UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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UNIFIED PATENTS, INC.
Petitioner

v.

VELOCITY PATENTS LLC
Patent Owner

_____

Patent 5,954,781

_____

DECLARATION OF SCOTT BENNETT, Ph.D.
13 July 2017

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I, Scott Bennett, hereby declare under penalty of perjury:

I. INTRODUCTION

1. I have personal knowledge of the facts and opinions set forth in this declaration, I believe them to be true, and if called upon to do so, I would testify competently to them. I have been warned that willful false statements and the like are punishable by fine or imprisonment, or both.

2. I am a retired academic librarian working as a Managing Partner of the firm Prior Art Documentation LLC at 711 South Race Street, Urbana, IL, 61801-4132. Attached as Appendix A is a true and correct copy of my Curriculum Vitae describing my background and experience. Further information about my firm, Prior Art Documentation Services LLC, is available at www.priorartdocumentation.com.

3. I have been retained by Fish & Richardson PC to authenticate and establish the dates of public accessibility of certain documents in an *inter partes* review proceedings for U.S. Patent No. 5,954,781. For this service, I am being paid my usual hourly fee of $91/hour. My compensation in no way depends on the substance of my testimony or the outcome of this proceeding.

II. BACKGROUND AND QUALIFICATIONS

4. I was previously employed as follows:

- University Librarian, Yale University, New Haven, CT, 1994-2001;

- Director, The Milton S. Eisenhower Library, The Johns Hopkins University, Baltimore, MD, 1989-1994;
- Assistant University Librarian for Collection Management, Northwestern University, Evanston, IL, 1981-1989;
- Instructor, Assistant, and Associate Professor of Library Administration, University of Illinois at Urbana-Champaign, Urbana, IL, 1974-1981; and
- Assistant Professor of English, University of Illinois at Urbana-Champaign, 1967-1974.

5. Over the course of my work as a librarian, professor of English, researcher, and author of nearly fifty scholarly papers and other publications, I have had extensive experience with catalog records and online library management systems built around Machine-Readable Cataloging (MARC) standards. I also have substantial experience in authenticating printed documents and establishing the date when they were accessible to researchers.

6. In the course of more than fifty years of academic life, I have myself been an active researcher. I have collaborated with many individual researchers and, as a librarian, worked in the services of thousands of researchers at four prominent research universities. Over the years, I have read some of the voluminous professional literature on the information seeking behaviors of

academic researchers. And as an educator, I have a broad knowledge of the ways in which students in a variety of disciplines learn to master the bibliographic resources used in their disciplines. In all of these ways, I have a general knowledge of how researchers work.

III. PRELIMINARIES

7. *Scope of this declaration*. I am not a lawyer and I am not rendering an opinion on the legal question of whether any particular document is, or is not, a "printed publication" under the law.

8. I am, however, rendering my expert opinion on the authenticity of the documents referenced herein and on when and how each of these documents was disseminated or otherwise made available to the extent that persons interested and ordinarily skilled in the subject matter or art, exercising reasonable diligence, could have located the documents before 10 March 1996.

9. *Materials considered*. In forming the opinions expressed in this declaration, I have reviewed the documents and attachments referenced herein. These materials are records created in the ordinary course of business by publishers, libraries, indexing services, and others. From my years of experience, I am familiar with the process for creating many of these records, and I know these records are created by people with knowledge of the information in the record. Further, these records are created with the expectation that researchers and other

members of the public will use them. All materials cited in this declaration and its attachments are of a type that experts in my field would reasonably rely upon and refer to in forming their opinions.

10. *Persons of ordinary skill in the art*. I am told by counsel that the subject matter of this proceeding relates to optimizing the operation of an engine-driven vehicle.

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

12. I am told by counsel that a person of ordinary skill in the art related to, and at the time of the invention of, the '781 Patent ("POSITA") would have been someone with a good working knowledge of electrical engineering, including sensors, processing systems, and notification circuitry. The person would have a Bachelor of Science degree in electrical engineering or a comparable field, in combination with training or two to three years of related work experience with vehicular systems such as automotive electronics.

13. It is my opinion that such a person would have been engaged in research starting at least in college, learning though study and practice in the field

and possibly through formal instruction the bibliographic resources relevant to his or her education and/or work. In the 1980s and 1990s such a person would have had access to a vast array of long-established print resources in electrical/computer engineering and computer science as well as to a rich and fast changing set of online resources providing indexing information, abstracts, and full text services for electrical/computer engineering and computer science.

14. *Library catalog records*. Some background on MARC formatted records, OCLC, WorldCat, and OCLC's Connexion is needed to understand the library catalog records discussed in this declaration.

15. Libraries world-wide use the MARC format for catalog records; this machine readable format was developed at the Library of Congress in the 1960s.

16. MARC formatted records provide a variety of subject access points based on the content of the document being cataloged. All may be found in the MARC Fields 6XX. For example, MARC Field 600 identifies personal names used as subjects and the MARC Field 650 identifies topical terms. A researcher might discover material relevant to his or her topic by a search using the terms employed in the MARC Fields 6XX.

17. The MARC Field 040, subfield a, identifies the library or other entity that created the original catalog record for a given document and transcribed it into machine readable form. The MARC Field 008 identifies the date when this first

catalog record was entered on the file. This date persists in all subsequent uses of the first catalog record, although newly-created records for the same document, separate from the original record, will show a new date. It is not unusual to find multiple catalog records for the same document.

18. WorldCat is the world's largest public online catalog, maintained by the Online Computer Library Center, Inc., or OCLC, and built with the records created by the thousands of libraries that are members of OCLC. WorldCat provides a user-friendly interface for the public to use MARC records; it requires no knowledge of MARC tags and codes. WorldCat records appear in many different catalogs, including the Statewide Illinois Library Catalog. The date a given catalog record was created (corresponding to the MARC Field 008) appears in some detailed WorldCat records as the Date of Entry.

19. Whereas WorldCat records are very widely available, the availability of MARC formatted records varies from library to library.

20. When an OCLC participating institution acquires a document for which it finds no previously created record in OCLC, or when the institution chooses not to use an existing record, it creates a record for the document using OCLC's Connexion, the bibliographic system used by catalogers to create MARC records. Connexion automatically supplies the date of record creation in the MARC Field 008.

21. Once the MARC record is created by a cataloger at an OCLC participating member institution, it becomes available to other OCLC participating members in Connexion and also in WorldCat, where persons interested and ordinarily skilled in the subject matter or art, exercising reasonable diligence, can locate it.

22. When a book has been cataloged, it will normally be made available to readers soon thereafter—normally within a few days or (at most) within a few weeks of cataloging.

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

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

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

26. Prominent indexing services include:

27. Science Direct. Science Direct, provided by the major publisher Elsevier, is a database of abstracts and articles in the physical sciences and engineering, the life and health sciences, and the social sciences and humanities. It has over 12 million items from 3,500 journals and 34,000 books.

28. Google Scholar. Google Scholar indexes the texts and metadata of scholarly publications across a wide range of disciplines. It includes most peer-reviewed online academic journals, conference papers, theses, technical reports, and other material. Google does not publish the size of the Google Scholar database, but researchers have estimated that it contained approximately 160 million items in 2014 (Enrique Oduña-Malea, et al., "About the size of Google Scholar: playing the numbers," Granada: EC3 Working Papers, 1B: 23 July 2014, available at https://arxiv.org/ftp/arxiv/papers/1407/1407.6239.pdf).

IV. OPINIONS REGARDING INDIVIDUAL DOCUMENTS

Document 1. Automotive Electronics Handbook. Ronald K. Jurgen, ed. New York: McGraw-Hill, 1995.

Authentication

29. Document 1 is a book edited by Ronald Jurgen and published by McGraw-Hill in 1995.

30. Attachment 1a is a true and accurate copy of the book's cover, fly leaf, preliminary pages, title page, title page verso, table of contents, list of contributors, preface, and introductory chapter from the University of Illinois at Urbana-Champaign Library. Attachment 1b is a true and accurate copy of that library's catalog record, in MARC format, for Document 1, showing that Document 1 is held by the University of Illinois at Urbana-Champaign.

31. Attachment 1a is in a condition that creates no suspicion about its authenticity. Specifically, the contents pages, preface, and introductory chapter not missing any intermediate pages, the text on each page appears to flow seamlessly from one page to the next, and there are no visible alterations to the document. Attachment 1a was found within the custody of a library – a place where, if authentic, it would likely be found.

32. Based on finding Document 1 in a library and on finding library catalog records for Document 1, I conclude that Document 1 is an authentic document and that Attachment 1a is an authentic copy of Document 1.

