 Political, Social, Linguistic, and Economic Concerns

Groups involved in NDLTD may base their definition on a variety of issues. For example, representation on the NDLTD Steering Committee deals covers national groups (e.g., Canada, UK), continental programs (e.g., African Virtual University), social groups (e.g., those with disabilities), or economic forces (e.g., companies involved in information technology, like IBM).

Various groupings can be used when establishing a pilot program (Figure 2). At the University of Virginia, the pilot began with bachelor theses in the College of Engineering. In many universities, the effort begins with a voluntary program, bringing in innovators and early adopters. In yet others, certain departments are particularly capable regarding technology, or see economic benefits that can come from electronic publishing (e.g., when large numbers of expensive photographs would be required).

NDLTD seeks to avoid economic limitations and difficulties. If ETDs are prepared as a natural part of the education of students, they can be produced without special financial (university line item budget) support. If automation of processing is implemented, the clerical costs of handling ETDs is actually less than in the previous paper-based system. Since we argue that ETDs complement other types of publications, we hope that outside publishers will not feel economic pressure from NDLTD,

and so will make it easy for universities to collaborate through the NDLTD.

5. COLLABORATION

As a result of collaborative activities, the NDLTD has been growing rapidly. Subsections below consider that growth and collaboration.

5.1 Accesses

Since September 1996, when the US Department of Education funded Virginia Tech to expand work on NDLTD, there has been considerable interest and rapid growth in accesses. Figure 3a shows that interest as reflected in accesses to our WWW sites. Shown separately are the counts for the project, for instructions on preparation and submission, and totals. Figure 3b records accesses to the collection of ETDs. Of thesis accesses, 32.3% are downloads of the full-text ETD (PDF file). The remainder of the accesses involve only the cover page and abstract (stored together as an HTML page). Note that these statistics represent about 2 orders of magnitude increase relative to the number of circulations in the campus library of a paper thesis.

5.2 Joining

With all this interest in NDLTD, universities have been joining steadily. After a year, twenty were official members, with letters giving contact information for coordinators in the Graduate School, Library, and Computing. These several contacts have been signed up separately in focused listservs, as well as in the general listserv, `etd-l@listserv.vt.edu`.

Members come from Africa, Australia, Europe, and North America. In the U.S., because of a SURF sponsored pilot that began in 1995, most members are in the Southeast, but there are members throughout the nation, including Hawaii. Since NDLTD encourages regional and national collaboration, we encourage not only universities but also national libraries, international consortia, and others interested.

5.3 Adaptation and Innovation

As NDLTD expands, we expect that the extensive set of materials produced by Virginia Tech will be adapted to local situations, translated into other languages, and extended to reflect local practices. We hope that tools and standards will be liberally applied to reduce

