UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

OXFORD NANOPORE TECHNOLOGIES, INC.
Petitioner

v.

PACIFIC BIOSCIENCES OF CALIFORNIA, INC.
Patent Owner

Case No. Unassigned
Patent 9,738,929

DECLARATION OF SYLVIA D. HALL-ELLIS, PH.D.

I. INTRODUCTION

1. My name is Sylvia D. Hall-Ellis. I have been retained as an expert by Oxford Nanopore Technologies, Inc. (Oxford).

2. I have written this report at the request of Oxford to provide my expert opinion regarding the authenticity and public availability of several publications. My report sets forth my opinions in detail and provides the basis for my opinions regarding the public availability of these publications.

3. I reserve the right to supplement or amend my opinions, and bases for them, in response to any additional evidence, testimony, discovery, argument, and/or other additional information that may be provided to me after the date of this report.

4. I am being compensated for my time spent working on this matter at my normal consulting rate of $300 per hour, plus reimbursement for any additional reasonable expenses. My compensation is not in any way tied to the content of this report, the substance of my opinions, or the outcome of this litigation. I have no other interests in this proceeding or with any of the parties.

5. All of the materials that I considered are discussed explicitly in this declaration.

II. QUALIFICATIONS

6. I am currently an Adjunct Professor in the School of Information at San José State University. I obtained a Masters of Library Science from the University of North Texas in 1972 and a Ph.D. in Library Science from the University of Pittsburgh in 1985. Over the last forty-five years, I have held various positions in the field of library and information resources. I was first employed as a librarian in 1966, and have been involved in the field of library sciences since, holding numerous positions.

7. I am a member of the American Library Association (ALA) and its Association for Library Collections & Technical Services (ALCTS) Division, and I served on the Committee on Cataloging: Resource and Description (which wrote the new cataloging rules) and as the chair of the Committee for Education and Training of Catalogers and the Competencies and Education for a Career in Cataloging Interest Group. I also served as the Chair of the ALCTS Division's Task Force on Competencies and Education for a Career in Cataloging. Additionally, I have served as the Chair for the ALA Office of Diversity's Committee on Diversity. Currently I serve as a member of the Editorial Board for the ALCTS premier cataloging journal, *Library Resources and Technical Services*.

8. I have also given over one hundred presentations in the field, including several on library cataloging systems and Machine-Readable Cataloging

("MARC") standards. My current research interests include library cataloging systems, metadata, and organization of electronic resources.

9. My full curriculum vitae is attached hereto as Exhibit D.

III. LIBRARY CATALOGING PRACTICES

10. I am fully familiar with the library cataloging standard known as the MARC standard, which is an industry-wide standard method of storing and organizing library catalog information.[1] MARC was first developed in the 1960's by the Library of Congress. A MARC-compatible library is one that has a catalog consisting of individual MARC records for each of its items. Today, MARC is the primary communications protocol for the transfer and storage of bibliographic metadata in libraries.[2]

11. A MARC record comprises several fields, each of which contains specific data about the work. Each field is identified by a standardized, unique, three-digit code corresponding to the type of data that follow. For example, a

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[1] The full text of the standard is available from the Library of Congress at http://www.loc.gov/marc/bibliographic/.

[2] Almost every major library in the world is MARC-compatible. *See, e.g.*, *MARC Frequently Asked Questions (FAQ)*, Library of Congress, https://www.loc.gov/marc/faq.html (last visited September 10, 2018) ("MARC is the acronym for Machine-Readable Cataloging. It defines a data format that emerged from a Library of Congress-led initiative that began nearly forty years ago. It provides the mechanism by which computers exchange, use, and interpret bibliographic information, and its data elements make up the foundation of most

work's title is recorded in Field 245, the primary author of the work is recorded in Field 100, an item's International Standard Book Number ("ISBN") is recorded in Field 020, an item's Library of Congress call number is recorded in Field 050, and the publication date is recorded in Field 260 under the subfield "c." If a work is a periodical, then its publication frequency is recorded in Field 310, and the publication dates (*e.g.*, the first and last publication) are recorded in Field 362, which is also referred to as the enumeration/chronology field.

12. The library that created the record is recorded in Field 040 in subfield "a" with a unique library code. When viewing the MARC record online via Online Computer Library Center's ("OCLC") Connexion database, hovering over this code with the mouse reveals the full name of the library. I used this method of "mousing over" the library codes in the OCLC database to identify the originating library for the MARC records discussed in this report. Where this "mouse over" option was not available, I consulted the Directory of OCLC Libraries in order to identify the institution that created the MARC record.[3]

13. MARC records also include several fields that include subject matter classification information. An overview of MARC record fields is available

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library catalogs used today."). MARC is the ANSI/NISO Z39.2-1994 (reaffirmed 2016) standard for Information Interchange Format.

[3] https://www.oclc.org/en/contacts/libraries.html.

through the Library of Congress at http://www.loc.gov/marc/bibliographic/. For example, 6XX fields are termed "Subject Access Fields." *See* http://www.loc.gov/marc/bibliographic/bd6xx.html. Among these, for example, is the 650 field; this is the "Subject Added Entry – Topical Term" field. *See* http://www.loc.gov/marc/bibliographic/bd650.html. The 650 field is a "[s]ubject added entry in which the entry element is a topical term." *Id.* These entries "are assigned to a bibliographic record to provide access according to generally accepted thesaurus-building rules (*e.g.*, *Library of Congress Subject Headings* (LCSH), *Medical Subject Headings* (MeSH))." *Id.* Further, MARC records include call numbers, which themselves include a classification number. For example, the 050 field is the "Library of Congress Call Number." *See* http://www.loc.gov/marc/bibliographic/bd050.html. A defined portion of the Library of Congress Call Number is the classification number, and "source of the classification number is *Library of Congress Classification* and the *LC Classification-Additions and Changes*." *Id.* Thus, included in the 050 field is a subject matter classification. Each item in a library has a single classification number. A library selects a classification scheme (*e.g.*, the Library of Congress Classification scheme just described or a similar scheme such as the Dewey Decimal Classification scheme) and uses it consistently. When the Library of Congress assigns the classification number, it appears as part of the 050 field. If a

local library assigns the classification number, it appears in a 090 field. In either scenario, the MARC record includes a classification number that represents a subject matter classification.

14. The OCLC was created "to establish, maintain and operate a computerized library network and to promote the evolution of library use, of libraries themselves, and of librarianship, and to provide processes and products for the benefit of library users and libraries, including such objectives as increasing availability of library resources to individual library patrons and reducing the rate of rise of library per-unit costs, all for the fundamental public purpose of furthering ease of access to, and use of, the ever-expanding body of worldwide scientific, literary and educational knowledge and information."[4] Among other services, OCLC and its members are responsible for maintaining the WorldCat database (http://www.worldcat.org/), used by independent and institutional libraries throughout the world.

15. OCLC also provides its members online access to MARC records through its OCLC Connexion database. When an OCLC member institution acquires a work, it creates a MARC record for this work in its computer catalog system in the ordinary course of its business. MARC records created at the Library

of Congress are tape-loaded into the OCLC database through a subscription to MARC Distribution Services daily or weekly. Once the MARC record is created by a cataloger at an OCLC member institution or is tape-loaded from the Library of Congress, the MARC record is then made available to any other OCLC members online, and therefore made available to the public. Accordingly, once the MARC record is created by a cataloger at an OCLC member institution or is tape-loaded from the Library of Congress or another library anywhere in the world, any publication corresponding to the MARC record has been cataloged and indexed according to its subject matter such that a person interested in that subject matter could, with reasonable diligence, locate and access the publication through any library with access to the OCLC Connexion database or through the Library of Congress.

16. When an OCLC member institution creates a new MARC record, OCLC automatically supplies the date of creation for that record. The date of creation for the MARC record appears in the fixed Field (008), characters 00 through 05. The MARC record creation date reflects the date on which, or shortly after which, the item was first acquired or cataloged. Initially, Field 005 of the MARC record is automatically populated with the date the MARC record was

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[4] Third Article, Amended Articles of Incorporation of OCLC Online Computer Library Center, Incorporated (available at

created in year, month, day format (YYYYMMDD) (some of the newer library catalog systems also include hour, minute, second (HHMMSS)). Thereafter, the library's computer system may automatically update the date in Field 005 every time the library updates the MARC record (*e.g.*, to reflect that an item has been moved to a different shelving location within the library). Field 005 is visible when viewing a MARC record via an appropriate computerized interface, but when a MARC record is printed to hardcopy, no "005" label appears. The initial Field 005 date (*i.e.*, the date the MARC record was created) does appear, however, next to the label "Entered."[5] The date upon which the most recent update to Field 005 occurred also appears, next to the label "Replaced." Thus, when an item's MARC record has been printed to hardcopy—as is the case with the exhibits to this report—the date reflected next to the label "Entered" is necessarily on or after the date the library first cataloged and indexed the underlying item.

17. Once one library has cataloged and indexed a publication by creating a MARC record for that publication, other libraries that receive the publication do not create additional MARC records—the other libraries instead rely on the original MARC record. They may update or revise the MARC record to ensure

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https://www.oclc.org/content/dam/oclc/membership/articles-of-incorporation.pdf).

[5] In this report, I sometimes refer to the "Entered" entry as Field 008, characters 00-05.

accuracy, but they do not replace or duplicate it. This practice does more than save libraries from duplicating labor. It also enhances the accuracy of MARC records. Further, it allows librarians around the world to know that a particular MARC record is authoritative (in contrast, a hypothetical system wherein duplicative records were created would result in confusion as to which record is authoritative).

18. The date of creation of the MARC record by a cataloger at an OCLC member institution reflects when the underlying item is accessible to the public. Upwards of two-thirds to three-quarters of book sales to libraries come from a jobber or wholesaler for online and print resources. These resellers make it their business to provide books to their customers as fast as possible, often providing turnaround times of only a single day after publication. Libraries purchase a significant portion of the balance of their books directly from publishers themselves, which provide delivery on a similarly expedited schedule. In general, libraries make these purchases throughout the year as the books are published and shelve the books as soon thereafter as possible in order to make the books available to their patrons. Thus, books are generally available at libraries across the country within just a few days of publication.

19. Catalogers can create MARC records for all types of print, online, and digital resources. For example, MARC records cover serial publications, including both serially-published monographs and journals. OCLC hosts MARC records for

more than 320 million serial publications. Serial publications are those publications that have the same collective title but are intended to be continued indefinitely with enumeration such as a volume or issue number (*e.g.*, magazines, journals, etc.). In the OCLC Connexion database, the first issue of the serial publication is typically cataloged (*i.e.*, a corresponding MARC record is created), but the date is left open-ended with the use of a punctuation mark such as a dash. OCLC serial publication MARC records represent the entire run of the serial title. With knowledge of the first issue published, future issues can be predicted based on the information provided in the MARC record, for example in Field 362. In my extensive professional experience, is it highly unusual for a library to stop collecting and shelving a serial publication prior to the end of its publication run. If a subscription to a serial publication ends its run or is cancelled before the end of its run, the library will denote that it has stopped receiving new volumes by filling in the end date in the MARC record.

20. The handling of printed journal subscriptions is shown on the covers of individual issues. As was the best practice among libraries, issues arrived at a central facility and were immediately received, verified as part of a subscription, checked in, and stamped with the institution's name and date. Determining that the issue was part of the library subscription ensured that the entire set of publications for the year had been received so that they could be professionally bound and

retained. This process also verified that all of the published issues arrived so that the library staff did not have to request or claim an issue that did not arrive as expected. In large public libraries with branches and multi-campus libraries within academic institutions, the journals were sorted and delivered to the subscribing unit. The issues were frequently stamped again to acknowledge receipt. The new issue was placed in the public area; the older issue was stored so that it remained available.

21. The foregoing process has been standard library practice longer than I have been working in the profession. I first learned the steps in the process in the late 1970s and later supervised it. Although the checking in process has become automated and now links electronically to holdings records for the MARC record for each serial title, the manual stamping and placing the issue in a public area has not changed for 50 years. Unless I note otherwise below in reference to a specific serial publication, it is my expert opinion that this standard protocol was followed for each of the serial publications discussed below.

22. In preparing this report, I used authoritative databases, such as the OCLC Connexion database and the Library of Congress Online Catalog, to confirm citation details of the various publications discussed. Unless I note otherwise below in reference to a specific serial publication, it is my expert opinion that this standard protocol was followed for each of the serial publications

discussed below.

23. *Indexing*. A researcher may discover material relevant to his or her topic in a variety of ways. One common means of discovery is to search for relevant information in an index of periodical and other publications. Having found relevant material, the researcher will then normally obtain it online, look for it in libraries, or purchase it from the publisher, a bookstore, a document delivery service, or other provider. Sometimes, the date of a document's public accessibility will involve both indexing and library date information. However, date information for indexing entries is often unavailable. This is especially true for online indices.

24. Indexing services use a wide variety of controlled vocabularies to provide subject access and other means of discovering the content of documents. The formats in which these access terms are presented vary from service to service.

25. Online indexing services commonly provide bibliographic information, abstracts, and full-text copies of the indexed publications, along with a list of the documents cited in the indexed publication. These services also often provide lists of publications that cite a given document. A citation of a document is evidence that the document was publicly available and in use by researchers no later than the publication date of the citing document.

IV. PRELIMINARIES

26. *Scope of this declaration.* I am not an attorney and will not offer opinions on the law. I am, however, rendering my expert opinion on the authenticity of the documents referenced herein and on when and how each of these documents was disseminated or otherwise made available to the extent that persons interested and ordinarily skilled in the subject matter or art, exercising reasonable diligence, could have located the documents before September 24, 2007.

27. I am informed by counsel that a printed publication qualifies as publicly accessible as of the date it was disseminated or otherwise made available such that a person interested in and ordinarily skilled in the relevant subject matter could locate it through the exercise of ordinary diligence.

28. While I understand that the determination of public accessibility under the foregoing standard rests on a case-by-case analysis of the facts particular to an individual publication, I also understand that a printed publication is rendered "publicly accessible" if it is cataloged and indexed by a library such that a person interested in the relevant subject matter could locate it (*i.e.*, I understand that cataloging and indexing by a library is sufficient, though there are other ways that a printed publication may qualify as publicly accessible). One manner of sufficient indexing is indexing according to subject matter category. I understand that the

cataloging and indexing by a single library of a single instance of a particular printed publication is sufficient, even if the single library is in a foreign country. I understand that, even if access to a library is restricted, a printed publication that has been cataloged and indexed therein is publicly accessible so long as a presumption is raised that the portion of the public concerned with the relevant subject matter would know of the printed publication. I also understand that the cataloging and indexing of information that would guide a person interested in the relevant subject matter to the printed publication, such as the cataloging and indexing of an abstract for the printed publication, is sufficient to render the printed publication publicly accessible.

29. I understand that routine business practices, such as general library cataloging and indexing practices, can be used to establish an approximate date on which a printed publication became publicly accessible.

30. *Persons of ordinary skill in the art*. I am told by counsel that the subject matter of this proceeding relates to nanopore sequencing.

31. I have been informed by counsel that a "person of ordinary skill in the art at the time of the inventions" is a hypothetical person who is presumed to be familiar with the relevant field and its literature at the time of the inventions. This hypothetical person is also a person of ordinary creativity, capable of understanding the scientific principles applicable to the pertinent field.

32. I am told by counsel that a person of ordinary skill in this subject matter or art would be someone with a Ph.D. or an equivalent amount of experience in molecular biology, genetics, biochemistry or a related field. I was also informed by counsel that the person of ordinary skill in the art would have experience in DNA sequencing techniques including Maxam-Gilbert and Sanger sequencing, as well as other techniques available on or before the priority date of the patent such as Applied Biosystems/Life Technologies, Solexa/Illumina, Helicos, and PacBio sequencing.

33. It is my opinion that such a person would have been engaged in research, learning though study and practice in the field and possibly through formal instruction the bibliographic resources relevant to his or her research. In the 2000s such a person would have had access to a vast array of long-established print resources in nucleic acid sequencing as well as to a rich set of online resources providing indexing information, abstracts, and full text services for nucleic acid sequencing.

V. Exhibit 1007 ("MINER")

34. Attached Exhibit A1 is a copy of Volume 32, Number 17 of the journal *Nucleic Acids Research* found in the National Library of Medicine. The article "Molecular Barcodes Detect Redundancy and Contamination in Hairpin-Bisulfite PCR" by Brooks E. Miner, Reinhard J. Stöger, Alice F. Burden, Charles

D. Laird, and R. Scott Hansen (hereafter "Miner") appears beginning on page e135 of this issue dated 2004. The document indicates a publication online September 30, 2004. The exhibit filed in this proceeding as Exhibit 1007 is a true and correct copy of the article of Exhibit A1 (pages e135, 1-4). I obtained this copy of the article from the National Library of Medicine which comprises Exhibit 1007. Specifically, the text of the article is complete; no pages are missing, and the text on each page appears to flow seamlessly from one page to the next; further, there are no visible alterations to the document. Exhibit 1007 was found within the custody of a library – a place where, if authentic, a copy of this journal would likely be. Exhibit 1007 is a true and correct copy in a condition that creates no suspicion about its authenticity.

35. The cover of the 2004 issue of the journal *Nucleic Acids Research* has a stamp affixed at the National Library of Medicine which shows that it was received, verified, and checked in on November 3, 2004. Therefore, this issue of the journal *Nucleic Acids Research* would have been available to users at the National Library of Medicine on that date.

36. Attached hereto as Exhibit A2 is a true and correct copy of the MARC record for the journal *Nucleic Acids Research* at the National Library of Medicine. The library ownership is indicated by the presence of the library's code (DNLM) in the 040 field. I personally identified and retrieved the MARC record that is

Exhibit A2. The library continues to update this MARC record and enhanced the MARC record to meet current cataloging rules.

37. Based on finding a print copy of Exhibit A1 in the National Library of Medicine and MARC record in its online library catalog attached as Exhibit A2, it is my opinion that the article "Molecular Barcodes Detect Redundancy and Contamination in Hairpin-Bisulfite PCR" by Miner et. al. published in the journal *Nucleic Acids Research* was available at the National Library of Medicine on November 3, 2004.

38. As noted in the holdings information, the National Library of Medicine has received the journal *Nucleic Acids Research* since January 1974 and continues to receive the publication. In view of the MARC record for Exhibit 1007, the Miner article was publicly available no later than November 3, 2004, because the serial title had been received, cataloged, and indexed at the National Library of Medicine and made part of its online catalog database.

39. Attached hereto as Exhibit A3 is a true and correct copy of the MARC record for the journal *Nucleic Acids Research* obtained from the OCLC Connexion database. I personally identified and retrieved the MARC record that is Exhibit A3. As previously noted, the library that created the record is recorded in field 040 with a unique library code. For Exhibit A3, that library code is "DLC," which means that the MARC record for this serial was cataloged at the Library of

Congress. As can be seen in the "Entered" field in the MARC record for this exhibit, a cataloger at the Library of Congress created OCLC record number 1791693 on October 15, 1974. The "BLvl" entry in Exhibit A3 is "s," which indicates that the journal *Nucleic Acids Research* is a serial publication. Field 310 of Attachment 1b reads "Semimonthly, May 1979-." The Field 321 entry of Attachment 1b indicates that the frequency was monthly (Jan. 1974-Apr. 1979). Accordingly, the MARC record for Exhibit 1007 corresponds to those issues of the journal *Nucleic Acids Research* from the time of the serial title began publication in January 1974 to the present day. The library continues to update this MARC record and enhanced the MARC record to meet current cataloging rules.

40. Exhibit A3 further includes an entry in field 050 ("QP620 ‡b .N8")—as described above, this includes a subject matter classification number consistent with the Library of Congress classification system (analogous to the Dewey Decimal System). Exhibit A3 further includes an entry in field 082 ("574.8/732"), a subject matter consistent with the Dewey Decimal System. Exhibit A3 further includes an English language field 650 entry reading "Nucleic acids ‡v Periodicals." Thus, as of its cataloging, the publication corresponding to the MARC record attached hereto as Exhibit A3 was indexed according to its subject matter by virtue of at least three independently sufficient classifications: the field 050 entry, the field 082 entry, and the field 650 entry. Further, as of October 15,

1974, the MARC record attached hereto as Exhibit A3 was accessible through any library with access to the OCLC Connexion database or the online catalog at a library that subscribed to the serial, which means that the corresponding publication was publicly available on or before that same date through any library with access to the OCLC Connexion database or through an individual library.

41. Exhibit A3 indicates that the journal *Nucleic Acids Research* as cataloged at the Library of Congress is currently available from 528 libraries. In view of the above, this issue of the journal *Nucleic Acids Research* was publicly available no later than November 3, 2004, because by that date it had been cataloged and indexed at the Library of Congress, made part of the OCLC Connexion database, and received at the National Library of Medicine. For these reasons, it is my opinion that Exhibit 1007 was published and accessible to the public no later than November 3, 2004.

VI. EXHIBIT 1008 ("O'DEA")

42. Exhibit B1 is a copy of Section 5.3 of Volume 2 of the *Current Protocols in Nucleic Acid Chemistry* found in the Ebling Library for the Health Sciences at the University of Wisconsin – Madison. The section "Engineering Specific Cross-Links in Nucleic Acids Using Glycol Linkers" by Timothy O'Dea and Larry W. McLaughlin (hereafter "O'Dea") appears beginning on page 5.3.1. The exhibit filed in this proceeding as Exhibit 1008 is a true and correct copy of

the article of Exhibit B1 (pages e135, 1-4). I obtained this copy of the section from the Ebling Library for the Health Sciences at the University of Wisconsin – Madison which comprises Exhibit 1008. Specifically, the text is complete; no pages are missing, and the text on each page appears to flow seamlessly from one page to the next; further, there are no visible alterations to the document. Exhibit 1008 was found within the custody of a library – a place where, if authentic, a copy of this journal would likely be. Exhibit 1008 is a true and correct copy in a condition that creates no suspicion about its authenticity.

43. Attached hereto as Exhibit B2 is a true and correct copy of the MARC record for the *Current Protocols in Nucleic Acid Chemistry* at the Ebling Library for the Health Sciences at the University of Wisconsin – Madison. The library ownership is indicated by the presence of the library's code (UW) in the second 035 field. I personally identified and retrieved the MARC record that is Exhibit B2.

44. Based on finding a print copy of Exhibit B1 in the Ebling Library for the Health Sciences at the University of Wisconsin – Madison and MARC record in its online library catalog attached as Exhibit B2, it is my opinion that the *Current Protocols in Nucleic Acid Chemistry* by O'Dea, *et. al.* was available at the Ebling Library for the Health Sciences at the University of Wisconsin – Madison on April 14, 1999. This Exhibit has a print date of 2000 and is included in the

compilations of the *Current Protocols in Nucleic Acid Chemistry*. The library continues to update this MARC record and enhanced the MARC record to meet current cataloging rules.

45. Attached hereto as Exhibit B2 is a true and correct copy of the MARC record for the *Current Protocols in Nucleic Acid Chemistry* obtained from the OCLC Connexion database. I personally identified and retrieved the MARC record that is Exhibit B2. As previously noted, the library that created the record is recorded in field 040 with a unique library code. For Exhibit B2, that library code is "DLC," which means that the MARC record for this loose-leaf book was cataloged at the Library of Congress. As can be seen in the "Entered" field in the MARC record for this exhibit, a cataloger at the Library of Congress created OCLC record number 41380325 on April 14, 1999. The library continues to update this MARC record and enhanced the MARC record to meet current cataloging rules.

46. Exhibit B3 further includes an entry in field 050 ("QP620 ‡b .C87 2000")—as described above, this includes a subject matter classification number consistent with the Library of Congress classification system (analogous to the Dewey Decimal System). Exhibit B3 further includes an entry in field 082 ("572.8"), a subject matter consistent with the Dewey Decimal System. Exhibit B3 further includes an English language field 650 entry reading "Nucleic acids ‡v

Laboratory manuals." Thus, as of its cataloging, the publication corresponding to the MARC record attached hereto as Exhibit B3 was indexed according to its subject matter by virtue of at least three independently sufficient classifications: the field 050 entry, the field 082 entry, and the field 650 entry. Further, as of April 14, 1999, the MARC record attached hereto as Exhibit B3 was accessible through any library with access to the OCLC Connexion database or the online catalog at a library that purchased this book, which means that the corresponding publication was publicly available on or before that same date through any library with access to the OCLC Connexion database or through an individual library.

47. Exhibit B3 indicates that the *Current Protocols in Nucleic Acid Chemistry* as cataloged at the Library of Congress is currently available from 24 libraries. In view of the above, this issue of the *Current Protocols in Nucleic Acid Chemistry* was publicly available no later than April 14, 1999, because by that date it had been cataloged and indexed at the Library of Congress, made part of the OCLC Connexion database, and received at the Ebling Library for the Health Sciences at the University of Wisconsin – Madison. For these reasons, it is my opinion that Exhibit 1008 was published and accessible to the public no later than April 14, 1999.

VII. EXHIBIT 1012 ("SANGER")

48. Attached Exhibit C1 is a copy of Volume 214, Number 4526 of the

journal *Science* found in the Geology & Geophysics Library at the University of Wisconsin – Madison. The article "Determination of Nucleotide Sequences in DNA" by Frederick Sanger (hereafter "Sanger") appears beginning on page 1205 of this issue dated December 11, 1981. The exhibit filed in this proceeding as Exhibit 1012 is a true and correct copy of the article of Exhibit C1 (pages 1205-1210). I obtained this copy of the article from the Geology & Geophysics Library at the University of Wisconsin – Madison which comprises Exhibit 1012. Specifically, the text of the article is complete; no pages are missing, and the text on each page appears to flow seamlessly from one page to the next; further, there are no visible alterations to the document. Exhibit 1012 was found within the custody of a library – a place where, if authentic, a copy of this journal would likely be. Exhibit 1012 is a true and correct copy in a condition that creates no suspicion about its authenticity.

49. The cover of the December 11, 1981 issue of the journal *Science* has a stamp affixed at the Geology & Geophysics Library at the University of Wisconsin – Madison which shows that it was received, verified, and checked in on December 4, 1981. Therefore, this issue of the journal *Science* would have been available to users at the Geology & Geophysics Library at the University of Wisconsin – Madison on that date.

50. Attached hereto as Exhibit C2 is a true and correct copy of the MARC

record for the journal *Science* at the Geology & Geophysics Library at the University of Wisconsin – Madison. The library ownership is indicated by the presence of the library's code (UW) in the second 035 field. I personally identified and retrieved the MARC record that is Exhibit C2. The library continues to update this MARC record and enhanced the MARC record to meet current cataloging rules.

51. Based on finding a print copy of Exhibit C1 in the Geology & Geophysics Library at the University of Wisconsin – Madison and MARC record in its online library catalog attached as Exhibit C2, it is my opinion that the article ""Determination of Nucleotide Sequences in DNA" by Sanger published in the journal *Science* was available at the Geology & Geophysics Library at the University of Wisconsin – Madison on December 4, 1981.

52. As noted in the holdings information, the Geology & Geophysics Library at the University of Wisconsin – Madison has received the journal *Science* since July 1880 and continues to receive the publication. In view of the MARC record for Exhibit 1012, the Sanger article was publicly available no later than December 4, 1981, because the serial title had been received, cataloged, and indexed at the Geology & Geophysics Library at the University of Wisconsin – Madison and made part of its online catalog database.

53. Attached hereto as Exhibit C3 is a true and correct copy of the MARC

record for the journal *Science* obtained from the OCLC Connexion database. I personally identified and retrieved the MARC record that is Exhibit C3. As previously noted, the library that created the record is recorded in field 040 with a unique library code. For Exhibit C3, that library code is "MUL," which means that the MARC record for this serial was cataloged as part of the Minnesota Union List of Serials at the University of Minnesota Library. As can be seen in the "Entered" field in the MARC record for this exhibit, a cataloger at the University of Minnesota Library created OCLC record number 1644869 on September 21, 1975. The "BLvl" entry in Exhibit C3 is "s," which indicates that the journal *Science* is a serial publication. Field 310 of Attachment 3b reads "Weekly except last week in Dec." Accordingly, the MARC record for Exhibit 1012 corresponds to those issues of the journal *Science* from the time of the serial title began publication in July 1880 to the present day. The library continues to update this MARC record and enhanced the MARC record to meet current cataloging rules.

54. Attachment 3b further includes an entry in field 050 ("Q1 ‡b .S35")—as described above, this includes a subject matter classification number consistent with the Library of Congress classification system (analogous to the Dewey Decimal System). Exhibit C3 further includes an entry in field 082 ("505"), a subject matter consistent with the Dewey Decimal System. Exhibit C3 further includes an English language field 650 entry reading "Science ‡v Periodicals."

Thus, as of its cataloging, the publication corresponding to the MARC record attached hereto as Exhibit C3 was indexed according to its subject matter by virtue of at least three independently sufficient classifications: the field 050 entry, the field 082 entry, and the field 650 entry. Further, as of September 21, 1975, the MARC record attached hereto as Exhibit C3 was accessible through any library with access to the OCLC Connexion database or the online catalog at a library that subscribed to the serial, which means that the corresponding publication was publicly available on or before that same date through any library with access to the OCLC Connexion database or through an individual library.

55. Exhibit C3 indicates that the journal *Science* as cataloged at the University of Minnesota Library is currently available from 4,148 libraries. In view of the above, this issue of the journal *Science* was publicly available no later than December 4, 1981, because by that date it had been cataloged and indexed at the University of Minnesota Library, made part of the OCLC Connexion database, and received at the Geology & Geophysics Library at the University of Wisconsin – Madison. For these reasons, it is my opinion that Exhibit 1012 was published and accessible to the public no later than December 4, 1981.