Public accessibility

33. Attachment 1c is a true and accurate copy of a Statewide Illinois Library catalog record for Document 1, showing this book is held by 160 libraries world-wide. Attachment 1c also indicates that Document 1 was cataloged or indexed in a meaningful way—including being cataloged by subject. The date of entry in Attachment 1c is 5 October 1994, identical to the MARC Field 080 date in Attachment 1b. The MARC Field 040, subfield a, in Attachment 1b indicates this record was created at the Library of Congress (OCLC code = DLC). That this is a cataloging-in-publication record is indicated by the presence of such catalog information on the verso of the title page in Attachment 1a. I conclude that Document 1 was bibliographically identifiable by 5 October 1994.

34. Attachment 1d is a true and accurate copy of the United States Copyright Office record for Document 1, showing that Document 1 was published on 23 November 1994. Document 1 was registered for copyright on 2 November 1995. I conclude that Document 1 was publicly available from its publisher on or about 23 November 1994.[1]

[1] The evidence of library circulation slip date stamps and of citations of Document 1 by researches, discussed next, indicate that the Document 1 was in fact distributed and in actual use before its publication date of 23 November 1994.

35. Attachment 1a, a copy of Document 1 from the University of Illinois at Urbana-Champaign Library, includes a library circulation slip. Date stamps on this circulation slip indicate that Document 1 was first circulated to a reader with a return due date of 22 November 1995 and returned on 8 November [1995].

36. Attachment 1e is a true and accurate copy of a second Statewide Illinois Library catalog record for Document 1. This record is for the copy of Document 1 held at the Université du Québec à Rimouski. The date of entry for this record, which applies only to the copy of Document 1 held at the Université du Québec à Rimouski, is 12 May 1995.

37. I conclude that Document 1 was publicly available and in use at the University of Illinois at Urbana-Champaign Library no later than 22 November 1995. I conclude further that researchers would have had no difficulty locating other copies of Document 1. For instance, allowing for some time between the cataloging of Document 1 and its appearance on library shelves where it would have been publicly available, I conclude that Document 1 was available to an ordinarily skilled person interested in the art, exercising reasonable diligence, in at least one other library by no later than June 1995.

38. Attachment 1f is a true and correct copy of a Science Direct record for a paper citing Document 1. This paper is by A. Garcia-Ortiz, "Intelligent Transportation Systems—Enabling Technologies," Mathematical and Computer

Modelling, 22,4-7 (August-October 1995):11-81. The 16th item in the list of references for this paper cites a "second edition" of Document 1 with a 1995 publication date.[2]

Conclusion

39. Based on the evidence presented here—book publication, library catalog records and a library circulation slip, copyright record, and citation—it is my opinion that Document 1 is an authentic document that was bibliographically identifiable by 5 October 1994 and publicly available from its publisher on or about 23 November 1994. It is my further opinion that Document 1 was publicly available and in use in at least one library by 22 November 1995. It is also my opinion that the citation evidence presented here indicates that Document 1 was in actual use by researchers no later than October 1995.

Document 2. M. H. Westbrook and J.D. Turner. Automotive Sensors. Bristol: Institute of Physics Publishing, 1994.

Authentication

40. Document 2 is a book by M. H. Westbrook and J.D. Turner published by the Institute of Physics Publishing in 1994.

[2] A second edition of Document was in fact published in 1999. The Garcia-Ortiz reference was probably to a second printing of the 1995 first edition of Document 1.

41. Attachment 2a is a true and accurate copy of the cover, fly leaf, preliminary pages, title page, title page verso, table of contents, preface, introduction, Chapter 1, and back cover from the University of Illinois at Urbana-Champaign Library. Attachment 2b is a true and accurate copy of that library's catalog record, in MARC format, for Document 2, showing that Document 2is held by the University of Illinois at Urbana-Champaign.

42. Attachment 2a is in a condition that creates no suspicion about its authenticity. Specifically, the preface, introduction, and Chapter 1 not missing any intermediate pages, the text on each page appears to flow seamlessly from one page to the next, and there are no visible alterations to the document. Attachment 2a was found within the custody of a library – a place where, if authentic, it would likely be found.

43. Attachment 2c is the British National Bibliography online record for Document 2. The British National Bibliography is the single most comprehensive listing of titles published in the United Kingdom.

44. Based on finding Document 2 in a library and on finding library catalog and online records for Document 2, I conclude that Document 2 is an authentic document and that Attachment 2a is an authentic copy of Document 2.

Public accessibility

45. Attachment 2d is a true and accurate copy of a Statewide Illinois Library catalog record for Document 2, showing this book is held by 102 libraries world-wide. Attachment 2d also indicates that Document 2 was cataloged or indexed in a meaningful way—including being cataloged by subject. I conclude that researchers would have had no difficulty locating copies of Document 2.

46. The date of entry in Attachment 2d is 29 April 1994, identical to MARC Field 080 date in Attachment 2b. The MARC Field 040, subfield a, in Attachment 2b indicates this record was created at the Library of Congress (OCLC code = DLC). That this is a cataloging-in-publication record is indicated by the presence of such catalog information on the verso of the title page in Attachment 2a. I conclude that Document 2 was bibliographically identifiable by 29 April 1994.

47. Attachment 2e is a true and accurate copy of the British Library catalog record, in MARC format, for Document 2. The MARC Field 040, subfield a, in Attachment 2e indicates this record was created at the British Library (former OCLC code = Uk). The date of entry in Attachment 2e is 31 October 1994. Allowing for some time between the cataloging of Document 2 and its appearance on library shelves where it would have been publicly available, I conclude that Document 2 was available to an ordinarily skilled person interested in the art,

exercising reasonable diligence, in at least one library by no later than late-November 1994.

48. Attachment 2a, a copy of Document 2 from the University of Illinois at Urbana-Champaign Library, includes a library circulation slip. Date stamps on this circulation slip indicate that Document 2 was first circulated to a reader with a return due date of 30 March 1995 and returned on 3 October [1995].

49. Attachment 2f is a true and accurate copy of the RERO (Library Network of Western Switzerland) catalog record for Document 2. The MARC Field 040, subfield a, in Attachment 2f indicates this record was created by RERO. The date of entry in Attachment 2f is 21 November 1995. Allowing for some time between the cataloging of Document 2 and its appearance on library shelves where it would have been publicly available, I conclude that Document 2 was available to an ordinarily skilled person interested in the art, exercising reasonable diligence, in at least one additional library by no later than late-December 1995.

50. I conclude that Document 2 was available to an ordinarily skilled person interested in the art, exercising reasonable diligence, in at least three libraries by late-November 1994, March 1995, and late-December 1994, respectively.

51. Attachment 2g is a true and correct copy of the first page a Google Scholar list of 51 publications citing Document 2. One of these publications is

Chaitanya K. Narala et al., "Materials Chemistry Issues Related to Advanced Materials Applications in the Automotive Industry," Chemistry of Materials, 8,5 (14 May 1996): 984-1003. Document 2 is the 7th item in the list of references for this paper.

Conclusion

52. Based on the evidence presented here—book publication, library catalog and online records, and citation—it is my opinion that Document 2 is an authentic document that was bibliographically identifiable by 29 April 1994 and was publicly available in at least one library by late November 1994. It is also my opinion that the citation evidence presented here indicates that Document 2 was in actual use by researchers no later than May 1996.

V. ATTACHMENTS

53. The attachments attached hereto are true and correct copies of the materials identified above. Helen Sullivan is a Managing Partner in Prior Art Documentation Services LLC (see http://www.priorartdocumentation.com/hellen-sullivan/). One of her primary responsibilities in our partnership is to secure the bibliographic documentation used in attachments to our declarations.

54. Ms. Sullivan and I work in close collaboration on the bibliographic documentation needed in each declaration. I will sometimes request specific bibliographic documents or, more rarely, secure them myself. In all cases, I have

carefully reviewed the bibliographic documentation used in my declaration. My signature on the declaration indicates my full confidence in the authenticity, accuracy, and reliability of the bibliographic documentation used.

55. Each Attachment has been marked with an identifying label on the top of each page. However, no alterations other than these noted labels appear in these attachments, unless otherwise noted. All attachments were created on 24-26 June 2017 and all URLs referenced in this declaration were available 25 June 2017.

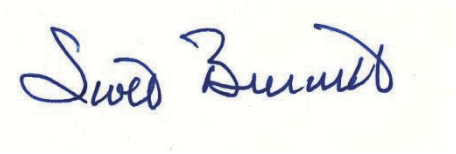
VI. CONCLUSION

56. In summary, I have concluded that Documents 1 and 2, discussed above, are both authentic documents that were both publicly accessible before 10 March 1996.

