Group 13

WHEATSTONE BRIDGE CALCULATOR

Connor
Erik
Chittawat
Tom

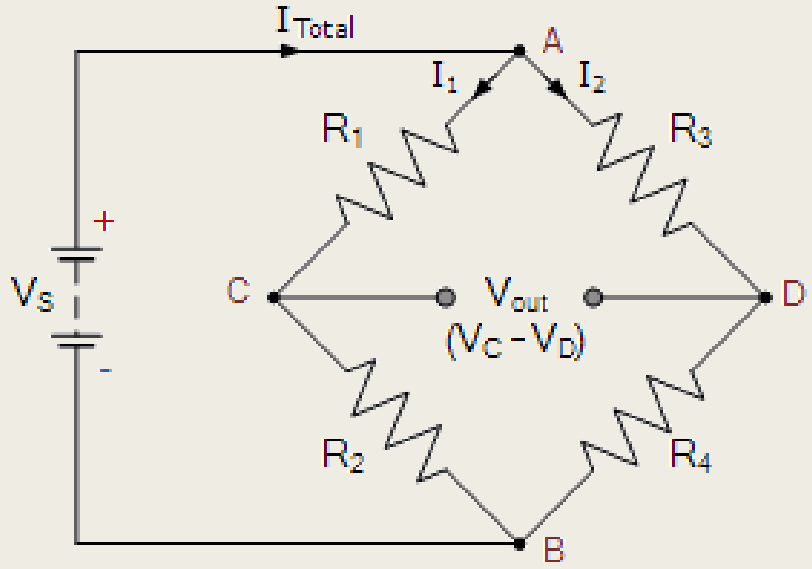
What is it?

- The Wheatstone bridge calculator is a simple but powerful tool that allows you to calculate the unknown resistor in the circuit. It also briefly explains the concepts and theory behind it to help you get your head around the problem. This program can be used for any Wheatstone bridge and it can help anyone having difficulties with the material.

How does it work?

Wheatstone Bridge Theory

A Wheatstone bridge is a circuit that determines if a “Potential Divider” circuit is either Balanced or Unbalanced.



Picture 1

For example. If R4 is an unknown resistance in this picture. Using the value of the other three Resistors in the equation:

$$\frac{R_1}{R_2} = \frac{R_3}{R_X} = 1(Balanced)$$

Equation 1

We can rearrange to find the value of Rx (R4). The way this structure works is when the Voltmeter connected between the two parallel wires reads “zero” we know the voltage dropped across one resistor must equal the voltage dropped across the other. So by changing R3 to a variable resistor we can adjust this value until the voltage reads zero. We then have all of the elements we need to insert into the equation and find the value of the resistor Rx.

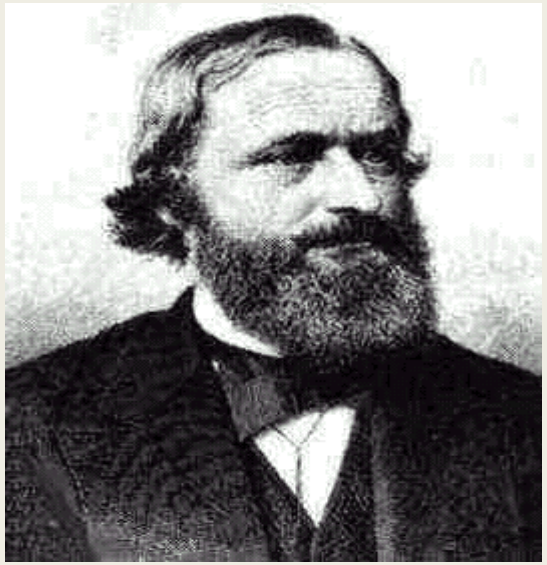
How does it work?

By rearranging the balance equation we can determine the unknown resistor by the following:

$$R_4 = \frac{R_2 R_3}{R_1} = R_X$$ Equation 2

In order for this equation to function properly all other elements must be present to find the outstanding resistance value. To do this you will need to set a known value for three resistances to find the final.

