UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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MEDIT CORPORATION,
Petitioner

v.

3SHAPE A/S,
Patent Owner

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U.S. Patent No. 9,629,551

IPR2023-01313

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 Bracewell LLP, on behalf of Petitioner Medit Corporation ("Medit" or "Petitioner").

2. I have written this report at the request of Medit 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 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 $350 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 Master of Library Science from the University

of North Texas in 1972 and a Ph.D. in Library and Information Science from the University of Pittsburgh in 1985. Over the last fifty 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, as a member of the national Board of Directors for REFORMA, as a member of the Editorial Board for the ALCTS premier cataloging journal, *Library Resources and Technical Service,* as a Co-Chair for the Library Research Round Table (LRRT) of the American Library Association, and as a member of the LRRT Nominating Committee.

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 an Appendix to this report.

III. LIBRARY CATALOGING PRACTICES

A. MARC RECORDS AND THE ONLINE LIBRARY CATALOG

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 1960s 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]

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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/ (last visited July 5, 2023).

[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 July 5, 2023) ("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 fifty years ago. It provides the mechanism by which computers exchange, use, and interpret

11. MARC is a framework into which descriptive bibliographic data are transcribed to interact with the software in online library catalogs to provide access to books, journals, and other resources in the collection. The bibliographic data provide points of access and can be searched by a person of ordinary skill in the art at the time of the invention ("POSITA," see paragraphs 39-42 below) to identify and obtain resources in the library collection. An information seeker (or POSITA) can search a local online library catalog or the holdings of a group of libraries in a state or region or in the global catalog WorldCat.

12. MARC records are not designed for public viewing. Although a significant number of libraries provide access to the MARC version of a bibliographic record, the public display is designed to show information in a succinct manner that is quickly understood and useful to the information seeker. Libraries determine the default search for the online catalog to make the entry of search terms efficient and result in a successful search. Information seekers can enter a keyword, title, author, or standard number for the item. Libraries may also provide a search capability called "Summon" that allows the information seeker to enter known

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bibliographic information, and its data elements make up the foundation of most library catalogs used today."). MARC is the ANSI/NISO Z39.2-1994 (reaffirmed 2016) standard for Information Interchange Format.

information about the item to conduct a search.

13. Since at least the early 1970s and continuing to the present day, MARC has been the primary communications protocol for the transfer and storage of bibliographic metadata in libraries.[3] As explained by the Library of Congress:

> You could devise your own method of organizing the bibliographic information, but you would be isolating your library, limiting its options, and creating much more work for yourself. Using the MARC standard prevents duplication of work and allows libraries to better share bibliographic resources. Choosing to use MARC enables libraries to acquire cataloging data that is predictable and reliable. If a library were to develop a "home-grown" system that did not use MARC records, it would not be taking advantage of an industry-wide standard whose primary purpose is to foster communication of information.
>
> Using the MARC standard also enables libraries to make use of commercially available library automation systems to manage library operations. Many systems are available for libraries of all sizes and are designed to work with the MARC format. Systems are maintained and improved by the vendor so that libraries can benefit from the latest

[3] A complete history of the development of MARC can be found in *MARC: Its History and Implications* by Henrietta D. Avram (Washington, DC: Library of Congress, 1975) and available online from the Hathi Trust (https://babel.hathitrust.org/cgi/pt?id=mdp.39015034388556;view=1up;seq=1; last visited July 5, 2023).

> advances in computer technology. The MARC standard also allows libraries to replace one system with another with the assurance that their data will still be compatible.

Why Is a MARC Record Necessary? LIBRARY OF CONGRESS.[4]

14. Thus, almost every major library in the world is MARC-compatible. *See, e.g.*, *MARC Frequently Asked Questions (FAQ)*, LIBRARY OF CONGRESS.[5] ("MARC is the acronym for MAchine-Readable Cataloging. It defines a data format that emerged from a Library of Congress-led initiative that began fifty 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 library catalogs used today."). MARC is the ANSI/NISO Z39.2-1994 standard (reaffirmed in 2016) for Information Interchange Format. The full text of the standard is available from the Library of Congress.[6]

15. Examining the MARC records for a specific item reveals the comprehensive data transcribed about a particular item at the time that cataloging and classification occurred. In addition to the creator, title, subjects, and standard numbers, additional information may provide additional and relevant data depending

[4] http://www.loc.gov/marc/umb/um01to06.html#part2

[5] https://www.loc.gov/marc/faq.html

[6] http://www.loc.gov/marc/bibliographic/

on the type of resource. Understanding the full extent of bibliographic data for an item and the points of access associated with it provides essential information that can be used to determine the indexing and public availability for documents described in this declaration.

B. MARC RECORDS

16. 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 work's title is recorded in Field 245; the primary author of the work is transcribed in Field 100; an item's International Standard Book Number ("ISBN") consisting of ten or thirteen digits is transcribed in Field 020; an item's International Standard Serial Number ("ISSN") is transcribed in Field 022; the Library of Congress classification notation 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.[7]

17. The library that created the record is recorded in Field 040 in subfield

[7] http://www.loc.gov/marc/bibliographic/bd3xx.html

"a" with a unique library code. When viewing the MARC record online via Online Computer Library Center's ("OCLC") bibliographic 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 Declaration. Where this "mouse over" option was not available, I consulted the Directory of OCLC Libraries to identify the institution that created the MARC record.[8]

18. MARC records also include several fields that include subject matter classification information. An overview of MARC record fields is available through the Library of Congress.[9] For example, 6XX fields are termed "Subject Access Fields."[10] Among these, for example, is the 650 field; this is the "Subject Added Entry – Topical Term" field.[11] The 650 field is a "[s]ubject added entry in which the entry element is a topical term." 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

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

[9] http://www.loc.gov/marc/bibliographic/

[10] http://www.loc.gov/marc/bibliographic/bd6xx.html

[11] http://www.loc.gov/marc/bibliographic/bd650.html

include a classification number. For example, the 050 field is the "Library of Congress Call Number."[12] A defined portion of the Library of Congress Call (LCC) Number is the classification number, and "source of the classification number is *Library of Congress Classification* and the *LC Classification-Additions and Changes*." Thus, included in the 050 field is a subject matter classification. Further, the 082 field is the "Dewey Decimal Call Number."[13] A defined portion of the Dewey Decimal Call (DDC) Number is the classification number, and "source of the classification number is the *Dewey Decimal Classification and Relative Index*." Thus, included in the 082 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 LCC classification number, it appears as part of the 050 field. When the Library of Congress assigns the DDC classification number, it appears as part of the 082 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.

[12] http://www.loc.gov/marc/bibliographic/bd050.html

[13] http://www.loc.gov/marc/bibliographic/bd082.html

C. OCLC

19. 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."[14] 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.

20. OCLC also provides its members online access to MARC records through its OCLC bibliographic 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

[14] Third Article, Amended Articles of Incorporation of OCLC Online Computer Library Center, Incorporated (available at https://www.oclc.org/content/dam/oclc/membership/articles-of-incorporation.pdf).

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 bibliographic database or through the Library of Congress.

21. 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 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."[15] 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 MARC attachments to this Declaration—the date reflected next to the label "Entered" is necessarily on or after the date the library first cataloged and indexed the underlying item.

22. 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 accuracy, but

[15] Field 005 is visible when viewing a MARC record via an appropriate computerized interface. But when a MARC record is printed directly to hardcopy from the OCLC database, the "005" label is not shown. The date in the 005 field instead appears next to the label "Replaced."

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).

23. Catalogers can create MARC records for all types of print, online, and digital resources. 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 and magazine subscriptions to libraries come from a jobber or wholesaler for online and print resources. These resellers make it their business to provide items 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 and journals directly from publishers themselves, which provide delivery on a similarly expedited schedule. In general, libraries make these purchases throughout the year and shelve the newly received items as soon thereafter as possible to make them available to their patrons.

24. In preparing this report, I used authoritative databases, such as the OCLC bibliographic database and the Library of Congress Online Catalog, to confirm citation details of the various publications discussed.

25. *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.

26. 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.

27. 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.

28. Before the widespread development of online databases to index articles in journals, magazines, conference papers, and technical reports, libraries purchased printed volumes of indices. Graduate library school education mandated

that students learn about the bibliographic control of disciplines, the prominent indexing volumes, and searching strategies required to use them effectively and efficiently. Half of the courses that I studied in library school were focused on the bibliography and resources in academic disciplines.

29. Librarians consulted with information seekers to verify citations, check availability in union catalogs, printed books catalogs, the OCLC database, and make formal requests for materials (e.g., books, conference proceedings, journal articles). Requests were transmitted using Telex machines, rudimentary email systems, and the United States Postal Service. During my career, I have performed and supervised staff who handled these resource sharing tasks.

30. A major firm known for the breadth of subjects and comprehensive treatment in the preparation of index volumes, the H. W. Wilson Company offered these reference resources since the firm was founded in 1898. The *Reader's Guide to Periodical Literature* is one of the best-known titles available from H. W. Wilson. Each volume includes a comprehensive index for 300 of the most popular and important periodicals published in the United States and Canada. Information seekers have subject access expressed in plain language terminology, author access, and cross references to find the desired results from their searches. The family of index titles included *Science & Technology Index*, *Business Periodicals*, *Applied Science & Technology Index, Humanities Index, Biological & Agricultural Index*,

and *Industrial Arts Index*. These printed indices have been superseded by digital database offerings available to information seekers through Ebsco.

31. Online indexing services such as *Google Scholar*[16] or *ScienceDirect*[17] 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.

32. A citation of a document by another is evidence that the document was publicly available and in use no later than the publication date of the citing document.

IV. PRELIMINARIES

33. *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 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 July 15, 2011.

[16] https://scholar.google.com/

[17] https://www.sciencedirect.com/

34. 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.

35. 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 exercising reasonable diligence (*i.e.*, I understand that cataloging and indexing by a library in a manner that permits a person of ordinary skill in the relevant subject matter to locate the publication 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.

36. 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.

37. I have been informed by counsel that a "person of ordinary skill in the art at the time of the invention" (POSITA) 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.

38. I am told by counsel that, for purposes of this declaration, persons of ordinary skill in this subject matter or art would have had at least a bachelor's degree in computer engineering, computer science, computer vision, or an equivalent field, and one or two years of industry experience, as well as experience with three-dimensional imaging systems and three-dimensional modeling techniques. Additional education might compensate for less experience and vice-versa.

39. Based on my experience working in research libraries with researchers having the qualifications described above, or even lesser qualifications, it is my opinion that such researchers would have been able to locate the material discussed

herein on their own or with the assistance of a research librarian with relative ease using the tools and resources described herein.

V. PUBLICATIONS

A. Document 1: Exhibit 1 ("HERBST")

40. Exhibit 1 is a true and correct copy of the conference paper titled "Toward Object Discovery and Modeling via 3-D Scene Comparison" by Evan Herbst, Peter Henry, Xiaofeng Ren, and Dieter Fox (hereafter "Herbst"). This conference paper was published in the seven-volume set titled *2011 IEEE International Conference on Robotics and Automation* in volume 3 on pages 2623-2629. Exhibit 1 is a true and correct copy of the conference paper that I obtained from the Shanghai Library (Shanghai, China). The 2011 IEEE International Conference on Robotics and Automation was held on May 9-13, 2011, in Shanghai, China. Specifically, the text of the conference paper 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 1 was found within the custody of a library – a place where, if authentic, a copy of this seven-volume set of conference proceedings would likely be. Exhibit 1 is a true and correct copy in a condition that creates no suspicion about its authenticity.

41. The Herbst conference paper is available from the *IEEE Xplore*

database.[18] The Herbst conference paper was added on August 11, 2011.

