

Deliverables for PhD students of the course of Design of Experiments (ENG 606)

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1 Introduction

The project of the DOE course has a double objective:

1. to give to the participants the opportunity to apply the theoretical elements taught in the course,
2. to bring evidences of learning for the evaluation.

This document describes the deliverables for the course ENG-606 Design of experiments of the doctoral school (EPFL).

The course is usually taught in the Fall semester:

- The **proposal** is due a few weeks after the course.
- The **report** is due by the end of the next semester.

The two deliverables are in pdf format.

2 Proposal

The purpose of this document is to define who will be member of each group, what is the objective and the schedule of the project. It should allows the lecturer to help to scale the complexity of the problem and to avoid projects that would go out of the scope of the course.

The *proposal* must be provided as a *pdf* document of three pages maximum. Its name must be "*DOE YY Proposal authors_names.pdf*".

2.1 Structure of the document

The structure of the *proposal* document is the following

- Head
- Body
- Remarks

2.2 Head

The head of the document must contain the following Information:

- Title:** The title of the document must explicitly mention the subject investigated such as for a scientific paper. An example is "*Photo-tropic response of sun flower to blue light*".
- Subtitle:** The subtitle must be "*DOE proposal - Fall YY*", YY being the two last digits of the year of the course.
- Author(s):** The names of the group members¹.
- Affiliation:** The laboratories, the faculty and the school name.
- Date:** Date of the submission of the proposal.

¹The groups are constituted by two or three participants. Exceptions have to be negotiated with the lecturer.

2.3 Body

Here below are described the different elements that constitute the body of the text:

Group : A short explanation about the formation of the group, such as indicating if the group is casual or if the members are collaborating independently of this project. Indicate also if the investigation concerns more directly the thesis of one or some of the members.

Referee: The referee is a senior researcher competent in the subject matter of the investigation. The referee will read the report and confirm by a short message to the lecturer that the investigation is sound in the given domain and has followed the rules of the art. It could be the same thesis director of one of the members of the group or even a colleague chosen for his insight in the subject matter, but obviously it cannot be another PhD student. It is a good policy to discuss the proposal with the referee, but no direct feedback to the lecturer is asked.

Mindmap : A mind map of any elected format (specific tool, hand drawing, ...) with the five different branches presented in the course, described with key words:

- Objective
- Factors
- Response(s)
- Model(s)
- Strategies

Here below is an example of a mind map :

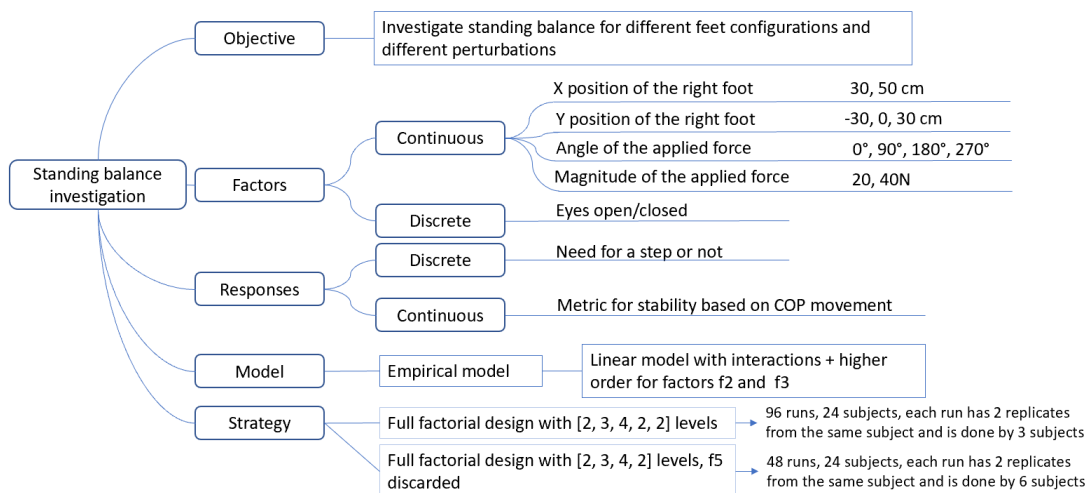


Figure 1: A project mind map by two former participants, E. Roussinova and O. Özge

Objective This part describes in a few words the objective of the project, giving a short explanation of the importance of the problem, indicating if it concerns a screening of factors or the optimization of a response. One sentence will summarize what should be the result of the measurement campaign. It is a reformulation of the first branch of the mind map that can be understood by non-specialists.