57. I reserve the right to supplement my opinions in the future to respond to any arguments that Patent Owner or its expert(s) may raise and to take into account new information as it becomes available to me.

58. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and 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.

Executed this 13th day of July, 2017, in Urbana, Illinois.



Scott Bennett

Appendix A

SCOTT BENNETT
Yale University Librarian Emeritus

711 South Race
Urbana, Illinois 61801-4132
2scottbb@gmail.com
217-367-9896

EMPLOYMENT

Retired, 2001. Retirement activities include:

- Managing Partner in Prior Art Documentation Services, LLC, 2015-. This firm provides documentation services to patent attorneys; more information is available at http://www.priorartdocumentation.com
- Consultant on library space design, 2004- . This consulting practice is rooted in a research, publication, and public speaking program conducted since I retired from Yale University in 2001. I have served more than 50 colleges and universities in the United States and abroad with projects ranging in likely cost from under $50,000 to over $100 million. More information is available at http://www.libraryspaceplanning.com/
- Senior Advisor for the library program of the **Council of Independent Colleges**, 2001-2009
- Member of the Wartburg College Library Advisory Board, 2004-
- Visiting Professor, Graduate School of Library and Information Science, **University of Illinois at Urbana-Champaign**, Fall 2003

University Librarian, **Yale University**, 1994-2001

Director, The Milton S. Eisenhower Library, **The Johns Hopkins University**, Baltimore, Maryland, 1989-1994

Assistant University Librarian for Collection Management, **Northwestern University**, Evanston, Illinois, 1981-1989

Instructor, Assistant and Associate Professor of Library Administration**, University of Illinois at Urbana-Champaign**, 1974-1981

Assistant Professor of English, **University of Illinois at Urbana-Champaign**, 1967-1974

Woodrow Wilson Teaching Intern, **St. Paul's College**, Lawrenceville, Virginia, 1964-1965

EDUCATION

University of Illinois, M.S., 1976 (Library Science)
Indiana University, M.A., 1966; Ph.D., 1967 (English)
Oberlin College, A.B. magna cum laude, 1960 (English)

HONORS AND AWARDS

Morningside College (Sioux City, IA) Doctor of Humane Letters, 2010

American Council of Learned Societies Fellowship, 1978-1979; Honorary Visiting Research Fellow, Victorian Studies Centre**, University of Leicester**, 1979; **University of Illinois** Summer Faculty Fellowship, 1969

Indiana University Dissertation Year Fellowship and an **Oberlin College** Haskell Fellowship, 1966-1967; **Woodrow Wilson** National Fellow, 1960-1961

PROFESSIONAL ACTIVITIES

American Association for the Advancement of Science: Project on Intellectual Property and Electronic Publishing in Science, 1999-2001

American Association of University Professors: University of Illinois at Urbana-Champaign Chapter Secretary and President, 1975-1978; Illinois Conference Vice President and President, 1978-1984; national Council, 1982-1985, Committee F, 1982-1986, Assembly of State Conferences Executive Committee, 1983-1986, and Committee H, 1997-2001 ; Northwestern University Chapter Secretary/Treasurer, 1985-1986

Association of American Universities: Member of the Research Libraries Task Force on Intellectual Property Rights in an Electronic Environment, 1993-1994, 1995-1996

Association of Research Libraries: Member of the Preservation Committee, 1990-1993; member of the Information Policy Committee, 1993-1995; member of the Working Group on Copyright, 1994-2001; member of the Research Library Leadership and Management Committee, 1999-2001; member of the Board of Directors, 1998-2000

Carnegie Mellon University: Member of the University Libraries Advisory Board, 1994

Center for Research Libraries: Program Committee, 1998-2000

Johns Hopkins University Press: Ex-officio member of the Editorial Board, 1990-1994; Co-director of Project Muse, 1994

Library Administration and Management Association, Public Relations Section, Friends of the Library Committee, 1977-1978

Oberlin College: Member of the Library Visiting Committee, 1990, and of the Steering Committee for the library's capital campaign, 1992-1993; President of the Library Friends, 1992-1993, 2004-2005; member, Friends of the Library Council, 2003-

Research Society for Victorian Periodicals: Executive Board, 1971-1983; Co-chairperson of the Executive Committee on Serials Bibliography, 1976-1982; President, 1977-1982

A Selected Edition of W.D. Howells (one of several editions sponsored by the MLA Center for Editions of American Authors): Associate Textual Editor, 1965-1970; Center for Editions of American Authors panel of textual experts, 1968-1970

Victorian Studies: Editorial Assistant and Managing Editor, 1962-1964

Wartburg College: member, National Advisory Board for the Vogel Library, 2004-

Some other activities: Member of the **Illinois State Library** Statewide Library and Archival Preservation Advisory Panel; member of the **Illinois State Archives** Advisory Board; member of a committee advising the **Illinois Board of Higher Education** on the cooperative management of research collections; chair of a major collaborative research project conducted by the **Research Libraries Group** with support from Conoco, Inc.; active advisor on behalf of the **Illinois Conference AAUP** to faculty and administrators on academic freedom and tenure matters in northern Illinois.

Delegate to **Maryland Governor's Conference on Libraries and Information Service**; principal in initiating state-wide preservation planning in Maryland; principal in an effort to widen the use of mass deacidification for the preservation of library materials through cooperative action by the **Association of Research Libraries** and the **Committee on Institutional Cooperation**; co-instigator of a campus-wide information service for **Johns Hopkins University**; initiated efforts with the **Enoch Pratt Free Library** to provide information services to Baltimore's Empowerment Zones; speaker or panelist on academic publishing, copyright, scholarly communication, national and regional preservation planning, mass deacidification.

Consultant for the **University of British Columbia** (1995), **Princeton University** (1996), **Modern Language Association**, (1995, 1996), **Library of Congress** (1997), **Center for Jewish History** (1998, 2000-), **National Research Council** (1998); Board of Directors for the **Digital Library Federation**, 1996-2001; accreditation visiting team at **Brandeis University** (1997); mentor for **Northern Exposure to Leadership** (1997); instructor and mentor for ARL's **Leadership and Career Development Program** (1999-2000)

At the **Northwestern University Library**, led in the creation of a preservation department and in the renovation of the renovation, for preservation purposes, of the Deering Library book stacks.

At the **Milton S. Eisenhower Library**, led the refocusing and vitalization of client-centered services; strategic planning and organizational restructuring for the library; building renovation planning. Successfully completed a $5 million endowment campaign for the humanities collections and launched a $27 million capital campaign for the library.

At the **Yale University Library**, participated widely in campus-space planning, university budget planning, information technology development, and the promotion of effective teaching and learning; for the library has exercised leadership in space planning and renovation, retrospective conversion of the card catalog, preservation, organizational development, recruitment of minority librarians, intellectual property and copyright issues, scholarly communication, document delivery services among libraries, and instruction in the use of information resources. Oversaw approximately $70 million of library space renovation and construction. Was co-principal investigator for a grant to plan a digital archive for Elsevier Science.

Numerous to invitations speak at regional, national, and other professional meetings and at alumni meetings. Lectured and presented a series of seminars on library management at the **Yunnan University Library**, 2002. Participated in the 2005 International Roundtable for Library and Information Science sponsored by the **Kanazawa Institute of Technology** Library Center and the Council on Library and Information Resources.

PUBLICATIONS

"Putting Learning into Library Planning," *portal: Libraries and the Academy*, 15, 2 (April 2015), 215-231.

"How librarians (and others!) love silos: Three stories from the field " available at the Learning Spaces Collaborary Web site, http://www.pkallsc.org/

"Learning Behaviors and Learning Spaces," *portal: Libraries and the Academy,* 11, 3 (July 2011), 765-789.

"Libraries and Learning: A History of Paradigm Change," *portal: Libraries and the Academy,* 9, 2 (April 2009), 181-197. Judged as the best article published in the 2009 volume of *portal*.

"The Information or the Learning Commons: Which Will We Have?" *Journal of Academic Librarianship*, 34 (May 2008), 183-185. One of the ten most-cited articles published in JAL, 2007-2011.

"Designing for Uncertainty: Three Approaches," *Journal of Academic Librarianship*, 33 (2007), 165–179.

"Campus Cultures Fostering Information Literacy," *portal: Libraries and the Academy*, 7 (2007), 147-167. Included in Library Instruction Round Table Top Twenty library instruction articles published in 2007

"Designing for Uncertainty: Three Approaches," *Journal of Academic Librarianship*, 33 (2007), 165–179.