42. Attached hereto as Attachment 1A is a true and correct copy of the metadata record for the seven-volume set of conference proceedings titled *2011 IEEE International Conference on Robotics and Automation* at the Shanghai Library. Library ownership is indicated by the presence of the library's name at the top of the screen. I personally identified and retrieved the metadata record that is Attachment 1A.

43. Attached hereto as Attachment 1B is a true and correct copy of the MARC record for the seven-volume conference proceedings set titled *2011 IEEE International Conference on Robotics and Automation* obtained from the OCLC bibliographic database. I personally identified and retrieved the MARC record that is Attachment 1B. As previously noted, the library that created the record is recorded in field 040 with a unique library code. For Attachment 1B, that library code is "J3G," which means that the MARC record for this seven-volume conference proceedings set was cataloged at the Kanagawa University Library (Kanagawa, Japan). As can be seen in the "Entered" field in the MARC record for this exhibit, a cataloger at the Kanagawa University Library created OCLC record number 939480278 on June 1, 2011, as shown in the "Entered" field ("20110601"). The

[18] https://ieeexplore.ieee.org/document/5980542

library continues to update this MARC record to meet current cataloging rules. The most recent enhancement to the MARC record occurred on June 16, 2022, as shown in the "Replaced" field ("20220616").

44. Attachment 1B shows that Exhibit 1 was catalogued with two descriptor terms reading "Robotics" (see Attachment 1C, Library of Congress subject heading sh85114628) and "Automation" (Attachment 1D, Library of Congress subject heading sh85010116) in the 650 fields. Thus, as of its cataloging, the publication corresponding to the MARC record attached hereto as Attachment 1B was indexed according to its subject matter by virtue of at least three independently sufficient classifications: the title (field 245 entry), the field 650 entries, and the names of the sponsoring bodies (field 710 entries). Further, as of June 1, 2011, the MARC record attached hereto as Attachment 1B was accessible through any library with access to the OCLC bibliographic database or the online catalog at a library that acquired the seven-volume conference proceedings set, which means that the corresponding publication was publicly available on or before that same date through any library with access to the OCLC bibliographic database or through an individual library.

45. Attachment 1B indicates that the seven-volume conference proceedings set titled *2011 IEEE International Conference on Robotics and Automation* as cataloged at the Kanagawa University Library was publicly available on June 1,

2011, because by that date it had been received, cataloged, and indexed at the Kangawa University Library and made part of the OCLC bibliographic database. For these reasons, it is my opinion that Exhibit 1 was published and publicly accessible on June 1, 2011.

B. Document 2: Exhibit 2 ("HÄHNEL")

46. Exhibit 2 is a true and correct copy of the conference paper titled "Map Building with Mobile Robots in Dynamic Environments" by Dirk Hähnel, Rudolph Triebel, Wolfram Burgard, and Sebastian Thrun (hereafter "Hähnel"). This conference paper was published in the three-volume conference proceedings set titled *2003 IEEE International Conference on Robotics and Automation* in volume 2 on pages 1557-1563. Exhibit 2 is a true and correct copy of the conference paper that I obtained from the Linda Hall Library of Science, Engineering & Technology (Kansas City, Missouri). Specifically, the text of the conference paper 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 2 was found within the custody of a library – a place where, if authentic, a copy of this three-volume conference proceedings set would likely be. Exhibit 2 is a true and correct copy in a condition that creates no suspicion about its authenticity.

47. The Hähnel conference paper is available from the *IEEE Xplore*

database[19] and in the digital repositories *ResearchGate*[20] and *Semantic Scholar*.[21] The *IEEE Xplore* website indicates that the Hähnel conference paper was added on November 10, 2003.

48. Attached hereto as Attachment 2A is a true and correct copy of the MARC record for the three-volume set titled *2003 IEEE International Conference on Robotics and Automation* at the Linda Hall Library of Science, Engineering & Technology. The volume contains the papers of the conference which was held on September 14-19, 2002, in Taipei, Taiwan. Library ownership is indicated by the presence of the library's code (LHL) in the 049 field. I personally identified and retrieved the MARC record that is Attachment 2A.

49. The three-volume conference proceedings set was cataloged on November 10, 2003, as shown in field 008 ("031110"). The library continues to update this MARC record and enhanced the MARC record to meet current cataloging rules. I personally identified and retrieved the library catalog record

[19] https://ieeexplore.ieee.org/document/1241816

[20] https://www.researchgate.net/publication/2543575_Map_Building_with_Mobile_Robots_in_Dynamic_Environments

[21] https://www.semanticscholar.org/paper/Map-building-with-mobile-robots-in-dynamic-H%C3%A4hnel-Triebel/9bb704b4194591cd33032d9631044fa47fe0ab4c

which is Attachment 2A.

50. Based on finding a print copy of Exhibit 2 in the Linda Hall Library of Science, Engineering & Technology and MARC record in its online library catalog attached as Attachment 2A, it is my opinion that the three-volume conference proceedings set titled *2003 IEEE International Conference on Robotics and Automation* was publicly available as of November 10, 2003. Therefore, this three-volume set would have been available to users at the Linda Hall Library of Science, Engineering & Technology on that date.

51. Attached hereto as Attachment 2B is a true and correct copy of the MARC record for the three-volume conference proceedings set titled *2003 IEEE International Conference on Robotics and Automation* obtained from the OCLC bibliographic database. I personally identified and retrieved the MARC record that is Attachment 2B. As previously noted, the library that created the record is recorded in field 040 with a unique library code. For Attachment 2B, that library code is "LHL," which means that the MARC record for this conference proceedings volume was cataloged at the Linda Hall Library of Science, Engineering & Technology. As can be seen in the "Entered" field in the MARC record for this exhibit, a cataloger at the Linda Hall Library of Science, Engineering & Technology created OCLC record number 53379733 on November 10, 2003, as shown in the "Entered" field ("20031110"). The library continues to update this MARC record to meet current

cataloging rules. The most recent enhancement to the MARC record occurred on June 9, 2022, as shown in the "Replaced" field ("20220609").

52. Attachment 2B further includes an entry in field 050 ("TJ210.3 $b .I14 2003")—as described above, a subject matter classification number consistent with the Library of Congress classification system (analogous to the Dewey Decimal classification system). Attachment 2B also shows that Exhibit 2 was catalogued with two descriptor terms reading "Robotics $v Congresses" (see Attachment 2C, Library of Congress subject heading sh2008110970) and "Automation $v Congresses" (Attachment 2D, Library of Congress subject heading sh2007101727) in the 650 fields. Thus, as of its cataloging, the publication corresponding to the MARC record attached hereto as Attachment 2B was indexed according to its subject matter by virtue of at least two independently sufficient classifications: the field 050 entry and the field 650 entries. Further, as of November 10, 2003, the MARC record attached hereto as Attachment 2B was accessible through any library with access to the OCLC bibliographic database or the online catalog at a library that acquired the three-volume conference proceedings set, which means that the corresponding publication was publicly available on or before that same date through any library with access to the OCLC bibliographic database or through an individual library.

53. Attachment 2B indicates that the three-volume conference proceedings set titled *2003 IEEE International Conference on Robotics and Automation* as

cataloged at the Linda Hall Library of Science, Engineering & Technology is currently available from 20 libraries. In view of the above, the conference proceedings volume titled *2003 IEEE International Conference on Robotics and Automation* was publicly available on November 10, 2003, because by that date it had been received, cataloged, and indexed at the Linda Hall Library of Science, Engineering & Technology and made part of the OCLC bibliographic database. For these reasons, it is my opinion that Exhibit 2 was published and publicly accessible on November 10, 2003.

VI. SUMMARY OF OPINIONS

54. In view of the foregoing, it is my opinion that the publication described above was publicly available no later than the corresponding date listed in the table below:

Exhibit	Publication	Publicly Available
1	Herbst, Evan, Peter Henry, Xiaofeng Ren, and Dieter Fox. "Toward Object Discovery and Modeling via 3-D Scene Comparison." *2011 IEEE International Conference on Robotics and Automation* (vol. 3, pp. 2623-2629). 7 vols. Piscataway, NJ: IEEE, ©2011.	June 1, 2011
2	Hähnel, Dirk, Rudolph Triebel, Wolfram Burgard, and Sebastian Thrun. "Map Building with Mobile Robots in Dynamic Environments." *2003 IEEE International Conference on Robotics and Automation* (vol. 2, pp. 1557-1563). 3 vols.	November 10, 2003

55. 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.

56. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

August 8, 2023

Sylvia D. Hall-Ellis, Ph.D.

Exhibit 1

2011 IEEE International Conference on Robotics and Automation

(ICRA 2011)

Shanghai, China
9-13 May 2011

Pages 1803-2730



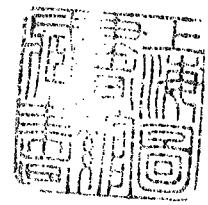
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Toward Object Discovery and Modeling via 3-D Scene Comparison

Evan Herbst Peter Henry Xiaofeng Ren Dieter Fox

Abstract— **The performance of indoor robots that stay in a single environment can be enhanced by gathering detailed knowledge of objects that frequently occur in that environment. We use an inexpensive sensor providing dense color and depth, and fuse information from multiple sensing modalities to detect changes between two 3-D maps. We adapt a recent SLAM technique to align maps. A probabilistic model of sensor readings lets us reason about movement of surfaces. Our method handles arbitrary shapes and motions, and is robust to lack of texture. We demonstrate the ability to find whole objects in complex scenes by regularizing over surface patches.**

I. Introduction

Suppose a mobile robot with an always-on camera makes multiple visits to a location, continuously running SLAM. There is information in the difference between two maps made at different times. We use the PrimeSensor, an *RGB-D* camera that provides dense registered color and depth measurements, to detect objects by means of their movement in 3-D between two maps of the same location.

At a high level this problem is similar to laser scan registration, for which van de Ven et al. [19] have shown it is possible to jointly infer clustering within scans and association between scans. They point out that the efficiency of inference depends heavily on the number of elements to be clustered and associated. Therefore we need to select a small number of surfaces by combining surface elements and, prior to inference, culling those least likely to be part of movable objects. In this work we call this process *object discovery*.

Object discovery in 2-D has been studied by both the computer vision and the robotics communities. In vision, motion segmentation has been used for object discovery assuming highly visually textured surfaces. Bhat et al. [1] assume each surface has enough SIFT matches that RANSAC will find a model for it. That isn't the case for us, partly because our objects occupy relatively little of each image; also we wish to handle textureless objects.

Scene segmentation without motion is difficult, and most work has made restrictive assumptions. Biswas et al. estimate object shape models and object-cluster memberships for pre-segmented object instances in 2-D occupancy grid maps [3]. They assume the number of objects is known and that each connected component of occupied cells is one object. Wolf and Sukhatme perform SLAM for long periods of time by maintaining two occupancy grids, one for static and one for movable objects, to identify cells occupied by movable objects at any given time [20]. Connected components is also the standard approach to segmenting objects in 3-D; for example, [16] assumes all objects are on a table, fits a plane to the table and takes each large remaining connected component of 3-D points to be an object. Several authors have segmented objects by fitting geometric solids to point clouds using the method of [17]. This method was developed to approximate a very dense cloud with a small number of models; its applicability to object modeling is less obvious, since a shape that can be fit well by a moderate number of geometric solids is generally better explained by a single higher-level model, e.g. a train engine. Since we are discovering objects, we don't have a database of predefined object models to fit, so we use only relatively low-level cues. We improve on previous segmentation efforts by identifying surface patches likely to have moved between two scenes. We use ray casting with a probabilistic model of sensor measurements that is robust to sensor noise and that enables us to fuse information from multiple sensor modalities.

