Biomechanics of Movement

Master in Biomedical Engineering, 1st Quarter, 2021-22

**Word template for biomechanics of movement report**

FirstName1 LastName1, FirstName2 LastName2 and FirstName3 LastName3

Department, University, {lastname1,lastname2,lastname3}@university.pt

Abstract — The informative abstract, as its name implies, provides information from the body of the report—specifically, the key facts and conclusions. To put it another way, this type of abstract summarizes the key information from every major section in the body of the report. It is as if someone had taken a yellow marker and highlighted all the key points in the body of the report then vaccuumed them up into a one- or two-page document. (Of course, then some editing and rewriting would be necessary to make the abstract readable.). The abstract cannot include figures, tables or equations and, in our case, cannot be longer than 20 lines using the font type and size adopted in this template (Times New Roman, 11 pts, Italic).

1. Introduction

The introduction is one of the most important sections of a report—or, for that matter, any document—but introductions are often poorly written. One reason may be that people misunderstand the purpose of introductions. An introduction introduces readers to the report and not necessarily, or only minimally, to the subject matter. "Introduction" does not equal "background"; it may contain some background but only minimally.

Readers have an understandable need to know some basic things about a report before they begin reading it: such as what is it about, why was it written, what's it for, for whom it written, and what are its main contents. Readers need a basic orientation to the topic, purpose, situation, and contents of a report—in other words, an introduction.

Imagine that, years ago, you were writing a recommendation report about CD-ROM computer devices. You might be tempted to use the introduction to discuss the background of compact disc development or its theoretical side. That might be good stuff to include in the report, and it probably belongs in the report—but not in the introduction, or at least not in much detail or length.

For 10-page reports, introductions might average one full page. On that one page, you might have three paragraphs. One of those paragraphs could be devoted to background information—in other words, to introducing the subject matter. But the other two paragraphs must do the job of introducing the report and orienting the reader to the report, as discussed in the following:

* Topic. Early in the introduction, indicate the specific topic of the report. Better is to indicate the topic early, such that you could circle the topic words in the first three to four lines.
* Purpose and situation: A good introduction needs to indicate why it was written, for whom, and for what purpose. If the report provides recommendations on whether to implement a program, the introduction needs to indicate that purpose. You might also consider indicating something of the scope of the report, what it is not intended to accomplish.
* Background on the topic: This is everybody's favorite! Some minimal background is usually in an introduction, for example, key definitions, historical background, theory, the importance of the subject. Information like this gets readers interested, motivated to read, grounded in some fundamental concepts. Watch out, though this discussion can get away from you and fill up more than page. If it does, that's okay, all is not lost. Move it in to the body of the report, or into an appendix.
* Background on the situation: Another kind of background is also a good candidate for introductions—the situation that brought about the need for the report. For example, if there were a lot of conflicting data about some new technology, which brought about the need for the research, this background could be summarized in the introduction. For example, if a company needed new equipment of some kind or if the company had some problem or need and some requirements in relation to that equipment,discussion of these matters should go in the introduction.
* Overview of contents: Indicate the main contents of the report. You can do this with an in-sentence list, as the examples illustrate. If you are concerned about readers' exaggerated expectations, indicate what topics the report does not cover.

The abstract may include figures that represent the contents and the purpose of the report, but it cannot start with a figure (or table. Actually, none of the sections, or sub-section, headers may be followed by figures, tables or equations. In the specific case of Biomechanics of Movement it is expected that each of the movements studied are described in sub-sections being the important information for their analysis be provided here also.

1. Methods used in the analysis

In this section of the report, not more than 3 pages long, you must present the computational methods used to complete your work. It must include a description of the biomechanical model and the data that it requires, how was the experimental data acquired in the Biomechanics Laboratory, what is that data all about, how is the data processed in order for the analysis codes to be able to analyze the models and how do the analysis code work. Each one of this individual parts must be described in a dedicated sub-section of your report

* 1. Biomechanical model for the human movement

Briefly describe your model and the data that it requires. Include a brief discussion on the range of movement that it is suited to be used and the limitations on its applications. You may include any relevant figure and, or, table with information. Keep this subsection under one page length.