This programme is to help users with the application of the balance equation. Proving the theory with Kirchoff's laws is not needed here as this is the first stage of understanding what is going on in terms of balanced and unbalanced circuits.



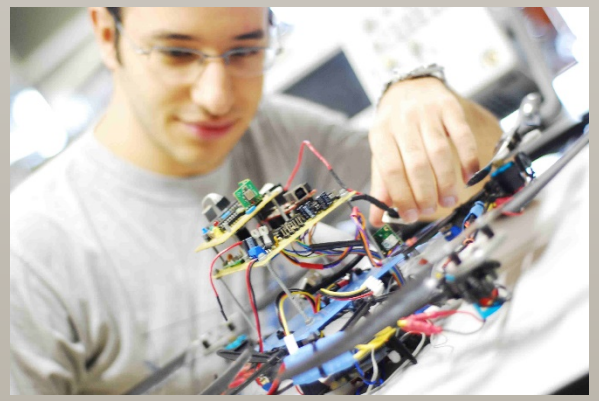
Picture 2

In this programme the circuit will always be 'balanced', this means that the voltmeter will always read zero. It shows the user that in order for the circuit to be in constant balance the resistor values must change to satisfy the balance equation in the previous slide (theory slide one).

Picture 1: Storr, W. (2013) *Wheatstone bridge circuit and theory of operation*. Available at: http://www.electronics-tutorials.ws/blog/wheatstone-bridge.html (Accessed: 16 February 2016).
Picture 2:*A little history about Kirchoff* (no date) Available at: http://ffden-2.phys.uaf.edu/211.fall2000.web.projects/Jeremie%20Smith/page1.htm (Accessed: 21 February 2016).
Equation 1: Storr, W. (2013) *Wheatstone bridge circuit and theory of operation*. Available at: http://www.electronics-tutorials.ws/blog/wheatstone-bridge.html (Accessed: 16 February 2016).
Equation 2: Storr, W. (2013) *Wheatstone bridge circuit and theory of operation*. Available at: http://www.electronics-tutorials.ws/blog/wheatstone-bridge.html (Accessed: 16 February 2016).

Who is it for?

Persona: Dave



Dave is an engineering student at university who is working on a section of electronic engineering concerning Wheatstone bridges. Dave has attended lectures regarding Wheatstone bridges and has been assigned a series of question requiring him to use simultaneous equations in relation to kirchoff's law to establish unknown values for resistors.

Scenario

Dave partially understands the theory behind the Wheatstone bridge, but uses the calculator when answering questions to check whether or not his calculations produce a correct answer as a precautionary measure.

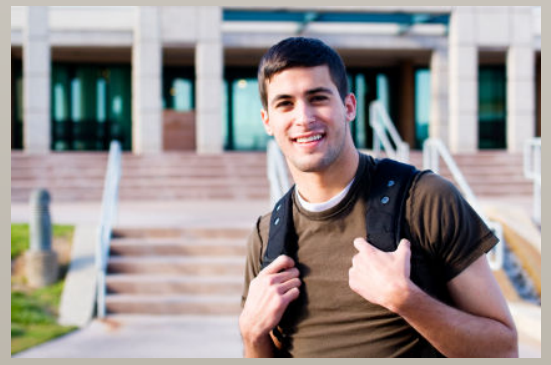
Persona: Anne

Anne is a fully qualified electronic engineer and is working in the engineering industry. She has been given a role requiring her to specify the specific values of resistors within a Wheatstone bridge to perform a given function.

Scenario

She fully understands the theory behind the Wheatstone bridge, and possesses the skills required to calculate unknown values, but has no need to prove it. Therefore, Anne can use the Wheatstone bridge solver to give the desired answer in a manner that is both convenient and time effective.

