Style and Technology of IAS Technical Papers

John R. Brauer, Guest Author

Thousands of conference papers have been published by the IEEE Industry Applications Society (IAS) since its formation in 1965. These IAS papers and contemporary industrial reports and papers have significantly changed in appearance over the years because of the changes in the technology of preparing papers.

In the earliest days of the American Institute of Electrical Engineers (AIEE), manuscripts submitted by authors went through a formal typesetting process to produce the papers that were actually distributed to attendees at conferences. Eventually, that practice gave way to the current tradition in which the author is responsible for preparing the manuscript distributed at conferences, and the only time that professional typesetting is employed is in the production of periodicals such as *IEEE Transactions on Industry Applications* and *IEEE Industry Applications Magazine*.

But regardless of the process by which they are created, technical papers always consist of words and images on paper. So, these three notions provide a structure for looking at the history of IAS technical papers.

Words: The Evolution of Typewriters

The first practical typewriter was invented in 1867 by C.L. Sholes in Milwaukee, Wisconsin. He began working on his invention in his spare time shortly after being appointed as Milwaukee's port collector by President Lincoln [1]. Striking one's finger onto a manual typewriter key caused a lever with a steel character to impact an ink-filled fabric ribbon held slightly above a piece of paper rolled onto a cylinder called a platen. The platen moved horizontally on its carriage after each key stroke, and the ribbon simultaneously advanced to supply ink to each character on the page.

Sholes arranged the keys on his design in the QWERTY format, which remains the most popular keyboard layout to this day. He chose the QWERTY format to address the mechanical problem; the keys that were most commonly used were placed adjacent to each other, resulting in the need to type more slowly to avoid having the mechanical linkages between the keys and the type clash into each other. The QWERTY arrangement (named for the curious sequence of letters on the top row of the keyboard) minimized this problem.

Sholes and his colleagues sold their typewriter patent rights to the Remington Corporation, who started manufacturing them commercially in 1873. By 1880, Mark Twain was one of the first to submit a typewritten manuscript to a publisher [1]–[4].

Manual typewriters were most commonly available with a serif font (similar to the modern times roman) and in one of two type sizes, pica and elite. All characters were of the same width: 0.1 in (2.54 mm) for pica and 0.08333 in (2.17 mm) for elite type [5]. The space bar produced a horizontal space of the same width. This led to the convention of inserting one horizontal space between words and two spaces between sentences [6]. Vertical spacing was governed by rotation of the platen, and standard typewriters commonly had detents for single-line spacing, double-line spacing, and occasionally, for half-line spacing. Vertical spacing for both elite and pica was six lines to the inch or 4.233-mm per line [5].

Manual typewriters were operated by human power. Keys had to be hit strongly enough for the type to impact the ribbon and release its ink legibly onto paper. As a result, manual typing was a tiring activity. Accuracy of typing was important. Hence, frequent breaks were required by operators, whose main task was usually to type letters and other documents from handwritten manuscripts or dictation [3].

The first electric typewriter was developed by J.F. Smathers of Kansas City, Missouri [7]. In 1923, Smathers sold his invention to Northeast Electric Company in Rochester, New York, who marketed it by the name Electromatic. IBM acquired the electric typewriter business in 1933.

Widely available after World War II, the electric typewriter was preferred over the manual typewriter because it greatly reduced the physical effort. Touching the typical

Digital Object Identifier 10.1109/MIAS.2010.939440
Date of publication: 16 December 2010

electric typewriter key closed a switch that sent power to the coil of a solenoid actuator [8] that caused the type bar to strike the ribbon against the paper. Electric typewriters, such as the IBM Model A Standard and later the IBM Executive Electric Typewriter [7], gave typists a new feeling of comfort and control as the carriage return, backspace, tabulator, and shift were electrically operated with a fingertip touch. The speed of typing was greatly increased.

The IBM Selectric typewriter appeared in 1961 and was common in business offices by the time of the first IAS Annual Meeting in 1966. The Selectric used a type ball instead of type bars. The type ball moved horizontally across the page while the platen and paper remained in a stationary position. Balls (Figure 1) were available with a variety of fonts, and type balls could be easily changed when non-English letters were required. A ball with Greek letters and mathematical symbols was often used when preparing technical papers. In the 1980s, an estimated 8 million Selectrics of various models were in use, mostly in North America and Europe [7].