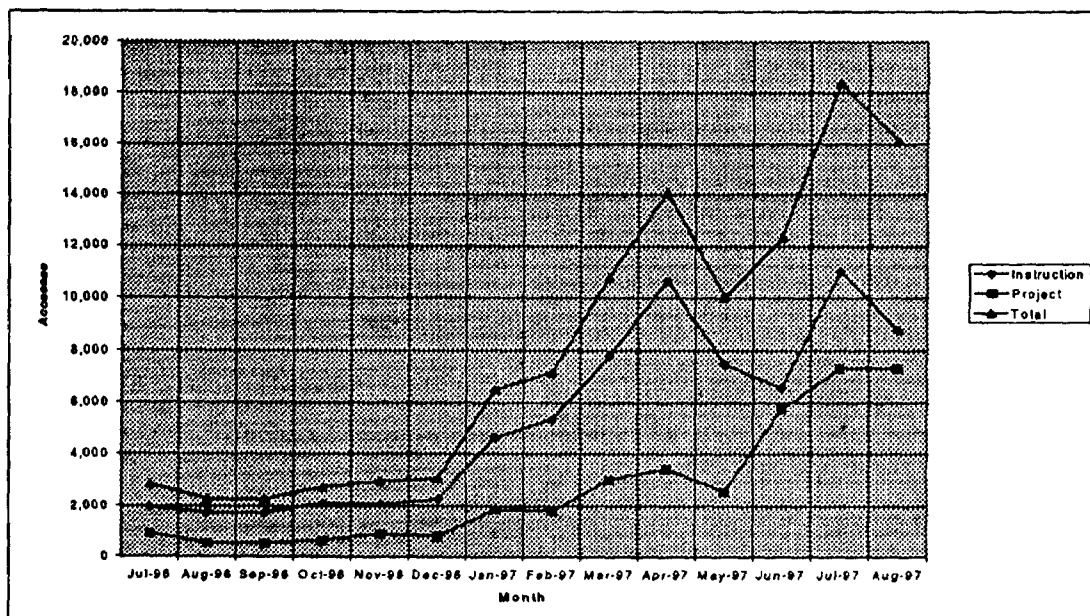


Figure 3(a) WWW Site Accesses

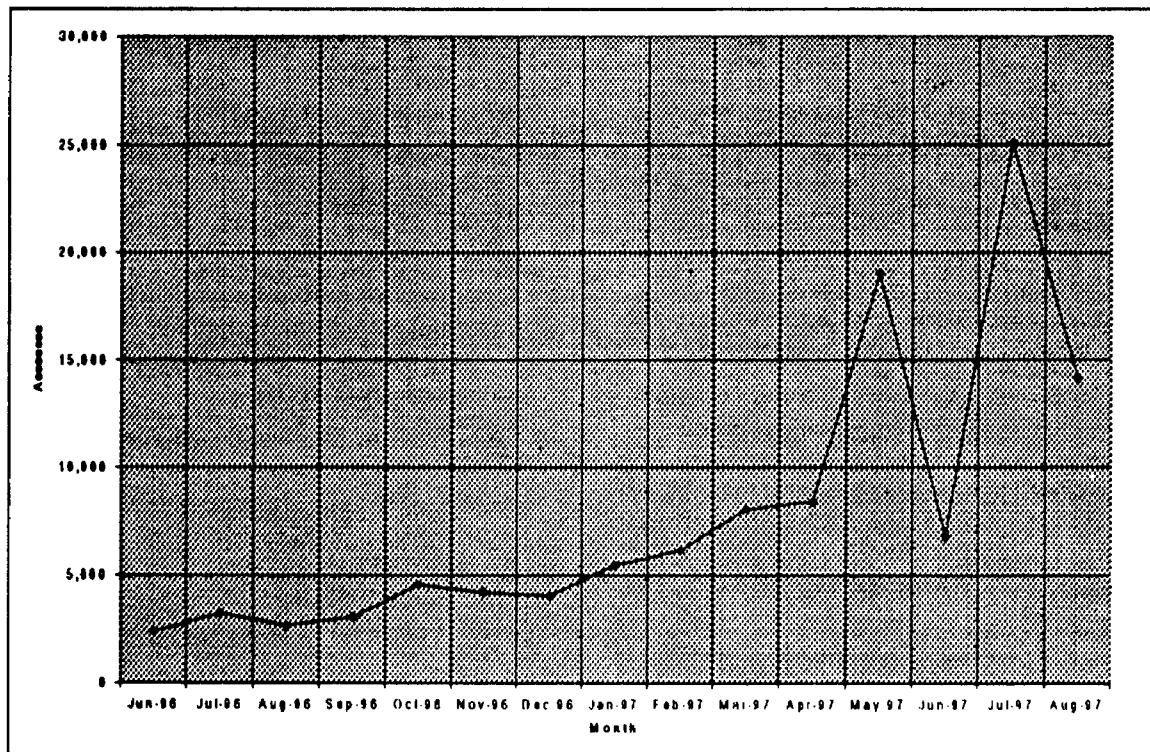


Figure 3(b) ETD Library Accesses

costs and ensure inter operability. At the same time, we hope that the full potential of electronic publishing will be realised, and that students will learn about publishing policies and practices (regarding copyright, intellectual property rights, and economic pressures) in the appropriate legal and cultural context.