Probabilistic measurement models are common in robot localization [7] and mapping [18]. This is natural: generative models are appealing for work with sensors because often we can accurately describe the process of measurement generation, and Bayesian models appeal when we need to combine many sensor readings. Hähnel et al. add dynamic object estimation to SLAM and use expectation-maximization to label each measurement static or dynamic [9]. Kim et al. probabilistically fuse information from multiple depth sensors and cameras for dense 3-D reconstruction [13]. We use a generative sensor measurement model with similar sensor modalities to those of [13], but discard some of their independence assumptions.

Probabilistic sensor models have also been used for change detection. Kaestner et al. [12] use a model of laser measurements to find changes in outdoor scenes. They perform global alignment of laser scans using iterated closest points (ICP) and detect changes using statistical significance testing for each measurement independently.

Our algorithm aligns the frames of each RGB-D video using SLAM, then reconstructs each scene as a dense set of surface elements (Section II). Our measurement model (Section III) tells us how likely each surface element is to have moved between two scenes. In Section IV-A we employ the model to detect differences between scenes and in Section IV-B we spatially regularize to find large surface regions that may belong to movable objects.

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(a) (b) (c)

Fig. 1: (a), (b) reconstruction of two scenes; (c) their superimposition after alignment.



(a) (b)

Fig. 2: Zoom into the edge of the table from Fig. 1: (a) after SIFT RANSAC alignment; (b) after additional ICP alignment.

II. Scene Reconstruction and Alignment

The inputs to our system are two or more RGB-D videos representing separate visits to the same location. From each sequence we generate a geometrically consistent 3-D reconstruction, or *scene*. Objects can move between visits but are assumed static during each visit.

A. Scene Reconstruction / SLAM

We build on RGB-D Mapping [10], a SLAM technique for generating dense 3-D maps. At a high level, RGB-D Mapping performs (1) pairwise frame alignment by visual odometry, (2) loop-closure detection and (3) global path optimization. In our off-line setting, we first compute visual features for all video frames. We choose SIFT as the descriptor, because accuracy is more important than speed to our application. Each visual feature is assigned the depth of the nearest pixel. The 3-D transformation between each pair of adjacent frames is estimated using RANSAC, using Horn's method [11] to fit models.

Loop-closure detection selects a subset of frames to be *keyframes* and speeds up the search by only matching pairs of keyframes. The same RANSAC algorithm as before is used to estimate the 3-D transformation between matching keyframes. Each time-adjacent frame pair and each pair of matched keyframes generates an edge in a *pose graph*, described by the transform produced by RANSAC. We use a pose-graph optimizer to globally adjust camera poses. The constraints used by this optimizer do not encode all the information from feature matching, so the optimization may introduce local inconsistencies. Therefore, we improve on RGB-D Mapping by following pose-graph optimization with bundle adjustment, again using 3-D-augmented SIFT descriptors. Bundle adjustment improves local consistency without disrupting global consistency.

Each frame consists of 250,000 colored 3-D points. Representing a scene by the concatenation of these point clouds is redundant, unwieldy and noisy. Following global registration, we convert points to *surfels* [14] to reduce map size and smooth evidence from multiple frames. Each 3-D point from each frame is assigned to a surfel, either an existing one or a newly created one if there is no existing surfel close to the point. Fig. 1 shows two reconstructions of a location.

We probabilistically model the position, color and orientation of each surfel, keeping uncertainty information as well as MAP values. A Gaussian over position can be updated recursively during reconstruction, and we compute distributions over color and normal after reconstruction. We exclude from differencing each surfel that has high uncertainty in any of these attributes.

The rest of our algorithm will require the surface to be representable as a finite set of local samples. We choose to use surfels for this paper, but the algorithm would work equally well with meshes or samples from implicit surfaces.

B. Scene Alignment

Assuming moved objects are a small part of each scene, we fit a single rigid transformation to the sets of point features in each pair of scenes using RANSAC. We compute SIFT features, assign each the 3-D location of the nearest depth point in its frame, and transform each image's features into a scene-global frame. This allows us to compute a transform between the sets of all features in each scene, which is more robust than the alternative of computing transformations between individual frames of different scenes and picking one to be the global transform. These transforms are inaccurate due to depth noise, so we furthermore run ICP, using the point-to-plane error of [5]. We ignore 30% of the worst-aligned points when calculating error, to account for the movable objects we expect. As an example of our global alignments, Fig. 1 shows the superimposition of two aligned scenes. A typical example of the improvement achieved by ICP is shown in Fig. 2.

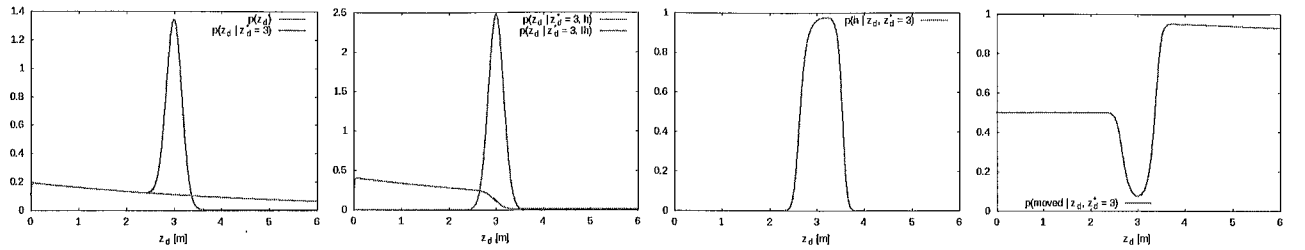
III. Measurement Model for RGB-D Cameras

We now introduce a sensor model for RGB-D cameras. Our model incorporates information from both depth and color, taking the correlations between the different sensor modalities into account.

RGB-D cameras provide a dense matrix of pixels, each measuring the color and distance of the closest surface in the pixel direction [10]. We make use of dense depth information to locally estimate surface normals and define a virtual

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(a) (b) (c) (d)

Fig. 3: (a) Probability of a depth measurement z_d given no knowledge about the environment (red) and given a model in which the closest surface patch along the pixel beam is at 3 m (blue). (b) Probability of measuring distance z_d given that the known surface caused (red) or did not cause (blue) the measurement. (c) Probability that the surface at $z_d^* = 3$ caused the measurement z_d. This probability serves as a weighting function for the mixture components of the color and orientation models. (d) Probability that the expected surface is missing given a depth measurement z_d. The model parameters used to make these plots are different from those used in our experiments.

measurement $z = \langle z_d, z_c, z_\alpha \rangle$, where z_d is the depth value of the pixel, z_c the color, and z_α the orientation of the detected surface. Our probabilistic model for pixel measurements is motivated by beam-based models for distance sensors such as laser range finders or sonar sensors, extending these to incorporate the additional color and local shape information provided by RGB-D cameras.

As will become clear in Section IV, we need to consider two cases, one in which there is no knowledge about the environment and one in which we have a 3-D reconstruction of the environment we expect to see.

A. No Scene / Surface Information

We now model an RGB-D pixel measurement z if there is no prior information about surfaces in the scene. We assume that in absence of any surface information, the depth, color, and orientation measurement components are independent:

$$p(z) = p(z_d, z_c, z_\alpha) \approx p(z_d)p(z_c)p(z_\alpha) \tag{1}$$

Following models developed for range sensors such as laser scanners and sonar sensors [18], [8], the distribution over depth measurements given no information about surfaces is a mixture between an exponential and a uniform distribution:

$$p(z_d) = \begin{pmatrix} w_{\text{short}} \\ w_{\text{rand}} \end{pmatrix}^T \cdot \begin{pmatrix} p_{\text{short}}(z_d) \\ p_{\text{rand}}(z_d) \end{pmatrix}$$

$$p_{\text{short}}(z_d) = \begin{cases} \eta\, \lambda_{\text{short}}\, e^{-\lambda_{\text{short}} z_d} & \text{if } z_d \leq z_{\max} \\ 0 & \text{otherwise} \end{cases}$$

$$p_{\text{rand}}(z_d) = \begin{cases} \frac{1}{z_{\max}} & \text{if } z_d < z_{\max} \\ 0 & \text{otherwise} \end{cases}, \tag{2}$$

where p_{short} models the probability that the pixel detects a surface before reaching maximum range, and p_{rand} is a uniform distribution over the measurement range. w_{short} and w_{rand} are mixture weights and λ_{short} and η are the scale parameter of the exponential distribution and its normalizer, respectively. An example for this mixture distribution is represented by the red line in Fig. 3(a).

Given no map of the environment, we model the color and orientation distributions $p(z_c)$ and $p(z_\alpha)$ as uniform distributions over the color and orientation spaces.

B. Known Scene / Surface

We now assume that a scene surface map is available. Given the location of the depth camera, we can use ray tracing to determine the distance, color, and local orientation of the closest surface along the pixel direction. This information can be encoded in an *expected* measurement $z^* = \langle z_d^*, z_c^*, z_\alpha^* \rangle$. Conditioning on the expected measurement and separating the individual components of the pixel measurement, we apply the chain rule:

$$\begin{aligned} p(z \mid z^*) &= p(z_d, z_c, z_\alpha \mid z^*) \\ &= p(z_d \mid z^*)p(z_c \mid z_d, z^*)p(z_\alpha \mid z_d, z_c, z^*) \\ &\approx p(z_d \mid z_d^*)p(z_c \mid z_d, z^*)p(z_\alpha \mid z_d, z^*)\,. \end{aligned} \tag{3}$$

In the last step we assume that the orientation z_α is independent of the color z_c. This model is similar to that of [13], which combines three cues—depth, color, and image gradients—for 3-D reconstruction. However, while they assume independence of the components, we explicitly model the dependences between color, orientation, and depth. As we will show below, this results in more accurate models since, given a surface patch, the distance provides additional information about the expected orientation and color.

We now derive models for the three components. The model for the depth value $p(z_d \mid z_d^*)$ is almost identical to that of existing models for laser or sonar beams. Here, we stay close to the one given by Thrun and colleagues [18], who model $p(z_d \mid z_d^*)$ as a mixture of four distributions [1]. We use three of their components [2]:

$$p(z_d \mid z_d^*) = \begin{pmatrix} w_{\text{hit}} \\ w_{\text{short}} \\ w_{\text{rand}} \end{pmatrix}^T \cdot \begin{pmatrix} p_{\text{hit}}(z_d \mid z_d^*) \\ p_{\text{short}}(z_d \mid z_d^*) \\ p_{\text{rand}}(z_d \mid z_d^*) \end{pmatrix} \tag{4}$$

p_{hit} represents the case in which the measurement hits the expected surface, and the other two components are just like those modeling unknown surfaces, with the exponential distribution cut off at the expected distance. The distribution

[1] We actually use the more correct but less intuitive model of [7].

[2] We do not explicitly model maximum-range measurements, since these correspond to uninformative noise in our RGB-D camera and can be ignored without substantial loss of expressiveness. Incorporating max range if necessary would be straightforward.

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for the first case is a Gaussian centered at the expected distance:

$$p_{\text{hit}}(z_d \mid z_d^*) = \begin{cases} \eta\, \mathcal{N}(z_d; z_d^*, \sigma_{\text{hit}}^2) & \text{if } z_d \le z_{\max} \\ 0 & \text{otherwise} \end{cases} \quad (5)$$

Here $z_{\max}$ is the maximum measurement range and η is a normalizer. σ_{hit}^2 is the distance measurement noise, which is a function of z_d^*, of the obliqueness of the viewing angle to the expected surface, and of the error in stereo depth estimation as a function of depth (we use a stereo noise model since our depth camera technology is based on stereo). Intuitively, the more obliquely the camera views a surface, the less accurate the measurement of that surface will be; we model this by

$$\sigma_{\text{hit}} = \frac{\sigma_0(z_d^*)}{\sin(\pi/2 - \theta)},$$

where θ is the angle between the viewing direction and the expected surface's normal. An example for the mixture distribution is given by the blue line in Fig. 3(a). Fig. 3(d) visualizes the posterior $p(\text{m} \mid z_d, z_d^*)$ resulting from ignoring color and orientation.