Example figure

Fig. : Example figure

A note about the figures and their usage is in place at this point. It is not acceptable that you simply scan and include figures in your report obtained from other sources without having: (1) the permission of their owner to be used; (2) the proper reference to where they are available (which is listed in the references). In principle you should generate the figures of your report by yourself so that you do not infringe any copyrights. However, if you use figures from any other work be very clear tp reference them properly.

All text in the figures (or in tables) should be the same size as the caption of the figure (9 pts if in Times New Roman, 8 pts if in Arial, etc). It is not accepted that figures have text if it cannot be read (smaller fonts than 9pts Times New Roman are unreadable) neither it is acceptable that fonts vary in size from figure to figure (even when they are imported from other authors with the correct references and permissions)

* 1. Data acquisition methods at the Lisbon Biomechanics Laboratory

Briefly describe the experimental setup at the Lisbon Biomechanics Laboratory and how it is used to collect the data that you, ultimately, use for your report. You may resort to figures from the LBL web page or to any source of information available in the course notes (provided that you make proper referenceing of the source). This template works as a permission by the authors of such figures for you to use them in the context of your academic works. Do not use more than one page to describe the experimental acquisition setup and comply with the rules stated for the figures and tables.

* 1. Data acquired and pre-processing

In this subsection you must describe the data that you acquired at the biomechanics laboratory, its structure and its contents. Afterwards, you must describe the methods used to process it up to the point in which you obtain the data files required by the kinematic and dynamic analysis programs. You may use sub-sub sections to separate the different steps of the pre-processing methodologies. If you use any equation to describe any part of the process, just make sure that it is in the format presented here as example

 (1)

If you need to use any table, you can format it using the example presented here. Note that in the Word tab named ‘References’ you have the tools to continuously number figures and tables and to refer to them in the text of your report. By using these tools you ensure that you have consistent references to the figures and tables of your report.

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Tab. : Example table

The referencing of figures and tables, as well as literarature, follows rules that are described in courses such as those that students attended in their first year at IST. For instance, Fig. 1 is and example on how a figure is inserted and captioned in the body of a text, while Eq. (1) may be one of the equations of your work and the contents of Tab. 1 are those presented in reference [1]. If you need to have an equation in the body of the paragraph the format is exemplified by , as obtained from [3].

* 1. Kinematic analysis of the human movements

In this section you must describe the methods used for the kinematic analysis of the human movement in the code that is made available to you, i.e., in MuboKAP. Notice that you are not expected to include in the report the specific equations for the joints or other basic information as that. But you should provide a description of the coordinates used, the basic equations to be solved, the numerical methods applied and of the output contents. The reader, not necessarily attending the classes of Biomechanics of Movement, should be able to have an idea of how a kinematic analysis is developed and what is the output of it. In any case, do not use much more than one page to describe the methodologies and the computational structure of the program.

* 1. Dynamic analysis of the human movements

In this section you must describe the methods used for the dynamic analysis of the human movement in the code that is made available to you, i.e., in MuboDAP. Notice that you are not expected to include in the report the specific equations for the joints or other basic information as that. But you should provide a description of the coordinates used, the basic equations to be solved, the numerical methods applied and of the output contents. The reader, not necessarily attending the classes of Biomechanics of Movement, should be able to have an idea of how a dynamic analysis is developed and what is the output of it. In any case, do not use much more than one page to describe the methodologies and the computational structure of the program.