"First Questions for Designing Higher Education Learning Spaces," *Journal of Academic Librarianship*, 33 (2007), 14-26.

"The Choice for Learning," *Journal of Academic Librarianship*, 32 (2006), 3-13.

With Richard A. O'Connor, "The Power of Place in Learning," *Planning for Higher Education*, 33 (June-August 2005), 28-30

"Righting the Balance," in *Library as Place: Rethinking Roles, Rethinking Space* (Washington, DC: Council on Library and Information Resources, 2005), pp. 10-24

Libraries Designed for Learning (Washington, DC: Council on Library and Information Resources, 2003)

"The Golden Age of Libraries," in *Proceedings of the International Conference on Academic Librarianship in the New Millennium: Roles, Trends, and Global Collaboration*, ed. Haipeng Li (Kunming: Yunnan University Press, 2002), pp. 13-21. This is a slightly different version of the following item.

"The Golden Age of Libraries," *Journal of Academic Librarianship*, 24 (2001), 256-258

"Second Chances. An address . . . at the annual dinner of the Friends of the Oberlin College Library November 13 1999," Friends of the Oberlin College Library, February 2000

"Authors' Rights," *The Journal of Electronic Publishing* (December 1999), http://www.press.umich.edu/jep/05-02/bennett.html

"Information-Based Productivity," in *Technology and Scholarly Communication*, ed. Richard Ekman and Richard E. Quandt (Berkeley, 1999), pp. 73-94

"Just-In-Time Scholarly Monographs: or, Is There a Cavalry Bugle Call for Beleaguered Authors and Publishers?" *The Journal of Electronic Publishing* (September 1998), http://www.press.umich.edu/jep/04-01/bennett.html

"Re-engineering Scholarly Communication: Thoughts Addressed to Authors," *Scholarly Publishing*, 27 (1996), 185-196

"The Copyright Challenge: Strengthening the Public Interest in the Digital Age," *Library Journal*, 15 November 1994, pp. 34-37

"The Management of Intellectual Property," *Computers in Libraries*, 14 (May 1994), 18-20

"Repositioning University Presses in Scholarly Communication," *Journal of Scholarly Publishing*, 25 (1994), 243-248. Reprinted in *The Essential JSP. Critical Insights into the World of Scholarly Publishing. Volume 1: University Presses* (Toronto: University of Toronto Press, 2011), pp. 147-153

"Preservation and the Economic Investment Model," in *Preservation Research and Development. Round Table Proceedings, September 28-29, 1992*, ed. Carrie Beyer (Washington, D.C.: Library of Congress, 1993), pp. 17-18

"Copyright and Innovation in Electronic Publishing: A Commentary," *Journal of Academic Librarianship*, 19 (1993), 87-91; reprinted in condensed form in *Library Issues: Briefings for Faculty and Administrators*, 14 (September 1993)

with Nina Matheson, "Scholarly Articles: Valuable Commodities for Universities," *Chronicle of Higher Education*, 27 May 1992, pp. B1-B3

"Strategies for Increasing [Preservation] Productivity*," Minutes of the [119th] Meeting [of the Association of Research Libraries]* (Washington, D.C., 1992), pp. 39-40

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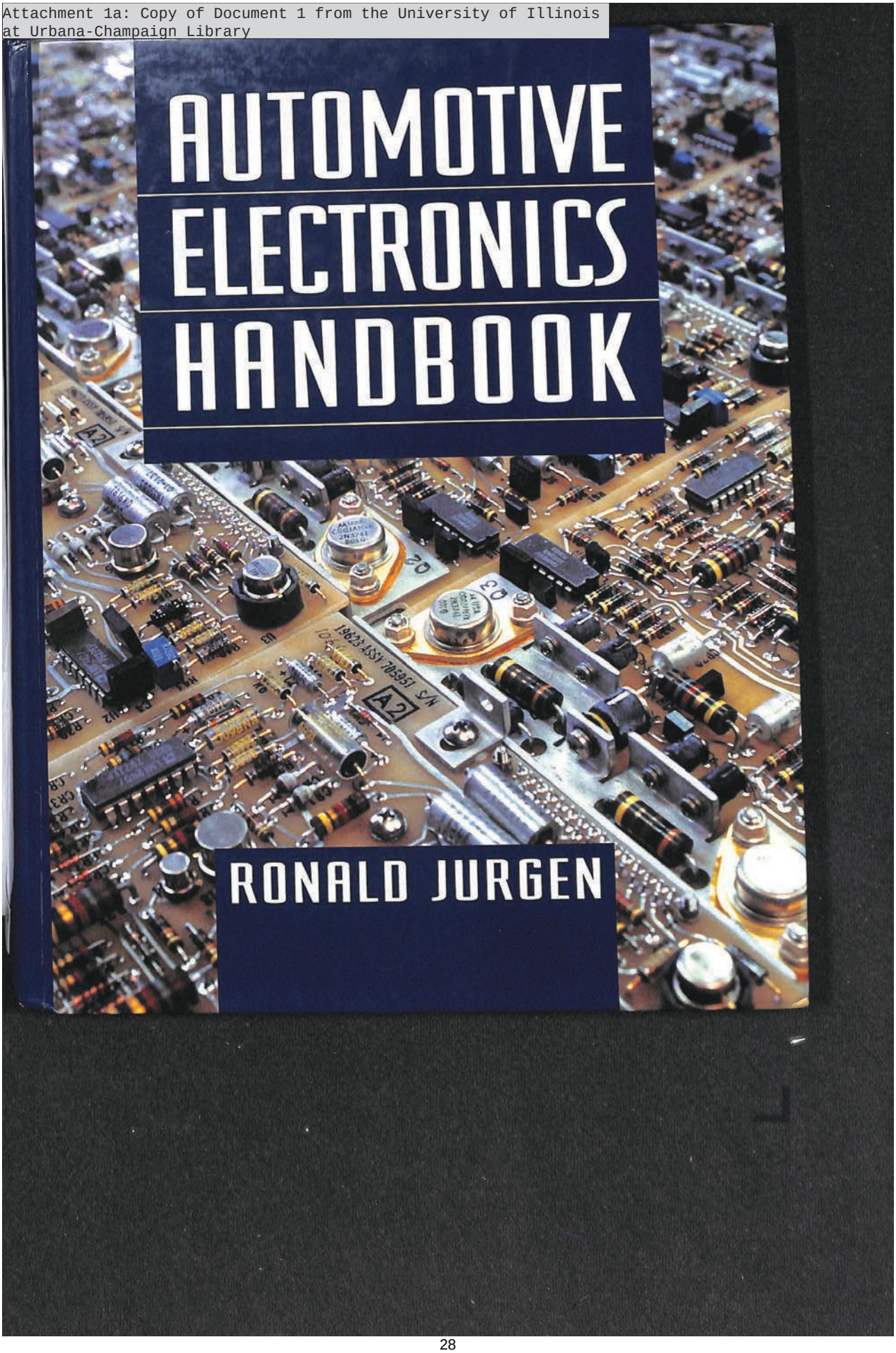

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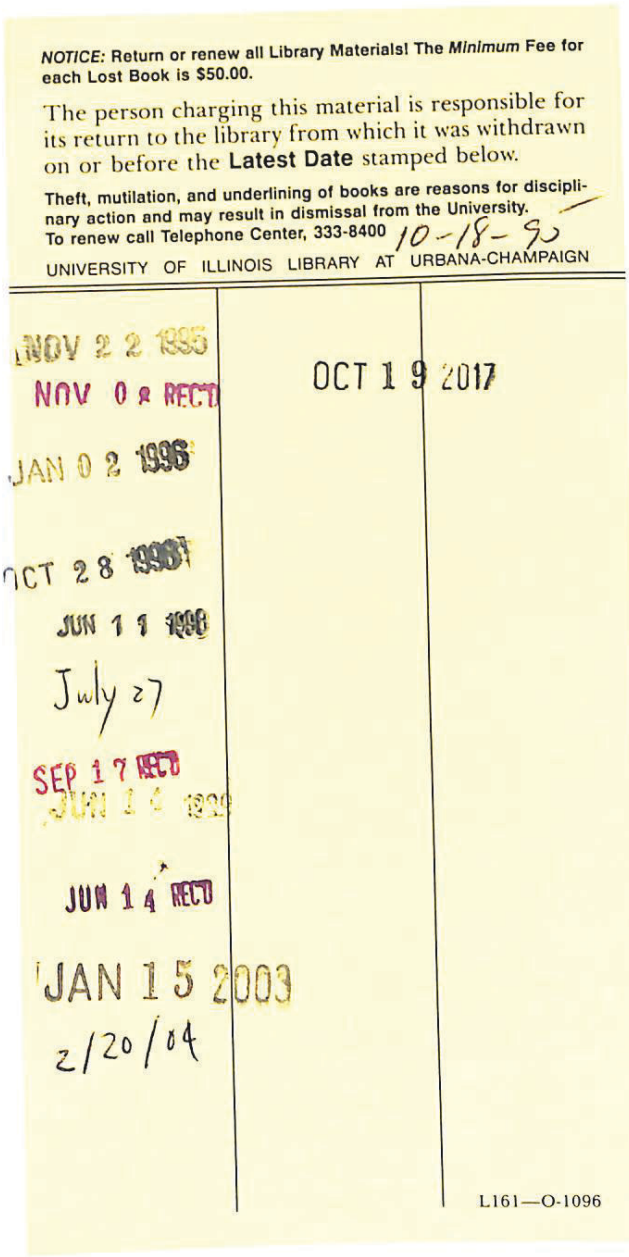