We now turn to the models for the color and orientation components of a measurement, respectively $p(z_c \mid z_d, z^*)$ and $p(z_\alpha \mid z_d, z^*)$. The color model obviously should depend on z_c^*, the color of the expected surface. However, the additional conditioning on z_d allows us to use the depth value to determine whether the measurement was actually caused by the expected surface or by some other surface (due to moving objects, for example). To do so, we introduce a binary random variable h whose value is whether the expected surface caused the measurement.

$$\begin{aligned} p(z_c \mid z_d, z^*) = {} & p(z_c \mid z_d, z^*, h)\, p(h \mid z_d, z^*) \\ & + p(z_c \mid z_d, z^*, \neg h)\, p(\neg h \mid z_d, z^*) \end{aligned} \quad (6)$$

follows directly by conditioning on h. We can model the first component of this mixture by a Gaussian with mean at the expected color:

$$p(z_c \mid z_d, z^*, h) \sim \mathcal{N}(z_c^*, \sigma_{\text{col}}^2) \quad (7)$$

We model the other mixture component in (6), $p(z_c \mid z_d, z^*, \neg h)$, by a uniform distribution over the color space.

To determine the weights of these two mixture components, we apply Bayes' rule to $p(h \mid z_d, z^*)$ and $p(\neg h \mid z_d, z^*)$, yielding

$$p(h \mid z_d, z^*) \propto p(z_d \mid h, z^*) p(h \mid z^*) \quad (8)$$

$$p(\neg h \mid z_d, z^*) \propto p(z_d \mid \neg h, z^*) p(\neg h \mid z^*) \quad (9)$$

with the same constant of proportionality in both. Here, $p(z_d \mid h, z^*)$ and $p(z_d \mid \neg h, z^*)$ are special cases of the distance model given in (4): $p(z_d \mid h, z^*)$ is the Gaussian component p_{hit}, and $p(z_d \mid \neg h, z^*)$ is a mixture of the other two components p_{short} and p_{rand}.

$p(h \mid z^*)$ in (8) can be computed as $\int_0^{z_{\max}} \frac{p_{\text{hit}}(z_d \mid z^*)}{p(z_d \mid z^*)} dz_d$. Example distributions for $p(z_d \mid h, z^*)$ and $p(z_d \mid \neg h, z^*)$ are given in Fig. 3(b). Plugging these distributions into the weighting function (8) results in the plot shown in Fig. 3(c). Again, this distribution serves as a weighting function for the mixture components in the color model (6). As a result, the measured color z_c should be similar to the expected color z_c^* if the depth measurement z_d is close to the surface distance z_d^*, and uniformly distributed otherwise.

The derivation of the orientation model $p(z_\alpha \mid z_d, z^*)$ is analogous and omitted for brevity. We model orientation by a von Mises-Fisher distribution, a common choice of distribution over a hypersphere because it has a closed-form pdf [2]. We use parameters $\mu = z_\alpha^*$ and $\kappa = 60$.

One way to balance evidence from these three components is to change the effective number of observations [18]. We use the reweighting

$$p(z \mid z^*) = p(z_d \mid z_d^*)^\alpha p(z_c \mid z_d, z^*)^\beta p(z_\alpha \mid z_d, z^*)^\gamma. \quad (10)$$

For all experiments below we use $\alpha = 1, \beta = 25, \gamma = 5$ to allow the color and normal components to override the depth component when the observed and expected depths are similar. These numbers are an educated guess, and results are robust to a wide range of values.

IV. Scene Differencing

A. Pointwise Motion Estimation

We are now equipped to detect differences between two 3-D maps. Consider a single surface patch in the first scene. Patch $s = \langle s_x, s_c, s_\alpha \rangle$ is described by its location s_x, color s_c, and surface orientation s_α. Using the alignment technique described in Section II, we can determine all camera poses of the second scene relative to s. Based on these camera poses we identify for each camera frame the pixel that points at that surface patch (if the patch is in the camera's field of view). From the camera pose and the surface descriptor s we can also compute the expected measurement z^*. We wish to determine for each s the probability that it *moved* away from its location in the first scene.

Let $\mathbf{z}_s$ denote the set of measurements taken in the second scene associated with a specific surface patch s in the first scene, and let $\mathbf{z^*}_s$ denote the expected measurements computed from $\mathbf{z}_s$ and s. We denote by m the Boolean variable representing whether s moved. By Bayes' rule,

$$p(\text{m} \mid \mathbf{z}_s, \mathbf{z^*}_s) = \frac{p(\text{m}, \mathbf{z^*}_s) p(\mathbf{z}_s \mid \text{m}, \mathbf{z^*}_s)}{p(\mathbf{z}_s, \mathbf{z^*}_s)} \quad (11)$$

$$\approx \frac{p(\text{m}) p(\mathbf{z^*}_s) p(\mathbf{z}_s \mid \text{m}, \mathbf{z^*}_s)}{p(\mathbf{z}_s \mid \mathbf{z^*}_s) p(\mathbf{z^*}_s)} \quad (12)$$

$$\propto p(\text{m}) \prod_{i=1}^{I} p(z_i \mid \text{m}, z_i^*)\,, \quad (13)$$

where I is the number of frames in the second scene, $p(\text{m})$ comes from prior knowledge (we usually use .1 because few of our surfels move) and

$$p(z_i \mid \text{m}, z_i^*) = \begin{cases} p(z_i \mid z_i^*), & \text{m} = 0 \\ p(z_i), & \text{m} = 1 \end{cases}. \quad (14)$$

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The idea behind (14) is that if the surface did not move, the measurement follows the surface-based model (3). If the surface patch moved, however, we have no knowledge about what to expect, so we use the prior model (1).

The pointwise motion probabilities computed for the surface patches of the left scene in Fig. 1 are shown in Fig. 5(a). The changed objects are detected as high-probability areas, using the combination of depth, color, and orientation cues. Furthermore, the grey areas appropriately represent surface regions that are occluded in the second scene (Fig. 1(b)). However, due to sensor noise and imperfect alignment, the individual motion probabilities are still noisy.

B. Spatial Regularization

To improve spatial consistency we generate a Markov random field with a node for each surface patch. Each node has two choices of label: moved and not moved. For efficiency we use only pairwise cliques in the MRF so that we can use graph cuts [4] for inference. The data energy for the MRF is straightforwardly calculated from the output of the pointwise model:

$$E_d(l) = \begin{cases} \log(1 - p(\mathrm{m} \mid \mathbf{z}, \mathbf{z}^*)), & l = \mathrm{m} \\ \log(p(\mathrm{m} \mid \mathbf{z}, \mathbf{z}^*)), & l = \neg\mathrm{m} \end{cases} \quad (15)$$

For the smoothness energy we use the Potts model, weighted by the curvature of the local region to discourage cuts in low-curvature areas:

$$E_b(s_i, s_j, l_1, l_2) = w_s \begin{cases} \frac{1}{\sqrt{\max(\kappa_i, \kappa_j, \kappa_0)}}, & l_1 \neq l_2 \\ 0, & l_1 = l_2 \end{cases} \quad (16)$$

Here s_i and s_j are surface patches and l_1 and l_2 their labels. κ_i is the previously computed local curvature at s_i. κ_0 is a constant representing the minimum curvature beyond which all surfaces can be described as "very flat"; we set it to 1 m^{-1}. We set the smoothness weight w_s by optimization over two scene pairs (not the ones visualized in Fig. 5 and Fig. 6). The result of applying this MRF to the probabilities displayed in Fig. 5(a) is shown in Fig. 5(b).

V. Experiments

We evaluate our sensor model and demonstrate the ability to discover and model objects in a tabletop setting. In each experiment, the RGB-D camera was carried by hand to generate partial coverage of the scene.

A. Depth-Dependent Color Model

Our color and orientation models take the expected color and orientation into account, but also model dependence on the expected vs. measured distance of the surface patch. In this experiment we demonstrate the advantage of our model over a sensor model that ignores this dependence (as that of [13]). The left two panels in Fig. 4 show top views of an experiment in which a white object is placed on the table in scene 1 (Fig. 4(a)) and is then occluded from the camera viewpoints by a white box in scene 2 (Fig. 4(b)). Fig. 4(c) shows the motion probabilities coming from a color model that does not model dependence on depth (a depth-independent mixture between a Gaussian and uniform color model). The model erroneously is certain that the white object in the left scene did *not* move (note the nearly black outline of the object). However, the second scene provides no evidence about this area since it is fully occluded by the white box. As can be seen in Fig. 4(d), our depth-dependent color model generates the correct probabilities, having near 0.5 probability in the occluded area.

B. Detecting Moved Objects

In Fig. 5 we show results on the complex scene pair of Fig. 1. Each scene contains a spray bottle and a cylindrical object in about the same location, such that simple nearest-neighbor point search would consider them the same objects. Due to our use of color and orientation information, we correctly detect changed surfaces at these locations in both scenes. One of the objects is also occluded, necessitating the use of our depth-dependent color model. In Fig. 5(a) and Fig. 5(c) we show the raw probabilities $p(\mathrm{m} \mid z_d, z^*)$ from our sensor model. Labels after regularization are shown in Fig. 5(b) for the first scene and Fig. 5(d) for the second scene, demonstrating that we find all movable objects with high accuracy despite using only low-level cues. We extract each connected component of same-label surface patches as a 3-D model and show the foreground (object) models in Fig. 7(a), along with the merge of the two background segments, which fills in some holes in each individual table.

Fig. 6 gives results for another scene pair. In the tvtable dataset, small objects move around on a cluttered table. In Fig. 7(b) we show four extracted foreground connected components along with the merged backgrounds; again we have filled in some holes on the table. We do not show foreground components that are very small, of which there are one in Fig. 5 and three in Fig. 6. We provide 3-D model files for these scenes, and the extracted objects, at `http://www.cs.washington.edu/robotics/projects/object-discovery/`. PLY files can be opened using Meshlab [6].

