How to Write an SAE International Technical Paper

(The title should contain the main thoughts and ideas behind the paper. The title needs to be short, but should be inclusive enough to search with any of the modern search engines.)

Pranab Saha et al

(The purpose of author listings is to give credit to those who have contributed to the research work. Be sure to include authors who have made a significant contribution to the concept, design, execution, or interpretation of the research study.)

SAE International Technical Quality Response Team (TQRT)

Helpful for experienced and new authors, the purpose of this paper is to provide guidance for the preparation of content of an SAE International technical paper. Guidance on each technical paper element has been placed in the appropriate section as much as possible.

A technical paper is a fact-based document used to close a project or a piece of work. Papers are written in an objective, formal, impersonal, third-person style.

SAE International does not restrict the number of pages for a technical paper, although the recommended length is 9-12 pages in a 2-column format.

Abstract

The abstract is what readers review first in order to decide whether the paper is relevant to their work and whether the paper deserves further study. The abstract should provide clear and concise statements on the contents of the paper. It should contain information on what the work is about; how the work is different from other previously-published, related work; a brief discussion on the novelty of the work; the methodology that has been followed; and the theory that has been used to complete the work. The abstract is a self-standing document and shall *not* include references, footnotes, figures (or references to them), or tables (or references to them). It should include brief findings, solutions, impacts, and concluding remarks of the work. The abstract should be written in one paragraph and it should be between 250-300 words.

Introduction

This document concerns content only. Formatting instructions can be found in the Style Guide on the author resources page of the SAE International website - http://volunteers.sae.org/authors/styleguide.pdf.

Prior to writing the technical paper, it is recommended that the author prepare an outline following the guidelines mentioned in this document. This will help the author to express thoughts in a systematic manner.

The Introduction of the paper is very important and serves three purposes. It discusses the importance and motivation behind the work. The Introduction states how the paper adds to the existing knowledge of similar work that has been done and is enumerated in the literature review. Lastly, it gives an outline of the paper that helps the reader understand what to expect in the remainder of the paper. Each of these three areas can be addressed by separate subsections within the Introduction.

The Introduction must indicate why the work presented in the paper is significant and introduces the reader to the paper's objective, motivation, and scope.

All claims, statements of fact, or new data/information shall be supported by references. While writing an effective Introduction, the author(s) should present the results of a literature search. The author is most likely basing the paper upon another's past work and often an author will forget to recognize those works. Referring to other researchers' work in the field authenticates the current work and allows an author to acknowledge the related work of others. Reference also allows one to distinguish what work has already been done and what new information is being presented in the current paper. Among other things, the following should be cited: historical data, statistical data, scientific facts, and related studies. For additional information on citing references, see the How to Cite References section.

The Introduction should be concluded with a description of the paper's layout. The paper should have a smooth flow of content telling a succinct story of the research work that has been completed. The conclusion of the Introduction should clearly identify for the reader the paper's purpose and highlight discussions that will be covered in the remainder of the paper.

Body of the Paper

General Overview

A paper will have several sections necessary to provide different types of information. Examples of these sections include Abstract, Introduction, "Body of the Paper," Conclusion(s), References, and Acknowledgements.

Each section starts with a header. Following the Introduction is the "Body of the Paper." This is the main section of the paper where the actual work is discussed. This section is not entitled "Body of the Paper." Rather, it is comprised of multiple sections and subsections titled using topical headings in a multi-level structure suitable for the work presented. The subsections should start with a subheading. Likewise, there could be sub-subheadings within a subsection. Although no specific heading titles are mandated, common examples include Methods, Results, and Discussion.

This section shall include a detailed and structured description of the work performed, including (as appropriate) methodology, assumptions, hardware, observations, analysis, and a comparison of results with prior work. This may include theoretical work, analytical derivation, measurements, and such other topics.