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PREFACE

Automotive electronics as we know it today encompasses a wide variety of devices and systems. Key to them all, and those yet to come, is the ability to sense and measure accurately automotive parameters. Equally important at the output is the ability to initiate control actions accurately in response to commands. In other words, sensors and actuators are the heart of any automotive electronics application. That is why they have been placed first in this handbook where they are described in technical depth. In other chapters, application-specific discussions of sensors and actuators can be found.

The importance of sensors and actuators cannot be overemphasized. The future growth of automotive electronics is arguably more dependent on sufficiently accurate and low-cost sensors and actuators than on computers, controls, displays, and other technologies. Yet it is those nonsensor, nonactuator technologies that are to many engineers the more "glamorous" and exciting areas of automotive electronics.

In the section on control systems, a key in-depth chapter deals with automotive microcontrollers. Without them, all of the controls described in the chapters that follow in that section—engine, transmission, cruise, braking, traction, suspension, steering, lighting, windshield wipers, air conditioner/heater—would not be possible. Those controls, of course, are key to car operation and they have made cars over the years more drivable, safe, and reliable.

Displays, trip computers, and on- and off-board diagnostics are described in another section, as are systems for passenger safety and convenience, antitheft, entertainment, and multiplex wiring. Displays and trip computers enable the driver to readily obtain valuable information about the car's operation and anticipated trip time. On- and off-board diagnostics have of necessity become highly sophisticated to keep up with highly sophisticated electronic controls. Passenger safety and convenience items and antitheft devices add much to the feeling of security and pleasure in owning an automobile. Entertainment products are what got automotive electronics started and they continue to be in high demand by car buyers. And multiplex wiring, off to a modest start in production cars, holds great promise for the future in reducing the cumbersome wiring harnesses presently used.

The section on electromagnetic interference and compatibility emphasizes that interference from a variety of sources, if not carefully taken into account early on, can raise havoc with what otherwise would be elegant automotive electronic designs. And automotive systems themselves, if not properly designed, can cause interference both inside and outside the automobile.

In the final section on emerging technologies, some key newer areas are presented:

- Navigation aids and intelligent vehicle-highway systems are of high interest worldwide since they hold promise to alleviate many of vehicle-caused problems and frustrations in our society.
- While it may be argued that electric vehicles are not an emerging technology, since they have been around for many years, it certainly is true that they have yet to come into their own in any really meaningful way.
- Electronic noise cancellation is getting increasing attention from automobile designers seeking an edge over their competitors.

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The final chapter on future vehicle electronics is an umbrella discussion that runs the gamut of trends in future automotive electronics hardware and software. It identifies potential technology developments and trends for future systems.

Nearly every chapter contains its own glossary of terms. This approach, rather than one overall unified glossary, has the advantage of allowing terms to be defined in a more application-specific manner—in the context of the subject of each chapter. It should also be noted that there has been no attempt in this handbook to cover, except peripherally, purely mechanical and electrical devices and systems. To do so would have restricted the number of pages available for automotive electronics discussions.

Finally, the editor would like to thank all contributors to the handbook and particularly two individuals: Otto Holzinger of Robert Bosch GmbH in Stuttgart, Germany and Randy Frank of Motorola Semiconductor Products in Phoenix, Arizona. Holzinger organized the many contributions to this handbook from his company. Frank, in addition to contributing two chapters himself and cocontributing a third, organized the other contributions from Motorola. Without their help, this handbook would not have been possible.

Ronald K. Jurgen

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INTRODUCTION

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CHAPTER 1
INTRODUCTION

Ronald K. Jurgen
Editor

1.1 THE DAWN OF A NEW ERA

In today's world of sophisticated automotive electronics, it is easy to forget how far the technology has come in a relatively short time. In the early 1970s, other than radios and tape players, the only standard electronic components and systems on most automobiles were alternator diodes and voltage regulators.[1] By the fall of 1974, "there were twelve electronic systems available, none of which were across the board standard production items. . . . The twelve electronic systems or subsystems were: alternator diodes, voltage regulators, electronic fuel injection, electronic controlled ignition, intermittent windshield wipers, cruise control, wheel lock control, traction control, headlamp control, climate control, digital clocks, and air bag crash sensors."[1]

1.1.1 Car Makers and the Electronics Industry: Friendly Adversaries

In the early days of automotive electronics, the automotive industry and the electronics industry were often at odds. Carmakers needed inexpensive components and systems that would operate reliably in the extremely harsh automotive environment. The electronics industry, on the other hand, used to producing high-quality but expensive parts and systems for the military, was skeptical about its ability to produce the components the automobile industry wanted at the prices they demanded. But both industries realized that electronics could provide the capability to solve automotive problems that defied conventional mechanical or electromechanical approaches.

Some of the leading electronics engineers who worked in the automotive industry—as well as their counterparts in the electronics industry—realized that this existing friendly adversarial relationship had to be converted to a mutual effort to find cost-effective and reliable solutions to urgent automotive problems.

Thus it was in 1973 that Trevor Jones (then with General Motors), Joseph Ziomek (then with Ford), Ted Schaller (Allen Bradley), Jerry Rivard (then with Bendix), Oliver McCarter (General Motors), and William Saunders (Society of Automotive Engineers), proposed that a new conference be held in 1974.[1] Dubbed Convergence to signify the coming together of the two industries, the first conference was successful and, sponsored alternately by the Society of Automotive Engineers and the Institute of Electrical and Electronics Engineers, it has been held successfully every other year ever since.

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1.1.2 The United States Government Forces the Issue

One of the major problems facing the automotive industry at the time of the first Convergence conference was upcoming stricter government-mandated exhaust emissions controls. When the United States government first mandated emissions standards for all United States cars, car makers met the challenge through the use of catalytic converters for hydrocarbon and carbon monoxide emissions and exhaust gas recirculation techniques for nitrogen oxides emissions. But they knew that in 1981, when the standards would be tightened from the previous limit of 2.0 grams per mile to 1.0 gram per mile, those approaches would no longer in themselves be sufficient. A new approach was necessary and it involved use of a three-way catalyst for all three emissions together with a closed-loop, engine control system.[2]

Tighter emissions control solved one problem but created another—fuel economy. The two seemed to be mutually exclusive. Charles M. Heinen and Eldred W. Beckman, writing in *IEEE Spectrum* in 1977,[3] said, "The simple truth is that there is very direct interaction between emissions and fuel economy. Probably the clearest example of that interaction is the fact that automobiles equipped to meet California's tight emissions control regulations have consistently demonstrated about 10 percent poorer fuel economy than have comparable cars equipped to meet the less stringent Federal U.S. standards." As a result of this interdependence, emissions and fuel economy measures tended to be compromises. Greater fuel economies could be achieved if emissions levels were not a problem.

1.2 THE MICROCOMPUTER TAKES CENTER STAGE

The microcomputer, introduced in 1971, had yet to make major inroads in automobiles. But it became increasingly obvious that it was the key to meeting government exhaust emission and fuel economy demands while also providing car buyers with cars that performed well. Meeting these needs necessitated precise engine control in such areas as the air/fuel ratio and idle speed.

1.2.1 Early Applications of Microcomputers

One of the first microcomputer applications in cars was an advanced ignition system built by Delco-Remy for the 1977 Oldsmobile Toronado. Called the MISAR (microprocessed sensing and automatic regulation) system, it controlled spark timing precisely no matter what load and speed conditions prevailed while meeting emissions control requirements and providing good driveability. Input signals from sensors provided data on crankshaft position, manifold vacuum, coolant temperature, and reference timing.[4] The microprocessor used had a capacity of 10,240 bits.