VIII. SUMMARY OF OPINIONS

56. In view of the foregoing, it is my opinion that the publications described above were publicly available no later than the corresponding date listed

in the table below:

Exhibit	Publication	Publicly Available No Later Than
1007	Miner, Brooks E., Reinhard J. Stöger, Alice F. Burden, Charles D. Laird, and R. Scott Hansen. "Molecular Barcodes Detect Redundancy and Contamination in Hairpin-Bisulfite PCR." *Nucleic Acids Research*, vol. 32, no. 17 (2004): e135.	November 3, 2004
1008	O'Dea, Timothy, and Larry W. McLaughlin. Unit 5.3, "Engineering Specific Cross-Links in Nucleic Acids Using Glycol Linkers." *Current Protocols in Nucleic Acid Chemistry*, vol. 2. Looseleaf. New York: Wiley, c2000-2009.	April 14, 1999
1012	Sanger, Frederick. "Determination of Nucleotide Sequences in DNA." *Science*, vol. 214, issue 4526 (11 December 1981): 1205-1210.	December 4, 1981

57. In signing this Declaration, I recognize that the Declaration will be filed as evidence in a case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

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DATED: September 21, 2018 By: Sylvia D. Hall-Ellis
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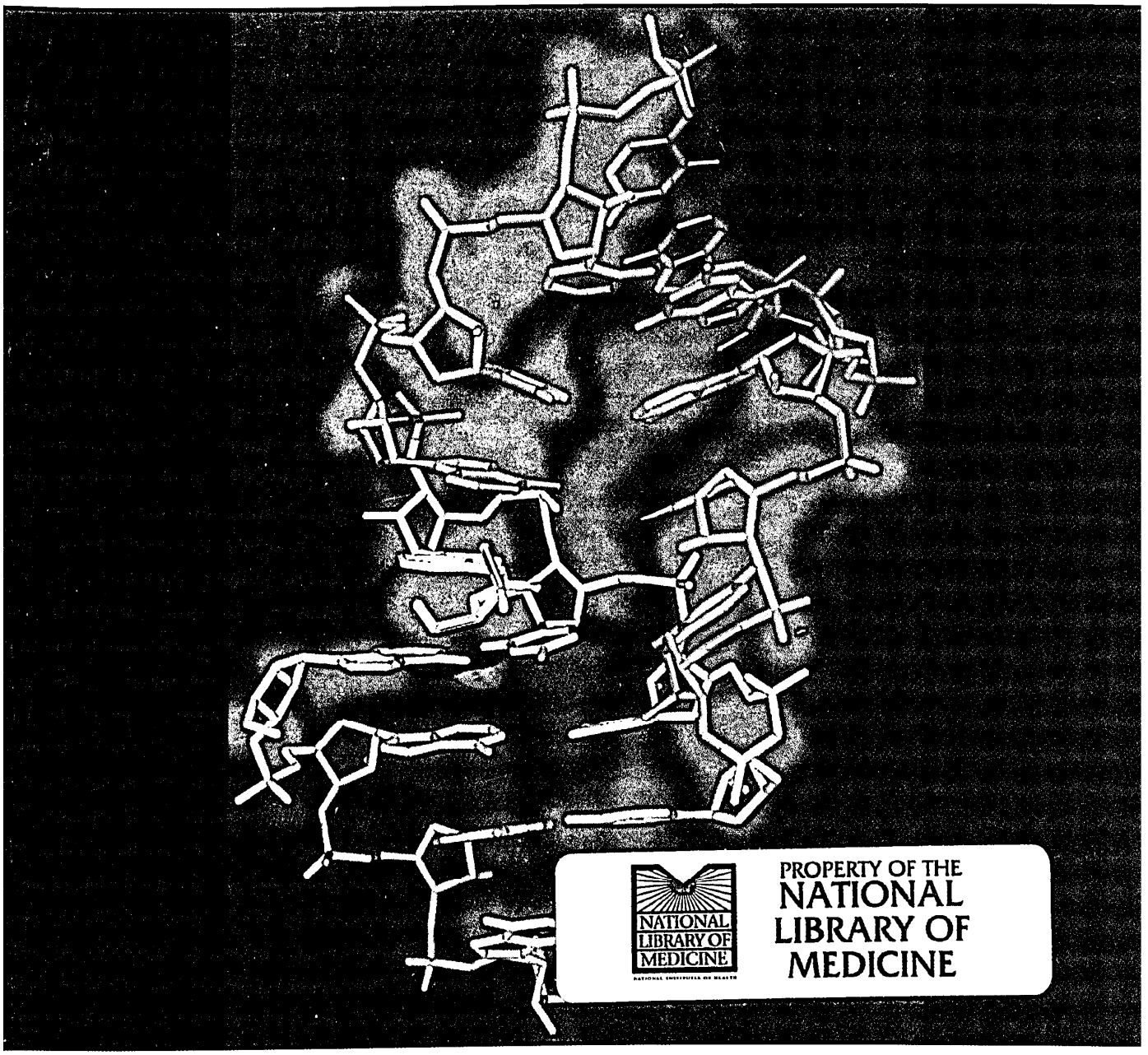

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US Postmaster: send address changes to *Nucleic Acids Research* (ISSN 0305-1048), c/o Mercury International, 365 Blair Road, Avenel, NJ 07001, USA.

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Cover: Modification-dependent tRNA binding to cognate codon on the 30S ribosomal subunit at 3 Å resolution. The position 37 modified nucleoside N6-threnonylcarbamoyl (red) adenosine (yellow) acts as a platform for the anticodon stem and loop domain of human tRNALys3 (gray) to bind cognate codon (blue). Anticodon U34 (aqua), U35 (green) and U36 (tan) are bound to codon AAA (blue). [Murphy,F., Malkiewicz,A., Agris,P.F. and Ramakrishnan,V., unpublished]. For further details see the paper by Agris in this volume [*Nucleic Acids Res.* (2004) **32**, 223–238].

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Contents (Continued)

M, contains a novel method

S, Supplementary Material available at NAR Online

Published online September 30, 2004

Nucleic Acids Research, 2004, Vol. 32, No. 17 ***e135***
doi:10.1093/nar/gnh132

Molecular barcodes detect redundancy and contamination in hairpin-bisulfite PCR

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Received August 12, 2004; Revised and Accepted September 11, 2004

ABSTRACT

PCR amplification of limited amounts of DNA template carries an increased risk of product redundancy and contamination. We use molecular barcoding to label each genomic DNA template with an individual sequence tag prior to PCR amplification. In addition, we include molecular 'batch-stamps' that effectively label each genomic template with a sample ID and analysis date. This highly sensitive method identifies redundant and contaminant sequences and serves as a reliable method for positive identification of desired sequences; we can therefore capture accurately the genomic template diversity in the sample analyzed. Although our application described here involves the use of hairpin-bisulfite PCR for amplification of double-stranded DNA, the method can readily be adapted to single-strand PCR. Useful applications will include analyses of limited template DNA for biomedical, ancient DNA and forensic purposes.

INTRODUCTION

The polymerase chain reaction (PCR) allows multiple copies of selected DNA sequences to be copied from limited amounts of DNA template (1). Reactions with limited template, however, increase the risk of amplifying contaminant DNA and can also result in a skewed yield of PCR products such that there is a high degree of redundancy for a small portion of the original genomic sequences (2). Redundancy can either be useful, e.g. in tracking mutations arising during the PCR amplification of individual molecules, or unwelcome, for example, when the goal is to compare and quantify sequences from different cells represented in the same DNA sample, as in bisulfite methylation analysis (3). The frequent observation of multiple amplified sequences derived from a single original molecule was also noted by Millar *et al*. (4) in the context of bisulfite genomic sequencing, a method increasingly used in epigenetic research.

In response to the challenges of PCR redundancy and contamination associated with PCR amplification of limited amounts of DNA template, we have labeled genomic DNA fragments with molecular sequence barcodes and 'batch-stamps' prior to PCR amplification. This was accomplished by including these molecular labels in the hairpin linker sequence that we use in hairpin-bisulfite PCR (5). This encoded information enables us to track the genomic origin of each sequence obtained from PCR and subsequent bacterial cloning. Each genomic fragment is marked prior to amplification, allowing us to identify contaminant and redundant sequences and to quantify accurately the proportion of cells carrying a particular sequence variant by counting only distinctly tagged sequences. This highly sensitive method offers confirmation of the independent genomic origin of all sequences in final data sets derived from PCR amplification.

MATERIALS AND METHODS

Conditions for hairpin-bisulfite PCR of human genomic *FMR1* sequences (5) were as follows: 5 μg of genomic DNA was cleaved by 10 U each of restriction endonucleases DraIII and AluI for 1 h at 37°C, followed by enzyme inactivation at 65°C for 20 min. The use of a second restriction endonuclease, in this case AluI, removed the CG-rich sequence distal to the region analyzed. Ligation of the hairpin linker (5′P-AGC-GATGCDDDDDDDGCATCGCT-TGA, with variations in the non-random nucleotides for batch-stamps) to DraIII-cleaved genomic DNA was for 15 min at 20°C, using 400 U of T4 ligase in 20 μl with 1× ligation buffer (New England Biolabs), followed by enzyme inactivation at 65°C for 20 min.

The bisulfite conversion followed the protocol of Laird *et al*. (5) with additional thermal denaturation steps. Hairpin-ligated DNA was denatured in 0.3 M NaOH for 20 min, then heated to 100°C for 1 min before addition of sodium bisulfite and hydroquinone to 3.4 M and 1 mM, respectively. The reaction mixture was incubated for 6 h at 55°C, with additional thermal denaturation steps (99°C for 90 s, 10 times over the 6 h), and then incubated for an additional 6 h at 55°C. This was followed by a purification step using QIAquick PCR purification columns (Qiagen), subsequent treament with NaOH (final concentration 0.3 M) at 37°C for 20 min, and another purification using Microspin S-200 HR columns (Amersham Pharmacia Biosciences). PCR conditions were Hotstar Master Mix

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(Qiagen), with denaturation at 95°C for 15 min, followed by 38 cycles of denaturing at 95°C for 30 s, annealing at 58°C for 30 s, and extension at 72°C for 45 s; this was followed by a final extension at 72°C for 5 min. Primers used were (i) first primer, 5′-CCTCTCTCTTCAAATAACCTAAAA-AC-3′ and (ii) second primer, 5′-GTTGYGGGTGTAAA-TATTGAAATTA-3′.

All PCR products were analyzed by agarose gel electrophoresis; further cloning and sequencing of appropriately sized products was with TOPO TA Cloning Kits (Invitrogen Life Technologies); sequencing reactions were carried out with fluorescent dideoxy nucleotides (BIGDYE Terminator 3.1, Applied Biosystems), at either the DNA Sequencing Facility, Department of Biochemistry, or the Comparative Genomics Center, Department of Biology, University of Washington. Each sequence was proofread against the sequence trace; errant base calling was corrected manually before being presented here. For purposes of analysis and presentation, the output sequence was folded, using word-processing software, into a hairpin conformation so that both strands aligned.

RESULTS

The challenge of amplifying limited amounts of DNA template can result from trace amounts of initial DNA sample, or from laboratory analyses that include substantial DNA degradation as a necessary side effect of processing, as in bisulfite genomic sequencing (6). One of the major problems encountered in these analyses is to capture accurately the genomic template diversity following the steps of PCR and bacterial cloning. Hairpin-bisulfite PCR involves the ligation of a synthetic hairpin linker to the ends of a double-stranded genomic DNA fragment prior to bisulfite conversion and PCR amplification (5). While the primary purpose of the hairpin linker is to maintain attachment of complementary strands, it can also be used to encode each ligated genomic fragment with information that distinguishes it from other sequences within a sample, allowing us to evaluate cloned sequences for redundancy and contamination. To accomplish this, we replaced the 6 nt loop of our hairpin linker (5) with 7 nt randomly selected from A, G and T. Cytosine was not used because its identity would be ambiguous after bisulfite conversion. With a random 7 nt barcode, the number of possible codes is 2187; in selecting 15 cloned PCR products from one DNA sample, the probability that two of these will be different genomic fragments labeled with identical 7 nt barcodes is 0.047 (see Supplementary Material). Some applications will require a larger pool of random-sequence barcodes if more independently derived sequences are required. We have used linkers with up to 13 nt in the hairpin loop with no observable detriments to sequence recovery. A 13 nt barcode gives $\sim 1.6 \times 10^6$ different codes; even for a selection of 100 cloned PCR products, the probability that two of these would be different genomic fragments labeled with identical barcodes is only 0.0031 (see Supplementary Material).

In addition to adding the random barcode, we 'batch-stamped' molecules by encoding the hairpin linker with information that would designate the sample analyzed and the date of analysis. We designed multiple variants of the hairpin linker by changing nucleotides in the stem of the linker. These stem changes represented different batches of linkers, each of which we used for the analysis of a different sample. Thus, the resulting sequences each bear a consistent 'batch-stamp' encoded in the stem, and a randomly variable barcode encoded in the loop (Figure 1).

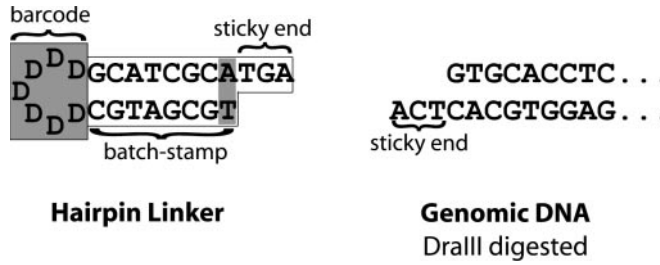

Figure 1. Schematic of barcoded and batch-stamped hairpin linker, designed for ligation to DraIII-cut genomic DNA of *FMR1*. The letter D represents a nucleotide randomly selected from A, G and T.

We applied our enhanced hairpin-bisulfite PCR method to the *FMR1* promoter region in the DNA of males with fragile X syndrome. The classes of sequences recovered included hypermethylated sequences with distinctive barcodes and patterns of methylation (Figure 2a), redundant hypermethylated sequences with identical barcodes and methylation patterns (Figure 2b–c), hypomethylated sequences with distinctive barcodes (Figure 2d), redundant hypomethylated sequences with identical barcodes (Figure 2e–f), and contaminant sequences with our original linker that predates the barcoding (Figure 2g). The number of sequences cloned influenced the observed proportion of redundancy among the recovered sequences; the observed proportions of both redundancy and contamination appeared to depend on the initial amount of DNA used and the quality of the bisulfite conversion. Among eight different DNA samples analyzed, the proportion of sequences that were redundant ranged from 7 to 51%, and the proportion of sequences that were contaminants ranged from 0 to 14%. Occasionally, contaminant sequences were cloned from PCR reactions in which control reactions (those without template DNA) showed no DNA bands on ethidium–bromide-stained agarose gels. In these contexts, barcoding serves as a highly accurate method for positive identification of desired sequences.

Within 142 barcodes recovered from multiple reactions with *FMR1*, the average nucleotide composition was 54% T, 26% G and 19% A. This bias is similar to that previously reported for the influence of loop nucleotides on the stability of DNA hairpin structures (7).

DISCUSSION

The concept of molecular barcoding has previously been used in signature-tagged mutagenesis (8,9), to track the origins of expressed sequence tags (10), and to label objects for identification and authentication (11,12). Here, we apply this concept to the labeling of individual genomic fragments with distinct sequence tags. The ability to barcode and 'batch-stamp' genomic DNA sequences from individual alleles is useful in situations where template DNA is limited, thus

Figure 2. FMR1 promoter sequences, with inferred methylation states of CpG sites, recovered from male fragile X patients using hairpin-bisulfite PCR with linker barcoding and batch-stamping. Methods are as described in the text. Unconverted (methylated) CpG dyads are black, and converted (unmethylated) CpG dyads are boxed. Within the 26 nt linker (boxed region at left), the randomized 7 nt variable barcodes are shaded at far left; the designated variable batch-stamps (A:T or T:A) are shaded at right. All sequences show 100% conversion of non-CpG cytosines. (**a**) A distinctive hypermethylated sequence. (**b** and **c**) Redundant hypermethylated sequences recovered from independent bacterial colonies, with identical barcodes and methylation patterns. (**d**) A hypomethylated sequence with a distinctive barcode. (**e** and **f**) Redundant hypomethylated sequences with identical barcodes recovered from independent bacterial colonies. These are distinguishable as redundant and as different from the hypomethylated sequence 'd' only because of barcoding. (**g**) A contaminant sequence bearing our original hairpin linker that predates the addition of the barcode and batch-stamp. This sequence was recovered during analysis of the same sample that generated sequences 'a–c'. Sequences 'a–c' carry a different batch-stamp than sequences 'd–f', with the inversion of the A–T base pair, confirming that these sequence sets came from different DNA samples. Redundant hypermethylated sequences are denoted with asterisks (*), and redundant hypomethylated sequences with plus signs (+).

identifying contaminants and redundant sequences arising from template re-cloning. We have identified contaminant sequences even when multiple control (no DNA) PCR samples were negative. Barcoding allows for quantification of the relative abundance of genomic methylation patterns or polymorphic sequences by correcting for skewing that can arise from PCR amplification or the cloning of the products. The barcoding method thus provides a definitive solution to the problem identified by both Taylor *et al*. (2) and Millar *et al*. (4), in which multiple amplified sequences are derived from a single original molecule when template DNA is limited or of poor quality. The method also allows for the analysis of mutations arising during PCR amplification. Although our application described here involves the use of hairpin-bisulfite PCR for amplification of double-stranded DNA, the method can readily be adapted to single-strand PCR. Useful applications will include analyses of limited template DNA for biomedical, ancient DNA and forensic purposes.

SUPPLEMENTARY MATERIAL

Supplementary Material is available at NAR Online.

ACKNOWLEDGEMENTS

We thank Stanley Gartler, Diane Genereux and Carl Bergstrom for helpful discussions and suggestions. Support was provided by National Institutes of Health Grants GM 53805, HD 02274 and HD 16659.

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EXHIBIT B1

CURRENT PROTOCOLS

IN NUCLEIC ACID CHEMISTRY

VOLUME 2

EDITED BY

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CURRENT PROTOCOLS IN NUCLEIC ACID CHEMISTRY

VOLUME 2

John Wiley & Sons, Inc.

Library of Congress Cataloging in Publication Data:

Current protocols in nucleic acid chemistry / editorial board, Serge L. Beaucage ... [et al.].

p. cm.

Includes bibliographical references and index.

ISBN 0-471-24662-X (loose-leaf : alk. paper)

1. Nucleic acids—Laboratory manuals. I. Beaucage, Serge L.

QP620.C87 1999

572.8—dc21 99-15481

CIP

Printed in the United States of America

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METHODS FOR CROSS-LINKING NUCLEIC ACIDS

5

continued

Engineering Specific Cross-Links in Nucleic Acids Using Glycol Linkers

Simple glycol linkers can be used to cross-link nucleic acid sequences. In the most straightforward approach, such cross-links can be used in place of nucleotide sequences to bridge two domains of higher-order nucleic acid structures. Such linkers can also be viewed as tethers between two independently hybridizing nucleic acid sequences, or between a nucleic acid and some other ligand or reporter group. Although most any carbon chain can be employed to introduce cross-links in nucleic acids, the hydrophilic nature of the ethylene glycol chain gives it one particular advantage. Whereas simple carbon chains may tend to collapse on themselves as the result of the hydrophobic effect, the glycol chains' alternating ethyl and oxygen ether subunits are more likely to be hydrated in aqueous solutions and thus maintain a more extended conformation, which permits them to easily bridge two different sites within the macromolecule. Additionally, a variety of ethylene glycol–based linkers are readily available (Fig. 5.3.1) and only require simple protection reactions in order to be used as cross-linking agents.

Oligo(ethylene glycol) linkers have been used most commonly to replace a portion (Williams and Hall, 1996) or the entirety of the loop structure at the end of DNA (Durand et al., 1990; Altmann et al., 1995) or RNA helices (Benseler et al., 1993; Ma et al., 1993; Thomson et al., 1993; Fu et al., 1994; Hendry et al., 1994; Komatsu et al., 1996), essentially to achieve cross-linking of the terminal residues of the double-stranded helix. However, in some cases ethylene glycol linkers have been used to tether different strands of nucleic acids (Cload and Schepartz, 1991; Amaratunga and Lohman, 1993; Moses and Schepartz, 1996) or even to tether minor groove-binding ligands to the nucleic acid (Robles et al., 1996; Rajur et al., 1997; Robles and McLaughlin, 1997). In most cases, the glycol linker is incorporated as part of the nucleic acid backbone, such that at each terminus the linker is incorporated into a phosphodiester linkage that also incorporates either the 3′ or 5′ hydroxyl of the adjacent nucleoside residue. It is also possible to incorporate more than a single linker at the same site. Thus, two residues of tri(ethylene glycol) could be used instead of hexa(ethylene glycol) (Benseler et al., 1993; Fu et al., 1994)—in the former case a negatively charged phosphodiester would bridge the two linkers. This approach can be used to generate structures with varying linker lengths via the preparation of only a single linker building block.

In the most common protocol, the linker is protected at one terminus as the 4,4′-dimethoxytrityl derivative (see Basic Protocol 1), and is converted to a phosphoramidite at the second terminus (see Basic Protocol 2). With such derivatives, the linker is simply incorporated into the DNA or RNA sequence by the same procedures as are used for common nucleoside phosphoramidites (see Basic Protocol 3). Preparation of the pro-

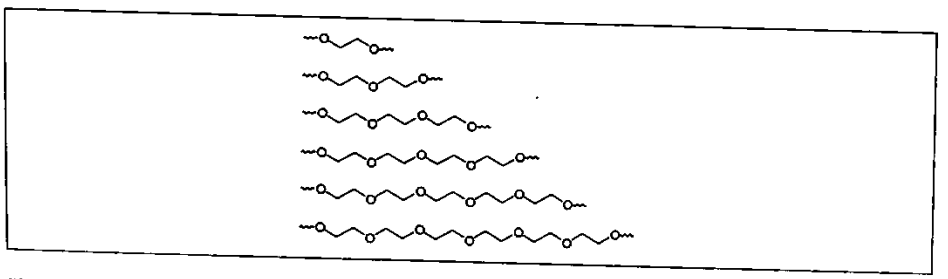

Figure 5.3.1 Varying lengths for readily available ethylene glycol–based linkers.

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Current Protocols in Nucleic Acid Chemistry (2000) 5.3.1-5.3.8

tected linker-phosphoramidites follows a common procedure regardless of length; protocols for the hexa(ethylene glycol) linker are presented here.

BASIC PROTOCOL 1

PROTECTION OF THE GLYCOL CHAIN WITH A TRITYL GROUP

The following protocol outlines the protection of one terminus of an ethylene glycol chain with a trityl group. The first reaction, illustrated in Figure 5.3.2, promotes monoprotection of the ethylene glycol chain with 4,4′-dimethoxytrityl chloride. Although the specific protocol for hexa(ethylene glycol) follows, this protocol has also been successful with glycol chains of various lengths: 1,3-propanediol, tri(ethylene glycol), the tetra- and penta-compounds, and so on. The monoprotected ethylene glycol product can be purified by silica-gel column chromatography.

Materials

Hexa(ethylene glycol) (HEG)
Anhydrous pyridine (preferably freshly distilled)
Nitrogen or argon gas
4,4′-Dimethoxytrityl chloride (DMT-Cl)
5% (v/v) methanol in dichloromethane
10% (v/v) aqueous sulfuric acid (H_2SO_4; Table A.2A.1)
Triethylamine (Et_3N, TEA)
Dichloromethane (CH_2Cl_2, DCM; preferably freshly distilled)
5% (w/v) aqueous sodium hydrogen carbonate ($NaHCO_3$)
Sodium sulfate (Na_2SO_4)
Methanol (CH_3OH, MeOH)

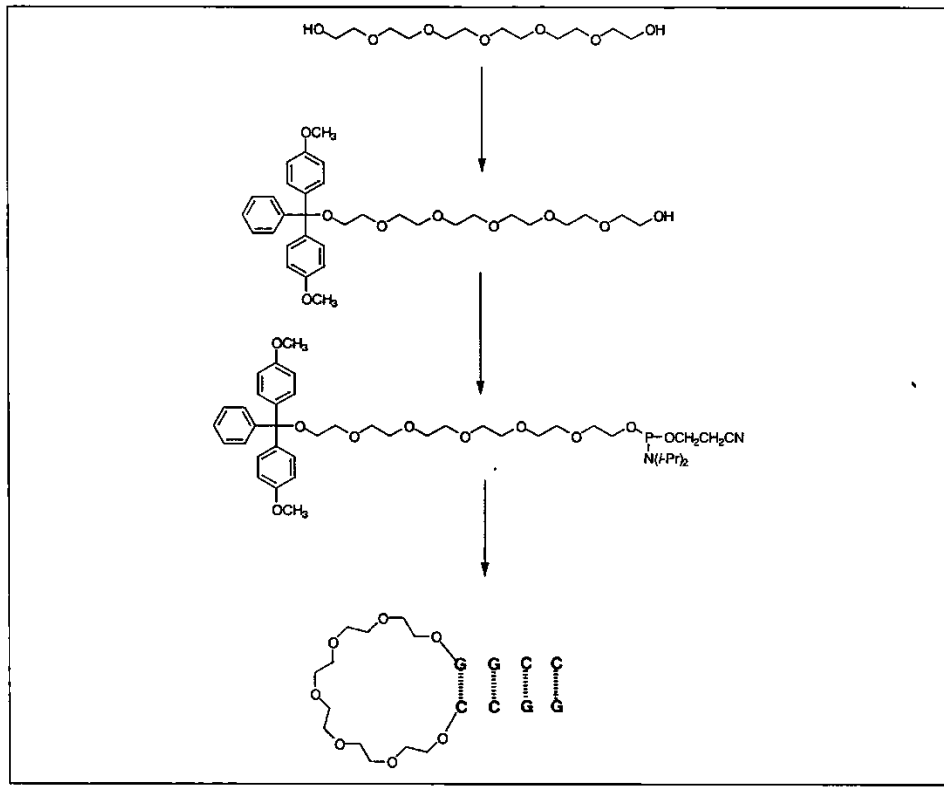

Figure 5.3.2 Reaction pathway for the preparation of a glycol linker and a sample nucleic acid sequence containing the linker.

Non-acid-generating desiccant: e.g., sodium hydroxide or calcium carbonate
100-mL round-bottom flask and rubber stopper
Device for maintaining nitrogen or argon atmosphere (e.g., balloon, syringe, and rubber stopper; see step 2)
Needle and syringe
Separatory funnel
Silica gel
Column for chromatography
Rotary evaporator
Thin-layer chromatography (TLC) apparatus (see *APPENDIX 3D*)

CAUTION: Pyridine and its vapors are toxic; exposure to pyridine must be minimal. The reaction should be performed in a fume hood.

Monoprotect ethylene glycol

1. Coevaporate 1.25 g (5 eq, 4.43 mmol) HEG twice with ~10 mL anhydrous pyridine in a 100-mL flask.
2. Under an anhydrous nitrogen or argon atmosphere, add 10 mL anhydrous pyridine and a dry stir bar, and seal the 100 mL-flask with a rubber stopper.

   The easiest means to create a nitrogen or argon atmosphere is via a balloon sealed to a syringe with a needle. To construct: Remove plunger from syringe, cut off the now opened end, slip a balloon onto this end, and seal well with parafilm. Fill balloon with gas, attach needle, and punch needle through rubber stopper.
3. Begin stirring at ambient temperature.
4. In a separate flask under nitrogen, dissolve 300 mg (1 eq, 0.885 mmol) DMT-Cl in ~3 mL anhydrous pyridine.
5. Using a syringe, puncture the rubber stopper and gradually add the DMT-Cl solution to the reaction flask.

   Useful increments are 0.5 mL every 5 min over a 30-min period.

   The reaction can be monitored by TLC (silica gel, 60 Å, see APPENDIX 3D) using 5% methanol in DCM as eluant. The R_f is 0.45. The product is visible under UV and turns orange when reacted with 10% aqueous H_2SO_4.
6. After 2 hr, add 2 mL TEA and dilute with ~25 mL DCM.

   TEA neutralizes the acid that has been generated, which otherwise will cleave the mono-DMT derivative of the ethylene glycol linker.
7. Extract the organic layer twice with 5% $NaHCO_3$ (~40 mL) and once with distilled water (~40 mL) using a separatory funnel.
8. Dry the organic layer over Na_2SO_4 and remove solvent with a rotary evaporator.

   The product remains as a clear or slightly colored oil.

Purify mono-DMT–ethylene glycol product

9. Pack a silica-gel column (~15 g, roughly 10× expected solute amount), using 0.5% TEA in DCM as eluant.

   Again, TEA reduces the acidic nature of the silica gel, thus reducing decomposition of the mono-DMT–ethylene glycol during chromatography.
10. Dissolve the mono-DMT–ethylene glycol product (from step 8) in a minimum quantity of DCM/TEA and pour onto the column. Elute with at least 400 mL of 0.5%

TEA in DCM, followed by a step gradient using 400-mL aliquots of 0.5% TEA/DCM containing from 0.5% to 3% MeOH.

The product will elute in <3% MeOH.

11. Test fractions by TLC (*APPENDIX 3D*; $R_f = 0.45$) using 5% MeOH in DCM as the eluant.

12. Combine fractions containing the correct product and remove solvent by rotary evaporation (high vacuum is needed to remove excess TEA in product).

13. Store in a sealed vial at ambient temperature over a desiccant.

The 4,4′-dimethoxytrityl-protected hexa(ethylene glycol) product (DMT-HEG) is stable for several months with minimal decomposition provided it is not stored over a desiccant that liberates acid (e.g., P_2O_5).

BASIC PROTOCOL 2

PHOSPHITYLATION OF THE MONOPROTECTED GLYCOL LINKER

The following protocol details the phosphitylation of a 4,4′-dimethoxytrityl-protected glycol linker with 2-(cyanoethyl)-*N*,*N*-diisopropylchlorophosphoramidite. For an efficient reaction with high yield, conditions must be kept scrupulously anhydrous. While the following procedure outlines the use of a monoprotected hexa(ethylene glycol) linker, the protocol has been successful with monoprotected glycol compounds of various lengths. The reaction is illustrated in Figure 5.3.2.

Materials

4,4′-Dimethoxytrityl-protected hexa(ethylene glycol) (DMT-HEG; see Basic Protocol 1)
Anhydrous pyridine (preferably freshly distilled; *UNIT 3.2*)
Non-acid-generating desiccant: e.g., sodium hydroxide or calcium carbonate
Nitrogen or argon gas
Anhydrous dichloromethane (CH_2Cl_2, DCM; preferably freshly distilled)
Diisopropylethylamine
2-(Cyanoethyl)-*N*,*N*-diisopropylchlorophosphoramidite
Ethyl acetate
10% (v/v) triethylamine (Et_3N, TEA) in ethyl acetate
5% (w/v) aqueous $NaHCO_3$
Saturated aqueous NaCl
Sodium sulfate (Na_2SO_4)
25-mL round-bottom flask and rubber stopper

CAUTION: Pyridine and its vapors are toxic; exposure to pyridine must be minimal. The reaction should be performed in a fume hood.

Phosphitylate DMT–ethylene glycol

1. Coevaporate 300 mg (1 eq, 0.51 mmol) of DMT-HEG twice with ~10 mL anhydrous pyridine. Place under high vacuum over a non-acid-generating desiccant and leave overnight.

2. In a rubber-stoppered 25-mL round-bottom flask with a dry stir bar under an anhydrous nitrogen or argon atmosphere, dissolve the DMT-HEG in 1 mL anhydrous DCM and 0.22 mL (3 eq, 1.54 mmol, 157 mg) anhydrous diisopropylethylamine.

A balloon sealed to a syringe provides an easy means to create a nitrogen or argon atmosphere (see Basic Protocol 1, step 2, for details).

TEA may be used here as an alternative to diisopropylamine, if preferred.

3. While stirring, add 0.115 mL (1 eq, 0.51 mmol, 121 mg) 2-(cyanoethyl)-*N,N*-diisopropylchlorophosphoramidite to the reaction flask using a syringe.

The reaction can be monitored via TLC using 9:1 (v/v) ethyl acetate/TEA as the eluant. The R_f of DMT-HEG is 0.50 and that of DMT-HEG-phosphoramidite is 0.80. The product is visible under UV and turns orange when treated with 10% H_2SO_4.

4. After 25 min, dilute reaction with ~20 mL ethyl acetate.

5. Extract the organic layer twice with 5% aqueous $NaHCO_3$ and once with saturated aqueous NaCl.

6. Filter organic layer over Na_2SO_4 and evaporate solvent with rotary evaporator.

Purify DMT–ethylene glycol–phosporamidite

7. Pack a silica-gel TLC column with 1% (v/v) TEA in ethyl acetate.

8. Elute the product with increasing percentages of TEA (1% to 5%) in ethyl acetate.

9. Test fractions by TLC (R_f = 0.80) using 10% TEA in ethyl acetate as the eluant.

10. Combine fractions containing the correct product and remove solvent using rotary evaporator (high vacuum is needed to remove the TEA).

11. Store in a sealed vial at –20°C

*The DMT-HEG-**P** will remain stable for several weeks.*

PREPARATION OF ETHYLENE GLYCOL LINKERS FOR INCORPORATION INTO OLIGONUCLEOTIDES

BASIC PROTOCOL 3

The DMT-protected and phosphitylated glycol linkers can be inserted into DNA sequences using standard automated phosphoramidite synthesis. Since the glycol linker is an oil, several preparative steps facilitate its incorporation using an automated synthesizer.

For an overview of oligonucleotide synthesis, see *APPENDIX 3C*.

Materials

Dimethoxytrityl-protected hexa(ethylene glycol) phosphoramidite (DMT-HEG-**P**) (see Basic Protocol 2)
Anhydrous dichloromethane (CH_2Cl_2, DCM; preferably freshly distilled)
Anhydrous acetonitrile (preferably freshly distilled)
Bottle from DNA synthesizer, tared

1. Dissolve 266 mg DMT-HEG-**P** (0.34 mmol) in 1.00 mL anhydrous CH_2Cl_2 under an anhydrous nitrogen or argon atmosphere.

A balloon sealed to a syringe provides an easy means to create a nitrogen or argon atmosphere (see Basic Protocol 1, step 2, for details).

2. Using a syringe, transfer 0.100 mL DMT-HEG-**P** solution to a suitable tared DNA synthesizer bottle.

3. Remove solvent on rotary evaporator and dry under high vacuum overnight.

4. Weigh DNA synthesis bottle to determine exact amount of DMT-HEG-**P**.

5. Dissolve 24 mg DMT-HEG-**P** (~30 µmol) in 250 µL anhydrous acetonitrile.

*Care must be taken to ensure DMT-HEG-**P** is dissolved completely.*

6. Place the bottle on the automated DNA synthesizer and purge as recommended by the manufacturer.

7. The ethylene glycol linker can now be incorporated into oligonucleotides by solid-support synthesis using standard phosphoramidite protocols.