The information presented shall be self-contained (in the sense that the reader is not assumed to have read prior papers) and provide an appropriate level of detail for the intended audience. However, references are made to published work on related topics as appropriate. All terms must be defined the first time they are mentioned and used consistently throughout the remainder of the paper.

Language Considerations

Standard rules for written English should be followed in the text of the paper. U.S. or UK rules are acceptable, but either must be applied consistently, not mixed. Standard grammar will ensure that the paper is easily understood by a wide audience including those not using English as a primary language.

Spell-check and grammar-check software can be used to inspect the written text, but should not be a substitute for a thorough personal review. A review by non-authors fluent in English is one way to check grammar, but must be completed prior to the SAE International peer-review process. (Official reviewers and organizers do not provide this service.) The complexity of the technical subject or an author's difficulty with technical writing are never excuses to avoid following these guidelines. A person unfamiliar with the topic should be able to read the paper and understand the general theme.

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Commercialism

The paper shall not be commercial in nature. Therefore, any commercialism shall be eliminated and commercial overtones shall be limited. However, the inclusion of the names of any hardware, software, or other tools used in the technical analysis, evaluation, or methodology is permissible as long as these are cited properly, as mentioned here. Note that a commercial reference (e.g., product name) may be mentioned once each in the Title, Abstract, and Introduction (for instance, to mention the trade name of a product that is the subject of a paper). Alternatively, a commercial reference may be placed at the end of the paper in the Acknowledgements section. There is no restriction on the number of citable (published) commercial references in the References section. More information on commercialism is located at http://volunteers.sae.org/authors/commercialism.htm.

The following is an example of a statement demonstrating unacceptable commercialism or advertising:

"Tests on XYZ Corporation's SuperProduct 1000 have demonstrated the superior quality of our product."

Plagiarism

The paper shall not have any plagiarism. Plagiarism is committed when an author purposely uses one's own or someone else's work, language, thoughts, or ideas without acknowledging the original source or getting proper approval from the original source. Therefore, it is required to cite and reference others who have worked in the field in order to avoid plagiarism. SAE International defines plagiarism as "the use or presentation of the ideas or words of [oneself or] another person from an existing source without appropriate acknowledgement to that source." For more information, see the How to Cite References section.

Examples of Unacceptable Text

A few examples of unacceptable text are:

Editorial comments, such as: "The jet aircraft costs $5,500,000. This is a substantial sum of money despite the casualness with which million-dollar sums are bandied about these days."

Personal history, such as: "The first military pre-stressing problem that came to my desk was in 1938 in connection with a request from the Army that we increase the displacement of its truck engines."

Unsubstantiated sweeping statements, such as: "I believe I can safely say that practically every failure of a new or retreaded jet tire, where the cause could be ascertained, has proved to be the result of a manufacturing error."

Units of Measure

The long-term goal for SAE is international communication with minimal effort and confusion. Therefore, the use of S.I. units in all

technical publications and presentations is preferred. SAE International will strive toward universal usage of S.I. units and will encourage their use whenever appropriate.

However, SAE International also recognizes that sectors of the mobility market do not yet use S.I. units because of tradition, regulatory language, or other reasons. Mandating the use of S.I. units in these cases will impede, rather than facilitate technical communication. Therefore, it is the policy to allow non-S.I. units and dual dimensioning where communication will be enhanced. This shall not be viewed as an avenue to circumvent the long-term goal of 100% S.I. usage.

Examples of Units

The general rule for capitalization is based on whether the unit was based on a proper noun, e.g., Newton. A few examples of units are shown here:

- Hz
- dB
- km
- Nm
- kPa
- kHz

Methodology

While writing a technical paper, the author shall clearly state everything that is necessary in setting up the work. This may include a description of any hypotheses, all implicit and explicit assumptions, equations, boundary conditions, different analysis techniques for solving analytical problems, equation verification, measurement setup, and all other pertinent items that make this paper a quality paper. The author shall use correct and consistent terminology used in the discipline. Addressing these elements properly is not only important for the credibility of the author and the paper, but also for successive researchers to classify the work and also to duplicate the study should that be required.