Factors This part describes the factors and they *a priori* characteristics in terms of

- ☐ nature (qualitative vs quantitative),
- ☐ range,
- ☐ continuity, metric and units,
- ☐ dependence, constraints and correlations,
- ☐ expected instability and uncertainty,
- ☐ difficulty to be varied (identify the hard-to-change factors),
- ☐ relation with the process (design factors vs environment factors) and confusion aspect

It is also important to mention an eventual arbitrary screening that is made among the factors and to say something about the rational which justified it.

Response(s) This part describes the response characteristics in terms of

- ☐ nature (experimental vs simulated),
- ☐ magnitude,
- ☐ accuracy ²,
- ☐ relation with the objective.

If the response is indirect, a short explanation of the different operations necessary to get a result with eventually a bloc diagram of the process between the raw experimental (numerical) data and the modeled response.

Model(s) This part described the algebraic model(s) that is (are) of interest as well as the background of this choice. A causal model in the form of a bloc diagram will represent the relation from the factors to the response(s). An example is given in 2.3

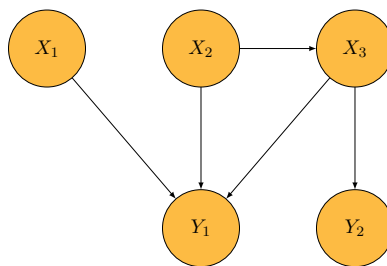


Figure 2: A causal model in which causes X_i are put in relation with consequences Y_j

Strategies This part describes the designs that have been selected and their main characteristics in terms of number of experiments, resolution, orthogonality, model variance, variance inflation factor, cost and eventually power. It is the main

²If the experiment is simulated, it is worth to indicate if it is a stochastic or a deterministic simulation.

part of the proposal. For the classical designs it is not necessary to recompute the statistical properties, their evocation will be sufficient.

Two strategies at the minimum must be analyzed. Present explicitly the relation between the design and the algebraic model(s), and the causal model(s).

If an iterative strategy is planed, explain well the branch lines.

Program This part describes the schedule for the project in terms of delays and work packages. A Gantt diagram can help to follow the path (if edited along the project).

2.4 Remarks

This parts is optional. It allows the group to indicate any important remarks about the constraints of the project in term of confidentiality, special needs, extraordinary delays, collaboration etc.

3 Report

The report of the DOE project aims to bring concrete element testifying of the mastering of the DOE concepts by the applicants.

It is a 8-page document presenting, in the majority of cases, an experimental situation, the experimental design selected to investigate it, the results and the analysis realized as schematized in figure 3. When data are already available, the process is the same but the different steps occurs in a different order.

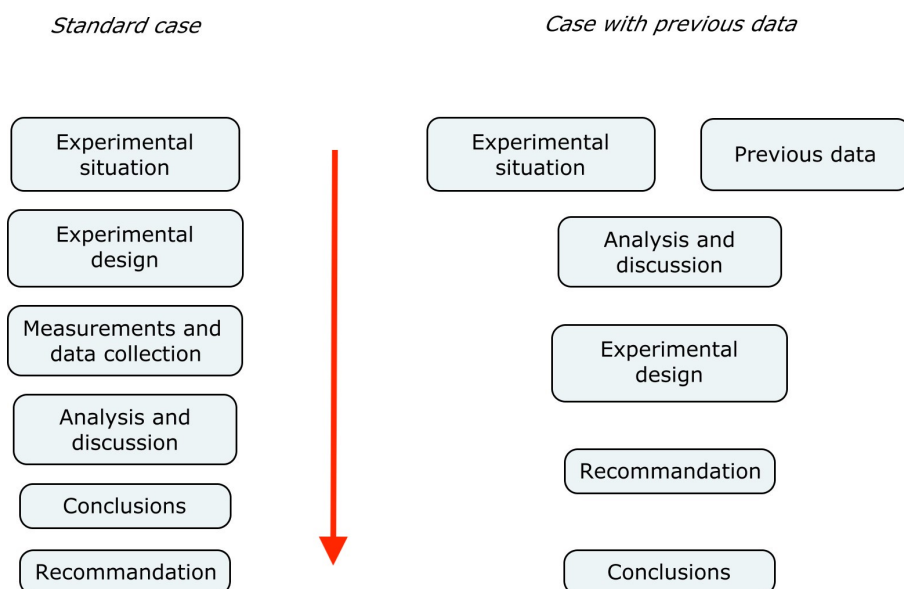


Figure 3: Generic structure for the report

The text must convey information in the most effective way for communication:

