

Statlab – A Manual for Students

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1 Introduction

A good working knowledge of DOE (design of experiments) is essential for both industrial statisticians and engineers. It is therefore essential that courses in statistics pay sufficient attention to this topic. However, a distinctive feature of DOE is that is pro-active, unlike many other statistical techniques. Hence, this requires a teaching approach that forces students to actively think about several aspects of setting up an experimental design, without steering the student too much. There should be room for the student to make mistakes and learning from them. In order to create such a teaching environment to be used in statistics courses at various departments of Eindhoven University of Technology, a web based tool called Statlab has been developed. Statlab has received positive reactions from students, who generally consider learning statistics using Statlab much more fun than traditional approaches.

Statlab contains several assignments to teach several aspects about setting up a designed experiment. The assignments can be divided into two parts: screening assignments and optimisation assignments. In a screening assignment you have to find significant effects. Some screening assignments have control factors and noise factors. The goal of these assignments is not only to find the significant effects, but also to find optimal settings for the control factors that minimise the variation due to the noise factors. In an optimisation assignment the significant effects are given and you have to find the optimal settings for these effects. Some assignments are used for practicing, while others are used for examinations. One needs a password to access the examination assignments. At the end of examination assignments, no grade is given, but Statlab sends

the results to the teacher by email. At the end of assignments meant for practising a grade is given and some hints if some things were not correct or forgotten.

2 Installing Statlab

Statlab is a freely accessible Java program. Its web page is <http://www.win.tue.nl/statlab>. The minimum required Java version is 1.4. The latest Java version can be downloaded freely from <http://java.com>. In order to use Statlab during examinations, the Java security settings must allow Statlab to save the results to the user's hard disk, and send an email to the teacher. When Statlab is started for the first time, the user is prompted to grant these permissions. But even when the Java security settings are correct, firewalls or virus scanners might prohibit Statlab to send emails. This is why the opening page of Statlab contains a "Detect Java Security" button that checks whether the right Java version is installed and whether Statlab is allowed to save results to disk and send an email. Students should always run this security check on the system that they will use during the exams.

3 Working with Statlab

Working with Statlab means navigating through several screens. In the opening screen you have to select the desired language by clicking on the appropriate country flag. When you have selected the language, the top part of the screen shows you which screens are available and which screen is currently shown. Each screen has its own help page. Note that in line with the general teaching philosophy behind Statlab as described above, Statlab hides options that students do not ask for!

Navigation buttons are always shown in the bottom part of the screen:

Back go back to the previous screen. Please note that this is not always allowed. For example, if you have chosen an assignment, you cannot return to the "Select Assignment" screen. You will have to press the Restart button to restart Statlab.

Forward go forward to the next screen. The actions that you have taken in the current screen might determine what screen will appear next.

Restart shows a question dialog that will ask you whether you want to restart the current assignment, or restart Statlab completely. If you restart the current assignment

Select Font lets you select the default font and font size. It is sometimes useful to change the font size if your screen does not display the screens properly.

Add explanation to your action Statlab forces you to think about your actions and make appropriate decisions. This button gives you the opportunity to add an explanation to your action, so you can let the teacher know why you made a certain decision.

Ask Question to the Process Engineer the company has a process engineer that answers questions that you might have about the process. Please use one key word per line to formulate your question. The process engineer has hardly any statistical knowledge. You can go to the process engineer whenever you want, but it is recommended not to bother her too often.