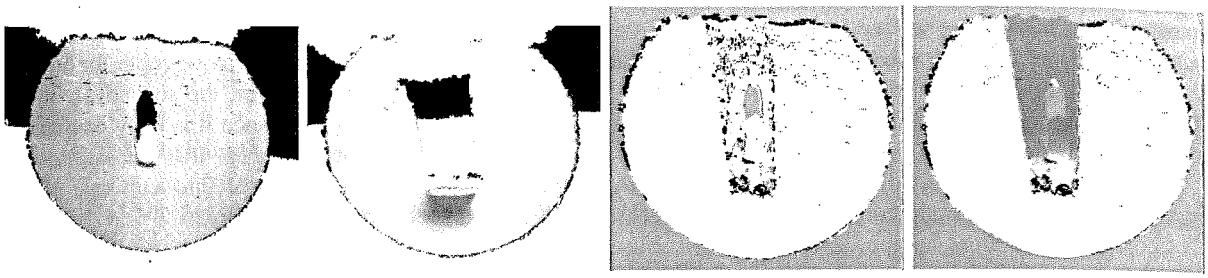
C. Quantitative Results

We manually annotated which surfels moved for each scene pair in a set of four scenes. (Occluded points were marked not moved.) Performance numbers for these scene pairs are given in table I. Precision and recall were calculated with respect to surfels annotated as moved, since those are a small minority of surfels and are the most salient surfels for most applications of differencing.

	precision	recall	accuracy	baseline accuracy	% error reduction
average	.965	.800	.990	.968	68.8
min	.911	.662	.980	.954	

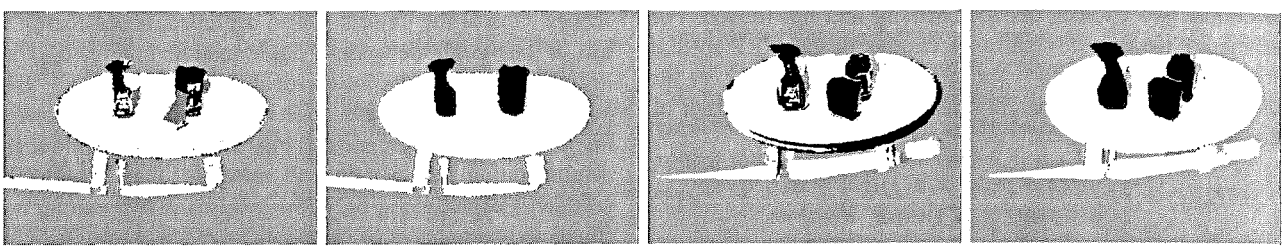
TABLE I: Performance statistics aggregated over 12 scene pairs after spatial regularization. "Baseline" refers to the classifier that labels all surfels not moved. "Error reduction" is our improvement w.r.t. the baseline error rate. To pick regularization parameters we optimized a modified F-1 score giving extra importance to precision.

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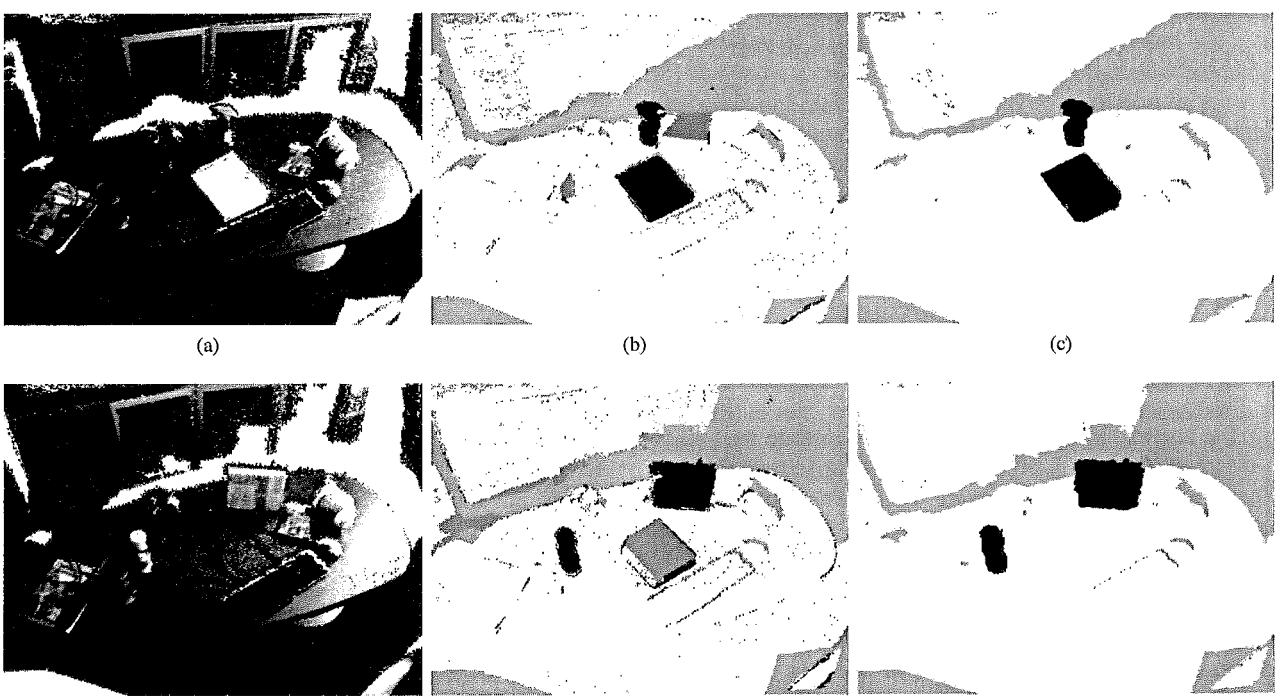
(a) (b) (c) (d)

Fig. 4: Depth-dependent color model. The white object in the left scene (a) is occluded by the white box in the second scene (b). A depth-independent model (c) generates a very high probability that the white object did *not* move. Our color model (d) correctly captures the occlusion and generates motion probabilities near 0.5 in the occluded area. In this and further figures, green represents points either not seen during mapping or seen in one map but not the other so that differencing is not possible. In (c) and (d), the floor has also been removed for clarity. Grayscale pixels give $p(\mathrm{m} \mid z)$: the darker, the higher the probability of movement.



(a) (b) (c) (d)

Fig. 5: (a) surfel-wise differencing and (b) regularization results for the first scene of Fig. 1; (c), (d) similarly for the second scene.



(a) (b) (c)

(d) (e) (f)

Fig. 6: (a), (d) two scenes from the tvtable dataset; (b), (e) surfel-wise differencing results for the two scenes; (c), (f) regularization results. A few surfels shown in the surfelwise result do not appear in the final output due to culling we perform prior to regularization. Three large occluded areas in (b) and (e) show as medium gray (movedness uncertain).

D. Timing

In table II we break down the time spent by our system on the scenes of Fig. 6 (differencing both ways). These two videos have 360 and 500 frames respectively; the maps contain 650k and 620k surfels respectively. Subsampling frames would speed up mapping, reconstruction and differencing.

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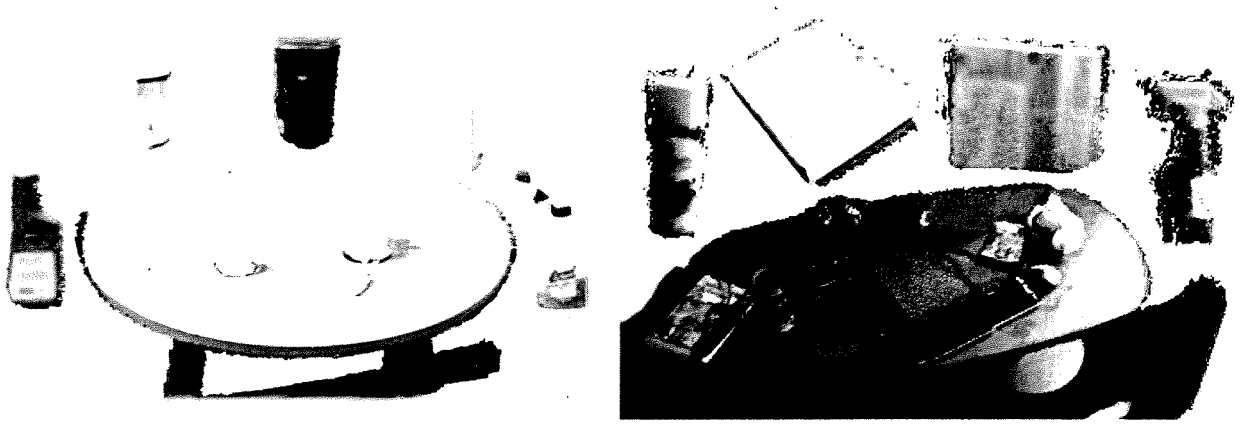


Fig. 7: Objects extracted from the scene pairs of Fig. 1 and Fig. 6, and the merged background components of each pair of scenes. In the right panel some of the background is faded for clarity.

There are a number of other ways to speed up mapping, but in our experience they are all very data-dependent; we used settings conservative enough to work in a relatively large number of cases at the expense of speed. Alignment could be sped up by subsampling the set of features given to RANSAC; here again we are conservative. The machine used has 16 hardware threads, and various parts of our system make use of this; in particular differencing is almost embarrassingly parallel.

Stage	Time
preprocessing	400s
mapping	600s (mostly bundle adjustment)
reconstruction	360s
alignment	140s (100s w/o ICP)
differencing	180s
regularization	24s

TABLE II: Time spent in each stage of our algorithm for the scene pair shown in Fig. 6.

VI. Conclusion

We have described a method to determine movable parts of a scene based on differencing with another scene. Our method makes no assumption on overall object shape, texture of surfaces, or large motion relative to object size. It also models and finds occluded surfaces. Phrasing the differencing problem in terms of a probabilistic model of sensor readings provides robustness to noisy data as well as a principled way to combine information from multiple sensors. The method relies on 3-D reconstruction, whose accuracy and robustness could use improvement; the difficulty of making good geometric maps is our largest obstacle. Our algorithm can also find large moving objects, such as furniture; see the website (given in Section V-B) for an example.

We plan to use the movement detection techniques presented here together with matching of surfaces among multiple scenes to improve object localization. With our differencing technique it is straightforward to combine evidence from multiple scenes to improve the input to spatial regularization. Matching can be initialized using point-feature matches for highly textured areas and point-cloud-based techniques for untextured regions. Then evidence about intra-scene and inter-scene similarity can be combined, perhaps using random fields similar to those of [19], to identify objects common to multiple scenes.

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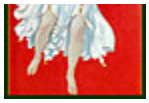
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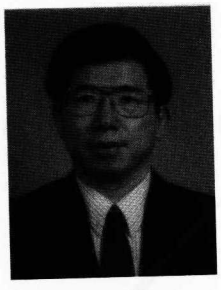
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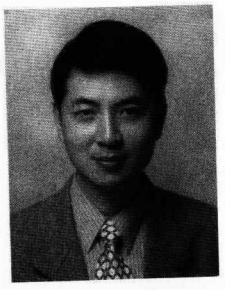
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A record number of papers, 1176, have been submitted to this conference Program Committee (PC) from 48 countries completely through the web on-line system developed locally, which demonstrates excellent capabilities in handling huge amount of paper submissions from all over the world and the subsequent review and registration matters. Special thanks should go to the Program Co-Chairs, Shigeo Hirose, C.S.G. Lee, Bruno Siciliano, and B.H. Lee and all PC members for their extraordinary work in reviewing such incredible amount of submitted papers and in selecting 714 papers for presentations over 14 parallel tracks per day in the three day main program. Topics of the accepted papers cover quite wide spectrum and are roughly grouped into 34 categories. To serve the conference participants with a technical program of greater variety, the sessions of paper presentation are made of several kinds besides the regular ones, including Organized/Invited Session, Industry Session, Video Session, and three plenary speeches as well as thee panel discussions. Such solid program will not be possible without tremendous help and professional support from members of the organizing committee and all other conference committees.

We wish you will have a fruitful conference and a very pleasant stay in Taiwan.



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Li-Chen Fu
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Map Building with Mobile Robots in Dynamic Environments

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Abstract

The problem of generating maps with mobile robots has received considerable attention over the past years. Most of the techniques developed so far have been designed for situations in which the environment is static during the mapping process. Dynamic objects, however, can lead to serious errors in the resulting maps such as spurious objects or misalignments due to localization errors. In this paper we consider the problem of creating maps with mobile robots in dynamic environments. We present a new approach that interleaves mapping and localization with a probabilistic technique to identify spurious measurements. In several experiments we demonstrate that our algorithm generates accurate 2d and 3d in different kinds of dynamic indoor and outdoor environments. We also use our algorithm to isolate the dynamic objects and to generate three-dimensional representation of them.