A few specific thoughts for preparing a paper based on experimental work would include the following:

- a description of the work and method used;
- a description of the measurement setup such that the experiment can be reproduced by others; and
- a discussion of the basis of the measuring principle/comments on the accuracy, precautions, and limitations on the measurement technique in general.

The paper should not list the equipment used as it may be listed in a laboratory report unless some specific equipment needs to be described to understand the work.

For simulation and analytical work, the system model needs to be described clearly. This includes identifying any commercially available software that may have been used to do the study. If proprietary software or special software has been developed, then the fundamental equations that are involved need to be discussed and identified so the credibility of the work is substantiated. However, the author has to be careful so there is no commercialism or commercial overtone. Information on various quality metrics, such as mesh geometry, justification of mesh sizes, and/or nodal boundary conditions needs to be provided.

Analysis

Analysis could be of two types, qualitative and quantitative. Qualitative means obtaining an in-depth understanding of properties of the product or the solution obtained. Quantitative means obtaining numerical values of the product or the solution obtained and thereby determining the performance metric of the product and/or the solution. These should be clearly discussed and explained for the long-term value of the work. In discussing the analysis process, tables, graphs, and photographs should be used to help visualize and explain the results of the analysis. The tables, graphs, and photographs need to be explained clearly in order to convey what they mean/stand for as opposed to just mentioning that the results are shown in the figure. Wherever possible, comparison results should be provided in graphical forms rather than tabular forms.

Examples of Various Illustrations

This section provides examples of various illustrations that may be used to prepare a quality paper.

Examples of Equations

Three examples of equations are shown here. All equations wider than 3.5 inches must be wrapped to the next line as shown in Equation 2. For more information on how to split an equation see the SAE Style Guide. Variables used in equations need to be defined in a Nomenclature section at the end of the paper or following the actual equation as shown in Equation 3.

$$\frac{d\lambda}{dt} = \left[\frac{\sqrt{1+161\left(\frac{x}{x^+}\right)^2}-12}{2(A/F)_{st}} - \frac{\sqrt{1+161\left(\frac{x_{prev}}{x^+}\right)^2}-1}{2(A/F)_{st}}\right](1 - BGF_{st}) \cdot \frac{12}{(t-t_{prev})} \tag{1}$$

$$\Delta K_{aero\_f}(0) = -\frac{1}{2}\frac{\partial K_f}{\partial W_f} L_{aero\_f} + \ldots + \frac{1}{2l}\left(l_r \frac{\partial F_{aero\_y}}{\partial \beta} + \frac{\partial M_{aero\_z}}{\partial \beta}\right)\left(\frac{l_f}{l_r K_r} - \frac{l}{mV^2}\right) K_f \tag{2}$$

$$N = L^m \tag{3}$$

Where,
N = number of possible designs
L = number of levels for each factor
m = number of factors

Examples of Figures

Three examples of figures are shown here:

1. Photograph

2. A schematic or qualitative data
3. Graphical presentation of data

Figure 1. Example of a photograph figure and figure caption

For a schematic or qualitative data presentation, the axes should be identified and should be legible if printed on an 8.5”x11” or A4 size paper.

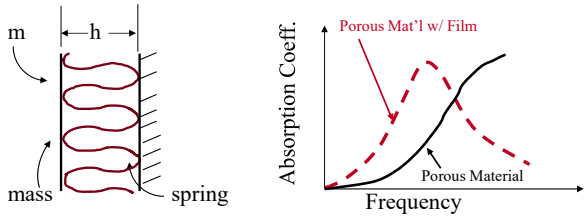

Figure 2. Example of a schematic and qualitative data

When plotting data in a graphical form, all the axes should be labeled with the proper units. If for proprietary reasons the actual data cannot be shared, the data should be non-dimensionalized, normalized, or provide relative data for presentation purposes. The axes information, including the numerical values of the tick marks, should be legible if printed on an 8.5”x11” or A4 size paper.