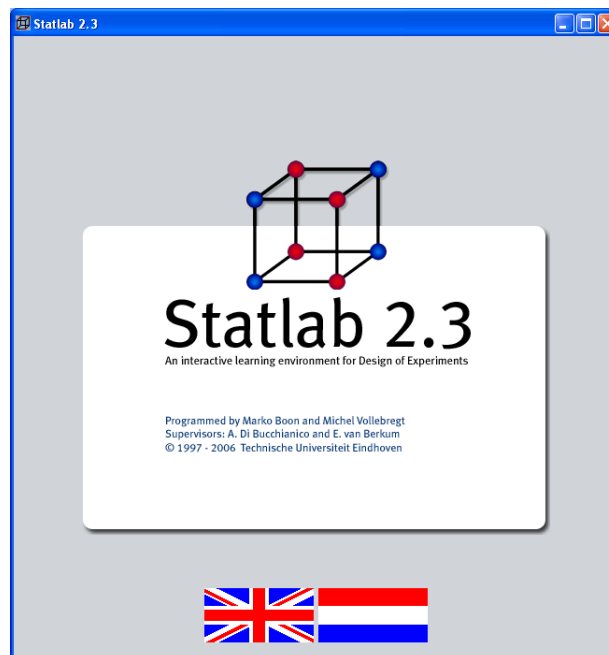
Ask Question to Statistical Expert the statistical expert is only allowed to help you with brief explanation of common terms in design of experiments

Help for this Screen shows a help window that gives detailed help for the screen that is currently visible. It is highly recommended to read the help for each screen when you are new to Statlab.

About Shows some information about the designers of Statlab.

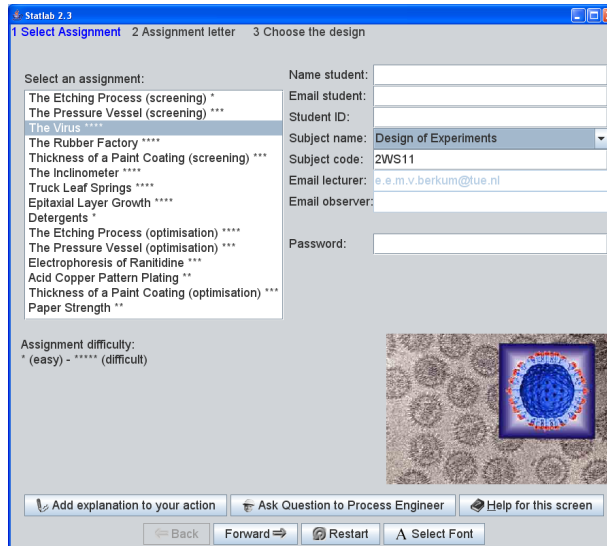
In the next section some information about all the screens is shown.

Opening Screen



In this screen you should choose your preferred language by clicking on the appropriate country flag.

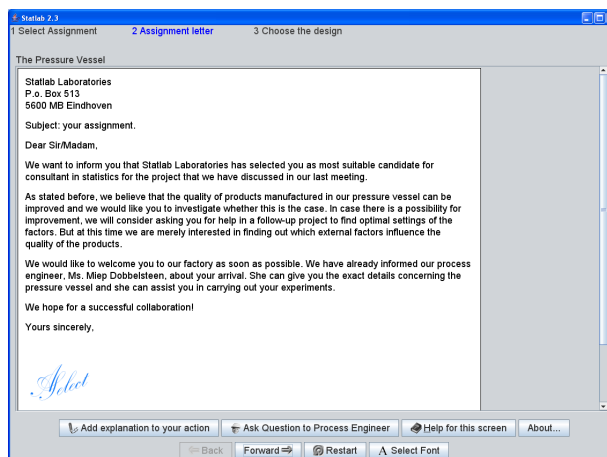
Screen 1: Select Assignment



In this screen you should select the assignment that you want to do. The difficulty of the assignments is marked by ★. One star means "easy", five stars means "very difficult".

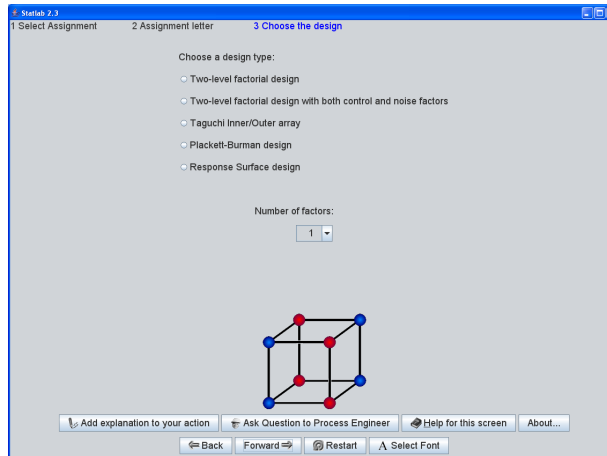
Some assignments are only accessible if you know the password. These are examination assignments. You teacher will give you the password when the examination starts. Do not forget to enter your Name, ID, email address and select the appropriate subject name.