The oligonucleotide can be synthesized with the DMT group on and then purified by HPLC analysis, or with the DMT group off and then purified by gel electrophoresis.

If poor coupling occurs, see Critical Parameters for possible solutions.

COMMENTARY

Background Information

The cross-linking agents described in this unit are those that are employed during the assembly of the DNA sequences—in this respect they are introduced at very specific sites. Other simple carbon-based linkers can also be employed in a similar manner, but as noted earlier, simple carbon chains may tend to collapse on themselves in an aqueous environment, while the glycol chains are more likely to be hydrated and thus maintain a more extended conformation. Other approaches to cross-linking are also available, most notably the introduction of thiol-based linkers, which upon oxidation form a disulfide cross-link between two sites within a higher-order nucleic acid complex (Ferentz and Verdine, 1991; Wolfe and Verdine, 1993; Goodwin and Glick, 1994; Cain and Glick, 1998; *UNITS 5.1 & 5.4*).

It has been difficult to design effective protocols to confirm the presence of the linker within the nucleic acid sequence. With other types of modified sequences, DNA digests can often be used to confirm the presence of the modification. In the present case, the linkers are not easily identifiable, and such digests only confirm the presence of the nucleoside components. However, when the linker is present in RNA, it is possible to treat a small quantity of the nucleic acid fragment with T2 RNase and an alkaline phosphatase, which results in cleavage of all linkages save that between the linker and the 5′ terminus of the nucleotide (there is no requisite 2′-OH at this linkage). The resulting nucleoside attached to the linker can then be identified after the appropriate standard is prepared (Fu et al., 1994).

Careful analysis of the digest by HPLC, with the use of an appropriate standard, can confirm the presence of the linker in the sequence of interest (Fu et al., 1994). However, this procedure can be tedious, and requires the preparation of the necessary standard(s). Recent work in the authors' lab (D.J. Fu, G. Xiang, and L. McLaughlin, unpub. observ.) has indicated that MALDI-TOF (*UNIT 10.1*) analyses of such nucleic acid analogues are much simpler and are effective in providing evidence for the presence of the linker in both DNA and RNA target sequences.

Critical Parameters

The synthesis of these linkers should not present significant problems for anyone with even a moderate level of laboratory experience. As can be noted with the protocol, the glycol linkers tend to be quite inexpensive and are used in excess over the DMT-Cl reagent to ensure that only the mono-protected product results. These reactions can be performed with stoichiometries of 1:1, but usually some of the bis-protected DMT-linker results. This unwanted product can be removed during the purification step.

For these protocols to succeed, the reactions must be performed under anhydrous conditions. Because of DMT-Cl's sensitivity to water, great care must be taken to maintain a dry environment for the reaction. All ethylene glycol reagents should be coevaporated with pyridine and kept under vacuum before use. A nitrogen or argon atmosphere for the reaction helps maintain the anhydrous conditions while the reaction is being run. The simplest apparatus is a balloon fixed to a syringe body and filled with dry argon/nitrogen. The reaction flask is sealed with a rubber septum and a needle affixed to the syringe is pushed through the septum. This simple apparatus keeps the reaction mixture under a slight positive pressure with an anhydrous inert gas.

High yields require that one be aware of the acid lability of the DMT-protecting group. To limit decomposition as a result of trace quantities of acid, a small amount of the organic base triethylamine (TEA) is added during work-up. It is also critical to have some TEA present (~0.5%) during the chromatographic purification step employing a silica-gel column. TEA neutralizes the slight acidity of the silicic acid, promoting greater stability of the product when

it is adsorbed on the column support. The ~0.5% TEA does not significantly alter chromatographic mobility, and its presence results in a greater overall yield of recovered product.

For the phosphitylation protocol, taking into consideration the lability of the phosphoramidite is critical for a successful experiment. Once synthesized, effort must be taken to minimize the exposure of the phosphoramidite to air and acidic compounds of any kind. Both the reagent and the isolated product should be stored in parafilm-sealed vials at −20°C. When the phosphoramidite reagent loses its pale-yellow color and becomes a deeper yellowish-orange color, the reagent has typically degraded and should not be used.

Preparation of the linker for use with a DNA synthesizer is only complicated by the fact that it is an oil rather than a solid. The authors have found the simplest procedure is one in which some of the oil is transferred to a suitable flask, weighed, and dissolved in sufficient anhydrous solvent. From this solution, an aliquot corresponding to ~30 μmol of linker (per coupling) is transferred to the DNA synthesis bottle. The solvent is then removed from the bottle under vacuum and the residue is kept under high vacuum overnight. The requisite amount of acetonitrile can then be added to the bottle before the latter is attached to the DNA synthesis machine—ensure that the residue in the bottle completely dissolves first.

To obtain efficient coupling of the linker to a DNA strand, the synthesizer programming need not to be altered. However, if efficient coupling is not achieved, several parameters can be changed to attain better coupling. First, extended "wait" periods can be added to the cycle—these are typically the time periods during which the coupling reaction takes place. A second option is to perform two coupling steps in sequence without any intervening capping or oxidation steps.

Anticipated Results

Yields for the protection of the glycol linker with DMT should be >70%. When isolated by column chromatography the DMT-ethylene glycol product is a pale-orange oil with R_f = 0.45 (5% MeOH in DCM). The yields expected for the phosphitylation protocol should be >70% when isolated from the column as a clear oil (R_f = 0.8, 1:9 TEA/ethyl acetate). Successful phosphitylation can be achieved without the column chromatography step. In this case, simply perform the aqueous work-up, dry the solution, and evaporate to an oil. ^{31}P NMR will confirm the ratio of the phosphitylated product to any phosphorus contaminants. So long as the latter are minimal in quantity, effective incorporation of the linker can be obtained with material prepared in this manner.

Time Considerations

Monoprotection of ethylene glycol and its isolation can be accomplished in <5 hr. The phosphitylation protocol can be done in <2 hr when the DMT-ethylene glycol product is prepared ahead of time (see Basic Protocol 1). Incorporation of the ethylene glycol linker into the oligonucleotide will not require more than a half-hour beyond the normal coupling time required of a standard phosphoramidite.

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Chestnut Hill, Massachusetts

EXHIBIT B2

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11 December 1981 • Vol. 214 • No. 4526 $2.00

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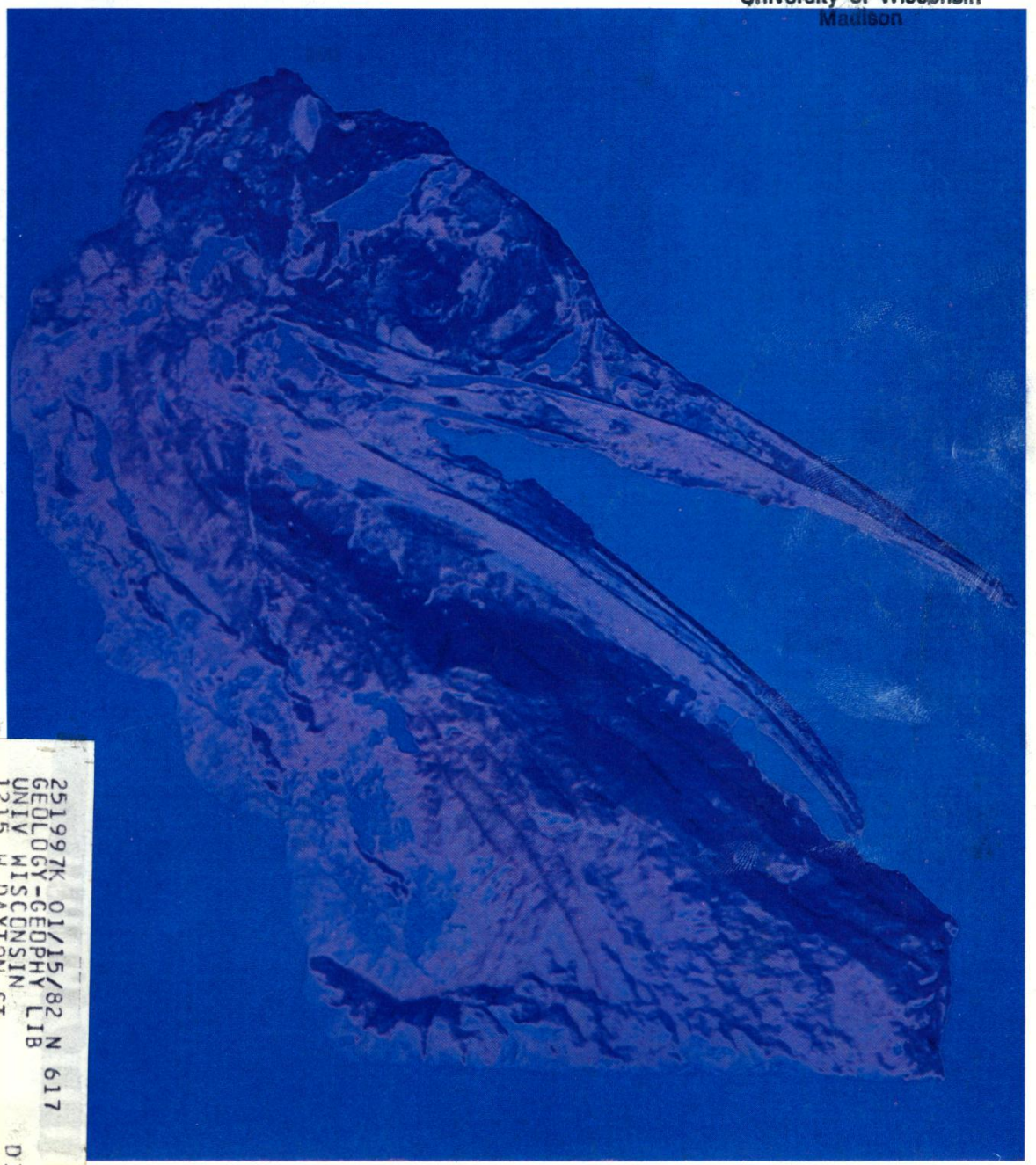

ISSN 0036-8075

11 December 1981

Volume 214, No. 4526

SCIENCE

SCIENCE is published weekly on Friday, except the last week in December, by the American Association for the Advancement of Science, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005. Second-class postage (publication No. 484460) paid at Washington, D.C., and at an additional entry. Now combined with **The Science Monthly**® Domestic individual membership and subscription (51 issues): $43. Domestic institutional subscription (51 issues): $80. Foreign postage extra: Canada $24, other (surface mail) $27, air-surface via Amsterdam $55. First class, airmail, school-year, and student rates on request. Single copies $2 ($2.50 by mail); back issues $3 ($3.50 by mail); classroom rates on request. **Change of address:** allow 6 weeks, giving old and new addresses and seven-digit account number. **Postmaster:** Send Form 3579 to *Science*, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005. *Science* is indexed in the *Reader's Guide to Periodical Literature* and in several specialized indexes.

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COVER

Skull of a paleognathous bird from the early Eocene of Wyoming, about 50 million years old. Somewhat older fossils from Montana also belong to this previously unknown group of medium-sized, flying birds. The ostrich-like palate of these birds is primitive and therefore cannot be used to define the ostrich-like birds (ratites) as a monophyletic group. See page 1236. [V. Krantz, Smithsonian Institution, Washington, D.C. 20560]

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41. For several years our research in inorganic and organometallic photochemistry has been supported by grants from the National Science Foundation (Chemical Dynamics Program). Collaboration with researchers at the Jet Propulsion Laboratory and with Dr. D. S. Kliger and his group at Santa Cruz has been aided by grants from the Continental Group Foundation, the Jet Propulsion Laboratory Director's Discretionary Fund, and the U.S. Department of Energy. Instrumentation was obtained with grants from the National Science Foundation (CHE78-10530) and from the Union Oil Company of California Foundation. Certain rhodium and iridium salts used in our research were lent to us by Johnson Matthey, Inc. A.W.M. acknowledges the National Science Foundation (1977 to 1980) and the Standard Oil Co. (Ohio) (1980 and 1981) for graduate fellowships. This is contribution No. 6415 from the Arthur Amos Noyes Laboratory.

Determination of Nucleotide Sequences in DNA

Frederick Sanger

In spite of the important role played by DNA sequences in living matter, it is only relatively recently that general methods for their determination have been developed. This is mainly because of the very large size of DNA molecules, the smallest being those of the simple bacteriophages such as ϕX174 (which contains about 5000 base pairs). It was therefore difficult to develop methods with such complicated systems. There are, however, some relatively small RNA molecules—notably the transfer RNA's of about 75 nucleotides, and these were used for the early studies on nucleic acid sequences (*1*).

Following my work on amino acid sequences in proteins (*2*) I turned my attention to RNA and, with G. G. Brownlee and B. G. Barrell, developed a relatively rapid small-scale method for the fractionation of ^{32}P-labeled oligonucleotides (*3*). This became the basis for most subsequent studies of RNA sequences. The general approach used in these studies, and in those on proteins, depended on the principle of partial degradation. The large molecules were broken down, usually by suitable enzymes, to give smaller products which were then separated from each other, and their sequence was determined. When sufficient results had been obtained they were fitted together by a process of deduction to give the complete sequence. This approach was necessarily rather slow and tedious, often involving successive digestions and fractionations, and it was not easy to apply it to the larger DNA molecules. When we first studied DNA some significant sequences of about 50 nucleotides in length were obtained with this method (*4*, *5*), but it seemed that to be able to sequence genetic material a new approach was desirable and we turned our attention to the use of copying procedures.

Copying Procedures

In the RNA field these procedures had been pioneered by C. Weissmann and his colleagues (*6*) in their studies on the RNA sequence of the bacteriophage Qβ. Phage Qβ contains a replicase that will synthesize a complementary copy of the single-stranded RNA chain, starting from its 3′ end. These workers devised elegant procedures involving pulse-labeling with radioactively labeled nucleotides, from which sequences could be deduced.

For DNA sequences we have used the enzyme DNA polymerase, which copies single-stranded DNA as shown in Fig. 1. The enzyme requires a primer, which is a single-stranded oligonucleotide having a sequence that is complementary to, and therefore able to hybridize with, a region on the DNA being sequenced (the template). Mononucleotide residues are add-

The author is head of the Division of Protein and Nucleic Acid Chemistry at the MRC Laboratory of Molecular Biology, Hills Road, Cambridge CB2 2QH, England. This article is the lecture he delivered in Stockholm, Sweden, on 8 December 1980, when he received the Nobel Prize in Chemistry, a prize he shared with Walter Gilbert and Paul Berg. Minor corrections and additions have been made by the author. The article is published here with the permission of the Nobel Foundation and will also be included in the complete volume of *Les Prix Nobel en 1980* as well as in the series *Nobel Lectures* (in English) published by the Elsevier Publishing Company, Amsterdam and New York. Dr. Berg's lecture appeared in the 17 July issue, page 296. Dr. Gilbert's lecture will be published in a subsequent issue.

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ed sequentially to the 3′ end of the primer from the corresponding deoxynucleoside triphosphates, making a complementary copy of the template DNA. By using triphosphates containing ^{32}P in the α position, the newly synthesized DNA can be labeled. In the early experiments synthetic oligonucleotides were used as primers, but after the discovery of restriction enzymes it was more convenient to use fragments resulting from their action as they were much more easily obtained.

The copying procedure was used initially to prepare a short, specific region of labeled DNA which could then be subjected to partial digestion procedures. One of the difficulties of sequencing DNA was to find specific methods for breaking it down into small fragments. No suitable enzymes were known that would recognize only one nucleotide. However, Berg, Fancher, and Chamberlin (*7*) had shown earlier that under certain conditions it was possible to incorporate ribonucleotides, in place of the normal deoxyribonucleotides, into DNA chains with DNA polymerase. Thus, for instance, if copying were carried out with ribo CTP (*7a*) and the other three deoxynucleoside triphosphates, a chain could be built up in which the C residues were in the ribo form. Bonds involving ribonucleotides could be broken by alkali under conditions where those involving the deoxynucleotides were not, so that a specific splitting at C residues could be obtained. Using this method we were able to extend our sequencing studies to some extent (*8*). However extensive fractionations and analyses were still required.

The "Plus and Minus" Method

In the course of these experiments we needed to prepare DNA copies of high specific radioactivity, and in order to do this the highly labeled substrates had to be present in low concentrations. Thus if [α-^{32}P]dATP was used for labeling, its concentration was much lower than that of the other three triphosphates and frequently when we analyzed the newly synthesized DNA chains we found that they terminated at a position immediately before that at which an A should have been incorporated. Consequently a mixture of products was produced all having the same 5′ end (the 5′ end of the primer) and terminating at the 3′ end at the position of the A residues. If these products could be fractionated on a system that separated only on the basis of chain length, the pattern of their distribution on fractionation would be proportional to the distribution of the A's along the DNA chain. And this, together with the distribution of the other three mononucleotides, is the information required for sequence determination. Initial experiments carried out with J. E. Donelson suggested that this approach could be the basis for a more rapid method, and it was found that good fractionations according to size could be obtained by ionophoresis on acrylamide gels.

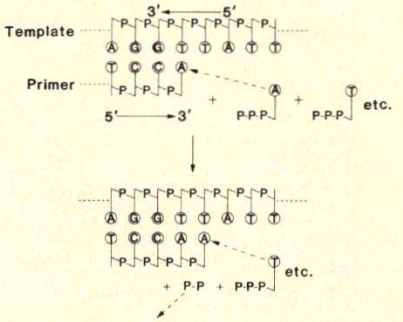

Fig. 1. Specificity requirements for DNA polymerase.

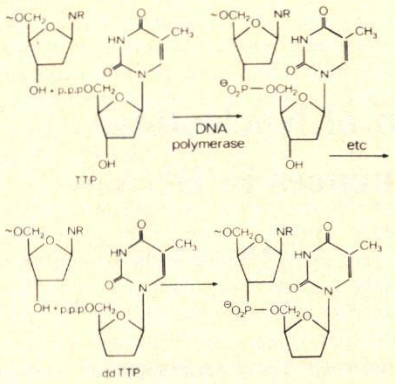

Fig. 2. Diagram showing chain termination with dideoxythymidine triphosphate (ddTTP). The top line shows the DNA polymerase-catalyzed reaction of the normal deoxynucleoside triphosphate (TTP) with the 3′ terminal nucleotide of the primer: the bottom line the corresponding reaction with ddTTP.

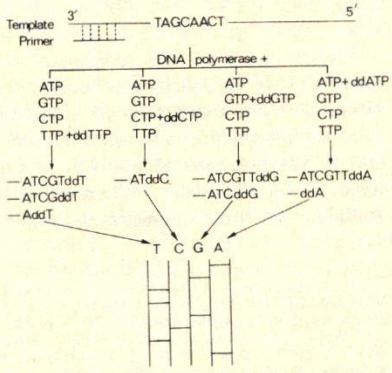

Fig. 3. Principle of the chain-terminating method.

The method described above met with only limited success but we were able to develop two modified techniques that depended on the same general principle, and these provided a simpler and much more rapid method of DNA sequence determination than anything we had used before (*9*). This, which is known as the "plus and minus" technique, was used to determine the almost complete sequence of the DNA of bacteriophage ϕX174, which contains 5386 nucleotides (*10*).

The "Dideoxy" Method

More recently we have developed another similar method that uses specific chain-terminating analogs of the normal deoxynucleoside triphosphates (*11*). This method is both quicker and more accurate than the plus and minus technique. It was used to complete the sequence of ϕX174 (*12*), to determine the sequence of a related bacteriophage, G4 (*13*), and has now been applied to mammalian mitochondrial DNA (mtDNA).

The analogs most widely used are the dideoxynucleoside triphosphates (Fig. 2). They are the same as the normal deoxynucleoside triphosphates but lack the 3′ hydroxyl group. They can be incorporated into a growing DNA chain by DNA polymerase but act as terminators because, once they are incorporated, the chain contains no 3′ hydroxyl group and so no other nucleotide can be added.

The principle of the method is summarized in Fig. 3. Primer and template are denatured to separate the two strands of the primer, which is usually a restriction enzyme fragment, and then annealed to form the primer-template complex. The mixture is then divided into four samples. One (the T sample) is incubated with DNA polymerase in the presence of a mixture of ddTTP (dideoxythymidine triphosphate) and a low concentration of TTP, together with the other three deoxynucleoside triphosphates (one of which is labeled with ^{32}P) at normal concentration. As the DNA chains are built up on the 3′ end of the primer, the position of the T's will be filled, in most cases by the normal substrate T, and extended further, but occasionally by ddT and terminated. Thus at the end of incubation there remains a mixture of chains terminating with ddT at their 3′ end but all having the same 5′ end (the 5′ end of the primer). Similar incubations are carried out in the presence of each of the other three dideoxy derivatives, giv-

ing mixtures terminating at the positions of C, A, and G, respectively, and the four mixtures are fractionated in parallel by electrophoresis on acrylamide gel under denaturing conditions. This system separates the chains according to size, the small ones moving quickly and the large ones slowly. As all the chains in the T mixture end at T, the relative position of the T's in the chain will define the relative sizes of the chains, and therefore their relative positions on the gel after fractionation. The actual sequence can then simply be read off from an autoradiograph of the gel (Fig. 4). The method is comparatively rapid and accurate, and sequences of up to about 300 nucleotides from the 3′ end of the primer can usually be determined. Considerably longer sequences have been read off but these are usually less reliable.

One problem with the method is that it requires single-stranded DNA as template. This is the natural form of the DNA in the bacteriophages ϕX174 and G4, but most DNA is double-stranded and it is frequently difficult to separate the two strands. One way of overcoming this was devised by A. J. H. Smith (*14*). If the double-stranded linear DNA is treated with exonuclease III (a double-strand specific 3′ exonuclease) each chain is degraded from its 3′ end, as shown in Fig. 5, giving rise to a structure that is largely single-stranded and can be used as template for DNA polymerase with suitable small primers. This method is particularly suitable for use with fragments cloned in plasmid vectors and has been used extensively in the work on human mtDNA.

Cloning in Single-Stranded Bacteriophage

Another method of preparing suitable template DNA that is being more widely used is to clone fragments in a single-stranded bacteriophage vector (*15–17*). This approach is summarized in Fig. 6. Various vectors have been described. We have used a derivative of bacteriophage M13 developed by Gronenborn and Messing (*16*), which contains an insert of the β-galactosidase gene with an Eco RI restriction enzyme site in it. The presence of β-galactosidase in a plaque can be readily detected by using a suitable color-forming substrate (X-gal). The presence of an insert in the Eco RI site destroys the β-galactosidase gene, giving rise to a colorless plaque.

Besides being a simple and general method of preparing single-stranded DNA, this approach has other advantages. One is that it is possible to use the same primer on all clones. Heidecker *et al.* (*18*) prepared a 96-nucleotide-long restriction fragment derived from a position in the M13 vector flanking the Eco RI site (Fig. 6). This can be used to prime into, and thus determine, a sequence of about 200 nucleotides in the inserted DNA. Smaller synthetic primers have now been prepared (*19, 20*) which allow longer sequences to be determined. The approach that we have used is to prepare clones at random from restriction enzyme digests and determine the sequence with the flanking primer. Computer programs (*21*) are then used to store, overlap, and arrange the data.

Fig. 4. Autoradiograph of a DNA sequencing gel. The origin is at the top and migration of the DNA chains, according to size, is downward. The gel on the left has been run for 2.5 hours and that on the right for 5 hours with the same polymerization mixtures.

Another important advantage of the cloning technique is that it is a very efficient and rapid method of fractionating fragments of DNA. In all sequencing techniques, both for proteins and nucleic acids, fractionation has been an important step, and major progress has usually been dependent on the development of new fractionation methods. With the new rapid methods for DNA sequencing, fractionation is still important; and, as the sequencing procedure itself is becoming more rapid, more of the work has involved fractionation of the restriction enzyme fragments by electrophoresis on acrylamide. This becomes increasingly difficult as larger DNA molecules are studied and may involve several successive fractionations before pure fragments are obtained. In the new method these fractionations are replaced by a cloning procedure. The mixture is spread on an agar plate and grown. Each clone represents the progeny of a single molecule and is therefore pure, irrespective of how complex the original mixture was. It is particularly suitable for studying large DNA's. In fact, there is no theoretical limit to the size of DNA that could be sequenced by this method.

We have applied the method to fragments from mtDNA (*22, 23*) and to bacteriophage λ DNA. Initially new data can be accumulated very quickly (under ideal conditions at about 500 to 1000 nucleotides a day). However, at later stages much of the data produced will be in regions that have already been sequenced, and progress then appears to be much slower. Nevertheless, we find that most new clones studied give some useful data, either for correcting or confirming old sequences. Thus, in the work with bacteriophage λ DNA, we have about 90 percent of the molecule identified in sequences and most of the new clones we study contribute some new information. In most studies on DNA one is concerned with identifying the reading frames for protein genes, and to do this the sequence must be correct. Errors can readily occur in such extensive sequences and confirmation is always necessary. We usually consider it necessary to determine the sequence of

each region on both strands of the DNA.

Although in theory it would be possible to complete a sequence determination solely by the random approach, it is probably better to use a more specific method to determine the final remaining nucleotides in a sequencing study. Various methods are possible (*22, 24*), but all are slow compared with the random cloning approach.

Bacteriophage ϕX174 DNA

The first DNA to be completely sequenced by the copying procedures was from bacteriophage ϕX174 (*10, 12*)—a single-stranded circular DNA, 5386 nucleotides long, which codes for ten genes. The most unexpected finding from this work was the presence of

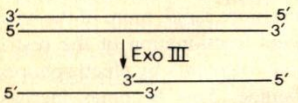

Fig. 5. Degradation of double-stranded DNA with exonuclease III.

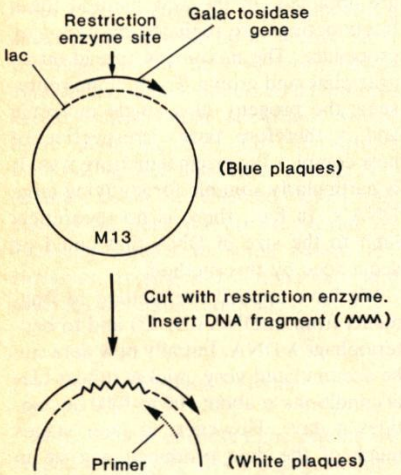

Fig. 6. Diagram illustrating the cloning of DNA fragments in the single-stranded bacteriophage vector M13mp2 (*16*) and sequencing the insert with a flanking primer.

Table 1. Coding changes in mitochondria.

Codon	Amino acid coded		
	Normal	Mitochondria	
		Mammalian	Yeast
TGA	Term*	Trp	Trp
AUA	Ile	Met	Ile
CTN	Leu	Leu	Thr
AGA, AGG	Arg	Term?	Arg
CGN	Arg	Arg	Term?

*Terminating.

"overlapping" genes. Previous genetic studies had suggested that genes were arranged in a linear order along the DNA chains, each gene being encoded by a unique region of the DNA. The sequencing studies indicated, however, that there were regions of the ϕX DNA that were coding for two genes. This is made possible by the nature of the genetic code. Since a sequence of three nucleotides (a codon) codes for one amino acid, each region of DNA can theoretically code for three different amino acid sequences, depending on where translation starts (Fig. 7). The reading frame or phase in which translation takes place is defined by the position of the initiating ATG codon, following which nucleotides are simply read off three at a time. In ϕX there is an initiating ATG within the gene coding for the D protein, but in a different reading frame. Consequently this initiates an entirely different sequence of amino acids, which is that of the E protein. Figure 8 shows the genetic map of ϕX. The E gene is completely contained within the D gene, and the B gene is within the A.

Further studies (*25*) on the related bacteriophage G4 revealed the presence of a previously unidentified gene, which was called K. This overlaps both the A and C genes, and there is a sequence of four nucleotides that codes for part of all three proteins, A, C, and K, using all of its three possible reading frames.

It is uncertain whether overlapping genes are a general phenomenon or whether they are confined to viruses, whose survival may depend on their rate of replication and therefore on the size of the DNA: with overlapping genes more genetic information can be concentrated in a given-sized DNA. Further details of the sequence of bacteriophage ϕX174 DNA have been described (*10, 12*).

Mammalian Mitochondrial DNA

Mitochondria contain a small double-stranded DNA (mtDNA) which codes for two ribosomal RNA's (rRNA's), 22 or 23 transfer RNA's (tRNA's) and about 10 to 13 proteins which appear to be components of the inner mitochondrial membrane and are somewhat hydrophobic. Other proteins of the mitochondria are encoded by the nucleus of the cell and specifically transported into the mitochondria. Using the above methods we have determined the nucleotide sequence of human mtDNA (*23*) and almost the complete sequence of bovine mtDNA. The sequence revealed a number of unexpected features which indicated that the transcription and translation machinery of mitochondria is rather different from that of other biological systems.

The genetic code in mitochondria. Hitherto it has been believed that the genetic code was universal. No differences were found in the *Escherichia coli*, yeast, or mammalian systems that had been studied. Our initial sequence studies were on human mtDNA. No amino acid sequences of the proteins that were encoded by human mtDNA were known. However Steffans and Buse (*26*) had determined the sequence of subunit II of cytochrome oxidase (COII) from bovine mitochondria, and Barrell, Bankier, and Drouin (*27*) found that a region of the human mtDNA that they were studying had a sequence that would code for a protein homologous to this amino acid sequence—indicating that it most probably was the gene for the human COII. Surprisingly the DNA sequence con-

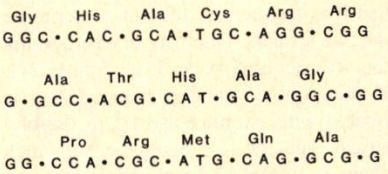

Fig. 7. Diagram illustrating how one DNA sequence can code for three different amino acid sequences. The dots indicate the positions of triplet codons coding for the amino acids.

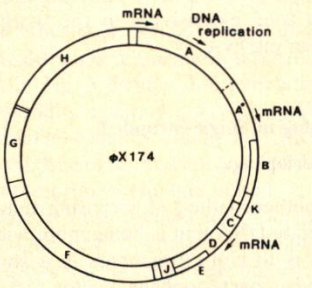

Fig. 8. Gene map of ϕX174 DNA.

Table 2. Normal coding properties of alanine tRNA's. The first position of the codon pairs with the third position of the anticodon and vice versa, for example:
$^{5'}GCU^{3'}$ (codon)
$_{3'}CGG_{5'}$ (anticodon)

Codon	Anticodon	
	Wobble	Mitochondria
GCU	GGC	UGC
GCC		
GCA	UGC	
GCG		

tained TGA triplets in the reading frame of the homologous protein. According to the normal genetic code TGA is a termination codon, and if it occurs in the reading frame of a protein the polypeptide chain is terminated at that position. It was noted that in the positions where TGA occurred in the human mtDNA sequence, tryptophan was found in the bovine protein sequence. The only possible conclusion seemed to be that in mitochondria TGA was not a termination codon but was coding for tryptophan. It was similarly concluded that ATA, which normally codes for isoleucine, was coding for methionine. As these studies were based on a comparison of a human DNA with a bovine protein, the possibility that the differences were due to some species variation, although unlikely, could not be completely excluded. For a conclusive determination of the mitochondrial code it was necessary to compare the DNA sequence of a gene with the amino acid sequence of the protein it was coding for. This was done by Young and Anderson (*28*) who isolated bovine mtDNA, determined the sequence of its COII gene, and confirmed the above differences.

Figure 9 shows the human and bovine mitochondrial genetic code and the frequency of use of the different codons in human mitochondria. All codons are used with the exception of UUA and UAG, which are terminators, and AGA and AGG, which normally code for arginine. This suggests that AGA and AGG are probably also termination codons in mitochondria. Further support for this is that no tRNA recognizing the codons has been found (see below) and that some of the unidentified reading frames found in the DNA sequence appear to end with these codons.

