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Integrating an Expanded Set of Reference Types into Engineering Writing*

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Engineering student writers must document their reference sources in their theses, papers, proposals, reports, and related documents that they prepare. This is generally done in Microsoft Word or in a LaTeX software package and typically done in the IEEE citation style which is widely used in engineering and technology. In this work, we identify 25 primary reference types and 21 secondary reference types that are used in present-day engineering writing. Because all 46 of these engineering reference types are typically not available in commercial reference management software, we have generated customization files for the widely used EndNote reference management software package that enable referencing to be done using either Cite-While-You-Write (CWYW) for Word users or using BibTeX for LaTeX users. These customization files and instructions on how to install and use them, herein called the Georgia Tech Engineering Reference Management System (GTERMS), are made available on an open-access free-to-use basis.

Keywords: Engineering writing; reference types; reference management

1. Background

Although technical writing by engineering students is widely recognized for its importance, the systematic development of engineering writing skills is frequently marginalized in engineering educational programs. Engineering writing is often not viewed with the importance that it deserves. This has resulted in numerous notable efforts to improve students' engineering writing skills. One major corrective thrust has been to integrate significant writing into engineering classes throughout the curriculum [1–10]. In particular, engineering writing can be conveniently incorporated into laboratory classes [11]. Stand-alone engineering writing programs and workshops for students represents another approach [12–20]. Still another option is the early introduction of engineering writing for first- and second-year students [21, 22]. Further, the introduction of writing tools can also improve students' written communication skills [23–25]. Promoting engineering writing for a non-technical audience can also be an effective method to teach clear, concise writing [26]. Given the challenges of engineering writing that necessitate these methods and approaches, it is clear that good engineering writing requires a concentrated effort over an extended period. Any methodologies to make the writing process more time efficient would be welcome.

2. Motivation for Present Work

Engineering technical writing for theses, papers, proposals, reports, and related documents is typically done in either Microsoft Word or in a LaTeX software package. Furthermore, the IEEE referencing style [27] which is a logical numbered-citation-sequence style is widely used in engineering and technology. Engineers, as a whole, are not enthusiastic about the necessary task of writing [28]. Ways of improving writing efficiency are always being sought. In this regard, getting the references into the correct format and style represents a major time-consuming effort.

The integrity of the final written product depends on careful, complete referencing of the sources used. In addition to affecting the accuracy of the end result, the lack of appropriate referencing can raise concerns about the quality of the underlying research itself. If the referencing is sloppy, then perhaps the research is also sloppy. Further, inadequate referencing can lead to serious negative effects on one's career. This has been highlighted by the plagiarism charges against now former Harvard President, Claudine Gay [29–31]. Inadequate referencing may also cast a negative shadow over the student's adviser for insufficiently reviewing the resulting written documents.

To facilitate correct referencing, powerful reference management software packages have been

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developed. This has greatly improved writing efficiency. However, the literature reference types needed by present-day engineers generally include a much broader set than are available in commercial software and users need to manually add the reference types (see, for example [32]). The systematic specification of these needed reference types and the associated customization files to integrate these types into the software and allow their citation in an appropriate output style is largely missing. This issue has been recognized [32] but only solved to a very limited degree. Alternate terminologies such as "electronic reference" and "virtual reference" also exist in the literature [33] and can be a source of confusion. The goal of the present work is to propose a systematic approach to overcome these deficiencies. At present, engineering students and practicing engineers must, in general, resort to extensive "hacking" to get their references to be cited correctly in their documents.

Based on decades of conducting research in the Optics Laboratory at Georgia Tech and based on six years of teaching the Research Method class at Georgia Tech [34], we have found that engineering researchers typically need to cite 25 primary reference types in preparing technical documents. These primary reference types are listed in Table 1. An additional 21 secondary reference types may also be needed and are listed in Table 2. These 46 reference types are typically not all available in standard reference management software packages. These commercial packages need to accommodate users in a wide variety of fields including history, art, psychology, economics, literature, sciences, law, and medicine. As such, they are not specialized to engineering and cannot be expected to fulfill all the needs of engineering writers. The widely used reference management software EndNote [35] directly incorporates 9 of the reference types needed (listed in Table E1 in Appendix E) in their native package. Two more are used with revised names (listed in Table F1). The other reference types are typically inserted manually by users.