1 Introduction

Learning maps with mobile robots is one of the fundamental problems in mobile robotics. In the literature, the mobile robot mapping problem is often referred to as the *simultaneous localization and mapping problem (SLAM)* [5, 7, 13, 17, 14, 10, 19]. This is because mapping includes both, estimating the position of the robot relative to the map and generating a map using the sensory input and the estimates about the robot's pose.

Whereas most of todays mapping systems are able to deal with noise in the odometry and noise in the sensor data, they assume that the environment is static during mapping. However, if a person walks through the sensor range of the robot during mapping, the resulting map will contain evidence about an object at the corresponding location. Moreover, if the robot returns to this location and scans the area a second time, pose estimates will be less accurate, since the new measurement does not contain any features corresponding to the person. The reduced accuracy of the resulting maps may have a negative influence on the overall performance of the robot, since it can obstruct the execution of typical navigation tasks such as localization and path planning.

In this paper we present a new algorithm to mapping with mobile robots in dynamic environments. Our approach applies the popular Expectation-Maximization (EM) algorithm. In the expectation step we compute a probabilistic estimate about which measurements might correspond to static objects. In the maximization step we use these estimates to determine the position of the robot and the map. This process is iterated until no further improvement can be achieved.

We apply our approach to 2d and 3d data obtained with laser-range scanners. In practical experiments we demonstrate that our algorithm can reliably filter out dynamic aspects and yields accurate models of the environment. A further advantage of our algorithm is that the filtered data can be extracted from the rest of all measurements. This way, we can obtain accurate textured 3d models of dynamic objects.

This paper is organized as follows. After discussing related work in the following section, we will present our EM-based procedure to learn which measurements correspond to static aspects of the environment in Section 3. In Section 4 we will present several experiments illustrating that our approach can successfully learn 2d and 3d maps with range scanners in dynamic environments.

2 Related Work

For mobile robots, there exist several approaches to mapping in dynamic environments. The approaches mostly relevant to the work reported here are the methods developed by Wang et al. [20] and our previous work described in [11]. Wang et al. [20] use a heuristic and feature-based approach to identify dynamic objects in range scans. The corresponding measurements are then filtered out during 2d scan registration. In our recent work [11] we describe an approach to track persons in range scans and to remove the corresponding data during the registration and mapping process. Compared to these techniques, our algorithm presented in this paper does not rely on any pre-defined features. Rather, it considers every measurement individually and estimates a posterior about whether or not this data item has been generated by a dynamic object.

Additionally, there has been work on updating maps or improving localization in populated environments. For example, in the system described in [4] we update a given static map using the most recent sensory input to deal with people in the environment during path planning. Montemerlo et al. [15] present an approach to simultaneous localization and people tracking. Siegwart et al. [18] present a team of tour-guide

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robots that operates in a populated exhibition. Their system uses line features for localization and has been reported to successfully filter range-measurements reflected by persons. Fox et al. [9] present a probabilistic technique to identify range measurements that do not correspond to the given model of the environment. These approaches, however, require a given and fixed map which is used for localization and for the extraction of the features corresponding to the people. Our technique, in contrast, does not require a given map. Rather it learns the map from scratch using the data acquired with the robot's sensors. Our algorithm repeatedly interleaves the process of estimating which beams are caused by dynamic objects with a mapping and localization algorithm. Thereby it iteratively improves its estimates and generates more accurate models of the environment.

From a more general perspective, the problem of estimating dynamic aspects in data can be regarded as an outlier detection problem, since the spurious measurements are data items that do not correspond to the static aspects of the environment which are to be estimated. The identification of outliers is an important subtask in various application areas such as data mining [12, 3, 16], correspondence establishment [6, 2], clustering [8], or statistics [1]. In all these fields, errors in the data reduce the accuracy of the resulting models and thus can lead to a decreased performance whenever the learned models are used for prediction or robot navigation, for example. The problem considered in this paper differs from these approaches in the fact that outliers cannot be detected solely based on their distance to the other data items. Rather, the measurements first have to be interpreted and transformed into a global representation (map) before individual measurements can be identified as outliers.

3 Learning Maps in Dynamic Environments

Our approach to discover measurements that correspond to dynamic objects is strictly statistical. We use the popular EM-algorithm to identify data items that cannot be explained by the rest of the data set. The input to our routine is a sequence of data items $z = \{z_1, \ldots, z_T\}$. The output is a model m obtained from these data items after incorporating the estimates about spurious measurements. In essence, our approach seeks to identify a model m that maximizes the likelihood of the data. Throughout this paper we assume that each measurement z_t consists of multiple data $z_{t,1}, \ldots, z_{t,N}$ as it is the case, for example, for laser-range scans. Throughout this paper we assume that the data $z_{t,n}$ are beams obtained with a laser-range scanner.

To accurately map a dynamic environment we need to know which measurements are caused by dynamic objects and therefore can safely be ignored in the alignment and map updating phase. To characterize spurious measurements in the data we introduce additional variables $c_{t,n}$ that tell us for each t and each n, whether the data item $z_{t,n}$ is caused by a static object or not. Each such variable $c_{t,n}$ is a binary variable, that is either 0 or 1. It is 1 if and only if the $z_{t,n}$ is caused by a static object. The vector of all these variables will be denoted by c.

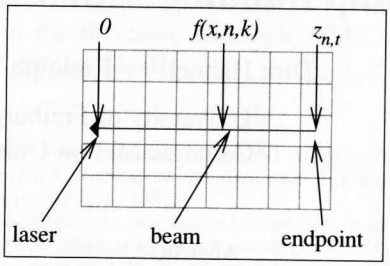


Figure 1: Beam covering $z_{t,n}$ cells of a map.

For the sake of simplicity, we give the derivation for beams that are parallel to the x-axis of the map. In this case, the length $z_{t,n}$ directly corresponds to the number of cells covered by this beam. We will later describe how to deal with beams that are not parallel to the x-axis. Let f be a function that returns for each position x_t of the robot, each beam number n, and each $k \leq z_{t,n}$ the index $f(x_t, n, k)$ of k-th field covered by that beam in the map (see Figure 1). To determine whether or not a beam is reflected by a dynamic object, we need to define the likelihood of a measurement given the current map m of the environment, the pose x of the robot, and the information about whether $z_{t,n}$ is reflected by a maximum range reading. Typically, maximum-range readings have to be treated differently, since those measurements generally are not reflected by any object. Throughout this paper we introduce indicator variables $\zeta_{t,n}$ which are 1 if and only if $z_{t,n}$ is a maximum range reading and 0, otherwise. The likelihood of a measurement $z_{t,n}$ given the value of $c_{t,n}$ and the map m can thus be computed as:

$$p(z_{t,n} \mid c_{t,n}, x_t, m) = \left[\prod_{k=0}^{z_{t,n}-1} (1 - m_{f(x_t,n,k)}) \right]^{\zeta_{t,n}} \cdot \left[[m_{f(x_t,n,z_{t,n})}]^{c_{t,n}} \cdot [1 - m_{f(x_t,n,z_{t,n})}]^{(1-c_{t,n})} \cdot \prod_{k=0}^{z_{t,n}-1} (1 - m_{f(x_t,n,k)}) \right]^{(1-\zeta_{t,n})} \quad (1)$$

The first term of this equation specifies the likelihood of the beam given it is a maximum range scan. In such a situation, we compute the likelihood as the product of the probabilities that the beam has covered the cells 0 to $z_{t,n-1}$. Please note, that the cell in which the beam ends does not provide any information since we do not know, whether there is an object or not given the beam is a maximum range reading. Thereby the probability that a beam covers a cell $k < z_{t,n}$ is equal to $1 - m_{f(x_t,n,k)}$. The second row of this equation specifies how to deal with the case that a cell that reflects a non-maximum range beam. If $z_{t,n}$ is not reflected by a dynamic object, i.e. $c_{t,n} = 1$, then the likelihood equals $m_{f(x_t,n,z_{t,n})}$. If, in contrast, $z_{t,n}$ is reflected by a dynamic object, the likelihood is $1 - m_{f(x_t,n,z_{t,n})}$. As well as for the maximum range measurements we have to

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consider in both cases that the beam has covered $z_{t,n} - 1$ cells before reaching cell $f(x_t, n, z_{t,n})$.

Based on the definition of the observation likelihood we now will define the likelihood $p(z, c \mid x, m)$ of the data which we try to maximize in order to find the most likely map of the environment.

$$p(z, c \mid x, m) = \prod_{t=1}^{T} p(z_t, c_t \mid x_t, m) \quad (2)$$

$$= \prod_{t=1}^{T} p(z_t, \mid x_t, m) \cdot p(c_t \mid x_t, m) \quad (3)$$

$$= \prod_{t=1}^{T} p(z_t, \mid x_t, m) \cdot p(c_t) \quad (4)$$

$$= \prod_{t=1}^{T} \prod_{n=1}^{N} p(z_{t,n}, \mid c_{t,n}, x_t, m) \cdot p(c_t) \quad (5)$$

We obtain Equation (3) from Equation (2) by assuming that the z_t and c_t are independent given x_t and m. We furthermore consider c_t as independent from the location x_t and the map m, which leads to Equation (4). Finally, Equation (5) is derived from Equation (4) under the usual assumption, that the neighboring beams of a single scan are independent given the map of the environment.

Maximizing $p(z, c \mid x, m)$ is equivalent to maximizing the corresponding log likelihood, which can be derived from Equation (5) and Equation (1) by straightforward mathematical transformations:

$$\begin{aligned}
&\ln p(z, c \mid x, m) \\
&= \ln \prod_{t=1}^{T} \prod_{n=1}^{N} p(z_{t,n}, \mid c_{t,n}, x_t, m) \cdot p(c_t) \\
&= N \cdot \sum_{t=1}^{T} \ln p(c_t) + \sum_{t=1}^{T} \sum_{n=1}^{N} \ln p(z_{t,n}, \mid c_{t,n}, x_t, m) \\
&= N \cdot \sum_{t=1}^{T} \ln p(c_t) \\
&\quad + \sum_{t=1}^{T} \sum_{n=1}^{N} \Bigg[(1 - \zeta_{t,n}) \cdot \Big[c_{t,n} \cdot \ln m_{f(x_t,n,z_{t,n})} \\
&\qquad + (1 - c_{t,n}) \cdot \ln(1 - m_{f(x_t,n,z_{t,n})}) \Big] \\
&\qquad + \sum_{k=0}^{z_{t,n}-1} \ln(1 - m_{f(x_t,n,k)}) \Bigg] \quad (6)
\end{aligned}$$

Since the correspondence variables c are not observable in the first place a common approach is to integrate over them, that is, to optimize the expected log likelihood $E_c[\ln p(c, z \mid x, m) \mid x, m, d]$ instead. Since the expectation is a linear operator, we can move it inside the expression. By exploiting the fact that the expectation of $c_{t,n}$ only depends on the corresponding measurement $z_{t,n}$ and the position x_t of the robot at that time. we can derive the following equation:

$$\begin{aligned}
&E_c[\ln p(z, c \mid x, m) \mid z, x, m] = \\
&\quad \gamma + \sum_{t=1}^{T} \sum_{n=1}^{N} \Bigg[e_{t,n} \cdot (1 - \zeta_{t,n}) \cdot \ln m_{f(x_t,n,z_{t,n})} \\
&\quad + (1 - e_{t,n}) \cdot (1 - \zeta_{t,n}) \cdot \ln(1 - m_{f(x_t,n,z_{t,n})}) \\
&\quad + \sum_{k=0}^{z_{t,n}-1} \ln(1 - m_{f(x,n,k)}) \Bigg] \quad (7)
\end{aligned}$$

For the sake of brevity, we use the term

$$e_{t,n} = E_c[c_{t,n} \mid z_{t,n}, x_t, m] \quad (8)$$

in this equation. The term

$$\gamma = N \cdot \sum_{t=1}^{T} E_c[\ln p(c_t) \mid z, x, m] \quad (9)$$

is computed from the prior $p(c_t)$ of the measurements which is independent of z, x, and m. Accordingly, γ can be regarded as a constant.