In parallel with our studies on mammalian mtDNA, Tzagoloff and his colleagues (*29, 30*) were studying yeast mtDNA. They also found changes in the genetic code, but surprisingly they are not all the same as those found in mammalian mitochondria (Table 1).

Transfer RNA's. Transfer RNA's have a characteristic base-pairing structure which can be drawn in the form of the "cloverleaf" model. By examining the DNA sequence for cloverleaf structures and using a computer program (*31*), it was possible to identify genes coding for the mitochondrial tRNA's.

Besides the cloverleaf structure, normal cytoplasmic tRNA's have a number of so-called "invariable" features that are believed to be important to their biological function. Most of the mammalian mitochondrial tRNA's are anomalous in that some of these invariable features are missing. The most bizarre is one of the serine tRNA's in which a complete loop of the cloverleaf structure is missing (*32, 33*). Nevertheless, it functions as a tRNA.

In normal cytoplasmic systems at least 32 tRNA's are required to code for all the amino acids. This is related to the "wobble" effect. Codon-anticodon relationships in the first and second positions of the codons are defined by the normal base-pairing rules, but in the third position G can pair with U. The result of this is that one tRNA can recognize two codons. There are many cases in the genetic code where all four codons starting with the same two nucleotides code for the same amino acid. These are known as "family boxes." The situation

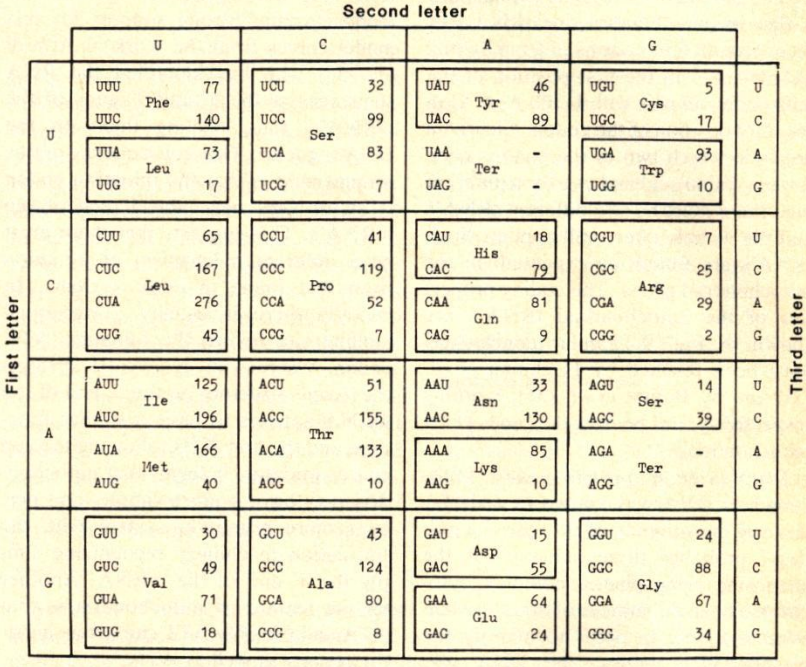

Fig. 9. The human mitochondrial genetic code, showing the coding properties of the tRNA's (boxed codons) and the total number of codons used in the whole genome shown in Fig. 10. (One methionine tRNA has been detected, but since there is some uncertainty about the number present and their coding properties, these codons are not boxed.)

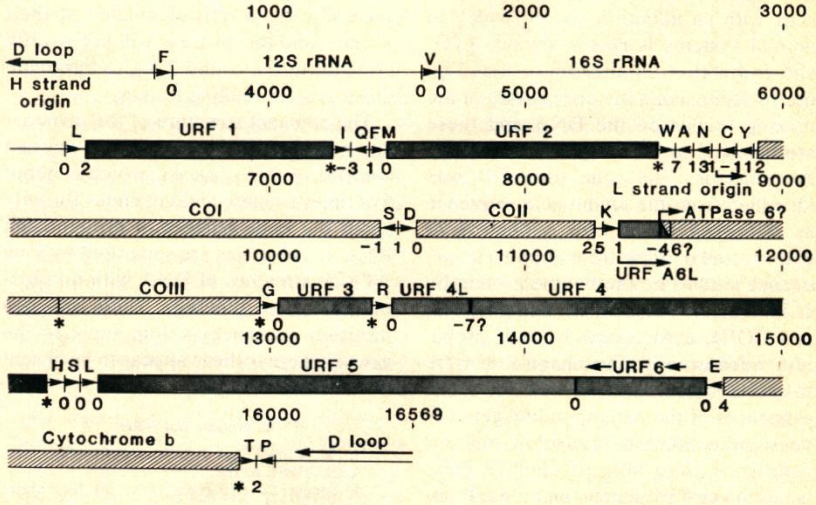

Fig. 10. Gene map of human mtDNA deduced from the DNA sequence. Boxed regions are the predicted reading frames for the proteins. URF, unidentified reading frame. The tRNA genes are denoted by the one-letter amino acid code and are either L strand coded (▶) or H strand coded (◀). Numbers above the genes show the scale in nucleotides and below the predicted number between genes. * Indicates that termination codons are created by polyadenylation of the mRNA.

for the alanine family box is shown in Table 2, indicating that with the normal wobble system two tRNA's are required to code for the four alanine codons.

Only 22 tRNA genes could be found in mammalian mtDNA, and for all the family boxes there was only one, which had a T in the position corresponding to the third position of the codon (*34*). It seems very unlikely that none of the other predicted tRNA's would have been detected, and the most feasible explanation is that in mitochondria one tRNA can recognize all four codons in a family box and that a U in the first position of the anticodon can pair with U, C, A, or G in the third position of the codon. Clearly in boxes in which two of the codons code for one amino acid and two for a different one, there must be two different tRNA's and the wobble effect still applies. Such tRNA's are found, as expected, in the mitochondrial genes. The coding properties of the mitochondrial tRNA's are shown in Fig. 9. Similar conclusions have been reached by Heckman *et al.* (*35*) and by Bonitz *et al.* (*36*), working respectively on neurospora and yeast mitochondria.

Distribution of protein genes. Mitochondrial DNA was known to code for three of the subunits of cytochrome oxidase, probably three subunits of the adenosine triphosphatase complex, cytochrome b, and a number of other unidentified proteins. In order to identify the protein-coding genes, the DNA was searched for reading frames; that is, long stretches of DNA containing no termination codons in one of the phases and thus being capable of coding for long polypeptide chains. Such reading frames should start with an initiation codon, which in normal systems is nearly always ATG, and end with a termination codon. Figure 10 summarizes the distribution of the reading frames on the DNA and these are believed to be the genes coding for the proteins. The gene for COII was identified from the amino acid sequence as described above, for subunit I of cytochrome oxidase from amino acid sequence studies on the bovine protein by J. E. Walker (personal communication), and COIII, cytochrome b, and, probably, adenosine triphosphatase 6 were identified by comparison with the DNA sequences of the corresponding genes in yeast mitochondria. Tzagoloff and his colleagues were able to identify these genes in yeast by genetic methods. It has not yet been possible to assign proteins to the other reading frames.

One unusual feature of the mtDNA is that it has a very compact structure. The reading frames for coding for the proteins and the rRNA genes appear to be flanked by the tRNA genes with no, or very few, intervening nucleotides. This suggests a relatively simple model for transcription, in which a large RNA is copied from the DNA and the tRNA's are cut out by a processing enzyme, and this same processing leads to the production of the rRNA's and the messenger RNA's (mRNA's), most of which will be monocistronic. Strong support for this model comes from the work of Attardi (*37, 38*) who has identified the RNA sequences at the 5′ and 3′ ends of the mRNA's, thus locating them on the DNA sequence. One consequence of this arrangement is that the initiation codon is at, or very near, the 5′ end of the mRNA's. This suggests that there must be a different mechanism of initiation from that found in other systems. In bacteria there is usually a ribosomal binding site before the initiating ATG codon, whereas in eukaryotic systems the "cap" structure on the 5′ end of the mRNA appears to have a similar function, and the first ATG following the cap acts as initiator. It seems that mitochondria may have a more simple, and perhaps more primitive, system with the translation machinery recognizing simply the 5′ end of the mRNA. Another unique feature of mitochondria is that ATA and possibly ATT can act as initiator codons as well as ATG.

On the basis of the above model, some of the mRNA's will not contain termination codons at their 3′ ends after the tRNA's are cut out. However they have T or TA at the 3′ end. The mRNA's are generally found polyadenylated at their 3′ ends, and this process will necessarily give rise to the codon TAA to terminate those protein reading frames.

The compact structure of the mammalian mitochondrial genome is in marked contrast to that of yeast, which is about five times as large and yet codes for only about the same number of proteins and RNA's. The genes are separated by long AT-rich stretches of DNA with no obvious biological function. There are also insertion sequences within some of the genes, whereas these appear to be absent from mammalian mtDNA.

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7a. The abbreviations C, A, G, U, and T are used to describe either the ribonucleotides or the deoxyribonucleotides, according to context. Other abbreviations used are CTP, cytidine triphosphate; dATP, deoxyadenosine triphosphate; TTP, thymidine triphosphate; N, any nucleotide. Single-letter and three-letter abbreviations of the amino acid residues are as follows: A, Ala, alanine; R, Arg, arginine; N, Asn, asparagine; D, Asp, aspartic acid; C, Cys, cysteine; Q, Gln, glutamine; E, Glu, glutamic acid; G, Gly, glycine; H, His, histidine; I, Iso, isoleucine; L, Leu, leucine; L, Lys, lysine; M, Met, methionine; F, Phe, phenylalanine; P, Pro, proline; S, Ser, serine; T, Thr, threonine; W, Trp, tryptophan; T, Tyr, tyrosine; V, Val, valine.

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           (Mar. 23, 1894); [2nd ser.] v. 1, no. 1 (Jan. 4, 1895)-

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500        $aPublished: Cambridge, Mass. : Science Company, Moses King,
            1883- ; Lancaster, Pa. : Science Press, -1944; Lancaster, Pa.
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264 _1 New York, N.Y. : ‡b [publisher not identified], ‡c 1880-

264 31 ‡3 <1991- > : ‡a Washington, D.C. : ‡b American Association for the Advancement of Science

300		volumes : ‡b illustrations ; ‡c 26-32 cm
310		Weekly (except last week in Dec.)
336		text ‡b txt ‡2 rdacontent
337		unmediated ‡b n ‡2 rdamedia
338		volume ‡b nc ‡2 rdacarrier
362	0_	Vol. 1, no. 1 (July 3, 1880)-v. 3, no. 82 (Mar. 4, 1882); [New ser.] vol. 1, no. 1 (Feb. 9, 1883)-v. 23, no. 581 (Mar. 23, 1894); [2nd ser.] v. 1, no. 1 (Jan. 4, 1895)-
500		"A weekly record of scientific progress."
500		Edited by J. Michels.
500		Published: Cambridge, Mass. : Science Company, Moses King, 1883- ; Lancaster, Pa. : Science Press, -1944; Lancaster, Pa. : American Association for the Advancement of Science, 1945- ; Washington, DC : American Association for the Advancement of Science, <Oct. 4, 1991->
500		Since Jan. 1901 the official proceedings and most of the papers of the American Association for the Advancement of Science have been included in Science.
500		Some issues accompanied by CD-ROM.
510	2_	Chemical abstracts ‡x 0009-2258
515		None issued for Jan. 7, Jan. 28-Feb. 1882.
525		Has occasional supplements.
530		Also issued online.
555		Index in last issue of v., -1996; index only available in online version, 1997-
588		Latest issue consulted: Vol. 338, issue 6113 (Dec. 14, 2012).
650	_0	Science ‡v Periodicals.
650	_2	Science.
650	_6	Sciences ‡v Périodiques.
650	_7	Hebdomadaires. ‡2 eclas
650	_7	Sciences. ‡2 eclas
650	_7	Science. ‡2 fast ‡0 (OCoLC)fst01108176
650	17	Natuurwetenschappen. ‡2 gtt
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650	07	Zeitschrift. ‡0 (DE-588)4067488-5 ‡2 gnd
650	07	Naturwissenschaften. ‡2 swd
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655	_7	Electronic journals. ‡2 lcgft

655 _7 Periodicals. ‡2 rbgenr
700 1_ Michels, John ‡c (Journalist) ‡4 edt
710 2_ American Association for the Advancement of Science.
770 0_ ‡t AAAS observer ‡x 1043-6936 ‡w (DLC)sn 88019924 ‡w (OCoLC)18455932
770 0_ ‡t Guide to biotechnology products and instruments, guide to scientific instruments ‡g 1986-1991 ‡w (DLC)sn 88012944 ‡w (OCoLC)15272570
770 0_ ‡t Guide to scientific instruments ‡g 1964-1985 ‡x 0533-5426 ‡w (DLC) 83646900 ‡w (OCoLC)1779025
776 0_ ‡c Microfilm ‡d Maxwell Scientific International ‡t Science ‡x 0036-8075 ‡w (OCoLC)70737295
776 08 ‡i Online version: ‡t Science (New York, N.Y. : Online) ‡x 1095-9203 ‡w (DLC)sn 96036234 ‡w (OCoLC)34298537
777 08 ‡i Vols. for 1911-1913 contain: ‡a Helminthological Society of Washington. ‡t Proceedings of the Helminthological Society of Washington ‡g 1st-15th ‡x 0018-0130 ‡w (DLC) 65032051 ‡w (OCoLC)1604661
780 05 ‡t Scientific monthly ‡g Jan. 1958 ‡x 0096-3771 ‡w (DLC) 16010072 ‡w (OCoLC)1765233
787 0_ American Association for the Advancement of Science. ‡t Summarized proceedings of the ... meeting ... together with the constitution and by-laws and rules of procedure adopted at the St. Louis meeting and also the list of fellows and other members corrected to June 15, 1921 ‡w (DLC) 98642021 ‡w (OCoLC)14153243
787 0_ American Association for the Advancement of Science. ‡t Summarized proceedings of the American Association for the Advancement of Science for the period from ... ‡w (DLC) 98642022 ‡w (OCoLC)6724869
787 0_ American Association for the Advancement of Science. ‡t Summarized proceedings ... including a chapter on the background and origin of the association and a directory of fellows and other members ‡w (DLC) 98642023 ‡w(OCoLC)14154019
787 0_ American Association for the Advancement of Science. ‡t Summarized proceedings for the period from ... and a directory of members as of ... ‡w (DLC) 12030236 ‡w (OCoLC)6926793
850 CU-I ‡a CU-Riv ‡a CU-RivA ‡a CU-RivP ‡a CaOTULS ‡a CoFS ‡a DLC ‡a DNAL ‡a InLP ‡a MBCo ‡a MCM ‡a MCSA ‡a MH ‡a MH-BH ‡a MH-BL ‡a MH-C ‡a MH-CS ‡a MH-Ed ‡a MH-GM ‡a MH-GS ‡a MH-HF ‡aMH-Hi ‡a MH-KG ‡a MH-Lm ‡a MH-O ‡a MH-PR ‡a MH-Ps ‡a MH-SI ‡a MH-SR ‡a MH-Z ‡a MSobPR ‡a MnSU ‡a MnU ‡a N ‡a NNC ‡a NNC-M ‡a NcD ‡a NcRS ‡a OU ‡a OrU-S ‡a P ‡a PU ‡a TxU
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EXHIBIT D

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EDUCATION

Ph.D., University of Pittsburgh, Pittsburgh, Pennsylvania, 1985
M.P.S., University of Denver, Denver, Colorado, 2014
Post Graduate Studies, University of Texas – San Antonio, Texas, 1975-1976
M.L.S., University of North Texas, Denton, Texas, 1972
B.A., Rockford University, Rockford, Illinois, 1971

PROFESSIONAL EXPERIENCE

1981- **Consultant for higher education, non-profit organizations, and corporations.**

2002- **Adjunct Professor, School of Information, San José State University, San José, California.** Serve as part-time faculty member teaching graduate students in technical services (cataloging, bibliographic control, classification), "core courses," and special topics.

2014-2016 **Director, Grants and Resource Development, Colorado Community College System.** Provided leadership and vision to foster the continued growth of rigorous scholarship, innovative projects, and creative work for statewide system, 13 campuses, and 50 teaching sites serving 155,000 students. Responsible for leadership and ensured efficient functioning of contract and grants in compliance with state & federal requirements and successful implementation and management. Served as a subject matter expert and liaison for college Grant Directors for all issues relating to grants and subcontracts.

2010-2014 **Senior Grant Administrator, Morgridge College of Education, University of Denver (Colorado).** Provided leadership and vision to foster continued growth of rigorous scholarship, innovative research, and creative work in the Morgridge College of Education. Ensure that contract and grants processes function effectively and efficiently for 60 faculty and researchers with a focus on the successful progression and efficient management of grants totaling $13M. Worked effectively and collegially with Department Chairs and Program Coordinators on operational grant-related management activities and with a broad range of internal and external constituencies. Supported the dissemination and promotion of faculty research and scholarship to outside constituents at conferences and through publications. Assisted Principal Investigators and grant project teams by coaching, mentoring, and financial management.

2011-2013 **Interim Director & Assistant Dean, Westminster Law Library, Sturm College of Law, University of Denver.** Planned, organized, and directed all administrative activities for the library serving students, faculty, and alumni; oversaw the employment, retention, promotion, transfer and termination of library personnel; represented the library at professional conferences and public meetings; created and promoted a climate and culture of acceptance for new programs and services, a positive high-quality image of the law library, and that reflect the organization's values, encourage excellent performance, and reward high productivity and innovation; provided leadership and set strategic direction of the organization; ensured that the library provided excellent customer service through solution-oriented staff response to patron needs and by responsiveness and continuous improvement of the organization; promoted, developed, and maintained positive working relationships with colleagues and customers including key stakeholders and groups, higher education institutions, the legal community, other regional libraries and districts statewide, and national library organizations.

2007-2014 **Associate Professor, Library & Information Science, Morgridge College of Education, University of Denver (Colorado).** Served in leadership role and worked collaboratively in program, college, campus and community environments. Advised and supervised students, taught core and specialized courses at the graduate level in an integrative, student-centered learning environment. Served on LIS, College, and University committees, and maintained working relationships with colleagues in other academic units and information professionals in the Rocky Mountain region and beyond. Served on and chair doctoral student dissertation committees. Oversaw and facilitated the College and LIS graduate student association.

2002-2007 **Assistant Professor, Library & Information Science, College of Education, University of Denver (Colorado).** Served as tenure-track faculty member teaching graduate students in "core courses," resource description and access, service learning, and independent studies. Advised graduate students, participate on LIS and College committees, and serve on doctoral student dissertation committees. Oversaw and facilitated the LIS graduate student association and alumni association.

2000-2002 **Affiliate Faculty, Library & Information Science, College of Education, University of Denver (Colorado).** Served as part-time faculty member teaching graduate students in technical services (cataloging, bibliographic control, classification), "core courses," and special topics. Oversaw and facilitated the LIS graduate student association and alumni association.

2000-2001 **Special Assistant to the Secretary's Regional Representative, U.S. Department of Education, Region VIII, Denver, Colorado.** Served as the principal advisor and representative of the U. S. Secretary of Education's Regional Representative (SRR). Ensured the implementation of major goals of the SRR and the Secretary. Provided leadership on behalf of the SRR in contacts with high-level officials in Region VIII requiring sensitive policy interpretation in communication with senior Department officials to solve problems and resolve issues raised by State and local education officials. Served as the primary contact for School-to-Work/Career, Children's Health Insurance Program, and Safe and Drug-Free Schools. Delivered technical assistance to local education agencies and institutions of higher education in technology, professional development, and school construction.

1999-2000 **Catalog Librarian, Jefferson County Public Library, Lakewood, Colorado.** Performed original, copy cataloging and classification of library materials (English and Spanish) using standard library protocols; completed original descriptive cataloging and subject analysis; enhanced brief catalog and authority records in III.

1997-1999 **Development Officer, McREL International, Aurora, Colorado.** Served as senior member of corporate management team in strategic planning, development of proposals and contracts, implementation, and evaluation of new services, products, and programs for educational agencies. Provided creative leadership to corporate committees to solicit ideas, identify goals and objectives, plan, develop, present, and evaluate professional development opportunities.

1995-1997 **Education Specialist, Education Service Center, Region One, Edinburg, Texas.** Served as member of Administrative Cabinet team in strategic planning, development of proposals and contracts, implementation, and evaluation of telecommunications capabilities, services, products, and programs for 40 school districts serving 283,000 students in 7 counties. Provided creative leadership to regional and state committees to solicit ideas, identify strategic goals and objectives, plan, develop, present, and evaluate funding opportunities and professional development for 400 librarians.

1993-1996 **Assistant Professor of Library Science, Sam Houston State University, Huntsville, Texas.** Served a faculty member teaching 400 graduate students in technical services (cataloging, bibliographic control, classification), automation, and networking. Participated in distance education program and coordinated annual conference. Conducted university and Texas Library Association-funded field research focused on library collection development and academic achievement.

1992-1993 **Head Librarian, Rocky Mountain College of Art & Design, Denver, Colorado.** Responsible for the daily operation, selection and acquisition of materials, formulation of policies for library operations, media center, and photography/slides archives. Designed and implemented library automation and delivery of electronic resources to college community.

1981-1985 **Development Officer, PRLC, Inc., Pittsburgh, Pennsylvania.** Served as senior member of corporate management team in strategic planning, development of proposals and contracts, implementation, and evaluation of new services, products, and programs for 100 institutional member organizations. Coordinated the development of proposals and contracts totaling $4,000,000 annually. Provided creative leadership to corporate committees to solicit ideas, identify goals and objectives, plan, develop, present, and evaluate professional development opportunities.

1981 **Director of Library Development, Pennsylvania Department of Education, Harrisburg, Pennsylvania.** Responsible for statewide development, technical assistance, professional development, resource sharing, children's services, institutional library services, networking, and state aid program for all libraries throughout the Commonwealth. Functioned as liaison to Governor's Advisory Council, LSCA Advisory Council, District Administrators, private colleges, universities, consortia managers, and network directors. Supervised $14,000,000 formula-based state aid program and $3,000,000 grant awards to individual libraries, consortia, and networks.

1978-1981 **Assistant Director, Southern Tier Library System, Corning, New York.** Coordinated operation of system-wide programs (technical assistance, professional development, resource sharing, technical services, outreach) to 40 public libraries in 5 counties serving 500,000 residents. Solicited ideas, identified goals, sponsored, and evaluated professional development opportunities and technical assistance sessions.

1976-1978 **Division Librarian for Technical Services, Corpus Christi Public Libraries, Corpus Christi, Texas.** Provided leadership in acquisitions, cataloging, serials control, and processing for main library and 4 branches serving 250,000 residents. Participated as senior member of library management team. Compiled and prepared technical evaluations, reports, and statistical analyses of Division operations to measure the achievement and cost of annual goals, objectives, and staff performance.

1975-1976 **System Coordinator, San Antonio Major Resource Center, San Antonio, Texas.** Served as senior member of the management team for District X Office, charged to provide technical assistance, resource sharing, media services, and professional development to librarians and staff representing 30 public library jurisdictions in 21 counties serving 1,500,000 residents. Functioned as liaison to System Director, staff, and members of governing bodies with the System Board of Directors and the Texas State Library and Historical Commission. Prepared LSCA grant applications and monitored awards totaling $1,100,000 annually.

1973-1975 **Bilingual Branch Librarian, San Antonio Public Library, San Antonio, Texas.** Worked as librarian providing reference, information, and readers' advisory services in branch serving 50,000 Spanish-speaking residents in southwest San Antonio. Participated in collection development and resource acquisition activities, specializing in children's work, Spanish language resources, and multicultural studies.

1972-1973 **Librarian, Holding Institute, Laredo, Texas.** Worked as high school librarian serving 500 boarding students in Spanish-speaking environment of private school. Provided reference, research assistance, and library instruction to students and 35 faculty members.

1966-1971 **Rockford Public Library, Rockford, Illinois.** Worked in branches as part-time as a Library Assistant, Clerk, and Page in city library serving 150,000 residents.

PUBLICATIONS

Editor-reviewed Monographs (Completed and in Progress)

Grealy, Deborah S., and Sylvia D. Hall-Ellis. *Organic Succession Planning: Upskilling and Sustaining Your Organization.* Santa Barbara, Calif.: ABC-Clio; Libraries Unlimited. Under contract & In development.

Hall-Ellis, Sylvia D., and Mary Beth Weber. *Contemporary Cataloging in an RDA Environment: A Handbook for Students and Practitioners.* Chicago, IL: American Library Association. Under contract & In development.

RDA Testing: Lessons Learned and Challenges Revealed. Sylvia D. Hall-Ellis and Robert O. Ellett, Jr., eds. Binghamton, N.Y.: Haworth, 2012. 128 p.

Hall-Ellis, Sylvia D., Stacey L. Bowers, Christopher D. Hudson, and M. Claire Williamson. *Librarian's Handbook for Seeking, Writing, and Managing Grants.* Santa Barbara, Calif.: Libraries Unlimited, 2011. 315 p.

Hall-Ellis, Sylvia D., with Ann Jerabek, and Merrie W. Valliant. *Contemporary Cataloging: A Handbook for Practitioners and Students.* Open access text. Athens, GA: University of Georgia System Regents, 2011. 767 p.

Grealy, Deborah S. and Sylvia D. Hall-Ellis. *From Research to Practice: The Scholarship of Teaching and Learning in LIS Education.* Westport, Conn.: Libraries Unlimited, 2009. 175 p.

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Hall-Ellis, Sylvia D., Doris Meyer, Frank W. Hoffmann, with J. Ann Jerabek. *Grant Writing for Small Libraries and School Library Media Centers.* Englewood, Colo: Libraries Unlimited, 2000. 173 p.

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Hall-Ellis, Sylvia D. "Grant Writing and Sponsored Research Funding for Academic Librarians." In *The New Librarianship.* Vol. 4. Bradford Lee Eden, ed. New York: Scarecrow Press, 2015. (pp. 163-174)

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Hall-Ellis, Sylvia D., ed. "Standard III: The Faculty." In the *Library and Information Science Program Self-Study Document for Accreditation by the American Library Association.* Denver, Colo.: University of Denver, Morgridge College of Education, 2010. 22 p.

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Lesesne, Teri S. and Sylvia D. Hall-Ellis. "The Selection, Evaluation, and Integration of Culturally Authentic Texts: A Case for Making the Online Catalog Reflect Parallel Cultures." In *Literacy: Traditional, Cultural, Technological.* Pittsburgh, Pa.: International Association of School Librarianship, 1995. (pp. 110-113)

Lesesne, Teri S. and Sylvia D. Hall-Ellis. *The Selection, Evaluation, and Integration of Culturally Authentic Texts: A Case for Making the Online Catalog Reflect Parallel Cultures.* In *Conference Proceedings* of the 23rd Annual International Association of School Librarianship, Pittsburgh, Pennsylvania, July 17-22, 1994. ERIC Document ED374816. 17 p.

Hall-Ellis, Sylvia D. "Curriculum Folio for School Library Media Specialist Programs." In the *National Council for Accreditation of Teacher Education Self-Study for Sam Houston State University.* Huntsville, Tex.: Sam Houston State University, College of Education and Applied Science, 1994. 25 p.

Bruntjen, Scott and Sylvia D. Hall. "Attempting to Automate: Lessons Learned Over Five Years." In *Advances in Library Administration*. Volume 4. Weston, Conn.: JAI Press, 1985. (pp. 177-192)

Peer-Reviewed Journal Articles (Completed and In Progress)

Hall-Ellis-Sylvia D. "Job Design for Cataloging and Metadata Librarians." Submitted to *Journal of Library Administration.* In progress.

Hall-Ellis, Sylvia D. "The Relationship of Situational Leadership and the Dreyfus Model of Skill Acquisition for Supervisors in Cataloging and Metadata Services." To be submitted to *Library Resources and Technical Services.* In progress.

Hall-Ellis, Sylvia D. *The Relationship of Core Competencies on Learning Outcomes and Employers' Expectations for Catalog Librarians and Metadata Specialists.* To be submitted to the *Journal of Education for Library and Information Science.* In progress.

Hall-Ellis, Sylvia D. "Building Cataloger Competencies: The Dreyfus Model as a Prototype for the Education and Professional Development of Catalog Librarians and Metadata Specialists in Bibliographic Control." To be submitted to the *Cataloging & Classification Quarterly.* In progress.

Hall-Ellis, Sylvia D. "Descriptive Impressions of Entry-Level Cataloger and Metadata Specialists Positions, 2000-2013: Reflections and Trends." To be submitted to *Library Resources and Technical Services.* In progress.

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Hall-Ellis, Sylvia D. "Stackable Micro-credentials – A Framework for the Future." *The Bottom Line 29*, no. 4 (April 2016), http://www.emeraldinsight.com/doi/pdfplus/10.1108/BL-02-2016-0006

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Hall-Ellis, Sylvia D. "Succession Planning and Staff Development – A Winning Combination." *The Bottom Line 28*, no. 3 (May 2015): 95-98.

Hall-Ellis, Sylvia D. "Metadata Competencies for Entry-Level Positions: What Employers Expect as Reflected in Position Descriptions, 2000-2013." *Journal of Library Metadata 15*, no. 2 (June 2015): 102-134.

Hall-Ellis, Sylvia D. "Onboarding to Improve Library Retention and Productivity." *The Bottom Line 27*, no. 4 (October 2014).

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Hall-Ellis, Sylvia D. "Reward Systems Promote High-Performance Work Teams Achieving Library Mission." *The Bottom Line 27*, no. 2 (April 2014): 66-69.

Hall-Ellis, Sylvia D. "Investment in Staff Development for Seeking External Grant Funds." *The Bottom Line 27*, no. 1 (January 2014): 22-25.

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Hall-Ellis, Sylvia D., and Deborah S. Grealy. "The Dreyfus Model of Skill Acquisition: A Career Development Framework for Succession Planning and Management in Academic Libraries." *College and Research Libraries* (June 2012). http://crl.acrl.org/content/early/2012/06/19/crl12-349.full.pdf+html

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Hall-Ellis, Sylvia D. and Mary Ann Berry. "The Impact of Library Resource Centers on Academic Achievement in Selected Public Schools in South Texas: Preliminary Findings." *Texas Library Journal* 71, no. 2 (Summer 1995): 94-97.

Hall-Ellis, Sylvia D. "Visual Arts as Foundation for Successful Library Automation: The Rocky Mountain College of Art & Design Experience." *Art Reference Serials Quarterly* 4 (1994): 43-54.

Hall, Sylvia D. *High School Databases: An Examination of Bibliographic Data Elements*. Dissertation. Pittsburgh, Pa.: University of Pittsburgh, School of Library and Information Science, 1985.

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Hall-Ellis, Sylvia D. *Colorado Community College System Grant Handbook.* Denver, CO: Colorado Community College System, 2015.

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Faculty Voices: Testimonials from the Frontiers of a Development Education Redesign. Elaine DeLott Baker, Marilyn Smith, and Sylvia D. Hall-Ellis, eds. Denver, CO: Colorado Community College System, 2014.

Lewis, Melanie, Jamie M. Van Leeuwen, and Sylvia D. Hall-Ellis. *Project Homeless Connect 7 Event Evaluation.* Denver, Colo.: University of Colorado Denver, 2009.

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Hall-Ellis, Sylvia D. *Strategic Plan for Denver Medical Library System: Final Report.* Denver, Colo.: HealthONE and Denver Medical Library, 2008.

Hall-Ellis, Sylvia D. and Duan Zhang. *Project Homeless Connect 5 Event Evaluation.* Denver, Colo.: Center for Community Engagement and Service Learning, 2008.

Hall-Ellis, Sylvia D. *Strategic Plan for Denver Medical Library System: Phase Two Report.* Denver, Colo.: HealthONE and Denver Medical Library, 2007.

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Hall-Ellis, Sylvia D. *Resources in Grant Writing for Colorado Schools and Libraries.* Sponsored by the Colorado Department of Education, Educational Telecommunications Unit, 1999. Revised September 2000.

Hall-Ellis, Sylvia D. *Lewis & Clark Fellows Concept Paper for the Bicentennial Commemoration.* Vancouver, Wash.: Lewis and Clark Bicentennial Council, 1998.