Early applications such as the MISAR paved the ground for what would later become the prolific use of microcomputers in cars. Once reliable microcomputers met the cost restraints of carmakers, there was no end in sight to microcomputer applications in cars. In the late 1970s, total engine control with microcomputers became widespread and, as time went on, use of microcomputers spread to other controls for transmission, braking, traction, suspension, steering, lighting, air conditioning, and so forth.

1.2.2 The Bells and Whistles Period

There was also a time in the early 1980s when carmakers, heady with success with microcomputers in other areas, went through a period of electronic overkill. Notable in this regard were voice commands and warnings that tended to wear out their welcome quickly with car drivers

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and elaborate and flashy information displays that also turned off many car buyers. It was a period of doing things with microcomputers because they could be done rather than doing them because they were needed.

That overindulgent microcomputer period quickly waned as car buyers made their feelings known. Voice commands were all but totally abandoned and displays were made less garish. There was even a return to analog displays for speedometers, for example, albeit electronically based rather than the old mechanical or electromechanical system. Carmakers returned to using microcomputers in truly functional ways to answer real needs.

1.3 LOOKING TO THE FUTURE

The future for automotive electronics is bright. Electronic solutions have proven to be reliable over time and have enabled carmakers to solve problems otherwise unsolvable. But what does the future hold? Some predictions for the future have been discussed in the following pages by contributors.

1.3.1 Contributors' Predictions

Although there have been many significant automotive electronics advances over the years, the end is certainly not in sight. The final chapter in this handbook describes many upcoming advances in detail. Authors Frank and Momin, for example, state that a likely future scenario "will be a combination of centralization and distributed intelligence where the centralization would be based along the lines of body, chassis and safety, powertrain, and audio/entertainment and communications. Within these centralized systems would be distributed intelligence based on multiplex wiring with smart sensors, switch decoders, and smart actuators all controlled by a central intelligence."

Here are additional selected future developments cited by contributors in other chapters:

- Expansion of the air bag system to include side impact protection (Dunn, Chap. 7)
- Magnetic transistors and diodes that can be directly integrated with signal conditioning circuits (Dunn, Chap. 7)
- Electronic switched stop lamps involving a rate-of-closure detector system to determine if the vehicle's speed is safe for objects ahead of it. If the closure rate is unsafe, the stop lights could be activated to alert trailing drivers to a pending accident (Valentine, Chap. 14)
- The integration of watchdog and failsafe functions onto a microcontroller (Boehmer, Chap. 11)
- Microcontrollers that operate at frequencies of 24 MHz or 32 MHz to allow more code to be executed in the same amount of time (Boehmer, Chap. 11)
- In the mid-90s, cars will have twice the electronic content of today's cars but will be easier to manufacture because there will be half the number of modules due to feature content integration. The data network interconnecting the modules will reduce the size and number of cables and cut the number of circuits by 50 percent (Miesterfeld, Chap. 26)
- A move from switching units to stepped operation actuators and the substitution of continuous for discrete time control (Müller, Chap. 10)
- Electrorheological and magnetorheological fluid actuators (Müller, Chap. 10)
- Micromechanical valves as actuators for converting low control power as in regulating the flow of fluids in hydraulic or pneumatic systems (Müller, Chap. 10)

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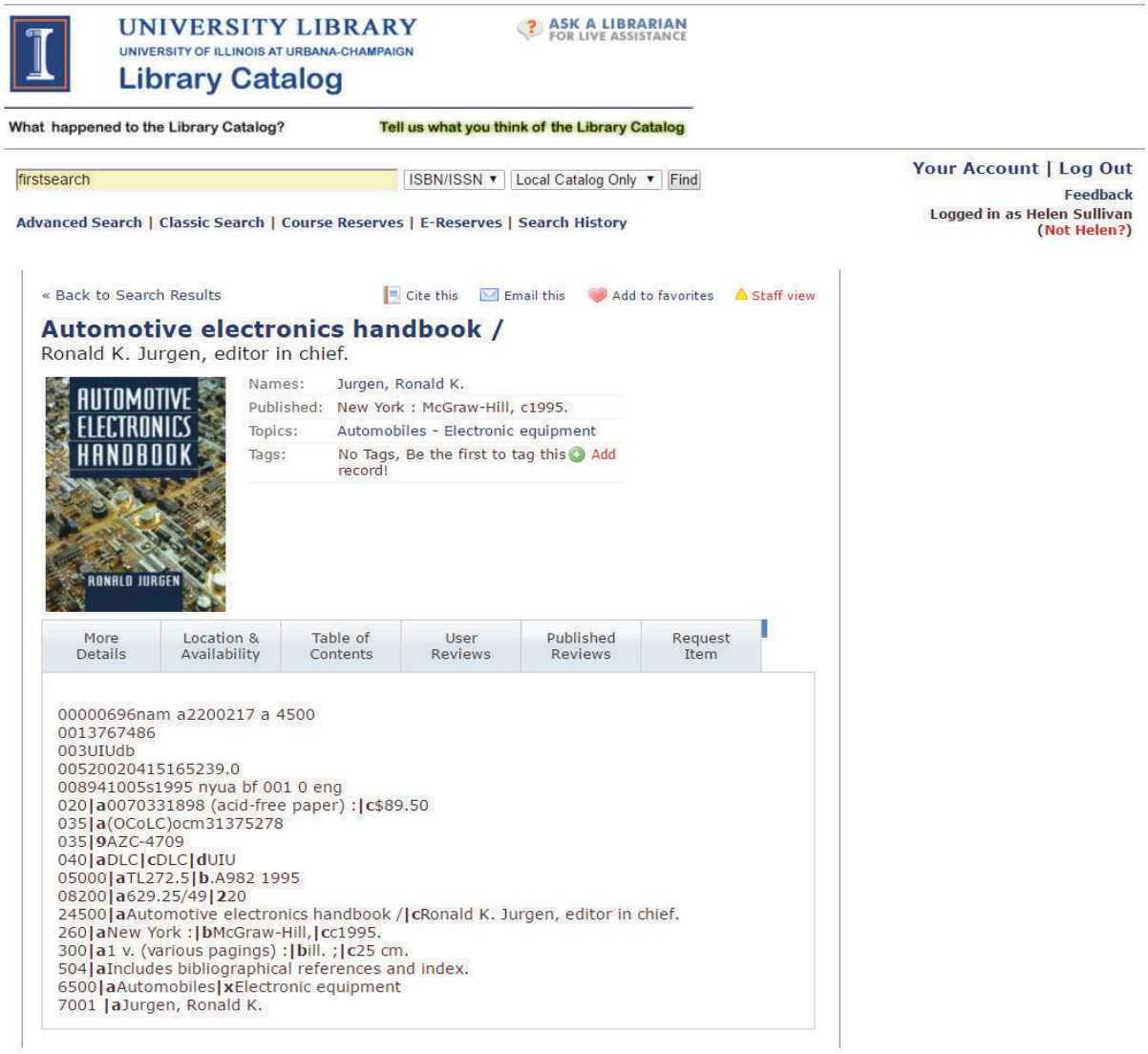