An inordinate amount of time is spent by engineering graduate students on compiling their references and in citing them in proper style. It has become a "rite of passage" for engineering thesis students to spend many hours "hacking" references into the required output style. To get the references into their correct styles, the steps typically involved are shown in the flow chart of Fig. 1.

Upon downloading the bibliographic information into EndNote, if the default reference type is correct, it may be possible to achieve the final correct style by adjusting the field entries. If the reference type is not correct, another reference type is chosen. If it, in turn, is correct, the correct style may again by achievable by adjusting the field entries. If not, the process continues to select further reference types and repeat the process until the correct style is achieved. This is indicated by the feedback loop in Fig. 1. This can be time-consuming and is non-productive, wasting the engineering student's time which is a valuable resource. It is the aim of the present work to simplify and shorten this process.

In this work, we supply the files to customize EndNote to include directly all 25 needed primary engineering reference types and to include indirectly all 21 secondary engineering reference types. The selection of the numbers 25 and 21 is based on experience and these numbers are somewhat arbitrary. These engineering reference types are being made available here to Microsoft Word users through Cite-While-You-Write and simultaneously available to LaTeX users by generating the corresponding BibTeX files. Thus, by having the needed reference types available, the referencing task can proceed without the iterations shown in Fig. 1. In order to achieve this efficiency, EndNote is customized as described in the present work. We have named this the Georgia Tech Engineering Reference Management System (GTERMS). The customization process to install this system is described by the flow chart in Fig. 2.

The lesser-used 21 secondary engineering reference types are listed in Table 2. These reference

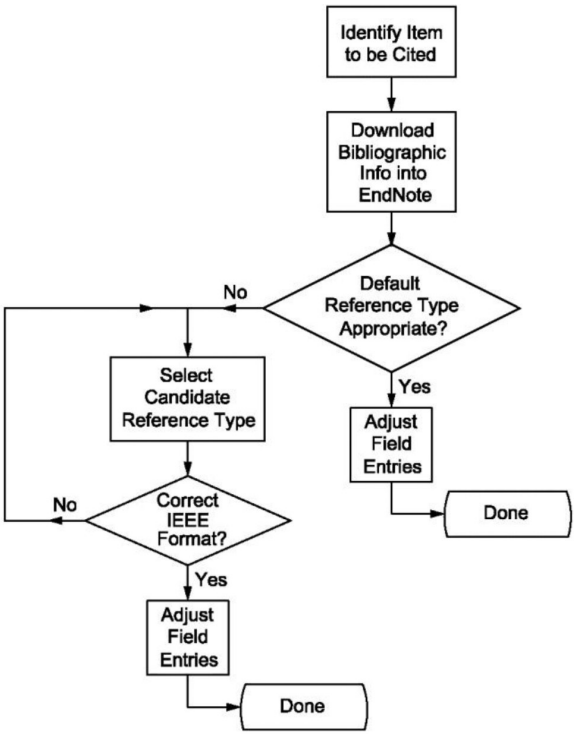

Fig. 1. Flow-chart depiction of the steps needed to get the reference citations to be in the correct IEEE output style.

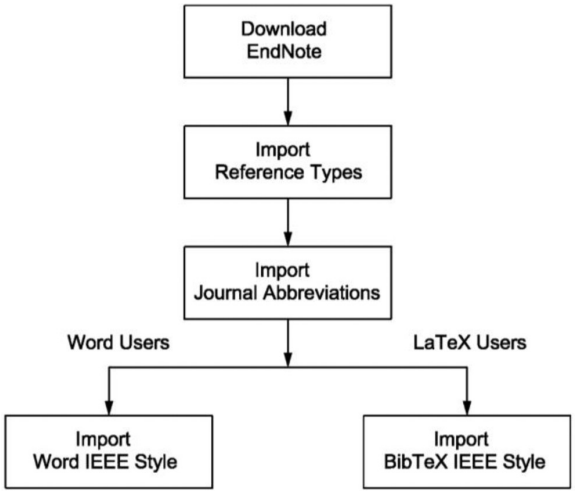

Fig. 2. Flow chart depicting the process to customize EndNote to enable the engineering reference types to be available for both Word and LaTeX users.