Hall-Ellis, Sylvia D. and Mary Ann Berry. *The Impact of Library Resource Centers on Academic Achievement in Public Schools in Texas: The Final Report.* Prepared under the sponsorship of the Research Enhancement Fund award from Sam Houston State University, the Texas Association of School Librarians, the Children's Services Round Table, and the Young Adults' Services Round Table. Huntsville, Tex.: Sam Houston State University, College of Education and Applied Science, 1997.

Hall-Ellis, Sylvia D. *The Impact of Library Resource Centers on Academic Achievement in Selected Public Schools in Texas.* Huntsville, Tex.: Sam Houston State University, College of Education and Applied Science, 1997.

Hall-Ellis, Sylvia D. *Planning for Educational Technology: the Distance Education Implementation Phase: An Investigation of Technology and Telecommunication Needs for Region One Education Service Center, South Texas Community College, TCI Cablevision of South Texas, Inc., Tech Prep of the Rio Grande Valley, Inc., Texas State Technical College, Centro Cultural en el Valle de Texas, McAllen Independent School District, Harlingen Consolidated Independent School District, Donna Independent School District, Edinburg Consolidated Independent School District, La Joya Independent School District, Mercedes Independent School District, Pharr-San Juan-Alamo Independent School District, Sharyland Independent School District, Easter Seal Society of the Rio Grande Valley, Inc., and McAllen Memorial Library.* Harlingen, Tex.: Tech Prep of the Rio Grande Valley, 1996.

Hall-Ellis, Sylvia D. "Barcodes for the Texas Library Connection." Prepared under the sponsorship of the Office of Technology Services, Texas Education Agency. Austin, Tex.: TENET News and Conferences, March 1995.

Hall-Ellis, Sylvia D. *[et. al.] Planning for Educational Technology: A Study of Future Technology Needs for the Donna Independent School District, Region One Education Region Service Center, Tech Prep of the Rio Grande Valley, Inc. South Texas Community College, and the Department of Library Science, Sam Houston State University.* Research team: Sylvia D. Hall-Ellis, Ruth Ann Riggins, Noe Torres, Patricia G. Bubb, and Michael D. Bell. Harlingen, Tex.: Tech Prep of the Rio Grande Valley, 1994. Funded through a grant award from the Texas Education Agency.

Hall-Ellis, Sylvia D. and Mary Ann Berry. *The Impact of Library Resource Centers on Academic Achievement in Selected Public Schools in South Texas.* Huntsville, Tex.: Sam Houston State University, College of Education and Applied Science, 1993. Funded through a grant award from the Sam Houston State University Research Enhancement Fund.

Hall-Ellis, Sylvia D., Alice Krueger, and Linda Brannan. *Thesaurus Development for National Curriculum Materials Database at the Eisenhower National Clearinghouse for Mathematics and Science Education, Columbus, Ohio.* Developed under the sponsorship of Mid-Continent Regional Educational Laboratory Corporate Library, Aurora, Colo. Washington, D.C.: National Science Foundation; Columbus, Ohio: ERIC Clearinghouse for Mathematics and Science Education, 1993.

Hall-Ellis, Sylvia D. and Clarence L. Coffindaffer. *Partners in Progress: The 1992 Montana Library Federation Study Final Report.* Helena, Mont: Montana State Library and The Blue Bear Group, Inc., 1992.

Hall-Ellis, Sylvia D. and Clarence L. Coffindaffer. *Montana Federation Study Identification Paper*. Denver, Colo.: The Blue Bear Group, Inc., 1992.

Bruntjen, Scott and Sylvia D. Hall. *Recommendations on the Development of System-Wide Efforts of the Northern Waters Library Service.* Ashland, Wisc.: Northern Waters Library Service and The Blue Bear Group, Inc., 1989.

Hall, Sylvia D. *The Iowa Union List of Serials as A Part of The Iowa Locator: Planning Document*. Des Moines, Ia.: State Library of Iowa, 1988.

Hall, Sylvia D. *Iowa Computer-Assisted Network (ICAN Users' Manual. IBM Compatible Edition: Version 7.0.* Des Moines, Ia.: State Library of Iowa, 1988.

Hall, Sylvia D. *Iowa Computer-Assisted Network (ICAN Users' Manual. IBM Compatible Edition: Version 5.0.* Des Moines, Ia.: State Library of Iowa, 1986.

Hall, Sylvia D. *Iowa Computer-Assisted Network (ICAN Users' Manual. Apple MacIntosh Edition: Version 5.0.* Des Moines, Ia.: State Library of Iowa, 1986.

Bruntjen, Scott and Sylvia D. Hall. *The District of Columbia Public Library Planning for Retrospective Conversion of Bibliographic Records and Automation Issues for the 1990's: Final Report*. Central City, Colo.: The Blue Bear Group, Inc., 1986.

Bruntjen, Scott and Sylvia D. Hall. *The Iowa Locator: Final Report.* Central City, Colo.: The Blue Bear Group, Inc., 1986.

Bruntjen, Scott and Sylvia D. Hall. *Discovering Resource Sharing Treasures: Accessing Pennsylvania's High School Library Collections*. Harrisburg, Pa.: State Library of Pennsylvania, Bureau of School Library Media Resources, 1985.

Hall, Sylvia D. *Retrospective Conversion and the Completeness of Cataloging in Pennsylvania High School Libraries.* Pittsburgh, Pa.: PRLC, Inc., 1985.

Bruntjen, Scott and Sylvia D. Hall. *The Iowa Locator.* Des Moines, Ia.: State Library of Iowa, 1985- http://www.statelibraryofiowa.org/ld/silo/locator

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Bruntjen, Scott and Sylvia D. Hall. *Zebras: Bar Codes, Standards, and Library Automation*. Central City, Colo.: The Blue Bear Group, Inc., 1985.

Hall, Sylvia D. and Scott Bruntjen. *Access Pennsylvania*. Harrisburg, Pa.: State Library of Pennsylvania, 1984- http://www.accesspa.org

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Other Publications

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Hall-Ellis, Sylvia D. and Robert O. Ellett, Jr. *Fundamentals of Cataloging I: an Online ALCTS Course.* Chicago, Ill.: American Library Association, 2009.

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Hall-Ellis, Sylvia D. *Cataloging Education: A New Emphasis for the Library and Information Science Curriculum.* Presentation delivered to the ALCTS Pre-conference, 132nd Annual Conference, American Library Association, Washington, D.C., June 22, 2007. http://www.loc.gov/aba/professional/

Hall-Ellis, Sylvia D. "*Cataloger Competencies: Do the Employers Require What the Professors Teach?*" Presentation delivered to the ALCTS CCS Heads of Cataloging Discussion Group, 131st Annual Conference, American Library Association, New Orleans, Louisiana, June 26, 2006. http://dlist.sir.arizona.edu/

Hall-Ellis, Sylvia D., guest editor, with Deborah S. Grealy, Clara L. Sitter, and Tassos Petrou. *Library Students' Voices in Colorado: An Issue of Colorado Libraries* 31:1 (Spring 2005).

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Hall-Ellis, Sylvia D. "Authority Control and Its Importance in School Library Media Online Catalogs." 1999. Unpublished manuscript.

Hall, Sylvia D. "Cooperation Improving Service in San Antonio System." *Texas Libraries* XXXVII (Spring 1976): 27-29.

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Book Reviews

ALA Book of Library Grant Money. Ann Kepler, ed. 8th ed. Chicago, IL: American Library Association, 2011. 978-0-8389-1058-0, $175.00 [*Colorado Libraries*, June 2012]

Developing a Compensation Plan for Your Library. Paula M. Singer and Laura L. Francisco, comps. 2nd ed. Chicago, IL: American Library Association, 2009. 978-0-8389-0985-0, $57.00 [*Colorado Libraries,* March 2012]

Frugal Librarian. Carol Smallwood, ed. Chicago, IL: American Library Association, 2011. 978-0-83891-075-7, $42.00 [*Colorado Libraries*, February 2012]

Dowlin, Ken. *Getting the Money: How to Succeed in Fundraising for Public and Nonprofit Libraries.* Westport, Conn.: Libraries Unlimited, 2008. 978-1-59158-597-X, $50.00 [*Colorado Libraries*, February 2009]

Lundahl, Mats. *Bebo de Cuba; Bebo Valdés y Su Mundo*, by Mats Lundahl. Traducción de Linda Oakeshott Dragó. Barcelona: RBA Libros, 2008. 978-849-86-7259-6, $33.99 [*Críticas*, November 2008]

Bonelli, Florencia. *Marlene*, by Florencia Bonelli. Buenos Aires: Aguilar, Altea, Taurus, Alfaguara, 2008. 978-987-04-0995-3, $24.95 [*Críticas*, October 2008]

Keret, Etgar. Traducción de Ana María Bejarano. *Pizzería Kamikaze y Otras Relatos.* México, D.F.: Editorial Sexto Piso, 2008. 968-5679-29-0, no price given [*Críticas*, September 2008]

Littauer, Marita, and Florence Littauer. *Enriquece tu Comunicación. Miami, Fla.: Editorial Unilit, 2008.* 978-0-7899-1521-4, $11.99 [*Críticas*, August 2008]

Martínez, Guillermo. *La Muerte Lenta de Luciana B.* New York: Rayo Planeta, 2008. 978-0-06-156551-9, $14.95 [*Críticas*, May 2008]

Matthews, Joseph R. *The Evaluation and Measurement of Library Services.* Westport, Conn.: Libraries Unlimited, 2007. 978-1-59158-532-9, $50.00 [*Colorado Libraries,* April 2008]

Gómez-Jurado, Juan. *A Masacre de Virginia Tech: Anatomía de una Mente Torturada.* Barcelona: Ediciones El Andén, 2007. 978-84-935789-4-7, €16.50 [*Críticas*, February, 2008]

Matthews, Joseph R. *Library Assessment in Higher Education.* Westport, Conn.: Libraries Unlimited, 2007. 978-1-59158-531-2, $45.00 [*Colorado Libraries,* February 2008]

Chacón, Inma. *La Princesa India: Cuando el Viento Azul.* México: Alfaguara, 2006. 970-770398-9, $19.95 [*Críticas*, June 2006]

Vargas Llosa, Mario. *Israel/Palestina: Paz o Guerra Santa.* fotogs. by Morgana Vargas Llosa. Spain/U.S.: Aguilar: Santillana, 2006. 84-03-09691-7, paper, $19.95 [*Críticas,* May 2006]

Findlay, Diane. *Digging into Dewey.* Fort Atkinson, Wisc.: Upstart Books, 2005. 978-1-932146-18-9, $16.95 [*Colorado Libraries,* May 2006]

Pequeñas Resistencias 4: Antología del Nuevo Cuento Norteamericano y Caribeño. Menéndez, Ronaldo, Ignacio Padilla & Enrique del Risco, eds. Madrid**:** Páginas de Espuma, 2005. 84-95642-59-X, paper, $36.95 [*Críticas,* April 2006]

Rueda, André. *Vengo a Salvar a España: Biografía de Un Franco Desconocido.* Madrid**:** Nowtilus (Investigación Abierta), 2005. photogs., bibliog. 84-9763-202-8, paper, $23.95 [*Críticas,* March 2006]

Becerra, Ángela. *El Penúltimo Sueño.* 1st ed. Barcelona: Planeta, 2005. 84-08-05795-2, $25.95. [*Críticas,* January 2006]

Aguilar Camín, Héctor. *La Conspiración de la Fortuna.* 1st ed. México: Planeta, 2005. 970-37-0368-2, $19.95 [*Críticas,* October 2005]

México en Sus Libros. Enrique Florescano with Pablo Mijangos, editors & compilers. 1st ed. México, D.F.: Taurus Aguilar, 2004. 968-19-0783-3, $16.95 [*Críticas,* September 2005]

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Czarnowsky, Christyne A. and Michael H. Williams. *Managing Your Wired Workforce: A Practical Guide.* Denver, Colo.: Bradford Pub., 2003. 1-883726-79-4, $24.95 [*Colorado Libraries,* 2004]

Abraham Lincoln. Colección Grandes Biografías. Madrid: Edimat Libros, 2003. 84-8403-858-0, €4.95 [*Críticas,* 2004]

Alponte, Juan María. *Colón: el Hombre, el Navegante, la Leyenda.* México, D.F.: Aguilar, 2003. 968-19-1260-8, $16.95 [*Críticas,* 2004]

Olcese Salvatecci, Alfieri. *Cómo Estudiar con Èxito: Téchnicas yHhábitos Para Aprender Major.* México, D.F.: Alfaomega Grupo Editor, 2002. 970-15-0764-9 [*Críticas,* 2003]

Mujeres Como Islas: Antología de Narradoras Cubanas, Dominicanas, Puertoriqueñas. Edición: Olga Marta Pérez, Thelma Jiménez, Andrés Blanco D., eds. Santo Domingo, República Dominicana: Ediciones Ferilibro, 2002. 959-209-419-5 [*Críticas,* 2003]

Tibol, Raquel. *Los Murales de Diego Rivera: Universidad Autónoma Chapingo.* México, D.F.: Editorial RM, Universidad Autónoma Chapingo, 2002. 968-5208-08-5 [*Críticas,* 2003]

Lindsay-Poland, John. *Emperors in the Jungle: the Hidden History of the U.S. in Panama.* Durham, N.C.: Duke University Press, 2003. 0-8223-3098-9, $18.95 [*Críticas,* 2003]

Kaplan, Allison G. and Ann Marlowe Riedling. *Catalog It! A Guide to Cataloging School Library Materials.* Worthington, Ohio: Linworth Pub., 2002. 1-58683-014-7, $44.95 [*Colorado Libraries,* 2002]

Bardach, Ann Louise. *Cuba Confidential: Love and Vengeance in Miami and Havana.* New York: Random, 2002. 0-375-50489-3, $25.95 [*Library Journal,* 2002]

Swan, James. *Fundraising for Libraries: 25 Proven Ways to Get More Money for Your Library.* New York: Neal Schuman, 2002. 1-55570-433-6, $69.95 [*Colorado Libraries,* 2002]

Puíg de Lange, Victoria. *Sol Con Agua.* Nashville, Tenn.: Editorial Vistazo/Ediciones Reio Negro, 2002. 0-9724506-0-2, $17.75 [*Críticas,* 2002]

The Encyclopedia of Latin American Politics. Edited by Diana Kapiszewski; assistant editor, Alexander Kazan. Westport, Conn.: Oryx Press, 2002. 1-57356-306-4, $74.95 [*Library Journal*, 2002]

Vargas Lizano, Isabel. *Y Si Quieres Saber de Mi Pasado.* Con la colaboración de J.C. Vales. Madrid: Santillana Ediciones Generales, S.L., 2002. 84-03-09278-4, $18.95 [*Críticas,* 2002]

Ruy Sánchez, Alberto. *Los Jardines Secretos de Mogador: Voces de Tierra.* México, D.F.: Alfaguara, S.A., 2001. 968-19-0879-1, $16.95 [*Críticas,* 2002]

Chávez, Ricardo and Celso Santajuliana. *El Final de las Nubes.* Barcelona: RBA Libros, S.A., 2001. 84-7901-760-0, $11.95 [*Críticas,* 2002]

The Power of Language / El Poder de la Palabra: Selected Papers from the Second REFORMA National Conference. Edited by Lillian Castillo-Speed and the REFORMA National Conference Publications Committee. Englewood, Colo.: Libraries Unlimited, 2001. 1-563089459, $35.00 [*Colorado Libraries,* 2001]

Martínez, Rubén. *Crossing Over: A Mexican Family on the Migrant Trail.* Metropolitan: Holt, 2001. 0-8050-4908-8, $26.00 [*Library Journal*, 2001]

Guevara, Ernesto "Che." *The African Dream: the Diaries of the Revolutionary War in the Congo.* Translated from the Spanish by Patrick Camiller. With an introduction by Richard Gott and a foreword by Aleida Guevara March. New York: Grove Press, 2001. 0-8021-3834-9, $13.00 [*Library Journal*, 2001]

Cooper, Gail and Garry Cooper. *New Virtual Field Trips.* Englewood, Colo.: Libraries Unlimited, 2001. 1-56308-887-8, $27.50 [*Colorado Libraries,* 2001]

NATIONAL SERVICE & PROFESSIONAL AFFILIATIONS

American Library Association
Association for Library Collections & Technical Services
Cataloging, Classification, and Metadata Section
ALCTS Editorial Board, Member, 2015-
Committee on Cataloging: Description and Access, Member, 2008-2012
Test Site for RDA, Manager, 2009-2011
Nominating Committee, Member, 2007-2008
Committee for Education and Training of Catalogers, Chair, 2006-2007, Member, 2003-2007
Competencies & Education for a Career in Cataloging Interest Group, Chair, 2010-2012; Member, 2010-
President's Program Committee, 2015-2016
Education Committee, Member, 2005-2007
Task Force on Competencies and Education for a Career in Cataloging, Chair, 2007-2009
2007 Annual Meeting Pre-conference, "What They Don't Teach in Library School: Competencies, Education and Employer Expectations for a Career in Cataloging," Steering Committee Chair
Fundraising Committee, Member, 2004-2006
Office of Diversity
Committee on Diversity, Chair, 2010-2011
Diversity Research Advisory Committee, Member, 2009-2010
Spectrum Scholar Mentor, 2009
Diversity Grants Review Committee, Member, 2007, 2010, 2012
Office of Statistics and Research
Research and Statistics Committee, Member, 2005-2007; Intern, 2003-2005
Library Research Round Table
Board of Directors, Member At-Large, 2009-2012
Member, 2003-
Office of Accreditation
Accreditation Panel Member (training completed 2004)
Accreditation Review Panel Member (training completed 2004)

REFORMA
National Board of Directors, 2005-2013
National Fundraising Chair, 2005-2013
National Recruiting and Mentoring Committee, 2008-2010
Colorado Chapter, Secretary, 2004-2005
Colorado Chapter Liaison to National Board of Directors, 2004-2013

Online Audiovisual Catalogers Association (OLAC)
American Association of Law Libraries (AALL)
Colorado Association of Law Librarians (CoALL)

Association for Library and Information Science Education (ALISE)
University of Denver ALISE Representative, 2003-2008; 2010-2011
Membership Advisory Committee, 2007-2010
Technical Services Education Special Interest Group, 2003-
Garfield Doctoral Dissertation Award Reviewer, 2012
Garfield Doctoral Dissertation Scholarship Reviewer, 2014
American Association of University Professors (AAUP), 2006-
American Grant Writers Association, 2014-
Grant Professionals Institute, 2016-
National Grants Management Association, 2014-

Grant Reviewer (National and Regional Team Leader), U.S. Department of Education, 1998-
Grant Reviewer, Broadband Technologies Opportunity Program, U.S. Department of Commerce, 2009

Grant Reviewer, Institute of Museum and Library Services, 1998-2000
Grant Reviewer, Colorado Department of Education, 2014-
Grant Reviewer, Colorado State Library, 1998-
Grant Reviewer, American Association of Community Colleges *Working Connections* program, 1999
Peer Reviewer, *Journal for Library and Information Science Education*, 2005-
Peer Reviewer, *Journal of Library Metadata*, 2009
Peer Reviewer, *International Journal of Library and Information Science*, 2011
Regular Columnist, *The Bottom Line*, 2013-2016
Book Reviewer, *Library Journal*, 2001
Book Reviewer, *Críticas*, 2002-2009
Book Reviewer, *Colorado Libraries*, 2000-2012

REGIONAL SERVICE & PROFESSIONAL AFFILIATIONS

Mountain Plains Library Association
Professional Development Grants Committee, Member, 2005-2006
Professional Development Policy and Guidelines Sub-committee Chair, 2006

Colorado Association of Libraries
"Student Voices" Column Editor, *Colorado Libraries*, 2005-2006
Conference Planning Committee, Member, 2002
Technical Services and Automation Division, Chair, 2002-2003; Member, 2000-
Academic Libraries Division, Peer Review Conference Papers Committee, Member, 2007-2009
Education Committee, Member, 1988-1993
Diverse Populations Committee, Member, 2009-2013

SERVICE TO THE UNIVERSITY OF DENVER
Center for Teaching and Learning Faculty Advisory Board, 2007-2008; 2010-2012
Center for Community Engagement and Service Learning Advisory Board, 2007-2012
Faculty Senate
Executive Committee, 2008-2013
Nominations, Rules & Credentials Committee, Chair, 2008-2013; Member 2007-2013
Appointment, Promotion, and Tenure Revision Committee, 2010-2012
Grievance Policy Committee Member, 2007-2010
Law Library Director Search Committee Chair, 2012-2013
PROF Grant Review, College Representative to the University Review Team, 2006, 2008
Project Homeless Connect Evaluations, Principal Investigator, 2006-2009
University Technology Council, 2007-2009
University of Denver Hyde Interviews for Incoming Freshmen, 2003-2012

SERVICE TO THE MORGRIDGE COLLEGE OF EDUCATION
Appointment, Tenure & Review Committee
Member, voting, 2003-2005; 2007- 2009
Chair, Clinical Faculty Promotion & Tenure Policy Subcommittee, 2008-2009
Member, Community Engagement Subcommittee, 2007-2009
Member, Tenure Review Panel, 2003
Advancement and Alumni Relations Committee, Chair, 2003-2007; Member, 2002-2007
College Building Committee Member, 2004-2010
College of Education Student Association, Faculty Advisor, 2004-2007; 2009-2010
Faculty Senator, 2007-2013
Research and Scholarship Committee, Chair, 2008-2009; Member, 2002-2003, 2008-2009
Research and Grant Mentoring Committee, Chair, 2009-2010
Research Task Force Member, 2010-2012
Search Committee Member, Assistant Professor for Curriculum & Instruction, 2010-2011
Workload Task Force Member, 2010-2011

SERVICE TO THE LIBRARY & INFORMATION SCIENCE PROGRAM
Library and Information Science Student and Alumni Association, Faculty Advisor, 2002-2008
ALA Student Chapter, Faculty Advisor, 2005-2008
Beta Phi Mu Phi Chapter, Faculty Advisor, 2004-2014
Steering Committee Member, Accreditation by the American Library Association, 2001-2004
Search Committee Member, Associate Professor for LIS, 2006
Search Committee Chair, Assistant Professors for LIS, 2003, 2005, 2006, 2007
Search Committee Ex-Officio Member, Director for LIS, 2004

SERVICE TO SAM HOUSTON STATE UNIVERSITY
Rio Roundup: South Texas Literature Conference, Conference Coordinator, 1993
External Relations, Fund Raising, Grants Committee, Chair, 1993-1995
Advisory Council Committee, Chair, 1993-1995
Students, Admissions, and Advisement Committee, Chair, 1994
Institutional Effectiveness Committee, Member, 1993-1995

SERVICE TO THE COLLEGE OF EDUCATION AND APPLIED SCIENCE
Faculty Affairs Committee, Member, 1993-1995
Curriculum Committee, Member, 1993-1995
Continuing Education Committee, Member, 1993-1995

SERVICE TO THE COMMUNITY
Denver/Boulder Games 2022, Board of Directors, Secretary-Treasurer, 2015-
United Way Campaign Committee, College of Education, 2006
Arapahoe County, Election Judge for the County Clerk and Recorder, 2000-2005
Arthritis Foundation, Rocky Mountain Chapter, Certified Educator & Trainer, 1999-2008
Bonfils Blood Center, Silver Level Donor, 2000-
Denver Museum of Natural History, Docent, 1992
Tech Prep of the Lower Rio Grande Valley, Inc. (Harlingen, Texas) Board of Directors, 1995-1997
Executive Committee, 1996-1997; Chair, Development Committee, 1995-1997; Chair, Fiscal Agency Committee, 1995-1996; Chair, Colleges and Universities Committee, 1996-1997
Gilpin County (Colorado) Public Library Board of Trustees, 1986-1989; Vice President, 1987-1989
City of Central (Colorado) Economic Development Committee, 1987-1989
Columbine Family Health Centers, Inc. (Nederland and Black Hawk, Colorado) Board of Directors, 1988-1989

CERTIFICATION
Permanent Public Librarian Certificate - Pennsylvania, New York, Texas
Westlaw Expert Witness, 2008-
Certified Grant Writer®, 2016-

AWARDS AND HONORS
Advanced Practitioner for Service Learning and Community Engagement, University of Denver, 2011
Platinum Star Alumnae, College of Information, Library Science & Technologies, University of North Texas, 2009
Commendation for Integration of Technologies in Teaching & Learning Environment, University of Denver, 2006
Outstanding Adjunct Faculty Member Award, College of Education, University of Denver, 2002
Beta Phi Mu, Pi, University of Pittsburgh, 1985
Alpha Lambda Sigma, University of North Texas, 1972

Who's Who in America; Who's Who in American Women; Who's Who of Women Executives; Dictionary of International Biography; Who's Who in the East; Who's Who in the South and Southwest; Who's Who in the World; Who's Who of Online Professionals; Who's Who in Library and Information Science; 2,000 Notable Women; Who's Who of Emerging Leaders; Who's Who in Professional and Executive Women; Who's Who in American Education; International Who's Who of Professional and Business Women; International Leaders in Achievement; International Educator of the Year; Who's Who in Finance and Industry; Who's Who in Finance and Business

Invited International and National Conference Presentations

Hall-Ellis, Sylvia D. *Invest in Me -- I'm Your Future: Succession Planning for Libraries.* Keynote presentation delivered at the ALCTS President's Symposium, Boston, Mass., January 8, 2016.

Seidel, Kent E. and Sylvia D. Hall-Ellis. *Making Grants Work for You: Strategies for Doctoral Students and Early Career Scholars.* Presentation delivered at the University Council for Educational Administration, Early Career Scholars Session, Indianapolis, Ind., November 9, 2013.

Hall-Ellis, Sylvia D. *So You Want to be a Manager; Leadership Skills and Competencies for Technical Services Managers and Administrators.* Presentation delivered at the 138th Annual Conference, American Library Association, Chicago, Ill., June 29, 2013.

Seidel, Kent E., Karen S. Riley, Lyndsay Agans, Susan Korach, and Sylvia D. Hall-Ellis. *Making Grants Work for You (Instead of Just Working for Grants).* A panel discussion delivered at the University Council for Educational Administration, Early Career Scholars Session, Denver, Colo., November 17, 2012.

Hall-Ellis, Sylvia D. *After the Great TS Reorganization: The Westminster Law Library.* Presentation delivered at the 137th Annual Conference, American Library Association, Anaheim, Calif., June 23, 2012.

Hall-Ellis, Sylvia D. *Conversations with Catalogers in the 21st Century.* A panel discussion sponsored by the ALCTS Competencies for a Career in Cataloging Interest Group, delivered at the 137th Annual Conference, American Library Association, Anaheim, Calif., June 22, 2012.

Hall-Ellis, Sylvia D., moderator. *Mid-Career Leaders Program.* A panel discussion sponsored by the ALA Committee on Diversity delivered at the 136th Annual Conference, American Library Association, New Orleans, La., June 26, 2011.

Hall-Ellis, Sylvia D., moderator. *Diversity Town Hall.* A community conversation sponsored by the ALA Committee on Diversity delivered at the 136th Annual Conference, American Library Association, New Orleans, La., June 24, 2011.

LaBarre, Kathryn, Sylvia D. Hall-Ellis, Karen Anderson, Rick Hasenyager, Christopher Cronin, and Penny Baker. *Briefings from RDA Test Participants.* A panel discussion delivered at the Midwinter Conference, American Library Association, San Diego, Calif., January 7, 2011.

Miksa, Shawne, Marjorie Bloss, and Sylvia D. Hall-Ellis. *Educating the Next Generation of Catalogers: Teaching RDA.* A panel discussion delivered at the 97th Annual Conference, Association for Library and Information Science Education, San Diego, Calif., January 7, 2011.

Hall-Ellis, Sylvia D., Robert Maxwell, John Hostage, and George Prager. *RDA Panel: What Cataloging Managers Need to Know.* Presentation delivered at the 103rd Annual Conference, American Association of Law Librarians, Denver, Colo., July 12, 2010.

Hall-Ellis, Sylvia D. and Stacey L. Bowers. *Catalogers in the RDA Environment: Skill Sets, Expectations and Challenges.* Presentation delivered at the 103rd Annual Conference, American Association of Law Librarians, Denver, Colo., July 11, 2010.

Hall-Ellis, Sylvia D. *Comfortable in Your Cataloging and Metadata Specialist Skin? Or, So You Want to Hire a Cataloger.* Presentation delivered to the ALCTS Research Group at the 134th Annual Conference, American Library Association, Chicago, Ill., July 11, 2009.

Perez, Megan, Sylvia D. Hall-Ellis, and Denise Anthony. *From Novice to Expert: Collaboration for Succession Planning.* A "hot topic" presentation delivered at the 14th ACRL Conference, Seattle, Wash., March 13, 2009.

Hall-Ellis, Sylvia D. *Cataloging in the RDA Environment: Skill Sets, Expectations and Challenges.* Presentation delivered to the ALCTS Research and Publications Committee at the Midwinter Conference, American Library Association, Denver, Colo., January 24, 2009.

Hall-Ellis, Sylvia D. *LIS Cataloging Education for the 21st Century: Expectations and Challenges.* A panel discussion held at the 95th Annual Conference, Association for Library and Information Science Education, Denver, Colo., January 23, 2009.

Chu, Clara, Sylvia D. Hall-Ellis, and Mark Winston. *The Doctoral Degree & Building a Career.* A panel discussion delivered at the ALA Office of Diversity Spectrum Doctoral Fellows E.J. Josey Leadership Institute, Midwinter Conference, American Library Association, Denver, Colo., January 20, 2009.

Hall-Ellis, Sylvia D. and Robert O. Ellett, Jr. *Fundamentals of Cataloging Course: An Overview of the ALCTS Online Course.* Presentation delivered to the ALCTS Big Heads Group, 133rd Annual Conference, American Library Association, Anaheim, Calif., June 30, 2008.

Hall-Ellis, Sylvia D. *Employers' Expectations for Technical Services Librarians: What We Don't Know.* Presentation delivered to the ALCTS Research and Publications Committee Program, 133rd Annual Conference, American Library Association, Anaheim, Calif., June 28, 2008.

Hall-Ellis, Sylvia D., Virginia R. Maloney, and Mary Stansbury. *Institutional Responses to Engaged Scholarship: The Carnegie Foundation Engaged University Classification at Two Universities.* Presentation delivered to the 94th Annual Conference, Association for Library and Information Science Education, Philadelphia, Pa., January 11, 2008.

Hall-Ellis, Sylvia D. *Puzzles, Problems, and Predicaments.* Presentation delivered to the ALCTS Research Discussion Group, 132nd Annual Conference, American Library Association, Washington, D.C., June 23, 2007.

Hall-Ellis, Sylvia D. *Cataloging Education: A New Emphasis for the Library and Information Science Curriculum.* Presentation delivered to the ALCTS Pre-conference, 132nd Annual Conference, American Library Association, Washington, D.C., June 22, 2007. http://www.loc.gov/catdir/cpso/careercat.html

Ellett, Jr., Robert O. and Sylvia D. Hall-Ellis. *Copy Cataloging Done Smarter.* Presentation delivered to the International Conference on Interdisciplinary Information Sciences and Technologies (InSciT2006), October 25-28, 2006.

Hall-Ellis, Sylvia D. and Robert O. Ellett, Jr. *Cooperative Cataloging: Challenges and Opportunities for Defense Libraries.* Presentation delivered to the 1st Annual Conference of Defense Libraries, Spanish Ministry of Defense, Madrid, Spain, July 7, 2006.

Hall-Ellis, Sylvia D. *Cataloger Competencies: Do the Employers Require What the Professors Teach?* Presentation delivered to the ALCTS CCS Heads of Cataloging Discussion Group, 131st Annual Conference, American Library Association, New Orleans, La., June 26, 2006.

Grealy, Deborah S. and Sylvia D. Hall-Ellis. *From Research to Practice: The Scholarship of Teaching and Learning in LIS Education.* Presentation delivered to the at the 92nd Annual Conference, Association for Library and Information Science Education, San Antonio, Tex., January 18, 2006.