Images: Technical Illustrations

The illustrations in early technical papers originated as engineering drawings. Often, engineering drawings were made on drafting boards, using tools such as rulers, triangles, French curves, and compasses [9], [10]. Drawings in India ink were preferred and were often prepared on either fine linen or translucent paper. Drawings were also occasionally done with a well-sharpened pencil. In most cases, the author prepared a quick sketch and then relied on a professional drafter to produce the final illustration. As was the case with manuscripts prepared by typists, it was necessary for the author to carefully check the illustration for correctness.

Illustrative photographs were made with cameras using film. A professional darkroom was usually required to develop the film and obtain proper prints of the desired size. Most photographs were done in black and white. While color photography was a commercial reality in the mid-1930s, the cost and logistics of color reproduction caused monochrome to be the standard for technical papers.

Pen-plot data recorders were in widespread use long before the founding of IAS. A magnetic actuator [8] drove a pen, and a paper roll on a drum was moved by an electric motor at a constant (usually slow) speed alongside the pen to mark a permanent graph of the measured analog quantity versus time. Because of inertia of the pen, only slow variations with time could be plotted with these devices. Higher speed phenomena could be recorded using optical devices, in which a beam of light was deflected by an actuator before striking a sheet of light-sensitive paper.

MOST IAS AUTHORS USE MICROSOFT WORD OR A SIMILAR WYSIWYG WORD PROCESSOR.

Paper: The Author-Produced Manuscript

The primary objective in requiring the author to prepare the final conference manuscript was to transfer the cost of manuscript production from the AIEE (later named the IEEE) to the author. Graphically, requiring the author to prepare the manuscript means that there is a compromise, and there would be variations in the appearance of papers presented together at a conference. To minimize that variability, IEEE imposed some requirements on author-prepared manuscripts. The most notable was the requirement that the manuscript be prepared on model paper.

Model paper was an oversized paper that was distributed to authors who had papers accepted for future conferences. The paper was printed with faint layout lines to identify the margins of the preferred, two-column format. The paper was oversized, because the reproduction process introduced a 75% reduction. That size reduction not only helped to get more words on the final printed page but also helped to mask imperfections in the preparation of the manuscript.

In practice, after the author wrote the paper (often, in longhand), it would be typed in draft form. Prior to the mid-1980s, engineering offices usually had typists who were available to type the manuscript. Then, following an initial review by the conference organizers, the final conference-ready manuscript was transferred to a model paper. The normal approach was for the typist to type the manuscript directly onto the oversized pages. It was necessary for the author to carefully proofread the manuscript to assure that everything (including spelling) was correct.

Illustrations were handled in one of two ways. In the early days, it was common for the figures in a technical paper to be appended to the end of the paper. This was done because it was easier to type the complete text and then add the figures at the end. Some authors worked with the typists to leave appropriate space for figures within the body of the paper. This was a superior approach, because it allowed the readers to look at illustrations while reading the text, without having to flip to the end of the paper. Finally, the figures were pasted onto the model paper.

After the final manuscript was prepared, it was submitted to the conference

Two IBM Selectric balls shown with a €2 coin. Photo courtesy of IBM.

organizers who arranged for its reproduction. The tradition in IAS has always been to produce a conference record that contained all of the papers presented at a given conference, but other groups within the IEEE have followed an alternate tradition of publishing each paper presented at a conference as a freestanding document.

Today: Word Processors and Computer Graphics

One can often see artifacts of the original model paper manuscript when classic conference papers are retrieved from an archive such as IEEE *Xplore*. It's not unusual to see slight blurring of type (caused by fabric typewriter ribbons), random line lengths (justification to produce equal line lengths required a very tedious second typing of the manuscript and was usually not done), manually applied underlining, the absence of bolding, italic, or other typographic delineation, occasional handwritten formulas and mathematical expressions, and even hand-drawn illustrations. While preparation might seem unprofessional by today's standards, it was the norm for the period.

The differences today are striking. Instead of typewriters, the manuscript is prepared using a computer-based word-processing application. Word processors offer what you see is what you get (WYSIWYG) convenience; the version of the document that appears on the computer screen is exactly what appears when the document is printed. Special typographic features can be easily added, and mathematical expressions can be embedded quickly and legibly. Images can be created in computer-based graphics programs or can be imported as graphic files from digital cameras and laboratory instruments. In either case, once in the computer, illustrations can be embedded at the desired location in the electronic document. Manuscripts can be justified if desired, and the two-column format can be created automatically.