Unfortunately, optimizing Equation (7) is not an easy endeavor. A typical approach to maximize log likelihoods is the EM algorithm. In the particular problem considered here this amounts to generating a sequence of maps m of increasing likelihood. In the E-Step, we compute the expectations about the hidden variables c. In the M-step we then compute the most likely map m using the expectations computed in the E-Step. Both steps are described in detail in the remainder of this section.

In the E-step we compute the expectations $e_{t,n} = E_c[c_{t,n} \mid z_{t,n}, x_t, m]$ for each $c_{t,n}$ given the measurement $z_{t,n}$, the location x_t of the robot and the current map m. Exploiting the fact that $e_{t,n}$ equals $p(c_{t,n} \mid z_{t,n}, x_t, m)$ and considering the two cases that $z_{t,n}$ is a maximum range reading or not, we obtain:

$$e_{t,n} = \begin{cases} p(c_{t,n}) & \text{, if } \zeta_{t,n} = 1 \\ p(c_{t,n})\epsilon_{t,n} & \text{, otherwise} \end{cases}$$

where

$$\epsilon_{t,n} = \frac{1}{p(c_{t,n}) + (1 - p(c_{t,n}))(\frac{1}{m_{f(x_t,n,z_{t,n})}} - 1)} \quad (10)$$

The first equation corresponds to the situation that $z_{t,n}$ is a maximum range reading. Then, $e_{t,n}$ corresponds to the prior probability $p(c_{t,n})$ that a measurement is reflected by a static object. Thus, a maximum range reading does not provide any evidence about whether or not the cell in the map in which the beam ends is covered by a dynamic object.

In the M-Step we want to determine the values for m and x that maximize Equation (7) after computing the expectations $e_{t,n}$

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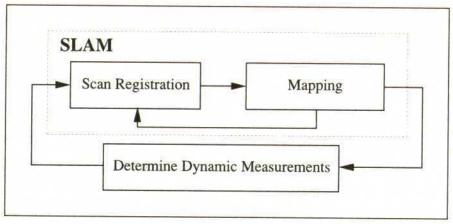


Figure 2: Iteration of SLAM and dynamic beam estimation.

about the hidden variables $c_{t,n}$ in the E-step. Unfortunately, maximizing this equation is also not trivial since it involves a solution to a high-dimensional state estimation problem. To deal with the enormous complexity of the problem, many researchers phrase it as an incremental maximum likelihood process [19, 10]. The key idea of incremental approaches is to calculate the desired sequence of poses and the corresponding maps by maximizing the marginal likelihood of the t-th pose and map relative to the $(t-1)$-th pose and map. In our algorithm, we additionally consider the estimations $e_{t,n}$ that measurement n at time t is caused by a static object of the environment:

$$\begin{aligned} \hat{x}_t &= \operatorname*{argmax}_{x_t} \left\{ p(z_t \mid c_t, x_t, \hat{m}^{[t-1]}) \right. \\ &\qquad \left. \cdot p(x_t \mid u_{t-1}, \hat{x}_{t-1}) \right\} \end{aligned} \tag{11}$$

In this equation the term $p(z_t \mid c_t, x_t, \hat{m}^{[t-1]})$ is the likelihood of the measurement z_t given the pose $\hat{x}_t$ and the map $\hat{m}^{[t-1]}$ constructed so far. The term $p(x_t \mid u_{t-1}, \hat{x}_{t-1})$ represents the probability that the robot is at location x_t given the robot previously was at position $\hat{x}_{t-1}$ and has carried out (or measured) the motion u_{t-1}. The registration procedure is then carried out using the same algorithm as described in our previous work [11].

It remains to describe how the measurement z_t is then used to generate a new map $\hat{m}^{[t]}$ given the resulting pose $\hat{x}_t$ and the expectations $e_{t,n}$. Fortunately, once $x_1, \ldots, x_t$, have been computed, we can derive a closed-form solution for $m^{[t]}$. We want to determine the value of each field j of the map $m^{[t]}$ such that the overall likelihood of $m^{[t]}$ is maximized. To achieve this, we sum over individual fields $j \in [1, \ldots, J]$ of the map. Thereby we use an indicator function $I(y)$ which is 1, if y is true and 0, otherwise.

$$\begin{aligned} \hat{m}^{[t]} = \operatorname*{argmax}_m \Bigg(\sum_{j=1}^{J} \sum_{t=1}^{T} \sum_{n=1}^{N} \Bigg[& I(f(x_t, n, z_{t,n}) = j) \\ & \cdot (1 - \zeta_{t,n}) \cdot (e_{t,n} \ln m_j + (1 - e_{t,n}) \ln(1 - m_j)) \\ & + \sum_{k=0}^{z_{t,n}-1} I(f(x_t, n, k) = j) \cdot \ln(1 - m_j) \Bigg] \Bigg) \end{aligned} \tag{12}$$

Now suppose, we define

$$\tilde{I}(x, n, k, j) \quad := \quad I(f(x, n, k) = j)$$

and

$$\alpha_j \quad := \quad \sum_{t=1}^{T} \sum_{n=1}^{N} \tilde{I}(x_t, n, z_{t,n}, j) \cdot (1 - \zeta_{t,n}) \cdot e_{t,n}$$

$$\begin{aligned} \beta_j \quad := \quad & \sum_{t=1}^{T} \sum_{n=1}^{N} \Bigg(\tilde{I}(x_t, n, z_{t,n}, j) \cdot (1 - \zeta_{t,n}) \\ & \cdot (1 - e_{t,n}) + \sum_{k=0}^{z_{t,n}-1} I(f(x_t, n, k) = j) \Bigg) \end{aligned}$$

The quantity α_j corresponds to the sum of the expectations $e_{t,n}$ that beam n of scan t is reflected by a static object of all beams that are not maximum-range beams and that end in cell j. The term β_j, on the other hand, is the sum of two terms. The first term is the sum of the expectations $1 - e_{t,n}$ that beam n of scan t is reflected by a dynamic object of all beams that are not maximum-range beams and that end in cell j. The second value of the sum simply is the number of times a beam covers j but does not end in j. Please note that this value is independent from whether or not the corresponding beam is reflected by a dynamic object or not. Please furthermore note that in a static world with $e_{t,n} = 1$ for all t and n the term α_t corresponds to the number of times a beam that does not have the maximum length ends in j. In contrast to that, β_j is the number of times a beam covers a cell.

Using the definitions of α_j and β_j, Equation (12) turns into

$$m^{[t]} = \operatorname*{argmax}_m \left(\sum_{j=1}^{J} \alpha_j \ln m_j + \beta_j \ln(1 - m_j) \right) \tag{13}$$

Since all m_j are independent, we maximize the overall sum by maximizing each m_j. A necessary condition to ensure that m_j is a maximum is that the first derivative equals zero:

$$\frac{\partial m}{\partial m_j} = \frac{\alpha_j}{m_j} - \frac{\beta_j}{1 - m_j} = 0 \tag{14}$$

By straightforward mathematical transformationswe obtain

$$m_j \quad = \quad \frac{\alpha_j}{\alpha_j + \beta_j}. \tag{15}$$

Please note that, given the sensor model specified in Equation (1), this closed-form solution for the most likely map m for given positions x and static environments corresponds to the naive counting technique in which one counts for each cell how often a beam has ended in that cell and how often a beam has covered it without ending in it.

The overall approach can be summarized as follows (see also Figure 2). We start with an initial map $\hat{m}$ obtained by the incremental mapping approach. Thereby the expectations $e_{t,n}$ are initialized with the prior probability $p(c_{t,n})$ that a measurement is caused by a static object. Given the resulting map $\hat{m}$ and the corresponding positions $\hat{x}$, we compute new expectations $e_{t,n}$ for each beam according to Equation (8). These expectations are then used to compute a new map. The overall process is iterated until no improvement of the overall likelihood (Equation (6)) can be achieved or a certain number of iterations has been exceeded.

Finally, we would like to discuss how to deal with beams that are not parallel to the x-axis. In this case we no longer can

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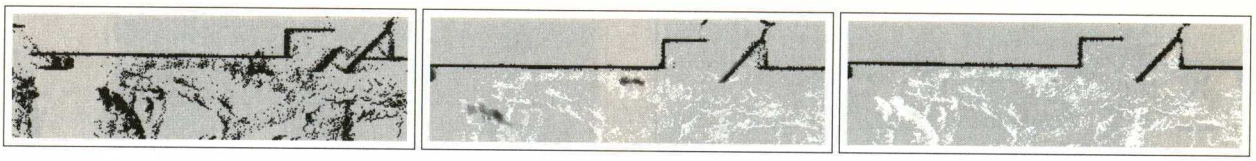


Figure 5: Evolution of the map during EM. The images corresponds to iteration 1, 2, and 6.

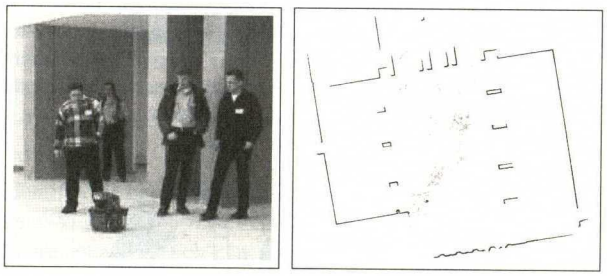


Figure 3: Robot Sam mapping the populated exhibition hall of the Byzantine Museum in Athens (left). In the resulting map (right), the measurements labeled as dynamic are shown in grey/orange.

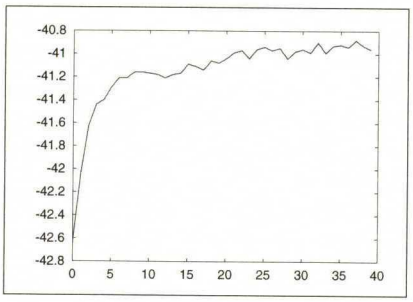


Figure 4: Evolution of the log likelihood (Equation (6)) during the individual iterations.

compute the likelihood that a beam covers a cell j of m as $(1 - m_j)$. Otherwise, transversal beams covering more cells would accumulate a lower likelihood. The solution to this is to weigh the beams according to the length by which they cover a cell. Suppose B is the set of cells in m covered by a beam. Furthermore suppose l_j is the length by which the beam covers field $j \in B$. Then, the likelihood of a covering all cells in B is computed as $\prod_{j \in B} (1 - m_j)^{l_j}$.

4 Experiments

The approach described above has been implemented and tested on different robotic platforms, in different environments and with 2d and 3d data. In all experiments, we figured out, that the system is robust even in highly dynamic environments. In one experiment carried out with a fast moving car, the system was able to accurately map the environment even if no odometry data was given.

4.1 Filtering People

The first experiments were carried out using the Pioneer 2 robot Sam in the empty exhibition hall of the Byzantine Museum in Athens, Greece. The size of this environment is 30m x 45m. The robot traveled continously 57m with an avg. speed of 0.37m/s and a max. speed of 0.96m/s. Figure 3 (left) shows the robot during the mapping process. There were 15 people walking with a typical speed through the environment while the robot was mapping it. Partially they stopped and continued moving. The most likely map resulting from the application of our approach is shown in athe right image of Figure 3. The beams labeled as dynamic are drawn grey/orange in this figure. As can be seen, our approach can reliably identify dynamic aspects and is able to learn maps that include the static aspects only. At this point we would also like to mention that the resulting map contains seriously less dynamic objects than the map obtained with our previous approach presented in [11].