Hall-Ellis, Sylvia D. *Employers' Expectations for Entry-Level Catalogers: What Position Announcement Data Indicate.* Research paper delivered to the Technical Services Special Interests Group, 91st Annual Conference, Association for Library and Information Science Education, Boston, Mass., January 12, 2005. http://dlist.sir.arizona.edu/

Hall-Ellis, Sylvia D. *Common Errors in MARC Records Prepared by LIS Students: What Does It Mean?* Research paper delivered to the ALCTS CCS Cataloging Norms Discussion Group, Mid-Winter Conference, 90th American Library Association, San Diego, Calif., January 10, 2004.

Hall-Ellis, Sylvia D. *Visual Arts as Foundation for Successful Library Automation: The Rocky Mountain College of Art & Design Experience.* Paper delivered at the 6th Annual Conference of Higher Education, Charleston, S. C., 1993.

Hall, Sylvia D. *Design Elements for Bibliographic Databases: An Overview.* Paper delivered at the 14th Online National Conference, New York, 1983.

Invited Regional Conference Presentations

Hall-Ellis, Sylvia D., Hudson, Christopher D., Brittany Cronin, and Kathryn Michaels. "The Colorado Law Project: Meeting the Public's Need for Legal Information." Panel discussion delivered at the Mountain Plains Library Association Conference, Billings, Mont., April 9, 2011.

Grealy, Deborah S. and Sylvia D. Hall-Ellis. *Education for Information Professionals in New Mexico: Library & Information Science Graduate Education at the University of Denver.* Presentation delivered at the New Mexico Library Education Summit, Las Vegas, N.M., September 26, 2005.

Hall-Ellis, Sylvia D. *Public Library-School Library Partnerships.* Presentation delivered at the 3rd Annual Colorado Association of Libraries Conference with the Mountain Plains Library Association, Denver, Colo., October 22, 2004.

Hall-Ellis, Sylvia D. *Learn All You Can – Educational Partnership Opportunities for the Lewis and Clark Bicentennial Commemoration.* Paper delivered at the 3rd Annual Lewis and Clark Bicentennial Council National Planning Conference, Bismarck, N.D., April 26, 1998.

Invited State Conference Presentations

Grealy, Deborah S. and Sylvia D. Hall-Ellis. *Academic Library Leadership Changes: Using Succession Planning and Mentoring*. Presentation delivered at the Minnesota Library Education Conference, St. Cloud, Minn., October 10, 2013.

Hall-Ellis, Sylvia D., Merrie Valliant, and Melissa Powell. *RDA: What Is It and What Do You Need To Do With It At Your Library?* Presentation delivered at the Colorado Library Consortium Spring Conference, Ft. Morgan, Colo., April 26, 2013.

Hall-Ellis, Sylvia D. *Service Learning and the Library & Information Science Graduate Education at the University of Denver.* Presentation delivered at the 4th LEADS Scholars Orientation, Denver, Colo., August 5, 2009.

Hall-Ellis, Sylvia D. *Service Learning: Enhancement to Library & Information Science Graduate Education at the University of Denver.* Presentation delivered at the 3rd LEADS Scholars Orientation, Denver, Colo., June 2008.

Hall-Ellis, Sylvia D. *Law Librarianship: A Community Conversation.* Sponsored by the Colorado Association of Law Libraries. Paper delivered at the Colorado Supreme Court Library, Denver, Colo., May 14, 2008.

Hall-Ellis, Sylvia D. *Opportunities and Challenges in Law Librarianship: A Community Conversation.* Presentation delivered at the Sturm College of Law, Denver, Colo., November 7, 2007.

Hall-Ellis, Sylvia D. *Grant Writing Resources for Nursing Professionals.* Presentation delivered at the Presbyterian / St. Luke's Health One Medical Center 1st Annual Research Symposium, Denver, Colo., October 17, 2007.

Hall-Ellis, Sylvia D. *Project Homeless Connect 4 Event Evaluation – Insights and Lessons Learned.* Presentation delivered at the Homelessness Research Symposium: What is DU Doing about Homelessness in Denver, Denver, Colo., September 14, 2007.

Hall-Ellis, Sylvia D. *Service Learning and the Library & Information Science Graduate Education at the University of Denver.* Presentation delivered at the 2nd LEADS Scholars Orientation, Denver, Colo., August 10, 2007.

Hall-Ellis, Sylvia D. *Education for Information Professionals in a Digital Environment: Library & Information Science Graduate Education at the University of Denver.* Presentation delivered at the 15th Spring Mountains and Plains Parapros Conference, Denver, Colo., February 24, 2007.

Hall-Ellis, Sylvia D. *Public Library Service to Spanish-Speaking and Latino Residents in Denver: A Case Study.* Presentation delivered at the 4th Annual Colorado Association of Libraries Conference, Denver, Colo., November 10, 2005.

Hall-Ellis, Sylvia D. *Education for Information Professionals in a Digital Environment: Library & Information Science Graduate Education at the University of Denver.* Presentation delivered at the 14th Annual Mountains and Plains Parapros Conference, Aurora, Colo., July 29, 2005.

Hall-Ellis, Sylvia D. *Educational Opportunities: Library & Information Science Graduate Education at the University of Denver.* Presentation delivered at the 13th Annual Mountains and Plains Parapros Conference, Centennial, Colo., August 6, 2004.

Hall-Ellis, Sylvia D. *Library Education & Training: Focus on the West: An LIS Faculty Member's Personal Response.* Presentation delivered at the 1st Annual Colorado Association of Libraries Conference, Keystone, Colo., October 18, 2002.

Hall-Ellis, Sylvia D. *Grant Writing for School Librarians.* Presentation delivered at the 2002 Annual Colorado Education Media Association Conference, Colorado Springs, Colo., February 15, 2002.

Hall-Ellis, Sylvia D. *Grants – Opportunities for the Future.* Paper delivered at the Southeast Regional Accountability Annual Conference, Lamar, Colo., November 12, 1998.

Hall-Ellis, Sylvia D. *The Texas Library Connection and Interlibrary Loan: An Experiment in Resource Sharing.* Paper delivered at the Texas Computer Educators' Association Annual Conference, Austin, Tex., February 6, 1997.

Hall-Ellis, Sylvia D. *Finding Grant Sources on the Internet: A Guide for Librarians.* Paper delivered at the 2nd Annual Institute for School Library Personnel, Pharr-San Juan-Alamo North High School, Pharr, Tex., July 29, 1996**.**

Hall-Ellis, Sylvia D. *Mathematical and Logical Thinking: A Critical Intelligence.* Paper delivered at the 3rd Annual Paraprofessional Conference at the University of Texas - Pan American, Edinburg, Tex., March 8, 1996.

Hall-Ellis, Sylvia D. *Cataloging Trends and Issues: Update Session.* Paper delivered at the 1st Annual Institute for School Library Personnel, South Texas Community College, McAllen, Tex., July 19, 1995.

Hall-Ellis, Sylvia D. *Grant Writing: Tips and Encouragement for School Librarians.* Paper delivered at the 1st Annual Institute for School Library Personnel, South Texas Community College, McAllen, Tex., July 18 and 19, 1995.

Hall-Ellis, Sylvia D. *How to Become an Expert Grant Writer.* Paper delivered at the 3rd Annual High School Principals' Academy, South Padre Island, Port Isabel, Tex., June 19, 1995.

Hall-Ellis, Sylvia D. *Texas Library Study: Results from Regions I and II.* Paper delivered at the 3rd Annual Technology Conference, Texas A&M University, College Station, Tex., November 18, 1994.

Hall-Ellis, Sylvia D. *Academic Achievement and Middle School Students.* Paper delivered at the 8th Annual Young Adult Conference, Sam Houston State University, Huntsville, Tex., November 5, 1994.

Hall-Ellis, Sylvia D. *Multimedia Resources for Library Leaders.* Paper delivered at the Institute for Librarians in A Multicultural Environment, Sam Houston State University, Huntsville, Tex., June 10, 1994.

Hall-Ellis, Sylvia D. *Finding the Resource: Empowering the User, or, the Case for Curriculum Based Subject Access to Learning Resource Center Collections.* Paper delivered at the 81st Annual Texas Library Association Conference, Corpus Christi, Tex., April 12-16, 1994.

Hall-Ellis, Sylvia D. and William H. Pichette. *Sam Houston State University Makes Use of OCLC/AMIGOS Collection Analysis CD.* Paper delivered at the 81st Annual Texas Library Association Conference, Corpus Christi, Tex., April 12-16, 1994.

Hall, Sylvia D. *Funding and Library Development in Pennsylvania: A Symbiotic Relationship.* Paper delivered at the Annual Graduate Student Colloquia, University of Pittsburgh, School of Library and Information Science, 1982.

Hall, Sylvia D. *Leadership for Public Library Trustees.* Paper delivered for the Trustees Division, Pennsylvania Library Association Annual Conference, Lancaster, Penn., 1981.

Seminar and Professional Development Presentations

Taylor, Meredith, and Sylvia D. Hall-Ellis. *Talent Management and Succession Planning.* ALCTS eForum, held March 22, 2017.

Hirsh, Sandra, Heather O'Brien, Michelle Holschuh Simmons, Michael Krasulski, and Sylvia D. Hall-Ellis. *Information Services Today: An Introduction. Part 3: Information Services: Roles in the Digital Age*. Rowan and Littlefield in partnership with Library Journal webinar, recorded February 5, 2015.

Hall-Ellis, Sylvia D. and Jennifer Sweda. *Copy Cataloging in an RDA Environment.* ALCTS eForum, held May 14 and 15, 2013.

Hall-Ellis, Sylvia D. *Law Librarianship: A Community Conversation.* Sponsored by the Colorado Association of Law Libraries, presented at the Colorado Supreme Court Library, Denver, Colo., May 14, 2008.

Hall-Ellis, Sylvia D. and Beatrice Z. Gerrish. *Reading and Libraries: Recent Research in Reading.* Presentation at the Ricks Center for Gifted Education, Denver, Colo., March 4, 2008.

Hall-Ellis, Sylvia D. *Cataloger Competencies: Do the Employers Require What the Professors Teach?* Presentation for the School of Library and Information Science, San José State University, February 12, 2008.

Hall-Ellis, Sylvia D. and Robert O. Ellett, Jr. *Cooperative Cataloging: Rules, Tools, and Conventions for Building a Multi-institutional Catalog.* Sponsored for the Spanish Ministry of Defense, Madrid, Spain, July 10, 2006.

Hall-Ellis, Sylvia D. *Cash for Kids: Grant Writing Opportunities for Youth Services Librarians.* Sponsored by the Colorado Young Adult Librarians; presented at Bemis Memorial Library, Littleton, Colo., November 13, 2002.

Hall-Ellis, Sylvia D. *MARC Records and Authority Control: Planning for Bibliographic Database Migration.* Sponsored and held at the Douglas County Public Library, Castle Rock, Colo., May 28, 2002.

Hall-Ellis, Sylvia D. *Grant Writing: A Refresher for Librarians.* Sponsored by Library and Information Science Program, College of Education, University of Denver; presented at University Center at Chaparral, August 12, 2000.

Hall-Ellis, Sylvia D. *Shaking the Money Tree – Basic Grant Writing for Colorado Educators.* Sponsored by the Office of Educational Telecommunications of the Colorado Department of Education.
Pikes Peak Community College, Colorado Springs, Colo., November 16, 1998.
Pueblo School District 60, Pueblo, Colo., November 12, 1998.
University of Northern Colorado, Greeley, Colo., November 10, 1998.
United Technology Educational Partnership, Grand Junction, Colo., November 9, 1998.

Hall-Ellis, Sylvia D. *Cataloging Multimedia, Kits, Globes and Map Materials in USMARC.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., April 24, 1997 and December 12, 1996.

Hall-Ellis, Sylvia D. *New Standards for School Library Media Centers.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., April 15, 1997.

Hall-Ellis, Sylvia D. *The School Library Media Specialist in the 21st Century: Visions for the Future.* Sponsored and hosted by Pharr-San Juan-Alamo Independent School District, Pharr, Tex., April 4, 1997.

Hall-Ellis, Sylvia D. *Cataloging Sound Recordings and Audio Materials in USMARC.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., March 20, 1997 and November 21, 1996.

Hall-Ellis, Sylvia D. *Evaluating and Selecting CD-ROMS for School Library Media Collections.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., March 18, 1997.

Hall-Ellis, Sylvia D. *Cataloging Audiovisual Materials in USMARC.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., February 27, 1997, November 7, 1996 and October 24, 1996.

Hall-Ellis, Sylvia D. *Introduction to Dialog: Basic Searching Strategies.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., February 14, 1997.

Hall-Ellis, Sylvia D. *Cataloging Books in USMARC.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., January 30, 1997, October 10, 1996, September 26, 1996 and August 8, 1996.

Hall-Ellis, Sylvia D. *Advanced Internet Searching Techniques for Librarians.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., January 21, 1997.

Hall-Ellis, Sylvia D. *Texas Library Connection Full-Text Searching.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., December 13, 1996 and October 25, 1996.

Hall-Ellis, Sylvia D. *Developing Evaluation Strategies for Grants and Proposals.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., December 10, 1996.

Hall-Ellis, Sylvia D. *Developing Needs Assessment for Grants and Proposals.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., November 12, 1996.

Hall-Ellis, Sylvia D. *Texas Library Connection Union Catalog Searching.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., November 8, 1996 and September 6, 1996.

Hall-Ellis, Sylvia D. *Grant Resources on the Internet.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., October 23, 1996.

Hall-Ellis, Sylvia D. *Preparing a Response to the Telecommunications Infrastructure Fund Board: Needs Assessment, Professional Development Framework, and Evaluation Strategies.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., October 16, 1996.

Hall-Ellis, Sylvia D. *Texas Library Connection: Building the Districtwide Bibliographic Database.* Sponsored and hosted by Mercedes Independent School District, Mercedes, Tex., September 13, 1996 and August 8, 1996. Sponsored and hosted by Los Fresnos Consolidated Independent School District, Los Fresnos, Tex., August 12, 1996.

Hall-Ellis, Sylvia D. *School-to-Work and Special Education: An Inclusive Partnership for Success.* Sponsored and hosted by the Office of Special Education, Region One Education Service Center, Edinburg, Tex., September 11, 1996.

Hall-Ellis, Sylvia D. *Telecommunications Infrastructure Fund Board: An Overview of Funding for Secondary Schools.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., August 31, 1996.

Hall-Ellis, Sylvia D. *Cataloging Books, Multimedia, and Realia in USMARC.* Sponsored and hosted by Edinburg Consolidated Independent School District, Edinburg, Tex., August 6, 1996.

Hall-Ellis, Sylvia D. *Internet Resources for Grant Writers.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., April 20, 1996.

Hall-Ellis, Sylvia D. *Enhanced Grant Writing Skills for Mathematics Educators: Writing Skills for Campus Teams.* Sponsored and hosted by the Office of General Education, Region One Education Service Center, Edinburg, Tex., March 22, 1996.

Hall-Ellis, Sylvia D. *Internet Resources for Grant Writers.* Sponsored and hosted by the College of Education and Applied Science, Sam Houston State University, Huntsville, Tex., March 9, 1996.

Hall-Ellis, Sylvia D. *Grant Writing for Mathematics Educators: A Development Process for Campus Teams.* Sponsored and hosted by the Office of General Education, Region One Education Service Center, Edinburg, Tex., March 4, 1996.

Hall-Ellis, Sylvia D. *Shaking the Money Tree: Preparing Successful Technology Grant Applications.* Sponsored and hosted by the Office of Technology and Media Services, Region One Education Service Center, Edinburg, Tex., February 29, 1996 and April 29, 1996.

Hall-Ellis, Sylvia D. *District-wide Technology Planning: Technical Assistance for the Texas Education Agency Initiative.* Sponsored and hosted by the Office of Technology and Media, Region One Education Service Center, Edinburg, Tex., February 2, 1996.

Hall-Ellis, Sylvia D. *Enhanced Grant Writing Skills.* Sponsored and hosted by Pharr-San Juan-Alamo Independent School District, Pharr, Tex., January 27, 1996.

Hall-Ellis, Sylvia D. *United States Copyright Act of 1976, Video Transmissions, Computer Software and the Internet.* Sponsored and hosted by the Office of Technology and Media, Region One Education Service Center, Edinburg, Tex., January 24, 1996.

Hall-Ellis, Sylvia D. *The Grant Writing Development Process.* Sponsored and hosted by Pharr-San Juan-Alamo Independent School District, Pharr, Tex., January 20, 1996.

Hall-Ellis, Sylvia D. *MARC Cataloging of Materials for Library Media Centers.* Sponsored and hosted by the Office of Media Services, Region One Education Service Center for the Donna Independent School District, Donna, Tex., August 17, 1995.

Hall-Ellis, Sylvia D. *Classification.* Sponsored by AJ Seminars, Rockville, Maryland; presented at University Hilton Hotel, Houston, Tex., May 10, 1995.

Hall-Ellis, Sylvia D. *Library Technical Services.* Sponsored by AJ Seminars, Rockville, Maryland; presented at University Hilton Hotel, Houston, Tex., April 26, 1995.

Hall-Ellis, Sylvia D. *Grant Writing: An Introduction for Public School Administrators.* Sponsored and hosted by the Office of Administrative Services, Region One Education Service Center, Edinburg, Tex., April 19, 1995.

Hall-Ellis, Sylvia D. *The School Library Media Specialist in the 21st Century: Visions for the Future.* Sponsored and hosted by the United Independent School District, Laredo, Tex., March 31, 1995.

Hall-Ellis, Sylvia D. *Using USMARC.* Sponsored by AJ Seminars, Rockville, Maryland; presented at University Hilton Hotel, Houston, Tex., March 29, 1995.

Hall-Ellis, Sylvia D. *Library Media Center Policies and Guidelines: How to Prepare for School Board Adoption.* Sponsored and hosted by the Office of Technology and Media Services, La Joya Independent School District, La Joya, Tex., March 10, 1995.

Hall-Ellis, Sylvia D. *Developing District-wide Policies and Guidelines for Library Media Centers.* Sponsored and hosted by the Office of Technology and Media Services, La Joya Independent School District, La Joya, Tex., January 10, 1995.

Hall-Ellis, Sylvia D. *MARC Cataloging of Audiovisual Materials for Library Media Centers.* Sponsored and hosted by the Office of Library Media and Technology Services, Cypress-Fairbanks Independent School District, Houston, Tex., December 1, 1994.

Hall-Ellis, Sylvia D. *The School Library Media Specialist in the 21st Century: Visions for the Future.* Sponsored and hosted by United Independent School District, Laredo, Tex., October 14, 1994.

Hall-Ellis, Sylvia D. *The School Library Media Specialist in the 21st Century: Visions for the Future.* Sponsored and hosted by the Laredo Independent School District, Laredo, Tex., October 7, 1994.

Hall-Ellis, Sylvia D. *MARC Cataloging for Library Media Centers.* Sponsored by the Office of Library Media and Technology Services, Cypress-Fairbanks Independent School District, Houston, Tex., October 5, 1994.

Hall-Ellis, Sylvia D. *Jump to the Head of the Class: Undergraduate Library Resources Available at Sam Houston State University.* Sponsored by the Office of the Associate Vice President for Student Services, Sam Houston State University, Huntsville, Tex., October 4, 1994.

Hall-Ellis, Sylvia D. *CD-ROMs - 1994's Newest and the Best for Secondary Level Media Centers.* Sponsored and hosted by Clear Lake Independent School District, Houston, Tex., June 3, 1994.

Hall-Ellis, Sylvia D. *Introduction to Classification.* Sponsored by AJ Seminars, Rockville, Maryland; presented at Holiday Inn, Market Center, Dallas, Tex., May 18, 1994.

Hall-Ellis, Sylvia D. *Basic Descriptive Cataloging.* Sponsored by AJ Seminars, Rockville, Maryland; presented at University Hilton Hotel, Houston, Tex., May 4, 1994.

Hall-Ellis, Sylvia D. *Shaking the Money Tree - Part II: Writing Successful Grant Applications.* Sponsored by Donna Independent School District, Donna, Texas, and Region One Education Service Center Edinburg, Texas; presented at South Texas Community College Library, McAllen, Tex., April 29, 1994.

Hall-Ellis, Sylvia D. *Using MARC.* Sponsored by AJ Seminars, Rockville, Maryland; presented at Holiday Inn, Market Center, Dallas, Tex., April 6, 1994.

Hall-Ellis, Sylvia D. *Automated Authority Control.* Sponsored by AJ Seminars, Rockville, Maryland; presented at University Hilton Hotel, Houston, Tex., March 23, 1994.

Hall-Ellis, Sylvia D. *Automating the District School Library Media Centers: Choices and Opportunities.* Sponsored and hosted by the Office of Technology and Library Media Services, Fort Bend Independent School District, Sugar Land, Tex., March 4, 1994.

Hall-Ellis, Sylvia D. *Shaking the Money Tree - Part I: Preparing Successful Grant Applications.* Sponsored and hosted by the Office of Library Media Services, Donna Independent School District, Donna, Tex., February 4, 1994.

GRADUATE COURSES TAUGHT

San José State University, School of Library and Information Science

INFO 249 – Advanced Cataloging and Classification (Fall 2015, 2016; Summer 2016)
INFO 287 – Special Topics in Cataloging and Classification (Spring 2017, 2018)
LIBR 248 – Beginning Cataloging and Classification (Summer 2002, 2003, 2004, 2005, 2006)
LIBR 249 – Advanced Cataloging and Classification (Summer 2003; Fall 2014; Summer 2015)

University of Denver, Morgridge College of Education

HED 5991 – Grant Writing in Higher Education (Spring 2011)
LIS 4010 – Organization of Information (Fall 2002, 2003, 2004, 2005, 2006, 2009; Winter 2005; Spring 2004, 2005, 2006)
LIS 4020 – Professional Principles and Ethics (Summer 2000)
LIS 4040 – Management of Libraries and Information Centers (Fall 2010; Spring 2003, 2009 (DS); Winter 2005)
LIS 4070 – Cataloging and Classification (Winter 2008, 2009, 2010, 2011, 2012; Fall 2009 (DS))
LIS 4321 – Collection Management (Spring 2005)
LIS 4326 – LIS Research (Winter 2009 (DS); Spring 2009 (DS))
LIS 4350 – Adult Materials and Services (Summer 2006, 2009)
LIS 4379 – Social Sciences Resources (Spring 2009)
LIS 4400 – Cataloging and Classification (Spring 2000, 2001; Winter 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009; Summer 2005, 2006 – course renumbered LIS 4070, September 2007)
LIS 4401 – Descriptive Cataloging (Winter 2001; Spring 2002, 2003, 2006, 2007, 2008, 2009; Summer 2005)
LIS 4402 – Subject Cataloging (Spring 2001, 2009; Summer 2005, 2006, 2007, 2008)
LIS 4403 – Classification Schemes (Fall 2007, 2008, 2009 (DS))
LIS 4405 – Authority Control (Winter 2009)
LIS 4510 – Materials and Services for Children (Winter 2004; Summer 2005)
LIS 4620 – Grant Writing and Fundraising (Summer 2000, 2002, 2004, 2010; Winter 2006; Fall 2006, 2007, 2008, 2009)
LIS 4700 – Seminar in Technical Services (Fall 2001)
LIS 4700 – Seminar in Public Libraries (Summer 2002)
LIS 4804 – Management of Electronic Records (Spring 2004; Fall 2005)
LIS 4902 – Capstone Projects (Winter 2003, Spring 2008, 2009, 2011)
LIS 4910 – Independent Study (every quarter Winter 2000 through Spring 2011)
LIS 4920 – Service Learning (every quarter Summer 2004 through Spring 2011)
RMS 4954 – Grant Writing (Summer 2013, 2014)
RMS 4959 – Content Analysis Methodology (Spring 2015)
QRM 4978 – Grant Writing (Summer 2011, 2012)

Rutgers University, School of Communication and Information

SC&I 522 – Cataloging and Classification (Summer 2013)

University of Arizona, College of Behavioral and Social Sciences

LIS 602 – Cataloging and Classification (Summer 1995)
LIS 612 – Advanced Online Search and Retrieval (Summer 1995)

Sam Houston State University, College of Education & Applied Science

LIS 532 - Cataloging and Classification (Fall 1993, 1994, 1995)
LIS 563 - Advanced Cataloging and Classification (Summer 1994)
LIS 567 - Research Methods (Spring 1994, Spring 1995)
LIS 591 - Educational Technology (Spring 1994, 1995)
LIS 596 - Networking and Computer Technologies in Education (Fall 1993, Summer 1994, Fall 1995)

Dissertations at the University of Denver

Bowers, Stacey L. *Library Anxiety of Law School Students: A Study Utilizing the Multidimensional Library Anxiety Scale.* Chair, May 5, 2010.

Fattor, Melissa M. *Student Engagement Differences by Ethnicity and Scale for Ninth Grade Students.* Chair, November 1, 2010.

Fulton, Roseanne. *A Case Study of Culturally Responsive Teaching in Middle School Mathematics.* Kent Seidel, Chair, June 18, 2009, Outside Chair.

Grealy, Deborah S. *Tribes and Territories in Library and Information Studies Education.* Bruce Uhrmacher, Chair, June 10, 2008, Committee Member.

McCord, J. Michael. *Developing a Standard of Care for Educational Malpractice.* Chair, April 15, 2011.

Priebe, Sarah J. *Distinguishing Effects of Domain and General Knowledge on Passage Fluency and Comprehension.* Jan Keenan, Chair. July 21, 2011, Outside Chair.

Snyder-Mondragon, Sandra M. *Institutional Factors that Impact the Retention of Graduate Students of Color in Schools of Library and Information Science: A Metaregression of Accredited Library School Statistics on Student Retention and Graduation Rates.* Kathy Green, Chair, July 24, 2009, Committee Member.

Taylor, Karen Pickles. *Effective Teaching.* Elinor Katz, Chair, July 15, 2009, Outside Chair.

Thompson, Jennifer. *Distinguishing a Western Women's College: A History of the Curriculum and Student Experience at Colorado Women's College.* Edith W. King, Chair, July 16, 2010, Committee Member.

Walker, Emelda. *Influence of Organizational Factors on Job Satisfaction of Disability Service Providers at Postsecondary Institutions.* Chair, April 29, 2010.

Dissertation Proposals at the University of Denver

Bowers, Stacey L. *Library Anxiety of Law School Students: A Study Utilizing the Multidimensional Library Anxiety Scale.* Chair, November 5, 2009.

McCord, J. Michael. *Developing a Standard of Care for Educational Malpractice.* Edith W. King, Chair. April 23, 2010.

Thompson, Jennifer. *History of Colorado Women's College.* Edith W. King, Chair, October 30, 2008. Committee Member.

Walker, Emelda. *Influence of Organizational Factors on Job Satisfaction of Disability Service Providers at Postsecondary Institutions.* Chair, July 21, 2009.

Dissertations at Other Institutions

Rodríguez-Mori, Howard. *The Information Behavior of Puerto Rican Immigrants to Central Florida, 2003-2009: Grounded Analysis of Six Case Studies Use of Social Networks during the Migration Process.* Kathleen Burnett, Chair, April 10, 2009, Florida State University, Committee Member.

Schwartz, Brian *More than a Look-up Skill: Medical Information Literacy Education in Osteopathic Medical Schools.* D. Mirah Dow, Chair, July 18, 2017. Emporia State University, Committee Member.

Snow, Karen. *A Study of the Perception of Cataloging Quality among Catalogers.* Shawne D. Miksa, Chair, August 1, 2011. University of North Texas, Committee Member.

Dissertation Proposals at Other Institutions

Schwartz, Brian *More than a Look-up Skill: Medical Information Literacy Education in Osteopathic Medical Schools.* D. Mirah Dow, Chair, December 4, 2015. Emporia State University, Committee Member.

Snow, Karen. *A Study of the Perception of Cataloging Quality among Catalogers.* Shawne D. Miksa, Chair, May 11, 2010. University of North Texas, Committee Member.

Master's Thesis at the University of Denver

Hemingson, Jeff. *Recital Paper.* Lamont School of Music, February 2010, Outside Chair.

Capstones at the University of Denver

Anthony, Alisa. *Correlation of Library and Information Science Program outcomes and Vacant Position Qualifications Listed on the Colorado State Library Jobline by Employers During the Period September 1, 2000 through August 31, 2002.* Chair, Winter Quarter, 2003.

Borden, Donna M. *Improving Emergency Communications Systems: Is a Radio Communications Network the Answer?* Fall Quarter, 2014.

Bowden, Heather L.M. *Exploring Biological Models for Long-term Data Preservation.* Chair, Spring Quarter, 2008.

Casenada, Cassandra Y. *Challenges to the Recruitment, Education, and Retention of Librarians of Color*. Chair, Spring Quarter, 2008.

Chang, Jennifer C. *Legal Research Practice and Preference: A Law Firm Perspective.* Chair, Spring Quarter 2011.

Ellis, Megan S. Fitzgerald. *Design of a Public Library Adult Volunteer Recruitment Program and Training Curriculum.* Chair, Winter Quarter, 2003.

Kircher, Kathy. *Development of a Library Pathfinder for Exobiology and Posting it on the Internet.* Chair, Winter Quarter, 2003.

Melhado, Loretta. *Design of St. John's Episcopal Church Library.* Chair, Spring Quarter, 2008.

Radcliff, Kathy. *Original Cataloging of Archival materials in the HERS Collection in Penrose Library*. Chair, Winter Quarter, 2003.

Sass, Carol Ann. *ACT Periodical Index: Access to Catholic Thinking Periodical Index: Web Index to Select Catholic Periodicals.* Spring Quarter 2000.

Stone, Sergio D. *Conducting Community Analysis for the Bemis Public Library (Littleton, Colorado) Using 2002 U.S. Census Data and the Online Outcome-Based Evaluation Toolkit.* Chair, Winter Quarter, 2003.

Tureson, Tamara. *Design and Use of an Information Audit Tool for Use in a Law Library.* Chair, Winter Quarter, 2003.

Tweed, Beth. *Evaluation of Email Reference Service in a Consumer Health Library Environment.* Chair, Winter Quarter, 2003.