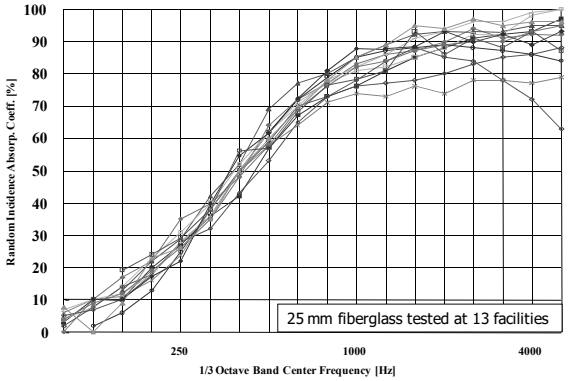

Figure 3. An example of a figure used for data presentation with a reference to related work [5]

Example of a Table

Table 1. This is an example of a table and table caption

Displaced Volume	1966 cc
Stroke	154 mm
Bore	127.5 mm
Connecting Rod	255 mm
Compression Ratio	14.3:1
Number of Valves	4
Exhaust Valve Open	34° BBDC @ 0.15 mm lift
Exhaust Valve Close	6° BTDC @ 0.15 mm lift
Inlet Valve Open	2° BTDC @ 0.15 mm lift

The preferred size for equations, figures, and tables is 3.5 inches or one-column width. If these elements are such that they cannot be placed in a 3.5-inch space (i.e., in one column), they can be placed using the entire width of the page (i.e., using both columns). (Requests to increase or decrease image sizes prior to publishing cannot be honored.)

How to Cite References

Only publicly-available references shall be used. Scientific and engineering peer-reviewed publication shall be the basis for all engineering and scientific claims. All claims or statement of facts made in the paper shall be supported by references. An exception to this would be a “private communication” described later in this section.

Authors should provide direct references to original research sources whenever possible. References to review articles can be an efficient way to guide readers to a body of literature; review articles do not always reflect original work accurately.

References need to be assembled in numerical order as they are cited in the paper. Each reference is cited using a number within square brackets [1]. These are numbered sequentially in the order of first appearance. Examples of references are provided at the end of this paper under the heading of References. The list of references is to be provided at the end of the paper, after Summary/Conclusion(s) (and Recommendation, if present) and before Acknowledgements or other closing sections.

Depending on the content of the work, references could also be cited under different sections or subsections, such as Introduction, Methodology, Analysis, or something similar. Authors shall not reference information that could change or that may not be available at a later time. An example of this is certain information posted on the internet (company website, blog, Wikipedia, etc.) unless the information is truly archival as is the case for most online journals.

References to “private communication” shall only be used to support non-critical content claims and if essential information is not available in the public domain.

All details of the reference citing need to be accurate - author, title of the article, proceeding, journal, where it was presented, date published, etc.

If an author uses material that is directly taken from another source (figures, tables, images, text, facts, equations, etc.), even if the source is another SAE International publication, the author is REQUIRED to obtain permission to use the material. A Copyright Permission Form for this purpose is located at http://volunteers.sae.org/authors/copyrightpermission.pdf. A reference to the original source of the information must be indicated at the end of the line of text in which the reference is made by sequentially numbering each instance. This (reference) number correlates to complete information about the original source which will be included in the References section at the end of the paper. In addition, images used with permission must include the copyright statement as provided by the copyright owner as part of the caption and must also include a reference number. Images without permission will need to be deleted.

The actual references listed in Table 2 are provided at the end of this paper.