Screen 2: Assignment Letter



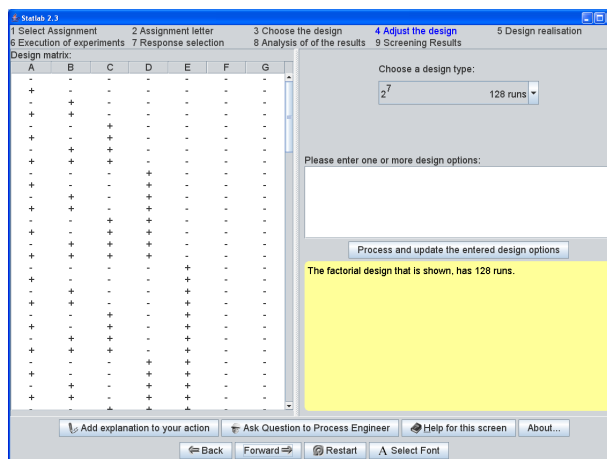
In this screen you will see the assignment letter that the company has sent to you. Read this letter carefully so you know what the company expects from you.

Screen 3: Choose the Design



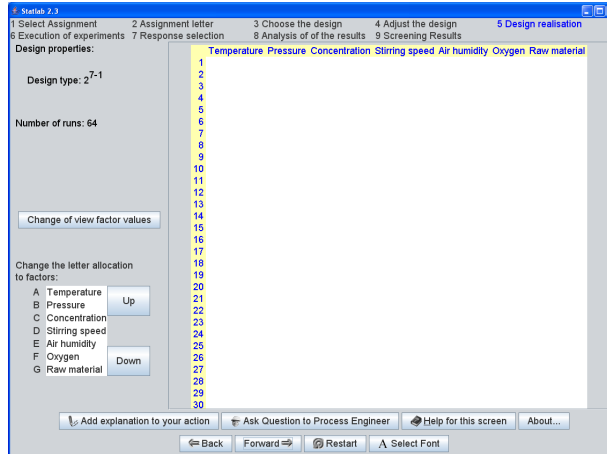
In this screen you should choose the appropriate design for your assignment and select the right number of factors. From now on you can ask the process engineer for help whenever you need it (just do not bother her to often). Depending on your choice, the following screens will be either Screening Assignment screens, or Optimisation Assignment screens. First we will discuss the screens for screening assignments, later we will discuss the screens for optimisation assignments.

Screen 4 for Screening Assignments: Adjust the Design



In this screen you have to select the appropriate design. At first only one design type is shown. If you want to change certain aspects of your design, you should enter design options (one option per line) and press the "Process and update the entered design options" button. Appropriate buttons will be shown in the screen, or more design types will be added to the list.

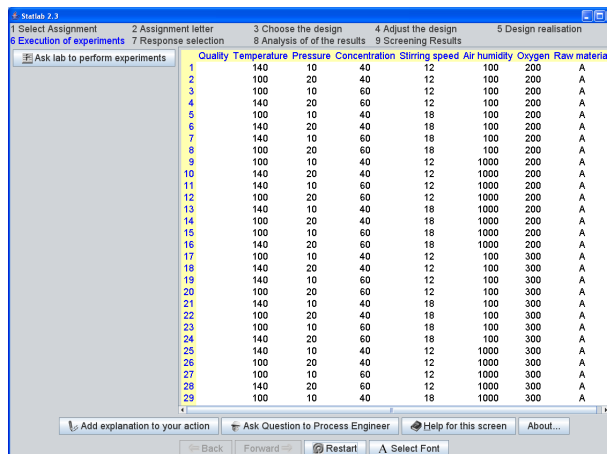
Screen 5 for Screening Assignments: Design Realisation



This screen shows the experimental design as it will be sent to the laboratory. The symbols + and – have been replaced by the setting in the original units. You should enter the appropriate values in the dialog that is shown when you press the "Change or view factor values" button. Allocation of factors to the letters A, B, C etc. may be changed on the left bottom of this screen by selecting a factor with the mouse and moving it up or down.