Virginia Tech support for NDLTD is aimed to be enabling, not prescriptive. NDLTD is aimed to be open and comprehensive; we hope that people or institutions will not start separate groups but rather work together in a unified international collaboration among universities. Starting in 1998, we hope that a worldwide user group will emerge, communicating electronically to expand NDLTD, and meeting in groups for regional discussions. Ongoing innovations by students, faculty, staff, universities and others are needed to accommodate diverse needs, and to ensure a fitting balance between the needs of all parties involved.

6. CONCLUSIONS

Since ETDs were first publicly discussed in 1987 at a UMI-led workshop in Ann Arbor, Michigan, work has proceeded at Virginia Tech to expand this initiative to improve graduate education worldwide. Support by SURA and the U.S. Department of Education has extended membership around the United States and into a number of nations around the world. NDLTD can support international collaboration in the Academy, and requires international collaboration to expand. We hope that information professionals, universities, government agencies and others will aid with further growth and facilitate further collaboration.

7. REFERENCES

1. Borgman, Christine L, et al. Social Aspects of digital libraries. Final Report to the National Science Foundation; Computer, Information Science, and Engineering

- Directorate; Division of Information, Robotics, and Intelligent Systems; Information Technology and Organisations Program. Award number 95-28808.1996
<<http://www.gslis.ucla.edu/DL/>>
2. Borgman, Christine L. Multi-media, multi-cultural, and multi-lingual digital libraries: Or how do we exchange data in 400 languages?. *D-Lib Magazine*, June 1997.
<<http://www.dlib.org/dlib/june97/06borgman.html>>
 3. Fox, Edward A, Eaton, John L, and McMaillan, Gail. Improving graduate education with a national digital library of theses and dissertations. Proposal submitted to the United States Department of Education. 1996.
<<http://www.ndltd.org/support/fipse10.pdf>>
 4. Fox, Edward A, et al. National digital library of theses and dissertations: A scalable and sustainable approach to unlock university resources. *D-Lib Magazine*, September 1996.
<<http://www.dlib.org/dlib/september96/theses/09fox.html>>
 5. Fox, Edward A, et al. Networked digital library of theses and dissertations: An international effort unlocking university resources. *D-Lib Magazine*, September 1997.
<<http://www.dlib.org/dlib/september97/theses/09fox.html>>
 6. Handle system overview v3.0.
<<http://www.handle.net/overview.html>>
 7. Kipp, Neill A. SGML usability and DTD design. SGML '96 Conference Proceedings. Graphics Communications Association, Alexandria, VA. 1996. 419-29.
 8. Kipp, Neill A. Document type definition for electronic theses and dissertations. March 1997.
<<http://etd.vt.edu/etd-ml/dtdetds.html>>
 9. Kipp, Neill A. Button bars, sticky notes, hep cats, and ripple: Using hytime hyperlinking to make lasting intranet relationships. *SGML Newsletter*, May 1997.
 10. Kipp, Neill A. The hytime engine peer-peer protocol (hep): Hep cats jam java in the digital library. International HyTime Conference 1997, Montreal, Quebec, Canada. 1997.
<<http://etd.vt.edu/hep/h97talk.hep>>
 11. Kipp, Neill A. A scenario from the networked digital library of theses and dissertations: the life of an ETD from creation to dissemination. 1997.
<<http://www.ndltd.org/howto/etdlife.html>>
 12. Kirschenbaum, Matthew G. Electronic theses and dissertations in the humanities: A directory of on-line references and resources. 1997.
<<http://etext.lib.virginia.edu/ETD/ETD.html>>
 13. Weibel, Stuart, Jul, Erik and Shafer, Keith. PURLS: Persistent Uniform Resource Locators.
<<http://purl.oclc.org/OCLC/PURL/SUMMARY>>