types may be entered manually using the Miscellaneous reference type, which is referred to here as "Universal Reference Type." It can be used to enter all of the reference types. However, it is particularly designed to enable the secondary reference types to be entered in their correct styles and to accommodate other bibliographic material that is not covered among the 46 GTERMS reference types. The Miscellaneous reference type is similar to the Generic reference type in EndNote, but is more flexible in that it allows any arbitrary format to be entered directly. The rapid pace of change in information science means that additions and changes are inevitable. Further engineering reference types that appear in the future can also be entered using the Miscellaneous reference type. The present effort is effectively a snapshot of what is needed currently and this will continue to change with time.

The Miscellaneous universal reference type is not included in the list of primary or secondary reference types. Likewise, note that "serial" is a class of reference types that includes periodicals, newspapers, or other sequentially numbered items. Therefore, it is also not included in either the list of primary or secondary reference types.

In general, the 25 primary reference types and the 21 secondary reference types included in GTERMS provide more engineering coverage than the major reference management software packages. Although the terminology differs significantly from package to package, an approximate comparison of GTERMS to EndNote, BibTex, Zotero [36], and ResearchGate [37] is given in Table 3. Since there is no standard terminology for reference types, an exact comparison cannot be made. Indeed, the present work can serve as a suggested standard for engineering reference type terminology.

Table 1. Primary reference types (25) used in engineering writing and included in GTERMS

Book	Grant	Patent Publication	Software
Book Chapter	Instruction Manual	PhD Thesis	Standard
Book Section	Issued Patent	Preprint Article	Trade-Journal Article
Company	Journal Article	Provisional Patent Application	Web-Page Article
Conference Paper	MS Thesis	Record of Invention	
Dataset	Newspaper Article	Report	
Datasheet	Patent Application	Roadmap	

Table 2. Secondary reference types (21) used in engineering writing and included in GTERMS. These reference types may be entered manually into EndNote for Word users and for LaTeX users by using the Miscellaneous universal reference type. Reference types marked with * are also available directly in EndNote

Accepted Paper	Computer Program*	Poster
Application Note	Conference Presentation without Proceedings	Press Release*
Associations	Legislative Action	Programs
Blog Post*	Magazine Article	Seminar
Boards	Manuscript	Unpublished Work*
BS Thesis	Personal Communication*	Video
Clip Art and Stock Images	Podcast	Webinar

Table 3. The number of engineering reference types included in selected reference management systems. This comparison is only approximate, since reference type terminology varies widely between software packages

Engineering Reference Types	**EndNote**	**BibTeX**	**Zotero**	**ResearchGate**	**GTERMS**
Primary	11	8	10	8	25
Secondary	7	2	3	2	21

3. Implementation

Example references in the IEEE output style for each of the 25 primary engineering reference types and 21 secondary reference types are given in Appendix A. In some cases, particularly with the secondary engineering references, the IEEE style is not firmly established. In these cases, we have chosen the current best estimate for the style. The reference types that are available in EndNote and are used without any changes are listed in Appendix E. Entirely new reference types that are introduced in this work are listed in Table F1 of Appendix F. The original reference type that was renamed is also listed there. For example, Ancient Text in native EndNote was renamed to be Book Chapter. EndNote supplies a total of 58 reference types currently. In this work, 25 of them are used for the primary reference types and one (Miscellaneous) is being utilized for the secondary reference types.

The instructions to incorporate the additional engineering-oriented reference types for Microsoft Word users and for LaTeX users are listed in Appendix B "Instructions for Users." The files necessary to customize EndNote to incorporate the additional engineering-oriented reference types is Reference_Types_GT_OL.xml. The file to provide the correct IEEE output style for Microsoft Word is IEEE_GT_OL.ens which is a modified version of the EndNote IEEE.ens file. For LaTeX, the file is BibTeX_Export_GT_OL.ens which is a modified version of the EndNote BibTeX Export.ens file. These are listed in Appendix C and may be found in the Supplementary Materials at the Georgia Tech library site [38].