GRANTS AND CONTRACTS

Student Learning in Agriculture STEM through Teacher Professional Development. Research team: Stanton Gartin (PI) and Cyndi Hofmeister, Northeast Junior College; Jeff Cash, Cheryl Sánchez, Anne-Marie Crampton, Lamar Community College; Suzanna Spears, Morgan Community College; Jack Wiley, Kerry Gabrielson, Trinidad State Junior College; Michael J. Miller, Colorado State University; Michael Womochil (Co-PI), Casey Sacks, and Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Agriculture, Agriculture and Food Research Initiative, Food, Agriculture, Natural Resources and Human Sciences Education and Literacy Initiative, $404,460 (2017-2020)

Leading and Achieving: the Colorado Agriculture Regional Consortium. Research team: Jack Wiley (PI), Kerry Gabrielson, Trinidad State Junior College; Jeff Cash (PI), Cheryl Sánchez, Anne-Marie Crampton, Lamar Community College; Suzanna Spears, Morgan Community College; Cyndi Hofmeister, Northeast Junior College; Michael Womochil (Co-PI), Casey Sacks, and Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Agriculture, Hispanic Serving Institutions Education Grants Program, $504,414 (2017-2020)

Cyber Prep Program Planning Grant. Research team: Debbie Sagen (PI), Brenda Lauer, Pikes Peak Community College; Gretchen Martin, Koiosa Insights; and, Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Commerce, Regional Alliances and Multi-stakeholder Partnerships to Stimulate (RAMPS) Cybersecurity Education and Workforce Development, $199,681 (2016-2018)

Career and Technical Education in Colorado: Pathways to Education and Employment. Research team: Heather McKay (PI), Rutgers University; Sarah Heath, Casey Sacks, Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Education, Institute of Education Sciences, $1,400,000 (2017-2021)

Pre-Alliance Planning Grant Colorado Community College Alliance. Research team: Victor Vialpondo (PI) and Janel Highfill, Community College of Aurora; Heidi Loshbaugh (Co-PI), Community College of Denver; Rick Reeves, Bill McGreevy, Liz Cox, and Kristin Aslin, Red Rocks Community College; Cathy Pellish, Front Range Community College; Samuel DeVries, Arapahoe Community College; Sylvia D. Hall-Ellis, Colorado Community College System. National Science Foundation, Louis Stokes Alliance for Minority Participation (LSAMP), $86,817 (2016-2017)

Towards Scalable Differentiated Instruction Using Technology-enabled, Competency-based, Dynamic Scaffolding. Research team: Karen Wilcox (PI) and Vijay Kumar, Center for Computational Engineering, Massachusetts Institute of Technology; Flora McMartin, Broad-based Knowledge; Quinsigamond Community College; and, Casey Sacks, and Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Education, First in the World Developmental Grant, $2,891,882 (2015-2019)

Colorado Strategic Partnerships Emergency Grant. Research team: Elise Lowe-Vaughn (PI), Amy Hodson, Celia Hardin, Barbara McBride, James Newby, Christopher Dewhurst, Nina Holland, Kate Anderson, MaryAnn Roe, Chrystalynn Chrystalynn, Elaine Edon, Mona Barnes, Tom Morgan, Rob Hanni, and Marie Valenzuela, Colorado Department of Labor and Employment; Steve Anton, Joelle Brouner, and, Katie Griego, Colorado Department of Human Services; Rebecca Holmes, Judith Martinez, and Jennifer Jirous, Colorado Department of Education; Emily Templin Lesh, Colorado Workforce Development Council; Cory Everett, Colorado Department of Regulatory Agencies; and, Casey Sacks and Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Labor, Strategic Partnerships Emergency Grant, $5,000,000 (2015-2017)

CAEL Jump Start Program: Competency-Based Education. Research team: Jerry Migler (PI), Casey Sacks, Debra Cohn, Thomas Hartman, and Sylvia D. Hall-Ellis, Colorado Community College System; Matt Jamison, Front Range Community College; Mike Coste, Red Rocks Community College; Amanda Corum, Pueblo Community College; Janet Colvin, Pikes Peak Community College; and, MaryAnn Matheny, Community College of Denver. Council for Adult and Experiential Learning, $15,000 (2015)

Summit on the Redesign of Developmental Education. Research team: Jerry Migler (PI), Casey Sacks, and Sylvia D. Hall-Ellis, Colorado Community College System; Chip Nava, Pueblo Community College; Kim Moultney, Arapahoe Community College; Debbie Ulibarri, Trinidad State Junior College; and, Kris Bernard, Front Range Community College. American Association of Community Colleges, $15,000 (2015-2016)

Equity in Excellence at Colorado Community Colleges. Research team: Keith Howard (PI) and Sylvia D. Hall-Ellis, Colorado Community College System; Estela Mata Bensimon, Center for Urban Education, University of Southern California; and Kerry Gabrielson, Trinidad State Junior College. Colorado Department of Higher Education, Colorado Opportunity Scholarship Program, $150,000 (2015-2016)

MBA High School of Business in Colorado. Research team: Laurie Urich (PI) and Sylvia D. Hall-Ellis, Colorado Community College System; Rudolph Sumpter and Beatrice Gerrish, Boulder Valley Schools; Keith Curry Lance, RSL Research Group. Colorado Department of Higher Education, Colorado Opportunity Scholarship Program, $501,295 (2015-2016)

Fullbridge Program in Colorado. Research team: Keith Howard (PI) and Sylvia D. Hall-Ellis, Colorado Community College System; Suzanna Spears, Fort Morgan Community College; and, Cheryl Sánchez and Anne-Marie Compton, Lamar Community College. Colorado Department of Higher Education, Colorado Opportunity Scholarship Program, $300,000 (2015-2017)

Colorado Community College System Alternative Credit Program. Research team: Jerry Migler (PI), Keith Howard, and Sylvia D. Hall-Ellis, Colorado Community College System. American Council on Education, $13,000 (2015)

Internationalization in Higher Education. Researcher: Samuel D. Museus. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, $8,000 (2014-2015)

International Perspectives on Bilingual Education. Researcher: Sharolyn Pollard-Durodola. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, $3,700 (2014-2015)

Cultivating Culturally Relevant and Responsive Curriculum and Pedagogy in College. Researcher: Samuel Museus. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, iRise Grant, $5,000 (2014-2015)

Project EMERGE (Educational Model for Evaluation and Replicability in Gifted Environments). Research team: Norma Hafenstein (PI) and Bruce Uhrmacher. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Lynde and Harry Bradley Foundation, $235,000 (2014-2015)

Collecting Asian American Refugee Stories. Researcher: Samuel Museus. Technical reviewer for MCE: Sylvia D. Hall-Ellis. American Educational Research Association, Research Grant, $5,000 (2014-2015)

Developing Expertise in Teaching K-5 Mathematics. Research team: Julie Sarama (PI) and Douglas H. Clements (Co-PI), in partnership with the School of Education at the University of Michigan. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, $130,344 (2013-2015)

Investigation of the Long-Term Outcomes for Special Education Students. Researcher: Antonio Olmos-Gallos. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Jefferson County School District, Office of Assessment, $40,000 (2014)

Refugee Community Collaboration. Researcher: Vicki Tomlin (PI) in partnership with the African Community Center and Jewish Family Service. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, $14,854 (2014-2015)

Access to Mathematics for All. Research team: Richard S. Kitchen (PI), Nicole M. Russell (Co-PI), and Terrence Blackman (Co-PI), Curriculum Studies and Teaching Program, Morgridge College of Education; Álvaro Árias (Co-PI, Department of Mathematics); and, James Gray (Co-PI), Department of Mathematics, Community College of Aurora. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, The Robert Noyce Scholarship Program, Capacity Building Project, $349,926 (2014-2016)

Cognitive Test Battery for Intellectual Disabilities. Research team: Karen Riley (PI), Lyndsay Agans, Jessica Lerner, and Karin Dittrick-Nathan in partnership with David Hessl (PI), The MIND Institute at the University of California – Davis, and Elizabeth Berry-Kravis, Rush University Medical Center. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Institutes of Health, Outcome Measures for Use in Treatment Trials for Individuals with Intellectual and Developmental Disabilities (R01), $2,499,996 ($588,672 at DU) (2014-2019)

Broadening Participation in Engineering among Women and Latino/as: A Longitudinal, Multi-Site Study. Researcher: Patton Garriott (PI) in partnership with the University of North Dakota and the University of Missouri. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, HER Core Research, $677,390 ($69,992 at DU) (2014-2019)

Designing a Teacher Evaluation System to Improve Teacher Effectiveness for Culturally and Linguistically Diverse Learners. Research team: María del Carmen Sálazar (PI), Jessica Lerner, and Kathy Green. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Professional Research Opportunities for Faculty, $29,988 (2014-2016)

Developing a College-Going Culture in Latina/O Families: Exploring the Influence of Funds of Knowledge on Family Outreach Programs. Researcher: Judy Marquez Kiyama. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Professional Research Opportunities for Faculty, $18,720 (2014-2016)

Assessment of Quality of Life in Neutral Implantation Surgery for the Treatment of Parkinson's Disease. Researcher: Cynthia McRae. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, $3,967 (2014-2015)

Pura Vida: Cloud Forest, Curriculum and Cross-Cultural Study. Research team: Norma Hafenstein (PI) and Bruce Uhrmacher (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, $8,000 (2014-2015)

Online Course Development for Curriculum and Instruction. Researcher: Ruth Chao. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, $3,000 (2014)

Online Course Development for Curriculum and Instruction. Researcher: María del Carmen Sálazar. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, $3,000 (2014)

Online Course Development for Curriculum and Instruction. Researcher: Jessica Lerner. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, $3,000 (2014)

Online Course Development for Curriculum and Instruction. Researcher: Duan Zhang. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, $3,000 (2014)

The Mathematics Education of African Americans, 1866 – 1954. Researcher: Nicole M. Russell. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Academy of Education, Spencer Foundation Postdoctoral Fellowship, $55,000 (2014-2016)

Early Childhood Care and Education Study. Research team: Carrie Germeroth (PI), Melissa Mincic, and Douglas H. Clements. Technical reviewer for MCE: Sylvia D. Hall-Ellis. State of North Dakota, Department of Public Instruction, $73,500 (2013-2014)

Graduate Level Specialty in Addiction Counselor Training with Emphasis on Integration of Native American Specific Content. Research team: Ruth Chao (PI) and Michael J. Faragher (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. The Galena Foundation, $289,732 (2013-2016)

The Collecting Asian American and Pacific Islander Refugee Stories (CARS) Project. Researcher: Samuel Museus. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, $15,000 (2014)

Parents in Transition: A Multiple Case Study of Parent and Family Orientation Programs. Researcher: Judy Marquéz Kiyama. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Faculty Research Fund, $1,500 (2014-2015)

The Sistah Network: Black Women Graduate Students Supporting and Retaining Each Other. Researcher; Nicole M. Russell. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Faculty Research Fund, $2,708 (2014-2015)

Evaluation of the Northeast Denver Babies Ready for College Program. Research team: Carrie Germeroth (PI), Melissa Mincic, and Douglas H. Clements. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Mile High Montessori, $9,922 (2013-2014)

Developing Teaching Expertise in K-5 Mathematics. Research team: Julie Sarama (PI) and Douglas Clements (University of Denver), in partnership with Timothy Boerst (PI), Meghan Shaughnessy, Deborah Ball, Hyman Bass (School of Education at the University of Michigan). Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, $449,827 ($130,344 at the University of Denver (2013-2015)

Early Learning Care and Education Study Program Grant for the State of North Dakota. Research team: Carrie Germeroth (PI), Melissa Mincic, and Sheridan Green. Technical reviewer for MCE: Sylvia D. Hall-Ellis. State of North Dakota Department of Public Instruction, $73,500 (2013-2014)

Local Professional Learning Community for School Leaders. Research team: Susan Korach (PI), Kristina Hesbol, and Rebecca McClure. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Education Development Center, $10,950 (2013)

Healthy Eaters, Lifelong Movers 2: Implementing Evidence-Based School Environment, Policy, and Curricular Changes to Increase Opportunities for Healthy Eating and Physical Activity in Low Income, Rural Colorado. Research team: Elaine Berlansky, University of Colorado at Denver (PI), Nicholas Cutforth, University of Denver (Co-PI), and Allison Reeds. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Health Foundation, $3,103,108 (2013-2017)

Hughes Rare Books Library Room Renovation in the Sturm College of Law. Project team: Patti H. Marks, Sylvia D. Hall-Ellis, and Leigh Elliott. Mabel T. Hughes Charitable Trust, $34,000 (2013-2014)

The Promise Center Partnership with the Marsico Institute for Early Learning and Literacy and the City and County of Denver. Research team: Karen Riley (PI), Douglas H. Clements (Co-PI), and Sheridan Green. Technical reviewer for MCE: Sylvia D. Hall-Ellis. The Piton Foundation, $223,468 (2013-2014)

Center of Excellence for Problem Gambling. Research team: Ruth Chao (PI) and J. Mike Faragher. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Department of Behavioral Health, $68,021 (2012-2013)

United Way Implementation and Validation Review. Research team: Douglas H. Clements (PI), Amanda Moreno, and Sheridan Green. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Mile High United Way, $19,737 (2013)

Math/Science Partnership in Rural Districts. Research team: Kristen Bunn (PI, Eagle County Schools), Paul Michalec (Co-PI), and Alegra Reiber. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Department of Education, Colorado's Mathematics and Science Partnership Program, $750,000 (2013-2014)

Mathematics and Science Education of African Americans. Research team: Nicole Russell (PI), Sylvia D. Hall-Ellis, Steve Fisher (Penrose Library). Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Professional Research Opportunities for Faculty, $29,994 (2013-2015)

Online Course Development for Curriculum and Instruction. Researcher: Nicole Russell. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, $3,000 (2013)

Discourse and Opportunity: Undocumented Students and Higher Education Policy. Researcher: Ryan Gildersleeve. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Academy of Education, Spencer Foundation Postdoctoral Fellowship, $55,000 (2012-2014)

An Anthropological Study of the Latino Graduation Ceremony. Researcher: Ryan Gildersleeve. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Spencer Foundation, $39,900 (2012-2013)

Fragile-X and Pharmaceutical Company: Clinical Trial of AFQ056. University of California – Davis Children's Hospital MIND Institute (Sacramento), Children's Hospital Denver, and Rush Children's Hospital at Rush University Medical Center (Chicago). Karen Riley, PI. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Novartis Pharmaceuticals Corporation, $394,206 (2012-2014)

Project Engage, Phase 2, a DAPRA Grant in partnership with Total Immersion Systems, Inc., and Texas A&M University. Research team: Karen Riley (PI) and Lyndsay Agans (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. U.S. Department of Defense, $60,000 (2011-2013)

International School Psychology Practicum Exchange. Researcher: Gloria L. Miller. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, $14,951 (2012-2013)

Online Course Development for Curriculum and Instruction. Research team: Bruce Uhrmacher (PI) and Norma Hafenstein (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, $18,193 (2012-2014)

Writers in the Schools. Research team: Karen Riley (PI) and Amanda Moreno (Co-PI).Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Humanities, $4,965 (2012-2013)

Learning Ecosystem Validation Grant. Research team: Karen Riley (PI), Lyndsay Agans, Kent Seidel, and Shimelis Assefa. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Bill & Melinda Gates Foundation, $315,000 (2012-2013)

Project Words of Oral Reading and Language Development (WORLD). Research team: Jorge E. Gonzalez (PI), Texas A&M University; Laura Saenz (Co-PI), University of Texas – Pan American; and, Sharolyn Pollard-Durodola (Co-PI), University of Denver. Technical reviewer for MCE: Sylvia D. Hall-Ellis. U.S. Department of Education, Institute of Education Sciences, $53,354 (2012-2015); award $640,718, transfer from Texas A&M University

Increasing the Efficacy of an Early Mathematics Curriculum with Scaffolding Designed to Promote Self-Regulation. Research team: Douglas H. Clements (PI) and Julie Sarama (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. U.S. Department of Education, Institute of Education Sciences, $1,445,315 (2008-2014); award $4,541,975, transfer from University at Buffalo, The State University of New York

Using Rule Space and Poset-based Adaptive Testing Methodologies to Identify Ability Patterns in Early Mathematics and Create a Comprehensive Mathematics Ability Test. Research team: Douglas H. Clements (PI) and Julie Sarama (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, $323,791 (2010-2014); award $1,194,944, transfer from University at Buffalo, The State University of New York

Comprehensive Postdoctoral Training in Scientific Education Research. Researcher: Julie Sarama (PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. U.S. Department of Education, Institute of Education Sciences, $133,458 (2010-2014); award $613,353, transfer from University at Buffalo, The State University of New York

Longitudinal Study of a Successful Scaling Up Project: Extending TRIAD. Research team: Douglas H. Clements (PI), Julie Sarama (Co-PI), and Abt Associates (Carolyn Layzer, Fatih Unlu, Laurie Bozzi, Lily Fesler, Alina Martinez, Cristofer Price, James van Orden). Technical reviewer for MCE: Sylvia D. Hall-Ellis. Institute of Education Sciences, $384,940 (2011-2015; award $1,250,286, transfer from University at Buffalo, The State University of New York

Early Childhood Education in the Context of Mathematics, Science, and Literacy. Research team: Julie Sarama (PI), Douglas H. Clements (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, $990,020 (2010-2014; award $2,285,228, transfer from University at Buffalo, The State University of New York

Early Childhood Clearinghouse Information Center Redesign. Research team: Karen Riley (PI) and Amanda Moreno (Co-PI).Technical reviewer for MCE: Sylvia D. Hall-Ellis. Office of the Lt. Governor of Colorado, $12,000 (2012-2013)

Morgridge Rural Educational Leadership Initiative. Research team: Lyndsay Agans (PI), Linda Brookhart (Co-PI), Susan Korach, and Rebecca McClure. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Morgridge Family Foundation, $100,000 (2012-2014)

Center of Excellence for Problem Gambling. Research team: Patrick Sherry (PI) and J. Mike Faragher. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Department of Behavioral Health, $55,000 (2012-2013)

Intermodal Transportation Institute Research Initiatives. Researcher: Patrick Sherry. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University Transportation Centers Program, Research and Innovative Technology Administration, U.S. Department of Transportation. $600,000 (2012-2014)

Mile High United Way Social Innovation Fund Early Literacy Initiative. Gloria L. Miller, PI, Amanda Moreano, Kim Hartnett-Edwards, and Sheridan Green. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Mile High United Way, $89,992 (2012-2013)

International School Psychology Practicum Exchange. Researcher: Gloria L. Miller. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, $1,000 (2012-2013)

Refugee Student Art Outreach. Researcher: Karin Dittrick-Nathan. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Faculty Research Fund, $3,000 (2012-2013)

Resistance, Resilience, and Reciprocity: Centering the Voices of Black Doctoral Women with Faculty Aspirations. Researcher: Nicole M. Russell. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Faculty Research Fund, $2,965 (2012-2013)

Assessing Learning through Student Notebooks. Research team: Keith Miller, Nancy Sasaki, and Kathy Green. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Professional Research Opportunities for Faculty, $30,000 (2012-2014)

International School Psychology Practicum Exchange. Researcher: Gloria L. Miller. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, $2,000 (2012-2013)

ELO in Colorado. Research team: Cynthia Hazel and Duan Zhang. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Legacy Foundation, $150,000 (2012-2013)

Creating Online LIS Courses. Research team: Mary C. Stansbury (PI), Shimelis Assefa, Denise Anthony, Xiao Hu, and Krystyna Matusiak. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Teaching and Learning, $15,000 (2011-2013)

Maritime Piracy Seminar. Researcher: Ved Nanda, The Nanda Center, Sturm College of Law. Technical reviewer for Sturm College of Law: Sylvia D. Hall-Ellis. Arsenault Family Foundation, $15,000 (2012-2013).

Early Childhood Librarianship: An Interdisciplinary, Experiential Learning MLIS. Researcher: Mary C. Stansbury (PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. Laura Bush's 21st Century Librarians Program, Institute for Museums and Library Services, $249,066 (2012-2014)

Learning Ecosystem Planning Grant. Research team: Karen Riley (PI), Lyndsay Agans, Kent Seidel, and Shimelis Assefa. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Bill & Melinda Gates Foundation, $281,217 (2011-2012)

Advanced Service Learning Practitioner Faculty Grant, Sylvia D. Hall-Ellis, University of Denver, Center for Community Engagement and Service Learning, $400 (2011)

Evaluating and Enhancing the EspeciallyMe Program. Research team: Lori D. Patton and Nicole Russell. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, Public Good Fellowship Grant, $24,780 (2012)

Choosing Excellence: Let Every Child Bloom. Research team: Shimelis Assefa (PI) and Mary C. Stansbury (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, Public Good Grant, $7,657 (2012)

K-8 STEM Content Specific Professional Development to Improve Elementary Student Achievement. Research team: Kent Seidel (PI), Nicole Russell (Co-PI), Kimberly Hartnett-Edwards, Paul Michalec, Jeff Farmer, Keith Miller, Alegra Reiber, and Nancy Sasaki. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Department of Education, Improving Teacher Quality Grant, (Title II ESEA), $307,299 (2011-2012)

Building a Better Principal Pipeline to Boost Student Achievement. Researcher: Susan Korach. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Denver Public Schools; a subcontract from the Wallace Foundation Grant, $170,000 (2011-2017)

Center of Excellence for Problem Gambling. Research team: J. Mike Faragher (Co-PI) and Bobbie Vollmer (PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Department of Behavioral Health, $79,999 (2011-2012)

An Exploration of Novice Teachers' Core Competencies: Impacts on Student Achievement, and Effectiveness of Preparation. Research team: Kent Seidel (PI), Kathy Green (Co-PI), Kimberly Hartnett-Edwards, and Duan Zhang. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Institute of Education Sciences, Effective Teachers and Effective Teaching, $990,987 (2012-2015)

Project Engage, a DAPRA Grant in partnership with Total Immersion Systems, Inc., and Texas A&M University. Research team: Karen Riley (PI) and Lyndsay Agans (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. U.S. Department of Defense, $49,964 (2011-2014)

User-centered Evaluation of Music Search Engines. Researcher: Xiao Hu. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Faculty Research Fund, $2,931 (2011-2012)

Educational Practicum in Vietnam and China to Promote the Inclusion of Young Children with Disabilities. Researcher: Gloria L. Miller. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, $5,000 (2011-2012)

Evaluation of Colorado's Enhancing Quality in Infant-Toddler (EQIT) Initiative. Research team: Virginia R. Maloney and Amanda Moreno. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Buell Foundation, $395,884 (2011-2013)

Creating Engaging Environments to Teach Pre-Algebra Mathematics to Elementary Students. Research team: Álvaro Arias, Mario López, María del Carmen Salazar, and Lyndsay Agans. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver Interdisciplinary Grant, $60,000 (2011-2012)

Morgridge Education Technology Accessible (META) Resource Project. Research team: Lyndsay Agans (PI) and Shimelis Assefa (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. Morgridge Family Foundation, $36,000 (2011)

MCE Connect: A 21st Century Framework for Faculty Development. Research team: Bruce Uhrmacher (PI), Shimelis Assefa (Co-PI), Lyndsay Agans (Co-PI), Kimberly Hartnett-Edwards, Norma Hafenstein, Xiao Hu, Paul Michalec (Co-PI), María del Carmen Salazar (Co-PI), and Sandra Snyder-Mondragon. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Teaching and Learning, $22,355 (2011-2012)

Parent Education and Parent Leadership and Advocacy. Research team: Virginia Maloney (PI) and Amanda Moreno, Marsico Institute for Early Learning and Literacy. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Health Foundation, $27,358 (2010-2011)

Intentional School Culture. Researcher: Cynthia Hazel. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Denver Public Schools, $38,040 (2010-2011)

Healthy Eaters, Lifelong Movers: Implementing Evidence-Based School Environment, Policy, and Curricular Changes to Increase Opportunities for Healthy Eating and Physical Activity in Low Income, Rural Colorado. Research team: Elaine Berlansky, University of Colorado at Denver (PI), Nicholas Cutforth, University of Denver (Co-PI), and Allison Reeds. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Health Foundation, $1,683,277 (2011-2014)

Second Life Learning Community. Research team: Don McCubbrey (PI), Sylvia D. Hall-Ellis (Co-PI), Walter LaMendola, and Paul Novak. University of Denver, Center for Teaching and Learning, $13,000 (2010-2011)

Reintroducing the Value of Law Librarians to Academic and Public Librarians in Colorado through the Identification and Use of Emerging Technologies. Research team: Sylvia D. Hall-Ellis (Co-PI), Stacey L. Bowers (PI), and Christopher Hudson, in partnership with Denver Public Library, Arapahoe Library District, and the Colorado State Supreme Court Library. University of Denver, Center for Community Engagement and Service Learning, $5,773 (2010-11)

Reintroducing the Value of Law Librarians to Public Librarians through the Identification and Use of Emerging Technologies and Resources. Research team: Stacey Bowers (PI) and Sylvia D. Hall-Ellis (Co-PI). American Association of Libraries, Wolters Kluwer Law & Business Grant Program, $2,725 (2010-2011)

Faculty Service Learning Pod. Research team: María del Carmen Salazar and Nicholas Cutforth (Curriculum and Instruction Program), Frank Tuitt (Higher Education Program), Cynthia Hazel and Gloria Miller (Child, Family, and School Psychology Program), and Sylvia D. Hall-Ellis (Library and Information Science Program). University of Denver, Center for Community Engagement and Service Learning, $8,000 (2010-2011)

Lincoln Collaborative. Research team: Antonio Esquibel (Principal, Lincoln High School), María del Carmen Salazar (Curriculum and Instruction Program), and. Sylvia D. Hall-Ellis. School Improvement Grant, Denver Public Schools, $375,000 (2010-2012)

Future LEADers of America: Leaders III. Research team: Denver Public Library (Kristen Svendson, PI), the University of Denver (Sylvia D. Hall-Ellis), the Colorado Chapter of REFORMA (Orlando Archibeque), and the Colorado Association of Libraries (Martin Garnar). Laura Bush's Recruiting Librarians for the 21st Century Program, Institute for Museums and Library Services, $988,366 (2009-2012)

Teaching for Success in the Library Environment: LIS 4030 in Library 2.0. Research team: Deborah S. Grealy (PI) and Sylvia D. Hall-Ellis (Co-PI). University of Denver, Center for Teaching and Learning, $ 9,350 (2009-10)

Writing Group Faculty Grant, Sylvia D. Hall-Ellis, University of Denver, Center for Community Engagement and Service Learning, $750 (2008-2009)

Collaborative Learning Faculty Grant, Sylvia D. Hall-Ellis, University of Denver, Center for Teaching and Learning, $1,500 (2008)

Connecting Information Literacy to Learning. Research team: Lori Micho, Merrie Valliant, Amanda Samland, and Sylvia D. Hall-Ellis. Colorado State Library, LSTA Discretionary Grant Program, $19,548 (2008-2009)

Law Librarianship Fellows Program. Research team: Sylvia D. Hall-Ellis (PI), Stacey Bowers (Co-PI), and Christopher Hudson, Westminster Law Library. Laura Bush's 21st Century Librarians Program, Institute for Museums and Library Services, $999,370 (2008-2012)

Grant Writing in a Cooperative Learning Environment. Sylvia D. Hall-Ellis. University of Denver, Center for Teaching and Learning, $2,000 (2008-2009)

Project Homeless Connect 6 Event Evaluation. Research team: Sylvia D. Hall-Ellis and Duan Zhang. University of Denver Center for Community Engagement and Service Learning, $9,785 (2008)

Project Ecuador: International Learning Service Libraries – A Faculty Development Experience in Ecuador. Sylvia D. Hall-Ellis, Office of Internationalization, University of Denver, $600 (2007)

Project Ecuador: International Learning Service Libraries – A Faculty Development Experience in Ecuador. Sylvia D. Hall-Ellis, International Service Learning Office, University of Denver, $400 (2007)

Project Homeless Connect 5 Event Evaluation. Research team: Sylvia D. Hall-Ellis and Duan Zhang. University of Denver Center for Community Engagement and Service Learning, $1,000 (2007)

Project Homeless Connect 4 Event Evaluation. Research team: Sylvia D. Hall-Ellis and Duan Zhang. University of Denver Center for Community Engagement and Service Learning, $4,595 (2007)

Future LEADers of America: Leaders II. Research team: Denver Public Library (Kristen Svendson, PI), the University of Denver (Sylvia D. Hall-Ellis), and the Colorado Chapter of REFORMA (Orlando Archibeque). Laura Bush's Recruiting Librarians for the 21st Century Program, Institute for Museums and Library Services, $988,518 (2007-2010)

Strategic Planning Assistance for the Denver Medical Library. Sylvia D. Hall-Ellis. Denver Medical Library, Inc., $30,000 (2006-2007)

Destiny Software for JMAC Student Lab. Sylvia D. Hall-Ellis, gift from the Sagebrush Corporation, Minneapolis, Minnesota, $10,000 (2006)

Libraries: Tools for Education and Development Worldwide: A Faculty Development Experience in France. Sylvia D. Hall-Ellis, Office of Internationalization, University of Denver, $800 (2005)

Denver Public Library: Opportunities for Change. Sylvia D. Hall-Ellis, Colorado Community Based Research Network, $2,000 (2005)

Future LEADers of America. Research team: Denver Public Library (Letty Icolari and Steve Taylor, PIs), Emporia State University (Jim Agee), and the University of Denver (Sylvia D. Hall-Ellis). Recruiting Librarians for the 21st Century Program, Institute for Museums and Library Services, $670,315 (2005-2008)

American Association of University Professors Summer Institute Professional Development Grant. Sylvia D. Hall-Ellis, American Association of University Professors, $300 (2005)

Beta Phi Mu Alumni Tea. Sylvia D. Hall-Ellis, gift from the Office of Alumni and Parent and Relations, University of Denver, $2,000 (2005)

Spectrum Software for LIS Student Lab. Sylvia D. Hall-Ellis, gift from the Sagebrush Corporation, Minneapolis, Minnesota, $5,000 (2005)

Developing Research Capacity in Community Organizations and Residents through Training and Technical Assistance. Nicholas J. Cutforth (PI) and Sylvia D. Hall-Ellis. Piton Foundation, $25,000 (2005-2006)

Libraries: Tools for Education and Development Worldwide: A Faculty Development Experience in Argentina. Sylvia D. Hall-Ellis, Office of Internationalization, University of Denver, $500 (2004)

Developing Research Capacity in Community Organizations and Residents through Training and Technical Assistance. Research team: Nicholas J. Cutforth (PI), Gary Lichtenstein and Sylvia D. Hall-Ellis, Piton Foundation, $25,000 (2003-2004)

Increasing Spanish-Speaking and Hispanic Diversity among Library and Information Science Students at the University of Denver: Development of a Student Recruitment Model. Researcher: Sylvia D. Hall-Ellis (PI), Office of Multicultural Excellence, University of Denver, $2,750 (2003-2004)

Collection Development Enrichment to Support the Cataloging & Classification Specialization and School Librarianship within the Library & Information Science Program at the University of Denver. Research team: Sylvia D. Hall-Ellis (PI) and Deborah S. Grealy. Women's Library Association, University of Denver, $4,000 (2003)

Collection Development Enrichment to Support the Library & Information Science Program at the University of Denver. Research team: Deborah S. Grealy (PI) and Sylvia D. Hall-Ellis. Women's Library Association, University of Denver, $4,000 (2001)

Wireless LAN for Library Education. Research team: Deborah S. Grealy (PI) and Sylvia Hall-Ellis. University of Denver, Center for Teaching and Learning, $24,000 (2001-2002)

Upward Bound – A Program for South Texas Youth. Research team: Monte Churchill, Executive Director of Community Relations; Gary R. Sauceda, Outreach Coordinator; Raymond Hernandez, (PI) Associate Dean for Student Success; and Sylvia D. Hall-Ellis, South Texas Community College (McAllen, Texas). U.S. Department of Education, Office of Postsecondary Education, $2,672,003 (1999-2003)

Write Now! Improving Elementary Students' Writing Skills. Research team: Caryl G. Thomason, Assistant Superintendent (PI); Karen Tankersley, Principal; and, Hal Anderson, Director of Technology, Cheyenne Mountain School District 12 (Colorado Springs, Colorado); and Sylvia D. Hall-Ellis. Colorado Department of Education, Educational Telecommunications Unit, $189,453 (1999-2001)

Operation Quick Start -- Distance Learning in Rural Colorado. Research team: Randal Weigum, Technology Coordinator (PI); Bonnie Barns, Director of Federal Programs and Staff Development; and, Adam "Joe" Raskop, Executive Director, Southeastern Board of Cooperative Educational Services (Lamar, Colorado); and Sylvia D. Hall-Ellis. Colorado Department of Education, Educational Telecommunications Unit, $400,000 (1999-2001)

Advanced Technological Training for Information Professionals for the 21st Century. Research team: Mario Reyna, Division of Business Director (PI) and Sylvia D. Hall-Ellis, South Texas Community College (McAllen, Texas). Phi Delta Kappa and the National Science Foundation, $250,000 (1999-2001)

Working Connections – Training Information Technologies Professionals for the 21st Century. Research team: Mario Reyna, Division of Business Director (PI) and Sylvia D. Hall-Ellis, South Texas Community College (McAllen, Texas). Microsoft Corporation and the American Association of Community Colleges, $1,147,775 (1999-2001)

The ROAD (Research Oriented Amplification of Development to Literacy) Program. Research team: Deborah J. Leong (PI), Metropolitan State University; Elena Bodrova, Metropolitan State University; Dmitri Semenov, Robert J. Marzano, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). Hewlett-Packard Foundation, $25,000 (1998-1999)

Press to Literacy. Research team: Deborah J. Leong (PI), Metropolitan State University; Elena Bodrova, Metropolitan State University; Dmitri Semenov, Robert J. Marzano, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). The Denver Post and the Robert S. McCormick Foundation, $49,818 (1998-1999)

International Telementor Center. Research team: David Neils, David B. Frost (PI), and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). Hewlett-Packard Philanthropy, $100,000 (1998-1999)

America Reads: Providing Tutor Training for the America Reads Challenge. Research team: Louis F. Cicchinelli (PI) and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). U.S. Department of Education, Office of Educational Research and Improvement, $306,000 (1998-1999)

Comprehensive School Reform. Research team: Louis F. Cicchinelli (PI), J. Timothy Waters, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). U.S. Department of Education, Office of Educational Research and Improvement, $285,000 (1998-1999)