- Use figures and tables.
- Use bulleted or numbered lists, but the bulk should be paragraphs made up of full sentences.
- Can use formatting to break up large slabs of text.

It is key, as for all scientific and technical documents to ease the job for the reader and foster his/her interest: this implies to stay simple, concrete and credible. The simplicity is guaranteed by finding the core of the ideas with simple sentences focused on the essential, be simple but not simplistic. The use of equations, diagrams, schemes, models, conceptual maps is heavily recommended in this perspective.

Science is in tension between concrete data and abstract ideas. We use abstractions to give a meaning to the concrete. It is important to avoid jargon which blurs the understanding .

The credibility is ensured if your discourse talks to the mind: anchor your ideas in the scientific literature and theory, describe your methods to confer credibility to your data and ensure the credibility of your conclusions by showing that they result from credible data and sound operations.

3.1 Head

The head of the *report* must contain the following parts:

- Title:** The title of the document must explicitly mention the subject investigated such as for a scientific paper. An example is "*Investigating the photo-tropic response of sun flower to blue light*". If possible keep the same title than for the proposal.
- Subtitle:** The subtitle must be "*DOE Report - Fall YY -Group a*", YY being the two last digits of the year of the course, and a being a letter distinguishing the groups and given by the lecturer as feedback to the proposal.
- Author(s):** The names of the members of the group
- Affiliation:** The laboratories, the faculty and the school name
- Date:** Date of the submission of the report.

3.2 Body

Abstract : This part states in one paragraph what the report is about:

- The purpose of the study and the research problem investigated;
- The basic design of the study;
- The major result of the analysis;
- A brief summary of the conclusions.

Introduction

This part states the problem to be investigated. Stay generic without forgetting that the focus is on the design of experiments and on the statistical analysis of the results. The introduction must answer the following questions:

- What is the problem that you address ?
- Why do you address this problem?
- What must be understood to follow the story?
- What is the precise question that you want to answer?
- What must be done to get that?

Experimental case

This part presents the case in a statistical perspective. It corresponds to the mind map (and the mind map must be presented) of the proposal. The reader expects to find here

- A short presentation of the factors with their eventual constraints and range,
- A broad description of the experimental set-up,
- The relation between the factors and answers of the problem and the experimental variables
- The explanation of the causal model and the description of the algebraic model(s) of interest

Experimental design

This part presents the adopted experimental strategy. The reader expects to find here the rationale that justifies the choice of the strategy, the main characteristics of the investigated designs, the arguments of the decision and the consequence for the organization of the experimental campaign.

Experimental results

This part contains the experimental results if there are not too voluminous. If they are voluminous they can also be placed in annex (at the end of the document or for very high volumes, in data files distributed with the report) and the main body will contain a summary of the results and eventual graphical representation.

Discussion

This part contains the analysis of the data. The reader expects to find here the ANOVA tables and all the statistical analysis aiming to qualify the quality of the inferences performed from the experimental data.

- List the findings of the study in decreasing order of their importance. The most important result is the one that answers your research question.
- Interpret your results
- discuss the limitations vs generalization of your results
- Contextualize the meaning of your findings for the reader. Do your results elaborate on previous findings, or differ significantly?
- highlight the unexpected results if any

Conclusion

- Mention how your results add values to those of previous studies

In the conclusion section, you remind the reader of what they have just read. Your conclusion should:

- Restate your hypothesis or research question
- Restate your major findings
- Tell the reader what contribution your study has made to the existing literature
- Highlight any limitations of your study
- State future directions for research/recommendations

Your conclusion should NOT:

- Introduce new arguments
- Introduce new data
- Fail to include your research question
- Fail to state your major results