4. Discussion

These customization files and instructions on how to install and use them are being made available on an open-access free-to-use basis. Others are welcome to modify and expand this GTERMS software as may fit their own individual needs. Due to the fast-changing nature of publishing and communication, the coverage and procedures described here will evolve going forward. Developing files directly analogous to those provided here, the above-listed reference types can also be implemented in other reference management software such as Mendeley [39], PaperPile [40], RefMan [41], ProCite [42], and Zotero [36] according to that software's customization instructions and capabilities. Similarly, output styles other than IEEE style such as ACM [43], ACS [44], APA [45], AIP [46], Chicago [47], Optica [48], Vancouver [49], MLA [50], and others [51] can be accommodated by developing their corresponding style files using the methods described in our instructions (Appendix B).

5. Conclusions

The Georgia Tech Engineering Reference Management System (GTERMS) has been developed to assist engineering student writers in compiling their references and in enabling them to cite these references in precisely correct style. This directly assists them in their preparation of their theses, papers, proposals, reports, and other documents that may be required. In the same manner, GTERMS can be a benefit to all engineering writers. In both cases, this approach addresses and reduces the large amount of time spent by these writers on the task of proper referencing. Based on our experience, it was found that engineering writers typically need to cite approximately 25 primary reference types and 21 secondary reference types. GTERMS enables engineering writers to customize EndNote to include directly all of the needed 46 reference types and to make them directly accessible in both Microsoft Word using Cite-While-You-Write and in LaTeX using the generated BibTeX files that are needed.

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37. ResearchGate, ResearchGate GmbH, *Berllin, Germany*, researchgate.net.
38. https://libguides.library.gatech.edu/endnote.
39. Mendeley, Elsevier, *Amsterdam, Netherlands*, mendeley.com.
40. PaperPile, PaperPile LLC, *Newton Mass*., paperpile.com.
41. Refman, Thomson Reuters, *Toronto, Canada*, refman.com. (discontinued).
42. ProCite, Thomson Reuters, *Toronto, Canada*, procite.software.informer.com. (discontinued).
43. ACM, Association for Computing Machinery, New York, NY.
44. ACS, American Chemical Society, Washington, DC.
45. APA, American Psychological Association, Washington, DC.
46. Applied Physics Letters, American Institute of Physics, College Park, MD.
47. Chicago, Chicago Manual of Style, 17th Edition, University of Chicago Press, Chicago, IL.
48. Optica, Optica Publishing Group, Washington, DC.
49. Vancouver, International Committee of Medical Journal Editors.
50. MLA, Modern Languages Association of America, New York, NY.
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Appendix A: Examples of the 46 Engineering Reference Types

Examples of the 46 engineering reference types (25 primary reference types and 21 secondary reference types) in IEEE output style are given in this appendix.

Book

J. W. Goodman, *Introduction to Fourier Optics*. New York: McGraw-Hill, 1996.

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Datasheet

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Texas Instruments Inc., "Low-cost low-power 2.4 GHz RF transceiver," Model CC2500, 2009, www.ti.com/product/CC2500.

ThorLabs, "Microlens array," Model MLA150-7AR, www.thorlabs.com.

Grant

C. Chiritescu, "SBIR Phase I: Quantitative Phase Imaging for Life Sciences," National Science Foundation, $150,000, Phi Optics Inc., 2013.

T. K. Gaylord, "Optical Fiber Grating Characterization for Haptic Sensors in Minimally Invasive Diagnostics and Surgery," National Science Foundation, $375,000, Georgia Tech, 2019.

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Appendix B: Instructions for Word and LaTeX Users

For both Microsoft Word users and LaTeX users, the instructions for customizing EndNote are "Customizing EndNote for IEEE Style: Instructions for Word and LaTeX Users" (EndNote_Instructions.pdf). For Word users, the IEEE style is established by following the "Cite-While-You-Write (CWYW) Instructions for Word Users of EndNote" (Word_CWYW_Instructions.pdf). For LaTeX users, the correct fields in the exported BibTeX references are set by following "BibTeX Instructions for LaTeX Users of EndNote" (BibTeX_Instructions.pdf). These files may be found in the Supplementary Materials at [38].