1. Case studies

In this section you describe the cases studied, their data and the results of the programs. You should proceed with the discussion base not only on your results but also on what you expected based on literature, or in the course notes. In the first part of this sections you may describe what is common to both movements, such as the data for the individual that served as ‘guinea pig’ for the data acquisition (gender, age, height and weight). Before the sub-sub sections you can provide all the information for the biomechanical model used, such as the length of the the anatomical segments, data for the kinematic joints, mass and inertia data for the model, etc.

* + 1. Movement case 1: Gait

Present here a description of the movement case and all specific data that is required for the analysis, including a figure with the cut-off frequencies for each one of the coordinates and for the force components. You may want to divide this sub-sub section into the kinematic analysis and dynamic analysis, and the data description with it.

You must discuss the results obtained from MuboKAP, or post-processed based on the results of the program, with reference to what is expected from the literature. Be extra careful when generating figures with graphics and discussing the results in face of those presented in the literature. If you compare your graphs with those from literature ensure that: Both use exactly the same scales with the same ranges and have exactly the same sizes. Ensure that the graphs, for the same quantities, are superimposed or, at least, presented side-by-side. Note that is not acceptable that the font size of the graphics (XY plots) is different in different graphs neither that its size is different from that of the New Times Roman 9 pts (which is the same of the Arial font with 8 pts). Exactly the same set of rules apply when discussing the results for the dynamic analysis obtained with MuboDAP.

* + 1. Movement case 2: ‘Name of our Second Movement’

Present here a description of the movement case and all specific data that is required for the analysis, including a figure with the cut-off frequencies for each one of the coordinates and for the force components. You may want to divide this sub-sub section into the kinematic analysis and dynamic analysis, and the data description with it. In general you must follow the same structure and address the same topics as addressed for the gait analysis, adapted to this other movement. The rules for the presentation of figures and graphs are the same in both movements.

It is natural that the literature information on the second movement that you selected is more scarce than that available for the gait analysis. In any case you must also be able to divide the movement cycle in phases and analyze the data in each of the phases using a structure similar to that developed for the gait case.

In both the gait and the ‘second movement’ you mays have several cycles of the same movement. It is to your benefit to show graphs of the movements with all the cycles that you have available. If you choose to do so just ensure that the abscissa of the graphs are for a single cycle (from 0% to 100%) and that the different cycle ‘curves’ are plotted in that graph (they will look like a bunch of curves forming a ‘corridor’ of responses, which is the way you see gait data plotted very often, i.e., with a corridor in which a particular quantity occurs with respect to the percentage of the cycle).

You can find in the web interesting applications to extract data from curves plotted in books and other material. Check out the WebhPlotDigitizer ([WebPlotDigitizer - Extract data from plots, images, and maps (automeris.io)](https://automeris.io/WebPlotDigitizer/)) or the GraphReader ([graphreader.com - Online tool for reading graph image values and save as CSV / JSON](http://www.graphreader.com/)) as examples of this type of applications.

1. Conclusions

A conclusion implies a summary of the main points that you report in the body, what decision you came, but it is not a summary of the work, i.e., it must not overlap the abstract. Use words to show that you are concluding your work to prepare readers that you’re about to finish. The conclusion should be short and concise. But the main idea is to cover every question that a reader may ask.

A "true" conclusion is a logical thing. For example, in the body of a report, you might present conflicting theories and explored the related data. Or you might have compared different models and brands of some product. In the conclusion, the "true" conclusion, you'd present your resolution of the conflicting theories, your choice of the best model or brand, i.e.,your final conclusions.

In this section you must not present figures, tables or equations, but you may refer to them. In the conclusions you may include your view on open points of your work that may be left for future works, if that is appropriate.

References

1. F. LastName1, *Book title*. Address: Publisher, 3 ed., 2016.
2. F. LastName1 and F. LastName2, “Paper title,” *Journal*, vol. 1, no. 2, pp. 100–110, 2016.
3. F. LastName1, F. LastName2, and F. LastName3, “Paper title,” in *Proceedings*, pp. 1–10, June 24 – 28, Lisbon, Portugal, 2018.