Figure 4 plots the evolution of $E_c[\ln p(c, z \mid x, m) \mid x, m, d]$ over the different iterations of our algorithm. It illustrates that our algorithm in fact maximizes the overall log likelihood. Please note, that this curve generally is not monotonic, because of the incremental maximum-likelihood solution to the SLAM problem. Slight variations in the pose can have negative effects in future steps, so that the map likelihood can decrease. However, we never observed significant decrease of the log likelihood.

4.2 Improved Localization Accuracy

Besides the fact that the resulting maps contain less spurious objects, our approach also increases the localization accuracy. If dynamic objects are not handled appropriately during localization, matching errors become more likely. Figure 6 shows a typical map we obtained when mapping a densely populated environment. In this case we mapped a part of the Wean Hall Corridor at Carnegie Mellon University during peak office hours when many persons were around. Some of them were trying to block the robot, so that the robot had to make detours around them. Therefore the robot traveled 74m with an avg. speed of 0.15m/s (0.35m/s maximum). Despite the fact, that the huge amount of spurious objects make the map virtually useless for navigation tasks, the map also shows serious errors in the alignment. Some of the errors are indicated by arrows in the corresponding figure.

Figure 7 shows the map generated by our algorithm. As the figure illustrates, the spurious measurements (indicated by grey/orange dots) have been filtered out completely. Additionally, the alignment of the scans is more accurate.

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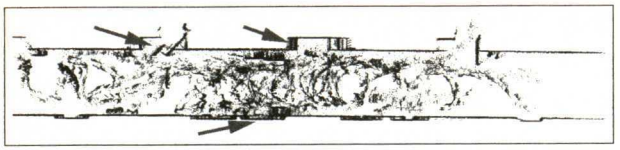


Figure 6: Map obtained in a populated corridor of the Wean Hall at Carnegie Mellon University using the raw input data.

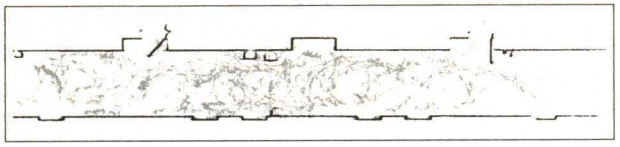


Figure 7: Map generated by our algorithm.

Figure 5 depicts the evolution of a part of the map in the different rounds of the EM. It shows how the beams corresponding to dynamic objects slowly fade out and how the improved estimates about these beams improve the localization accuracy.

4.3 Generating Large-Scale Outdoor Maps

To evaluate the capability of our technique to deal with arbitrary features, we mounted a laser-range scanner on a car and drove approximately 1km through Pittsburgh, PA, USA (Corner between Craig Street and Forbes Avenue). The maximum speed of the car was 35 MPH in this experiment. We then applied our approach to the recorded data. The map generated by our algorithm is shown in Figure 8. Whereas the black dots correspond to the static objects in the scene, the white dots are those which are filtered out using our approach. Again, most of the dynamics of the scene could be removed. Only a few cars could not be identified as dynamic objects. This is mainly because we quickly passed cars waiting for turns and because we drove along the path only once. Please also note, that due to the lack of a GPS, the map had to be computed without any odometry information.

4.4 Generating Textured 3D Maps

To demonstrate that our approach is not limited to 2d range data, we carried out several experiments with the mobile robot Robin (see Figure 9) which is equipped with a laser-scanner

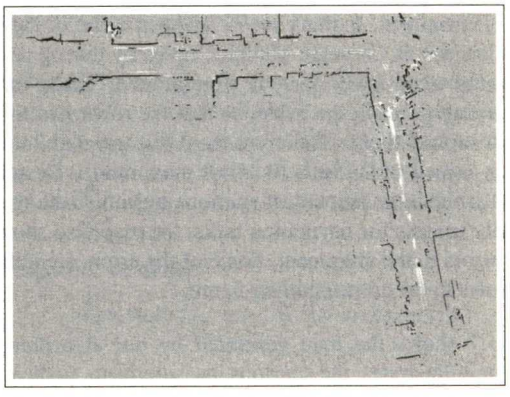


Figure 8: Map of an outdoor scene after filtering dynamic objects.

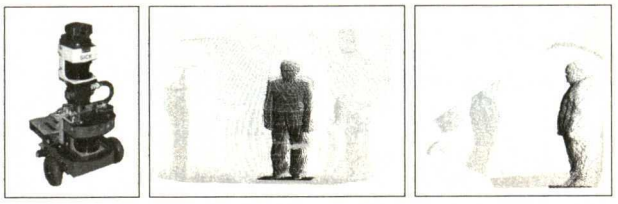


Figure 9: The mobile robot Robin used to generate textured 3d models (left). Beams reflected by a person are isolated from the rest of the data. This is achieved by computing a bounding box around those beams perceived with the horizontal scanner that are identified as corresponding to dynamic objects (center and right).

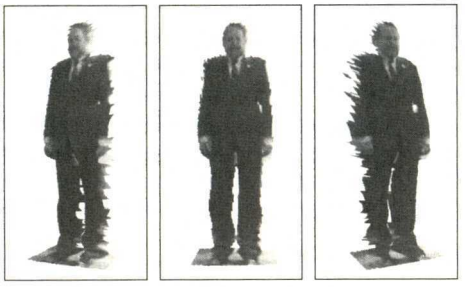


Figure 10: Textured 3d model of a person identified as a dynamic object.

mounted on an AMTEC pan/tilt unit. On top of this scanner we installed a camera which allows us to obtain textured 3d maps of an environment. Additionally, this robot contains a horizontally scanning laser range finder which we used in our experiments to determine dynamic objects. To label the beams in the 3d data as dynamic we use a bounding box around the dynamic 2d points. To filter dynamic objects in the textures recorded with Robin's cameras we choose for every polygon that image which has the highest likelihood of containing static aspects only. The left image of Figure 11 shows one particular view of a model obtained without filtering of dynamic objects. The arrow indicates a polygon whose texture contains fractions of an image of a person which walked through the scene while the robot was scanning it. After applying our approach the corresponding beams and parts of the pictures were filtered out. The resulting model shown in the right image of Figure 11 therefore only contains textures showing static objects.

4.5 Extracting Textured 3d Objects

Additionally to filtering dynamic objects and learning static aspects of environments our algorithm can also be used to separate dynamic objects from the environment. The key idea is to extract all measurements from the 3d data that lie within a bounding box around the beams whose probability that they are reflected by dynamic objects exceeds 0.7. Figure 9 shows two views of a typical 3d data sets obtained with this approach. Whereas the data points belonging to a dynamic object are shown in black, the rest of the data is depicted in grey. Again we used the camera to map textures on the 3d data that were

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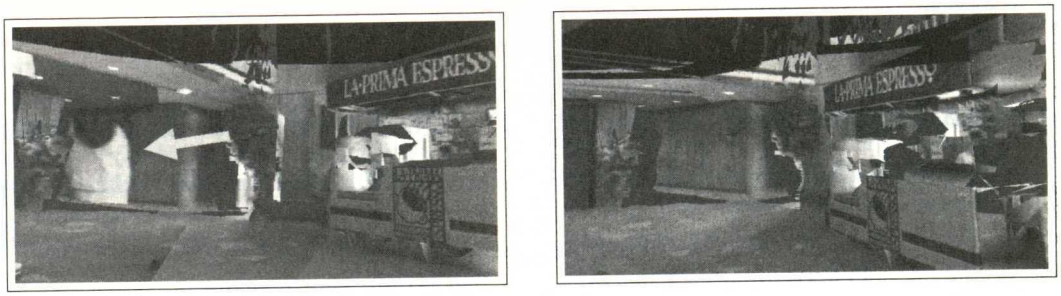


Figure 11: Textured 3d models obtained using Robin. The upper image shows the result without filtering. The lower image shows the resulting model obtained with our algorithm.

identified as belonging to a dynamic object. Figure 10 depicts three views of the resulting model. As can be seen from the figure, our approach can accurately extract realistic looking textured 3d models of dynamic objects.

5 Conclusions

In this paper we presented a probabilistic approach to mapping in dynamic environments. Our approach uses the EM algorithm to interleave the identification of measurements that correspond to dynamic objects with a mapping and localization algorithm. This way it incrementally improves its estimate about spurious measurements and the quality of the map. The finally obtained maps contain less spurious objects and also are more accurate because of the improved range registration.

Our technique has been implemented and tested on different platforms. In several experiments carried out in indoor and outdoor environments we demonstrated that our approach yields accurate maps even if used on a fast moving vehicle without odometry information. We also presented an application to learn textured 3d models of dynamic environments. Finally, we applied our algorithm to extract dynamic objects from 3d data. The results illustrate that our approach can reliably estimate which beams correspond to dynamic objects.

Acknowledgements

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APPENDIX

CURRICULUM VITAE SYLVIA D. HALL-ELLIS

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.

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

Hall, Sylvia D. "Summer is Sea Monstrously Fun!" *Texas Library Journal* L (December 1974): 224-226.

Hall, Sylvia D. "A Brief Annotated Bibliography of Non-book Materials on the Mexican American." *Texas Library Journal* XLVIII (October 1972): 213-232.

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]

Historia Económica de México. Coordinator, Enrique Semo. México: Universidad Nacional Autónoma de México, Editorial Oceano de México, 2004. 13 vols. 970-32-0805+3 (obra completa), $9.25 each [*Críticas*, August 2005]

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, Life Member
Association for Library Collections & Technical Services (now CORE)
Cataloging, Classification, and Metadata Section
ALCTS Editorial Board, Member, 2015-2019
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
Nominating Committee, 2022-2023
Membership Committee, 2019-2021
Board of Directors, Member At-Large, 2009-2012
Office of Accreditation
Accreditation Panel Member (training completed 2004)
Accreditation Review Panel Member (training completed 2004)

REFORMA, Life Member
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

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

American Association of University Women 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

French Teacher & Student Exchange with Laon, France, Monarch High School, Boulder Valley School District (Boulder, Colorado), 2017-
Denver/Boulder Games 2022, Board of Directors, Secretary-Treasurer, 2015-2018
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, 2000-2016
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
Albert Nelson Marquis Lifetime Achievement Award, 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

Driscoll, Margaret, Christy Confetti Higgins, Scott Brown, and Sylvia D. Hall-Ellis. *A View from Within: Open House Tour of Three Canvas Core Courses*. Presentation to be delivered at the School of Information, San José State University Professional Development Seminar, San José, California, October 17, 2019.

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.

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.

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.

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, 2019, 2020, 2021, 2022, 2023; Fall 2020, 2021, 2022, 2023)
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, University College
Grant Writing Certificate Seminar for Non-Profit Organizations (Fall 2020, 2021; Spring 2021)

University of Denver, Morgridge College of Education HED
5991 – Grant Writing in Higher Education (Spring 2011)
LIS 4010 – Organization of Information (Fall 2002-2009; Winter 2005; Spring 2004-2006)
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 2002-2009; Summer 2005, 2006 – course renumbered LIS 4070, September 2007)
LIS 4401 – Descriptive Cataloging (Winter 2001; Spring 2002, 2003, 2006-2009; Summer 2005)
LIS 4402 – Subject Cataloging (Spring 2001, 2009; Summer 2005, 2006, 2007, 2008)
LIS 4403 – Classification Schemes (Fall 2007, 2008, 2009 (DS)) LIS
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 2006-2009)
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, 2001-2003
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.

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