Appendix C: Files for Customizing EndNote

The file needed to customize EndNote for both Word and LaTeX users is Reference_Types_GT_OL.xml. For Word users, the file needed to load the IEEE style is IEEE_GT_OL.ens. For LaTeX users, the file to set the IEEE style in BibTeX is BibTeX_Export_GT_OL.ens. These files may be found in the Supplementary Materials at [38].

Appendix D: Comprehensive Documentation for Word and LaTeX Users

Comprehensive overall documentation on the processes and files used in this work is available as "Documentation on Adding Reference Types to EndNote for Word and LaTeX Users" (Documentation_Adding_Reference_Types.pdf). This file and may be found in the Supplementary Materials at [38].

Appendix E: Native EndNote Reference Type Names Used

In this work, the output styles of the following reference types have been modified to agree with present practice for IEEE style.

Table E1. Primary reference type names (9) that remain unchanged from their native EndNote names

Book	Dataset	Newspaper Article
Book Section	Grant	Report
Conference Paper	Journal Article	Standard

Table E2. Secondary reference type names (7) that remain unchanged from their native EndNote names

Blog	Manuscript	Podcast	Unpublished Work
Computer Program	Personal Communication	Press Release	

Appendix F: Renamed EndNote Reference Types

Table F1. New primary reference types (2) that are renamed in Endnote, but are otherwise unchanged from the native EndNote versions

Issued Patent	previously	Patent
Web-Page Article	previously	Web Page

Appendix G: Engineering Reference Types Added into EndNote

Table G1. New primary engineering reference types (14) that are renamed and revised from the native EndNote versions

Book Chapter	previously	Ancient Text
Company	previously	Unused1
Datasheet	previously	Statute
Instruction Manual	previously	Music
MS Thesis	previously	Interview
Patent Application	previously	Classical Work
Patent Publication	previously	Bill
PhD Thesis	previously	Film and Broadcast
Preprint Article	previously	Pamphlet
Provisional Patent Application	previously	Case
Record of Invention	previously	Hearing
Roadmap	previously	Unused2
Software	previously	Unused3
Trade-Journal Article	previously	Artwork

The universal reference type, Miscellaneous, which may be used for entering the 21 secondary reference types, was previously the native EndNote reference type Discussion Forum.

Appendix H: Native BibTeX Reference Types

The fourteen BibTeX reference types [52, 53] are referred to as "entry types" in LaTeX documents. For these 14 reference types there are equivalent "work types" used in ORCID [54], the alphanumeric code system that uniquely identifies authors of scholarly research.

Table H1. Reference types (14) in native BibTeX

Article	Incollection	Phdthesis
Book	Inproceedings	Proceedings
Booklet	Manual	Techreport
Conference	Mastersthesis	Unpublished
Inbook		Misc

Appendix I: Engineering Reference Types Added into BibTeX

In the present work, the 25 primary engineering reference types are made directly available to LaTeX users by modifying the native BibTeX reference types (entry types) as shown in Table I1.

Table I1. BibTeX reference types that have been modified to produce the 25 primary engineering reference types that have been added into BibTeX.

BibTeX Reference Type	Engineering Reference Type
@article	Journal Article
	Trade Journal Article
@book	Book
@booklet	Preprint Article
@inbook	Book Chapter
	Book Section
@inproceedings	Conference Paper
@mastersthesis	MS Thesis
@misc	Company
	Dataset
	Datasheet
	Grant
	Instruction Manual
	Issued Patent
	Newspaper Article
	Patent Application
	Patent Publication

	Provisional Patent Application
	Record of Invention
	Roadmap
	Software
	Standard
	Web-Page Article
@phdthesis	PhD Thesis
@techreport	Report

The 21 secondary engineering reference types, which may be entered using the universal Miscellaneous reference type, are exported as @misc in BibTeX. In addition to entering it as a Miscellaneous reference type, Unpublished Work may alternatively be exported directly as @unpublished in BibTeX.

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