Table 2. Reference Examples

Reference type	Corresponding Reference Number
Personal communication	1,13
Book	2 (with chapter reference),11,12 (with page numbers reference)
Conference paper	3,4
Conference paper with no paper number or DOI	5
Journal article	6
Journal article with DOI	7
Magazine articles	8
Standards	9,10
Patent	14
Internet reference	15
Thesis/Dissertation	16
Software	17
CD-ROM	18
Video	19

For complete instructions on formatting citations, please refer to the author resources – http://volunteers.sae.org/authors/FormattingCitations.pdf.

Discussion

This section is important as the objective is to provide an interpretation of the data and important findings of the work discussed earlier. This section also leads to the Summary/Conclusion(s).

Summary/Conclusion(s)

Serving several purposes, this section shall state a summary of the key learnings from the work presented including the problem and the solution. This section should also state precautions, limitations, and disadvantages of the work, if any. Depending on the work, this section may also include an explanation on the impact of this work on future work.

Recommendation

The Conclusion(s) may often result in a recommendation. When done properly, the Conclusion(s) and Recommendation will be separate sections and one can easily define the true value of the work and can, in fact, generate future work as a result.

Additional Information

This is an optional section for information that could not be provided in the main paper, but is important in writing a high quality technical paper.

Completing Author Information

Listing the authors tells readers who did the work and should ensure that the appropriate people get credit and take responsibility for the research. Misrepresentation of authorship is a form of research misconduct. All author and co-author information must be entered correctly into MyTechZone at the time the final manuscript is submitted.

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Nomenclature

Theoretical papers are likely to have multiple equations. Various terminologies used in these equations should be identified in a section entitled Nomenclature. Terminologies can also be listed following each respective equation.

Contact Information

This is where the main author information (author name, phone, and email address) is listed. If desired, the author can include background, education, and web address details. This is a required section.

Example:
Pranab Saha, Ph.D., P.E., INCE Board Certified
Work phone: (248) 674-4100
e-mail: prsaha@kandse.com

Acknowledgments

This is an optional section to acknowledge a person or an organization assisting to make the paper possible.

Example:
Thanks to the SAE International TQRT (Technical Quality Response Team) members and the associated SAE Staff members for making this paper possible.

Author Affiliation

The author/co-author information should credit their respective affiliations at the time the paper was written. Should the affiliations change prior to publication, the current company(ies) can be acknowledged in the Acknowledgements section of the paper.

Definitions, Acronyms, Abbreviations

This is an optional section. The following is an example:

barrier	A barrier is a material that causes the sound wave to lose energy as the wave is transmitted through the material and propagates from one region to the other.
SA	Sample Abbreviations
UBT	Use borderless table ≤ 3.5 inches wide.
test vector	Don't capitalize term unless an acronym or proper noun.

APPENDIX

Any bulk of information that interrupts the flow of thought in the paper should be placed in an appendix. Examples include large tables, large images, or long mathematical derivations. Examples:

$$STL = 10\log_{10}\left[\left\{1+\eta\left(\frac{P_s\omega Cos\theta}{2\rho c}\right)\left(\frac{B\omega^2}{P_s c^4}Sin^4\theta\right)\right\}+\left(\frac{P_s\omega Cos\theta}{2\rho c}\right)^2\left(1-\frac{B\omega^2 Sin^4\theta}{P_s c^4}\right)\right]^2 \quad \text{(A1)}$$

Table A3. DOE cases considered and their effect on the study

Frequency Range	Frequency (Hz)	General System Behavior	Influence of different factors (%)		
			Ratio of wear to mass filled layer density	Mass-filled layer thickness	Decoupler density
Range 1	125 to 315	Coupled System	3	10	86
Range 2	400 to 1000	Double Wall Resonance Effects	1	3	96
Range 3	1250 to 3150	Transition Region	3	3	90
Range 4	4000 to 8000	Double Wall Decoupled Region	7	7	77

Appendices can be structured using the same subsection headings and formatting used in other sections of the paper. When labeling figures, tables, and equations within an appendix, restart the numbering in each appendix and prefix the number with the letter of the appendix, e.g., Figure A7 or Eq. (A1). The appendix is one-column.