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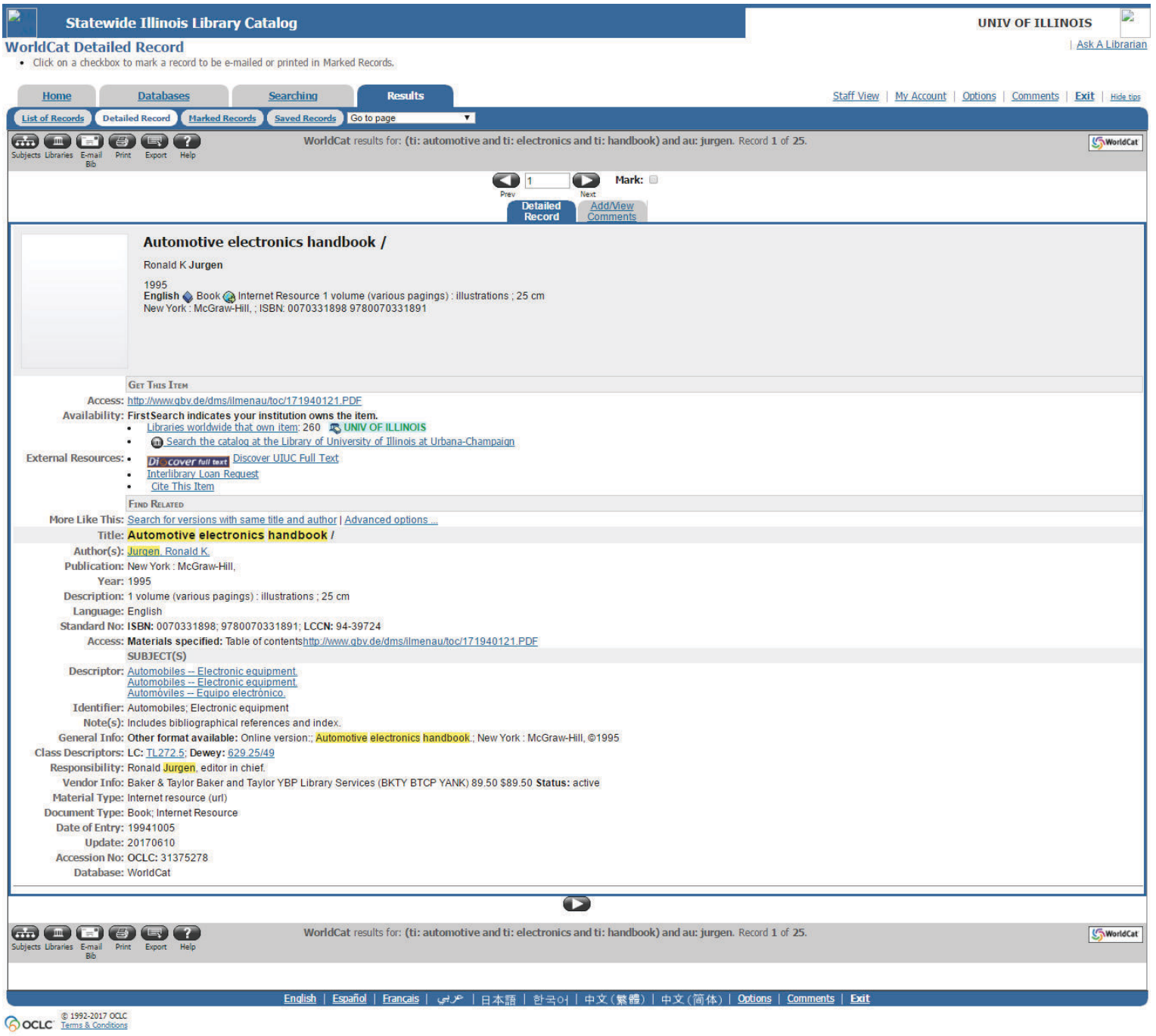

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1995

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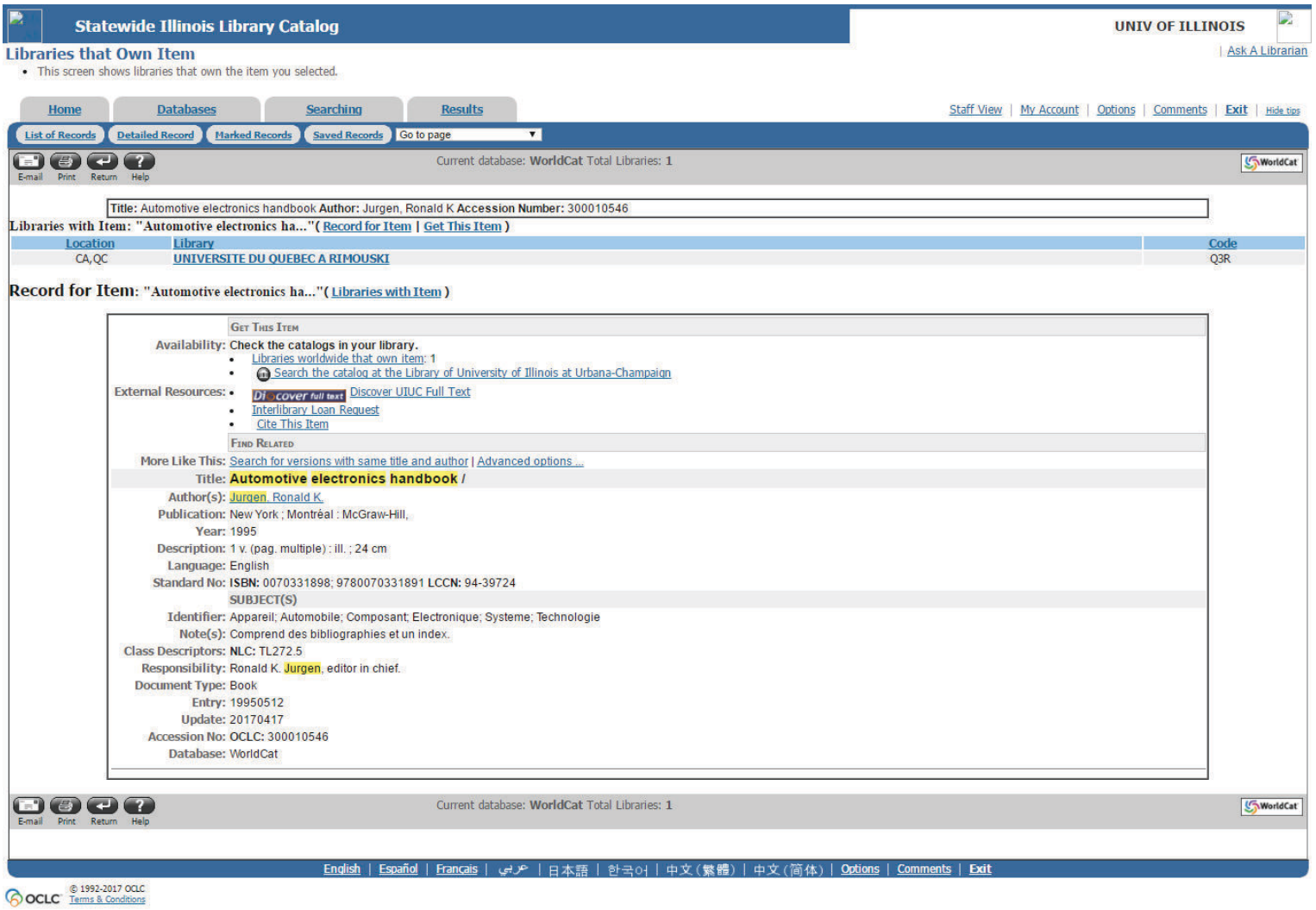

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Author(s): Jurgen, Ronald K.

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Language: English

Standard No: ISBN: 0070331898; 9780070331891 LCCN: 94-39724

SUBJECT(S)

Identifier: Appareil; Automobile; Composant; Electronique; Systeme; Technologie

Note(s): Comprend des bibliographies et un index.

Class Descriptors: NLC: TL272.5

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A. García-Ortiz

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Abstract

Intelligent transportation programs take many different names throughout the world; in the United States it is ITS, in Europe it is Prometheus, and in Japan it is AMTICS and RACS. All of them share very similar objectives, i.e., the development of advanced Traffic Management Systems, Traveler Information Systems, Vehicle Control Systems, Commercial Vehicle Operations, Public Transportation Systems, and Rural Transportation Systems. Several key technologies stand to serve the synthesis of each and every one of these objectives. These technologies are: Digital Maps, Computers, Path Planning, Human Factors, Sensors, Communications, Vehicle Control, and Traffic Control. This paper discusses each one of these subjects in enough detail to provide the reader with an introduction to both the technology and its state-of-the-art. In addition, the paper discusses socio-politico-economic issues associated with the implementation of the various programs. We believe that this highly neglected subject will serve to temper the development and deployment of these programs.