Please note that when you go forward to the next screen, you will not be able to return to this screen anymore!

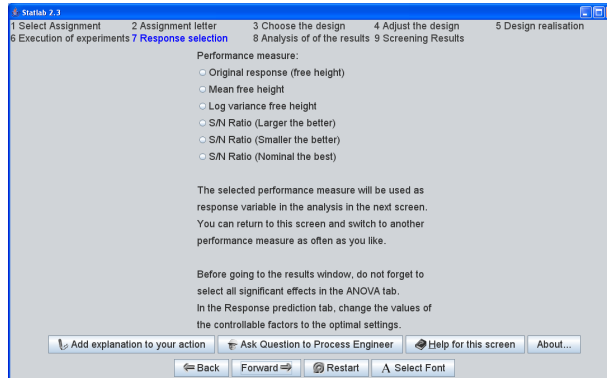
Screen 6 for Screening Assignments: Execution of Experiments



This screen shows the experimental design as it has been determined in the previous screen. This experimental design will be sent to the laboratory with the request to perform the corresponding measurements. Please press the button "Ask lab to perform experiments" to obtain the measurement results from the laboratory. After receiving all measurement results, you may proceed to the next screen.

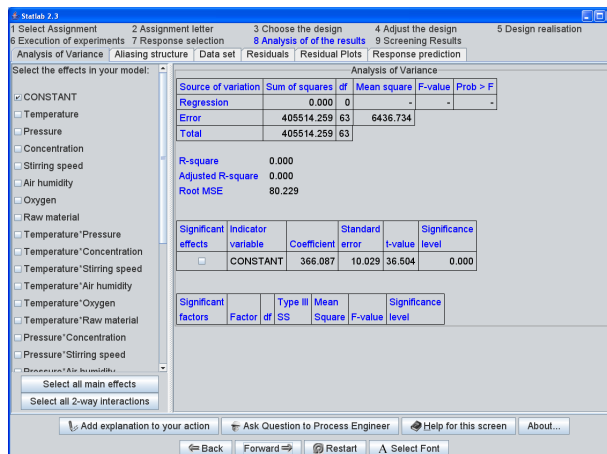
Warning: if (for whatever reason) an error occurs while performing the measurements, the assignments must be restarted.

Screen 7 for Screening Assignments: Response Selection



This screen is only shown for robust design assignments! You can select the response that will be analysed in the next screen. In robust parameter design assignments you should find factor settings that minimise variation, and result in an optimal process response. You can choose one of the response types and analyse it in the next screen. If you want to, you can return to this screen as often as you want and analyse a different response.

Screen 8 for Screening Assignments: Analysis of the Results



This screen consists of several tab panes. The tab panes that are visible depend on the design type that you have chosen, and the model that you have selected. The first tab shows an Analysis of Variance which includes all effects that are selected in the left hand side of the screen. Initially this is only the constant, so none of the other factors have been included in the model. Your task is to find an appropriate model which relates the response variable to the factors. The other tab

panes help you validate your model. Use the "Add explanation to your action" button frequently, to tell the teacher what conclusions you can draw about the model adequacy.

Important: this is the last screen of your assignment. In the next screen you Statlab will give you a grade and tell you what you might have done wrong. Before going to the "Screening Results" screen, make sure that you have selected all the significant effects (which is the goal of all screening assignments). If your assignment is a Robust Parameter Design assignment, make sure that you choose the best factor settings in the "Response Prediction" tab pane.