Sustainable Energy Education (SEE) Program for Grades 4-8: Preparing Today's Youth for Lifelong Learning and Responsible Actions in Energy Conservation. Research team: Mary Gromko, Colorado Department of Education; Gene McCarthy, Rocky Flats Field Office, U.S. Department of Energy; Gina Kissell, National Renewable Energy Laboratory; and Barbara L. McCombs (PI), Janet L. Bishop, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). State of Colorado Governor's Office for Energy Conservation, $499,936 (1997-1999)

Review of Kansas Curriculum Standards in Mathematics and Language Arts. Research team: Robert J. Marzano (PI), John S. Kendall, David B. Frost, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). Submitted to the Kansas State Department of Education, $25,903 (1998)

International Telementor Center. Research team: David Neils, John Kuglin, Chris Rapp, David B. Frost (PI), and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). Hewlett-Packard Company, $54,752 (1998)

Genesis Mission: Education Public Outreach. Developed in partnership by the Jet Propulsion Laboratory, California Institute of Technology, Los Alamos National Laboratory, Lockheed Martin Astronautics, and the Mid-continent Regional Educational Laboratory (Aurora, Colorado). Research team: John T. Sutton (PI), Alice Krueger, Martha Henry, Greg Rawls, Shae Isaacs, Jeff Johnson, Deb Jordan, Arlene Mitchell, David B. Frost, Jana Caldwell, J. Timothy Waters, and Sylvia D. Hall-Ellis. National Aeronautics and Space Administration, $139,700,000; subcontract award, $4,750,000 (1997-2007)

North Dakota Mathematics Assessment Project. Developed in partnership by the North Dakota Department of Education and Mid-continent Regional Educational Laboratory (Mid-continent Regional Educational Laboratory). Research team: Ann Clapper, Clarence Bina, Greg Gallagher, North Dakota Department of Education; Don Burger (PI), Hillary Michaels, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). U.S. Office of Education, $1,618,214; subcontract award, $389,076 (1997-2001)

Pacific Resources for Education and Learning Distance Education: Project Evaluation. Developed in partnership by the Pacific Educational Community, the Pacific Resources for Education and Learning (PREL), and Mid-continent Regional Educational Laboratory (McREL). Research team: John W. Kofel (PI), Executive Director, PREL; J. Timothy Waters, Executive Director; Joan Buttram, Robert Keller, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). U.S. Office of Education, Star Schools Program, $10,000,000; subcontract award, $500,000 (1997-2002)

Identification of Bilingual Gifted and Talented Children: A Comprehensive School Grants for Bilingual Education. Developed in partnership by Hidalgo (Texas) ISD, Los Fresnos (Texas) CISD, Progreso (Texas) ISD, University of Texas – Pan American (Edinburg, Texas), and Education Service Center, Region One (Edinburg, Texas). Research team: Hilda Medrano, Dean, College of Education, University of Texas – Pan American; Linda Phemister (PI), Janie Navarro, and Sylvia D. Hall-Ellis, Education Service Center, Region One. U.S. Department of Education, Office of Bilingual Education and Minority Languages Affairs, $1,670,633 (1997-2002)

Academics 2000: First Things First -- The Texas Goals 2000. Developed for Jim Hogg (Hebbronville, Texas) County ISD, Mirando City (Texas) ISD, and San Isidro (Texas) ISD. Research team: Hilda Medrano, Dean, College of Education, University of Texas - Pan American (Edinburg, Texas); Angie Lehmann, Amy Mares, Ellen Gonzalez (PI), and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg, Texas). Texas Education Agency, $339,987 (1997-2000)

Southwestern Bell's Learning Communities Initiative. Developed for Tech Prep of the Rio Grande Valley, Inc. (Harlingen, Texas); the Center for Professional Teacher Development, University of Texas – Brownsville; Teach for America – Rio Grande Valley (McAllen, Texas); and Education Service Center, Region One (Edinburg, Texas). Research team: Patricia G. Bubb, Executive Director (PI), Tech Prep of the Rio Grande Valley; Martin Winchester, Executive Director, Teach for America – Rio Grande Valley; Aileen Johnson, Director, School of Education, University of Texas – Brownsville; and Sylvia D. Hall-Ellis. Southwestern Bell Foundation, $100,000 (1997-1998)

Texas School to Work: Regional Implementation. Developed for Tech Prep of the Rio Grande Valley, Inc. (Harlingen), South Texas Community College (McAllen), Texas State Technical College (Harlingen), Texas Southmost College (Brownsville), Empowerment Zone of the Rio Grande Valley (Mercedes), Project VIDA (Weslaco), Youth Fair Chance (McAllen), and Education Service Center, Region One (Edinburg). Research team: Patricia G. Bubb (PI), Tech Prep of the Rio Grande Valley; Stephen Vassberg, Texas State Technical College; Ellen Trevino, Youth Fair Chance; Wanda Garza, Project VIDA; Leonardo Olivares, University of Texas – Pan American; Michael Bell, South Texas Community College; and Sylvia D. Hall-Ellis. Texas Workforce Commission, $4,250,000 (1997-2002).

Comprehensive Bilingual Education Grant for Hidalgo ISD and Roma ISD. Developed for Hidalgo (Texas) ISD, Roma (Texas) ISD, College of Education, University of Texas – Pan American (Edinburg, Texas), and Education Service Center, Region One (Edinburg, Texas). Research team: Tomas Thomas (PI), Director, Office of Bilingual Education and Sylvia D. Hall-Ellis. U.S. Department of Education, Office of Bilingual Education and Minority Languages Affairs, $1,531,361 (1997-2002)

Lopez High School, Porter High School, Rivera High School, Central Middle School, and Perkins Middle School, Brownsville (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $1,473,611 (1997-1998)

Donna High School, Todd Middle School, and Solis Middle School, Donna (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $704,052 (1997-1998)

Memorial Middle School and Nellie Schunior Middle School, La Joya Independent School District (Texas). Telecommunications Infrastructure Fund Board, $293,641 (1997-1998)

Martin High School, Christen Middle School, Cigarroa Middle School, Lamar Middle School, Laredo (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $1,200,000 (1997-1998).

Lasara Middle School, Lasara (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $246,210 (1997-1998)

Los Fresnos High School and Resaca Middle School, Los Fresnos (Texas) Consolidated Independent School District. Telecommunications Infrastructure Fund Board, $500,000 (1997-1998)

Lyford Junior High School, Lyford (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $354,997 (1997-1998)

Travis Middle School, McAllen (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $269,139 (1997-1998)

Mission High School, Mission (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $297,010 (1997-1998)

Progreso High School, Progreso (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $300,000 (1997-1998)

San Perlita High School, San Perlita (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $293,490 (1997-1998)

Myra Green Junior High School, Raymondville (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $225,000 (1997-1998)

Rio Grande City High School, Ringgold Middle School, Gruella Middle School, Rio Grande City (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $809,934 (1997-1998)

Rio Hondo Junior High School, Rio Hondo (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $297,024 (1997-1998)

Roma High School, Roma (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $333,178 (1997-1998)

San Benito High School, Miller Jordan Junior High School, San Benito (Texas) Consolidated Independent School District. Telecommunications Infrastructure Fund Board, $547,000 (1997-1998)

Santa Maria High School and Santa Maria Middle School, Santa Maria (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $400,000 (1997-1998)

Salvador High School, United Independent School District (Laredo, Texas). Telecommunications Infrastructure Fund Board, $250,879 (1997-1998)

Weslaco High School, Cabaza Middle School, Cuellar Middle School, Weslaco (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $874,242 (1997-1998)

Principals' Assessment and Training Center. Developed for Education Service Center, Region One (Edinburg, Texas). Research team: Roberto Zamora, Leonel Barrera, William H. Parry, and Sylvia D. Hall-Ellis. Texas Principals' Leadership Initiative, Texas Association of Secondary School Principals, Texas Association of Elementary School Principals, and the Sid Richardson Foundation. $461,439 (1996-1998)

The Texas Library Connection -- Integrating and Sharing Resources. Developed for Hidalgo County Library System (McAllen), Cameron County Library System (Brownsville), South Texas Community College (McAllen), the University of Texas - Pan American (Edinburg), University of Texas – Brownsville, and Education Service Center, Region One (Edinburg). Research team: William R. McGee, Coordinator, Hidalgo County Library System; Joe Garcia, Director, Cameron County Library System; Michael D. Bell, Library Director, South Texas Community College; Eleanor Folger Foster, University Library, University of Texas - Pan American; Jaime Vela (PI), Director of Instructional Technology and Media Services, Ron Pontius, Instructional Technology, and Fabiola Fuentes, Media Services, Education Service Center, Region One; and Sylvia D. Hall-Ellis. Office of Library Media Services, Technology Services, Texas Education Agency. $8,000 (1996-1997)

Developing Leadership Communities for Improving Algebra I for All Students. Developed for a partnership of the Region One Statewide Systemic Initiative Team. Research team: Noel Villarreal (PI), Eduardo Cancino, and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Statewide Systemic Initiative for Reform in Mathematics, Science and Technology Education to The Charles A. Dana Center for Mathematics and Science Education, The University of Texas at Austin. $25,000 (1996-1997)

Academics 2000: First Things First -- The Texas Goals 2000. Developed for Edinburg (Texas) CISD. Research team: Hilda Medrano, Dean, College of Education, University of Texas - Pan American (Edinburg); Helen Jones, Director (PI), Gifted and Talented Education, Edinburg CISD; and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Education Agency, $750,000 (1996-2001)

Texas Teachers Empowered for Achievement in Mathematics (TEXTEAM) Institute for Algebra I. Developed for Hidalgo ISD, Jim Hogg (Hebbronville) County ISD, La Joya ISD, La Villa ISD, Lyford ISD, Mission CISD, Pharr-San Juan-Alamo ISD, Rio Hondo ISD, San Isidro ISD, San Perlita ISD, Santa Maria ISD, Santa Rosa, Sharyland ISD, Valley View ISD, Webb (Laredo) CISD, Weslaco ISD, and Zapata County (Zapata) ISD. Research team: Noel Villarreal (PI), Chuck McInteer, Ellen M. Gonzalez, Education Service Center, Region One (Edinburg); and Sylvia D. Hall-Ellis. Charles A. Dana Center for Mathematics and Science Education, University of Texas - Austin, $15,975 (1996)

Community Learning Center for La Villa, Texas. Developed for Edcouch-Elsa Independent School District. Research team: Noe Gonzalez (PI), Assistant Superintendent, Edcouch-Elsa Independent School District, and Sylvia D. Hall-Ellis. Delta Region Subzone, Rio Grande Valley (Texas) Rural Empowerment Zone, $325,000 (1996-1997)

Monte Alto (Texas) Community Learning Center. Developed for Monte Alto Independent School District. Research team: Homero A. Diaz (PI), Superintendent, Monte Alto Independent School District, and Sylvia D. Hall-Ellis. Delta Region Subzone, Rio Grande Valley (Texas) Rural Empowerment Zone, $300,000 (1996-1997)

Community Learning Center for La Villa, Texas. Developed for La Villa Independent School District. Research team: Sam Gonzalez (PI), Assistant Superintendent, La Villa Independent School District; and Sylvia D. Hall-Ellis. Delta Region Subzone, Rio Grande Valley (Texas) Rural Empowerment Zone, $325,000 (1996-1997)

Building Project for Taylor Elementary. Developed for Mercedes (Texas) Independent School District. Research team: Mrs. Denise Rivera, Librarian, and Eduardo Infante, Principal, Taylor Elementary School; Ismael S. Cantu (PI), Federal Programs Director, Mercedes Independent School District; and Sylvia D. Hall-Ellis. Delta Region Subzone, Rio Grande Valley (Texas) Rural Empowerment Zone, $375,000 (1996-1997)

Border Education Network (BEN) - Distance Education through Cable Television. Developed for Edinburg (Texas) Consolidated Independent School District. Research team: Noe Torres (PI), Library Media Specialist, Magdalena Rosas, Library Media and Technology Coordinator, Edinburg Consolidated Independent School District; and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Edinburg (Texas) Consolidated School District, $250,000 (1996-1997)

Multiservice One-Stop Open Enrollment Charter School. Developed for the Information Referral Resource Assistance, Inc. (McAllen, Texas). Research team: Pablo Perez and Aguie Pena (PI), Executive Director, Information Referral Resource Assistance, Inc.; Roberto Zamora and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Education Agency, $3,066,000 (1996-2001)

Project OK: A Community Youth Opportunities Grant for Summer, 1996. Developed for McAllen (Texas) Independent School District, St. Joseph the Worker Catholic Church, and the Office of Adult Education, Education Service Center, Region One. Research team: Father Bart Flatt, St. Joseph the Worker Catholic Church; Noe Calvillo (PI), Office of Adult Education; Maria Louisa Garcia, McAllen Independent School District; and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Protective and Regulatory Agency through the Office of the Mayor, City of McAllen, $350,000 (1996-2001).

Early Childhood: a Time of Discovery. Developed for a partnership of Lasara ISD, Rio Hondo ISD, San Perlita ISD, the School of Education, University of Texas - Brownsville, and Education Service Center, Region One (Edinburg). Research team: Hugo Rodriguez, Dean, School of Education, University of Texas - Pan American; Leonel Barrera and Jack Damron, Field Service Agents, Ellen M. Gonzalez (PI), Administrator for Student Instructional Services, Ruth Solis, Education Specialist in Special Education, and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Education Agency, $722,090 (1996-2001)

Innovative Gifted and Talented Programs for Early Childhood and Elementary Education Students. Developed for a partnership of Edinburg (Texas) CISD, the School of Education, University of Texas - Pan American (Edinburg), and Education Service Center, Region One (Edinburg). Research team: Hilda Medrano, Dean, School of Education, University of Texas - Pan American; Helen de la Garza (PI), Director of Elementary Curriculum and Instruction, Edinburg CISD; and Sylvia D. Hall-Ellis. Texas Education Agency, $750,000 (1996-2001)

Reading Recovery in Early Elementary Grades. Developed for a partnership of La Villa (Texas) ISD the School of Education, University of Texas - Pan American (Edinburg), and Education Service Center, Region One (Edinburg). Research team: Hilda Medrano, Dean, School of Education, University of Texas - Pan American; Marcario Salinas (PI), Supervisor of Elementary Curriculum and Instruction, La Villa ISD; and Sylvia D. Hall-Ellis, Education Service Center, Region One. Texas Education Agency, $750,000 (1996-2001)

Connected Mathematics Project for Middle and Junior High Students. Developed for a partnership of Michigan State University, The Charles A. Dana Center for Mathematics and Science Education, The University of Texas at Austin and Region One Statewide Systemic Initiative Team. Research team: Jack Damron, Chuck McInteer, Noel Villarreal (PI), and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). National Science Foundation through Michigan State University to the Charles A. Dana Center at the University of Texas - Austin, $539,610 (1996-1999)

Sharing Resources: Testing the Interlibrary Loan Potential of the Texas Library Connection -- Integrating Media Resources. Developed under the sponsorship of the Hidalgo County Library System (McAllen) and Education Service Center, Region One (Edinburg). Research team: William H. McGee, Hidalgo County System Coordinator; Fabiola Fuentes, Library Media; Ronald Pontius (PI), Instructional Technology, Education Service Center, Region One; and Sylvia D. Hall-Ellis. Library Media Services Program, Office of Technology Services, Texas Education Agency, $25,000 (1996-1997)

State and Federal Adult Education JOBS Program. Developed for Education Service Center, Region One (Edinburg). Research team: Noe Calvillo (PI), Director, Adult Education Program, and Sylvia D. Hall-Ellis. Adult Education Program, Texas Education Agency, $532,846 (1995-1996)

Creating Safe and Drug-Free Schools and Communities. Developed for a partnership of the Region One Consortium for Safe and Drug-Free Education Environments. Research team: Clara Contreras (PI), Health Specialist, and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Education Agency, $150,000 (1995-1996)

Developing Leadership Communities for Improving Mathematics Performance for All Students on Title I Campuses. Developed for a partnership of the Region One Statewide Systemic Initiative Team. Research team: Jack Damron, Chuck McInteer, Noel Villarreal (PI), and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Statewide Systemic Initiative for Reform in Mathematics, Science and Technology Education to The Charles A. Dana Center for Mathematics and Science Education, The University of Texas at Austin, $50,669 (1995-1996)

The Impact of Library Resource Centers on Academic Achievement in Selected Public Schools in South Texas. Sylvia D. Hall-Ellis (PI). Developed under the sponsorship of the Department of Library Science, College of Education and Applied Science, Sam Houston State University (Huntsville). Texas Association of School Librarians, Children's Services Round Table, and Young Adults Round Table (Austin, Texas), $2,500 (1995)

School Library Media Specialists Fellowship Program. Sylvia D. Hall-Ellis (PI). Developed under the sponsorship of the Department of Library Science, College of Education and Applied Science, Sam Houston State University (Huntsville, Texas). U.S. Department of Education, HEA Title II-B, Library Education and Human Resource Development Program, $44,000 (1995-1996)

Planning for Educational Technology. Research team: Ruth Ann Riggins (PI), Director of Library Media and Technology Services, Donna (Texas) Independent School District; Noe Torres, Education Service Center, Region One; Patricia G. Bubb, Tech Prep of the Rio Grande Calley, Inc; Michael D. Bell, South Texas Community College; and Sylvia D. Hall-Ellis, Sam Houston State University. Developed under the sponsorship of Donna (Texas) Independent School District, Education Service Center, Region One (Edinburg), Tech Prep of the Rio Grande Valley, Inc. (Harlingen), South Texas Community College (McAllen), and the Department of Library Science, Sam Houston State University (Huntsville). Funded through Infusion of Educational Technology Planning Grant Program (H.B. 18: Models). Texas Education Agency, $18,000 (1993-1994)

The Impact of Library Resource Centers on Academic Achievement in Selected Public Schools in South Texas. Sylvia D. Hall-Ellis (PI) and Mary Ann Berry. Developed under the sponsorship of the Department of Library Science, College of Education and Applied Science, Sam Houston State University (Huntsville). Sam Houston State University Research Enhancement Fund, $7,500 (1993-1994)

Electronic Mail Resource Sharing System: Management and Operation of the Iowa Computer-Assisted Network. State Library of Iowa, $294,000 (1986-1993)

The Iowa Locator: A CD-ROM Resource Sharing Tool. State Library of Iowa, $567,000 (1986-1992)

Statewide Database Development: An OCLC Tape Analysis To Determine Feasibility. State Library of South Dakota, $15,000 (1987)

The Iowa Locator: A Feasibility Study. State Library of Iowa, $50,000 (1986)

Electronic Mail Resource Sharing System: A Feasibility Study for Libraries in the State of Iowa. State Library of Iowa, $5,000 (1985)

Access Pennsylvania: A Feasibility Study. State Library of Pennsylvania, $50,000 (1984)

Automating Library Administrative and Management Tasks: Procurement and Distribution of Microcomputer Systems for District Library Centers in the Commonwealth of Pennsylvania. State Library of Pennsylvania, $495,000 (1982)

Sharing Serial Titles Resources: Procurement and Distribution of Microfiche Readers for 550 Libraries in the Commonwealth of Pennsylvania. State Library of Pennsylvania, $500,000 (1982)

Electronic Mail System: A Pilot Project for Libraries throughout the Commonwealth of Pennsylvania. State Library of Pennsylvania, $125,000 (1982)

Literacy Program for Adults in Rural Upstate New York State: Program Outreach and Evaluation - Phase 3. Appalachian Regional Commission, $50,000 (1981)

Database Building: A Cooperative Project of the Finger Lakes Library System (Ithaca), Four County Library System (Binghamton), and the Southern Tier Library System (Corning). New York State Library, $450,000 (1980-1985)

Faces of the Southern Tier: A Professional Photographer-in-Residence. New York State National Endowment for the Humanities, $25,000 (1980)

Literacy Program for Adults in Rural Upstate New York State: Program Implementation - Phase 2. Appalachian Regional Commission, $50,000 (1980)

Small Business Resources Center: A Pilot Project for Rural Public Libraries. New York State Library, $50,000 (1980)

Media Programming: A Professional Development Program for Public Librarians in Upstate New York: A Program in Allegheny, Chemung, Schuyler, Steuben, and Yates Counties. New York State Library, $35,000 (1979)

Information and Library Resources for Inmates and Prisoners in Selected Upstate New York Facilities: A Cooperative Program in Allegheny, Chemung, Schuyler, Steuben, and Yates Counties. New York State Library, $25,000 (1979)

Library Resources for Homebound Adults in Upstate New York: An Outreach Program in Allegheny, Chemung, Schuyler, Steuben, and Yates Counties. New York State Library, $40,000 (1979)

Literacy Program for Adults in Rural Upstate New York State: Program Initiation and Establishment - Phase 1. Funded by the Appalachian Regional Commission. Awarded to the Corning (New York) Public Library, $50,000 (1979)

Information Reference Services to Homebound Adults. New York State Library, $31,000 (1978)

Books-By-Mail Services to Homebound Adults. New York State Library, $31,000 (1978)

System Headquarters Services and Programs for Public Libraries in District 10. Funded through Library Services and Construction Act Title I. Texas State Library and Historical Commission, $880,000 (1976)

County Library Development Grant for Atascosita County. Funded through Library Services and Construction Act Title I. Texas State Library and Historical Commission, $15,000 (1976)

Spanish Language Materials Collection Development Program. Texas State Library and Historical Commission, $40,000 (1975)

Establishment of System Headquarters for Alamo Regional Library System (District 10) Headquartered at the San Antonio (Texas) Public Library. Texas State Library and Historical Commission, $800,000 (1975)

SELECTED CONSULTANTSHIPS

Project Strategic Planning & Funding Proposal Development

Walden University, 2015.

Pikes Peak Library District, 2014.

Douglas County Public Libraries, 2011-2012.

Denver School for Science and Technology, 2008-2011.

Johnson & Wales University, Denver Campus, 2007-2009.

Challenges, Choices, and Images K-12 Charter School, Denver Public Schools, 2007.

Denver Medical Library, Inc., 2006-2010.

Bemis Public Library (Littleton), Ergonomic Design and Facilities Enhancement Consultant, 2003.

Curtis Park Community Center (Denver), Community Technology Center Evaluation and Proposal Development Consultant, 2003.

Colorado Community Based Research Network (Denver), Funding Research Associate, 2002-

Our Lady of the Rosary Academy (Edgewater), Learning Resource Center Development Project Consultant, 2001-

University of Southern Colorado (Pueblo). Technology Integration and Curriculum Enhancement into Higher Education Learning Environment. Proposal Development Consultant, 2000.

Jefferson County Library System (Lakewood), 1999-2000.

Southeastern BOCES (Lamar, CO). Distance Learning Curriculum Content Development Project. Proposal Development Consultant, 1998-2004.

Cheyenne Mountain School District 12 (Colorado Springs, CO). Technology Integration into Elementary Writing Curriculum Project. Proposal Development Consultant, 1998.

Telecommunications Infrastructure Fund Board Round #2 Application, 1997. Technical assistance to the following: La Villa (Texas) Independent School District; Mirando City (Texas) Independent School District; Monte Alto (Texas) Independent School District; San Isidro (Texas) Independent School District.

Telecommunications Infrastructure Fund Board Round #1, 1996. Technical assistance to the following: Brownsville (Texas) Independent School District; Donna (Texas) Independent School District; Edinburg (Texas) Consolidated Independent School District; Harlingen (Texas) Consolidated Independent School District; Jim Hogg County Independent School District (Hebbronville, Texas); La Feria (Texas) Independent School District; La Joya (Texas) Independent School District; La Villa (Texas) Independent School District; Los Fresnos (Texas) Consolidated Independent School District; Progreso (Texas) Independent School District; Raymondville (Texas) Independent School District; Rio Hondo (Texas) Independent School District; San Benito (Texas) Independent School District; Sharyland Independent School District (Mission, Texas); Weslaco (Texas) Independent School District; Zapata (Texas) County Independent School District.

South Texas Community College (McAllen). Strategy Development to Meet the Technology Instructional Needs for Vocational, School-To-Work and Academic Programs, 1994-2000. Development Consultant.

Donna (Texas) Independent School District. Planning for the Infusion of Technology in Middle Schools Serving High At-Risk Students, 1994-1995. Research Associate.

Pettus (Texas) Independent School District. Planning for District-wide Automation in School Library Media Centers: Preparation of Data, and CD-ROM Hardware/Software Configuration Evaluation, 1994. Principal Investigator.

Fort Bend Independent School District (Sugar Land, TX). Planning for District-wide Automation in School Library Media Centers, Preparation of Data, and CD-ROM Hardware/Software Configuration Evaluation, 1994-1995. Principal Investigator.

Northern Waters Library Services (Ashland, WI). Professional Consulting Services to Make Recommendations on the Development of System-Wide Efforts of the Northern Waters Library Service, 1988-1989. Research Associate.

State Library of Iowa (Des Moines). The Iowa Locator Compact Disc to Support Multi-Type Libraries Resource Sharing including Database Design, Building, Production, and Distribution, 1986-1991. Project Director.

State Library of Iowa (Des Moines). Iowa Computer-Assisted Network Development, Enhancement, and Operation, 1985-1992. Technical Director.

State Library of South Dakota (Pierre). Statistical Sampling and Analysis of Multi-Institutional OCLC Archive Tape for Statewide Online Database Building, 1985-1986. Research Associate.

District of Columbia Public Library (Washington, DC). Planning Document for the Retrospective Conversion of Bibliographic Records and Automation Issues in the 1990's, 1984-1985. Research Associate.

State Library of Pennsylvania (Harrisburg). Database Development for High School Libraries, 1984-1985. Research Associate.

MINITEX (Minneapolis, MN). Workshops for Retrospective Conversion, Bar Coding, Library Statistics, and OCLC Serials Format, 1985. Presenter and Research Associate.

ABC Film Consortium (Altoona, Bellefonte, Johnstown, PA). Database Building, System Design, and Implementation of Online Film Booking System, 1983-1985. Database Manager.

Library Automation -- System Design & Implementation

Douglas County Library District (Castle Rock, CO). Library Automation Technical and System Performance Specifications, 2001.

Pharr-San Juan-Alamo Independent School District (Pharr, TX). Library Automation Technical and System Performance Specifications, 1997. Project Development Consultant.

Harlingen (Texas) Independent School District. Planning for District-wide Automation in Junior High School Library Media Centers: Preparation of Data, and CD-ROM Hardware/Software Configuration Evaluation, 1996. Principal Investigator.

Sharyland (Texas) Independent School District. Design and Construction of New Elementary School Library and Technology Resources Center, 1995-1996. Principal Investigator.

South Texas Independent School District (Mercedes, TX). Design and Construction of a New High School Library and Technology Resources Center, 1995-1996. Principal Investigator.

Citizens' Library (Washington, PA). Online Community Resources Files: Design and Implementation, 1984. Research Associate.

Altoona (Pennsylvania) Hospital. Integrated Online System Upgrade Study, 1984. Research Associate.

State Library of South Dakota (Pierre). Automation Plan and State Database Development, 1982-1983. Principal Investigator.

State Library of Pennsylvania (Harrisburg). COM Production and Preparation of the Technical Specifications Document, Procurement, and Distribution of Microcomputers in the Commonwealth of Pennsylvania, 1983-1984. Research Associate.

Altoona (Pennsylvania) Area Public Library. Integrated System (Circulation/Online Catalog) Study, 1982-1983. Principal Investigator.

COPSCAULD (Council of Pennsylvania State College and University Library Directors, Edinboro, PA). Design of Online Media Catalog, 1982. Principal Investigator.

Erie (Pennsylvania) County Library System. Operations Research and Design for Automated Circulation, Hardware Upgrade and Re-Retrospective Conversion, 1982. Research Associate.

Michigan Library Consortium (Lansing, MI). Tape Management System Design and Implementation, 1982-1984. Research Associate.

State Library of Pennsylvania (Harrisburg). Preparation of the Technical Specifications Document, Procurement and Distribution of Microfiche Readers in the Commonwealth of Pennsylvania, 1982. Research Associate.

Community College of Allegheny County, Allegheny Campus (Pittsburgh, PA). Integrated Systems Study, 1981. Principal Investigator.

Community College of Allegheny County, South Campus (West Mifflin, PA). Retrospective Conversion Training Program for Handicapped Students, 1981. Technical Director.

Southern Tier Library System (Corning, NY). OCLC Acquisitions Subsystem Evaluation, 1981. Principal Investigator.

South Central Reference and Research Council (Ithaca, NY). South Central Regional Delivery System, 1980. Principal Investigator.

Southern Tier Library System (Corning, NY). Newspapers on Microfilm in the Chemung-Southern Tier Library System, 1979-1981. Principal Investigator.

Cataloging & Bibliographic Database Building

Challenges, Choices, and Images K-12 Charter School, Denver Public Schools, 2007.

Denver Medical Library, Inc., 2006-2010.

Ricks Gifted and Talented School Library, 2005-

American Humane Society (Englewood), 2004-2006.

Fisher Early Learning Center Library, 2004-

Colorado Community Based Research Network (Denver), 2004-

Boulder Valley School District (Boulder), 2002-2003.

Douglas Public Library District (Castle Rock), 2001-2002.

Bibliographic Center for Research, Inc. (Denver). Original Cataloging, 2001-2003 & 1992-1993. Professional Cataloger. Libraries include Arapahoe Library District (Centennial); Clarke College (Clarke, IA); Kaiser Permanente Center for Health Research (Portland, KS); Douglas County Library System (Carson City, NV); Grinnell College (Grinnell, IA); Kansas State University (Manhattan, KS); Kansas State Library (Topeka, KS); McPherson College (McPherson, KS); Newman University (Wichita, KS); Montana Technical University (Helena, MT); Montana State Library (Helena, MT); University of Texas Southwest Medical Center Library (Dallas, TX); Community College of Southern Nevada (Las Vegas, NV); Pikes Peak Library District (Colorado Springs); Mesa Community College (Grand Junction); Coe College (Cedar Rapids, IA); Briar Cliff College (Sioux City, IA); Tri-Care Health Systems (Aurora); The Penrose-St. Francis Healthcare System (Colorado Springs); Westminster Public Library (Westminster); Lutheran Medical Center Medical Library (Wheat Ridge); American Heritage Center, University of Wyoming (Laramie, WY); National Wildlife Research Center Library (Lakewood); University of Colorado Health Sciences Center, Denison Memorial Library (Denver); Water Resources Library, Denver District Office, Bureau of Land Management (Lakewood); Mesa State Community College Learning Resources Center (Pueblo); Front Range Community College Learning Resources Center (Westminster).

Colorado Historical Society Library (Denver). Original Cataloging of Serials for Multi-Institutional Union Listing Project, 1993. Technical Services Associate. Institutional partners: Denver Art Museum, Denver Museum of Natural History Library, and Denver Botanical Gardens Library.

Arapahoe Library District (Centennial). Original Cataloging of Major Media, 1991.

Original Cataloging Projects: Davis and Elkins College (Elkins, WV), 1989-1990; Waldorf College (Forest City, IA), 1989-1990; Kennametal Corporation (Latrobe, PA), 1984-1985; Pennsylvania Public Libraries Film Center (Harrisburg), 1982-1985.

Retrospective Conversion Projects: North Central Regional Library Service (Mason City, IA), 1987-1988; Southeastern Library Services (Davenport, IA), 1986-1987; Virginia Theological Seminary (Alexandria), 1984-1985; California University of Pennsylvania (California, PA), 1984-1985; Kennametal Corporation (Latrobe, PA), 1984-1985;West Virginia University (Morgantown), 1983-1985; Altoona Area Public Library (Altoona, PA), 1983-1984; George Washington University (Washington, DC), 1983-1984; Indiana University of Pennsylvania (Indiana, PA), 1983-1985; Health Education Center (Pittsburgh), 1983-1984; Central Pennsylvania District Library Center (Bellefonte, PA), 1982-1985; Duquesne University Law School Library (Pittsburgh), 1982-1983; Allegheny County Law Library (Pittsburgh), 1982-1984;Calgon Technical Information Center (Pittsburgh), 1982; Dow Corning Corporation, Technical Information Center (Midland, MI), 1982-1983; Tri-System Public Library Retrospective Conversion Project (Binghamton, Corning, and Ithaca, NY), 1978-1981, Technical Project Director.

Updated July 2017