Keywords

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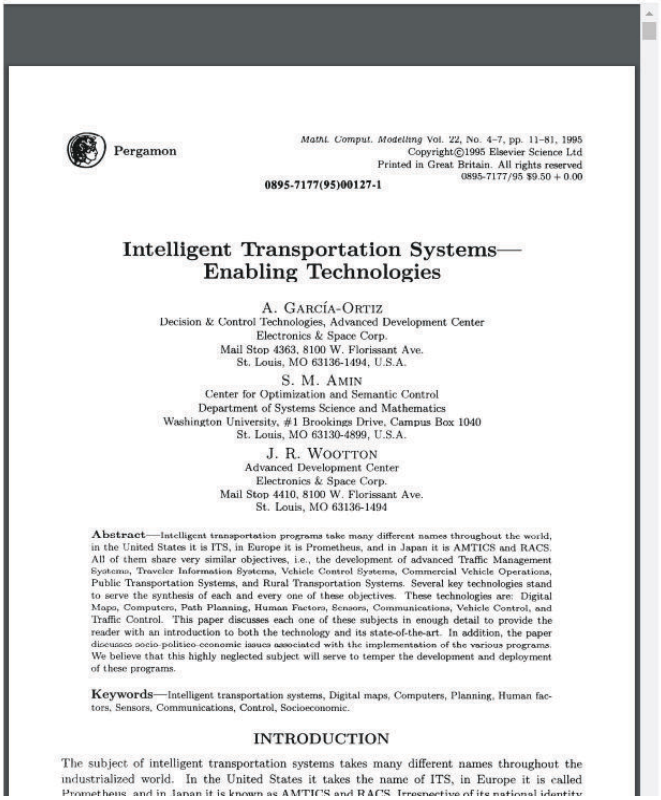

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Intelligent Transportation Systems— Enabling Technologies

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Abstract—Intelligent transportation programs take many different names throughout the world, in the United States it is ITS, in Europe it is Prometheus, and in Japan it is AMTICS and RACS. All of them share very similar objectives, i.e., the development of advanced Traffic Management Systems, Traveler Information Systems, Vehicle Control Systems, Commercial Vehicle Operations, Public Transportation Systems, and Rural Transportation Systems. Several key technologies stand to serve the synthesis of each and every one of these objectives. These technologies are: Digital Maps, Computers, Path Planning, Human Factors, Sensors, Communications, Vehicle Control, and Traffic Control. This paper discusses each one of these subjects in enough detail to provide the reader with an introduction to both the technology and its state-of-the-art. In addition, the paper discusses socio-politico-economic issues associated with the implementation of the various programs. We believe that this highly neglected subject will serve to temper the development and deployment of these programs.

Keywords—Intelligent transportation systems, Digital maps, Computers, Planning, Human factors, Sensors, Communications, Control, Socioeconomic.

INTRODUCTION

The subject of intelligent transportation systems takes many different names throughout the industrialized world. In the United States it takes the name of ITS, in Europe it is called Prometheus, and in Japan it is known as AMTICS and RACS. Irrespective of its national identity

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all of these programs share very similar goals, and the technologies that will help achieve those

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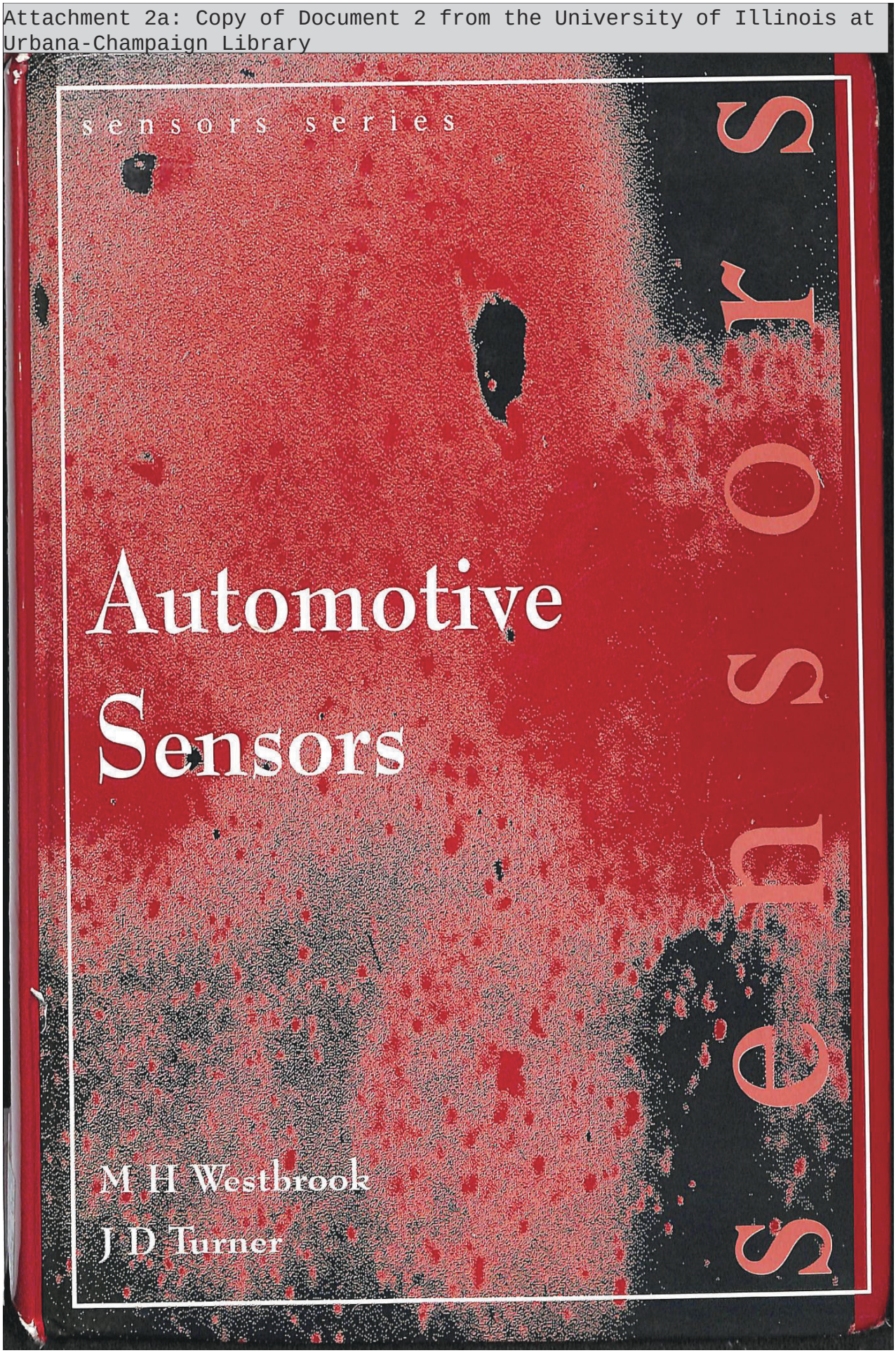

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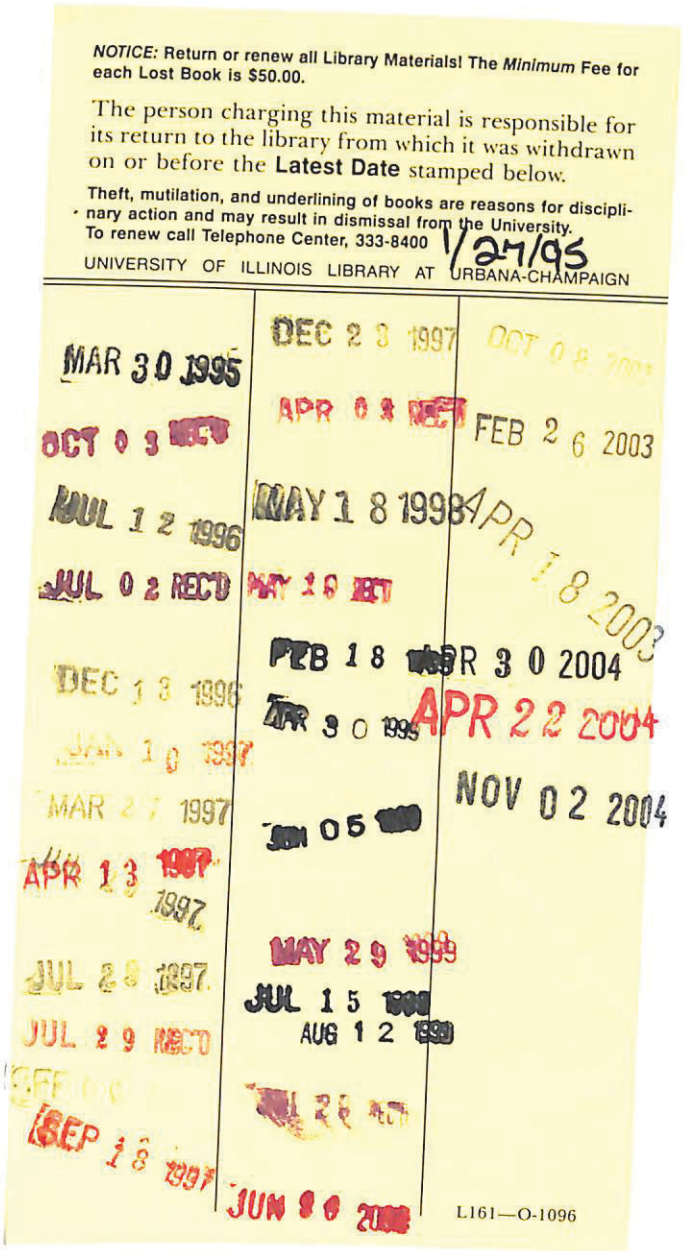

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