Screen 9 for Screening Assignments: Screening Results

This screen will give you a grade (1 = very bad, 10 = very good). In case you made certain mistakes, Statlab will give you some vague hints about what you might have done wrong.

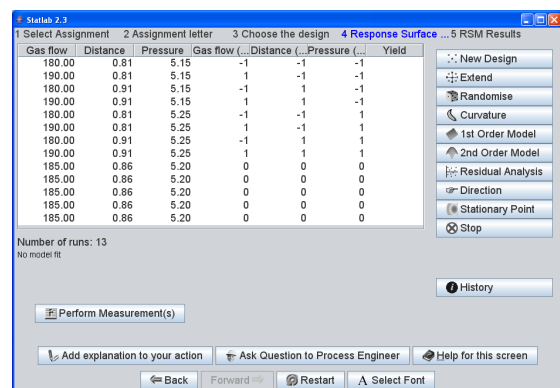
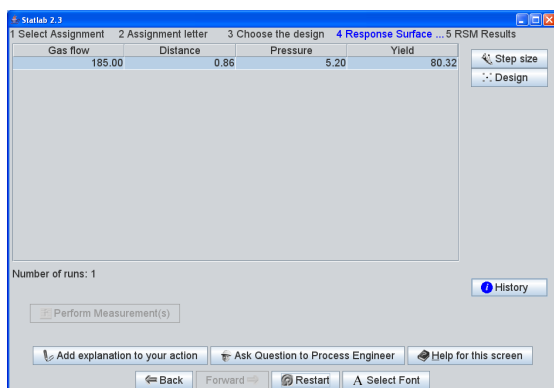
If your assignment is an examination assignment, no grade and no hints will be given. You will see buttons that allow you to save your results and send them by email to the teacher. Always save your results first! In case an error occurs while trying to send the results by email, two things might be wrong:

1. your laptop is not connected to the network of the Technische Universiteit Eindhoven.
2. your firewall and/or virus scanner prevent sending of the email

The first item cannot be solved, but if you want your SMTP server to be added to the list of supported SMTP servers, please send an email to marko@win.tue.nl.

You can find instructions on how to solve the second item on the Statlab web page. Click on the button "Detect Java Security".

Screen 4 for Optimisation Assignments: Response Surface Methods



Because of the iterative aspect of the optimisation process using steepest ascent, you will stay in screen 4 throughout the rest of your assignment. However, within screen 4 there are two states:

1. the ascent state. In this state (see picture on left hand side) you do measurements in a certain direction of steepest ascent (or descent). The available buttons are:

Step size set or change the step size between two consecutive runs along the path of steepest ascent.

Design create a factorial design at the selected run. This design can be used to find out whether you are near the optimum, or whether you have to determine a new path of steepest ascent. When you have selected a design, you will enter the design state.

2. the design state. In this state (see picture on right hand side) you can create, modify, extend and analyse the selected design. The available buttons are:

New Design Create a new factorial design. All runs and observations from the current design will be removed.

Extend Extend the current design. You can add replicates, centre points or axial points (star points) which will extend a two level factorial design to a central composite design.

Randomise Randomise all runs that have not been measured yet.

Curvature Test for significance of quadratic terms.

First order model Fits a first order model. This can be used to determine a new direction of steepest ascent. When you have selected a path of steepest ascent, you will enter the ascent state.

Second order model Fits a second order model. This can be used to determine the location of a stationary point.

Residual Analysis Shows a residual analysis of the last model that has been fitted.

Direction Determines the direction of steepest ascent based on the last model that has been fitted.

Stationary Point Determines the location of a stationary point based on the last model that has been fitted. When you have selected a stationary point, the assignment will end and you will go to the next screen.

Stop Stops the current assignment without determining an optimum. Use this button only if you are stuck and do not know how to continue, or if another error has occurred that makes it impossible to continue your assignment.

Besides the buttons that are mentioned above, two buttons are always visible:

History gives you information about the runs that you have done already, including the best setting that you found until now.

Perform Measurement(s) Measure the runs that have not been measured yet.