Most IAS authors use Microsoft Word or a similar WYSIWYG word processor, but a significant number of academic authors use LaTex. LaTex is a text processor in which the user keys in the text (words) and then adds coding to invoke typographic features. Illustrations are stored in a separate file, with coding in the electronic document to indicate their preferred placement. The text and illustrations are then combined automatically when the final version is printed.

The IEEE still maintains the standard for the format of conference papers. The traditional two-column format continues to be preferred, but there is an active debate in the publications community about shifting to a single-column format that requires less scrolling when reading electronic documents. IEEE specifies the pitch (size) of type and prefers serif fonts (because they are more legible than sans serif fonts).

In most instances today, the conference record is produced in an electronic form, most often as a compact disk. There are only a couple of IAS conferences that still offer a printed conference record. The version of the paper that appears in these electronic conference records is still the author-prepared manuscript; only today, it is a pdf version of the electronic file, supplied by the author. And modern manuscripts in electronic format can include color illustrations.

One of the most important changes that has taken place today in the process for preparing technical papers is that it is quite common for the author to have done all of the work involved in preparing the manuscript without the assistance of typists or drafters. This means that the author has far greater control over his final product, a consideration that many engineers find important.

Digital Papers and the World Wide Web

Digital storage of papers in the online database IEEE *Xplore* [24] enables readers to search for words or phrases and is thus a great advance over scanning by the human eye. With optical character recognition software, any scanned paper can be made searchable [11]. Indeed, the first IGA (Industry and General Applications, the original name of the IAS) transactions of 1965 has its words fully searchable in IEEE *Xplore*. Conference records are available in IEEE *Xplore*, going back to 1988.

Early IAS conference papers, from the first annual meeting in 1966 through the early 1990s, used typewritten text on special model paper, and thus appear strange to today's engineers. Their text and figures lack the sophisticated appearance of today's papers prepared on word processors with digital drawings and figures.

In some way, IAS papers are analogous to classic movies and literature. Classic literature typically lacks figures drawn by computer graphics, color photography, and modern typography of various fonts. But if one looks beyond the often unattractive appearance of older IAS papers, their content and style can make them worthwhile for today's engineers to learn from and emulate.

Acknowledgment

The author thanks Gary Shimek, director of the library at Milwaukee School of Engineering, for his continual help and for obtaining early IAS conference papers for this work.

References

[1] D. A. Simonis and C. Hertzenberg, *Scientists, Mathematicians, and Inventors: Lives and Legacies*. Phoenix, AZ: Oryx Press, 1999.

[2] *The Typewriter: History and Encyclopedia*. Mineola, NY: Dover, 2000.

[3] S. H. Strom, *Beyond the Typewriter: Gender, Class, and the Origins of Modern American Office Work, 1900–1930*. Urbana, IL: Univ. Illinois Press, 1992.

[4] M. Ierley, *Wondrous Contrivances*. New York: Clarkson Potter, 2002.

[5] G. A. Stevenson, *Graphic Arts Encyclopedia*, 2nd ed. New York: McGraw-Hill, 1979.

[6] *Civil Service Typing Tests*. New York: ARCO Publishing, 1985.

[7] IBM Corp. Education Department. (1949). The history of IBM electric typewriters [Online]. Available: http://www-03.ibm.com/ibm/history/exhibits/modelb/modelb_history.html

[8] J. R. Brauer, *Magnetic Actuators and Sensors*. Hoboken, NJ: Wiley IEEE Press, 2006.

[9] *Mechanical Drawing Guide*. Indianapolis, IN: Audel Div. Howard W. Sams & Co., 1960.

[10] F. E. Giesecke, A. Mitchell, H. C. Spencer, and I. L. Hill, *Technical Drawing*, 10th ed. Englewood Cliffs, NJ: Prentice-Hall, 1997.

[11] *IEEE Xplore* [Online]. Available: http://ieeexplore.ieee.org

[12] J. R. Brauer. (Dec. 2009–Apr. 2010). History of the preparation and appearance of IEEE papers. *IEEE Profession. Commun. Soc. Newslett*, [Online]. Available: http://ewh.ieee.org/soc/pcs/index.php?q=news_archive

IAS