Persona: Sam



Sam is doing A levels and one of the modules is electronics and electricity. He is starting to revise for exams and is revising through the material and doing example problems to test himself

Scenario

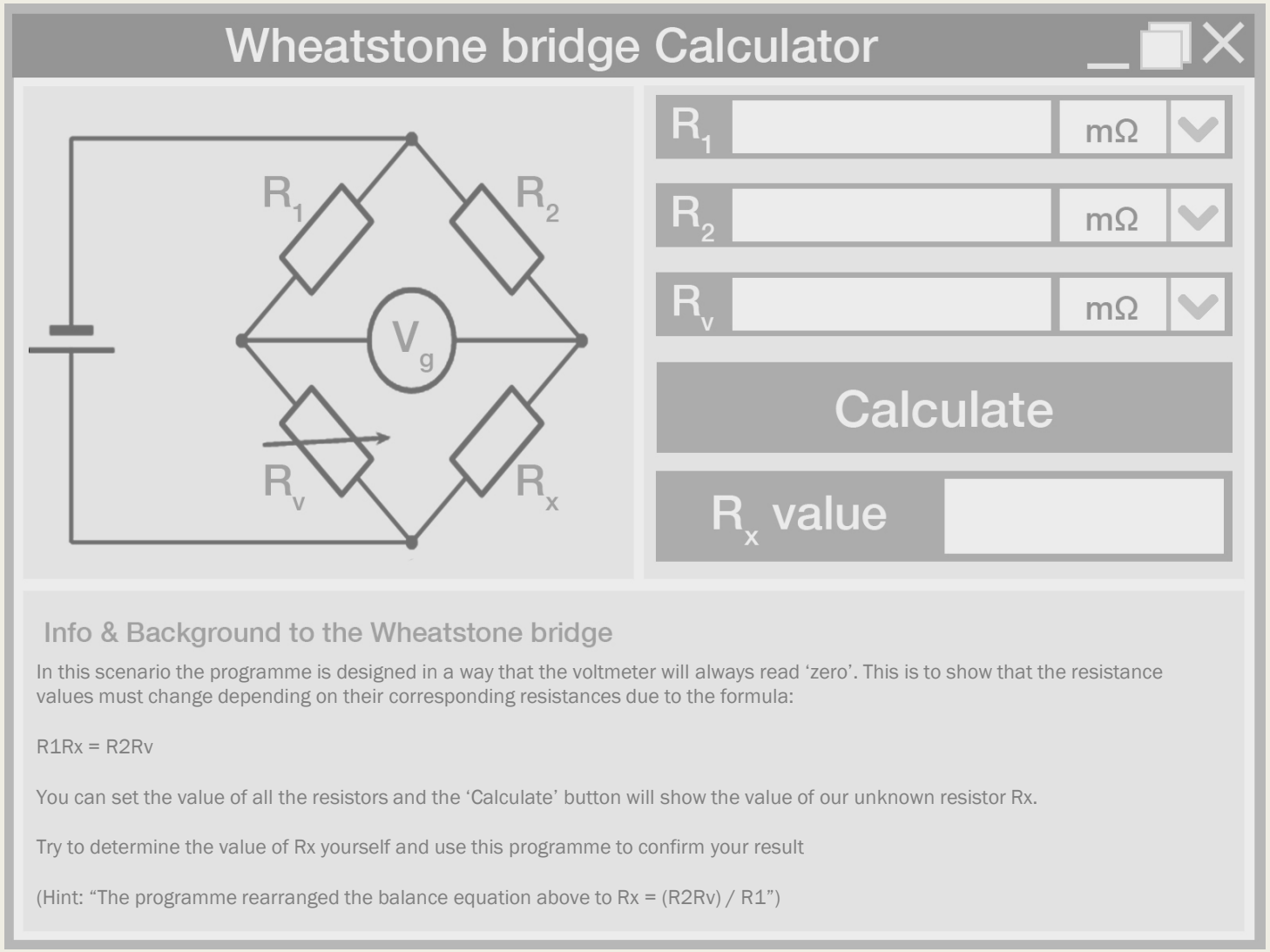
He needs a bit of software to help him solve problems with Wheatstone bridges quicker and easier. He also needs a brief description of the theory to revise for exams

How to use it?

- Using this software is really straight forward. The main window that you are presented with when you open the application is simple intuitive to use.
- The user can change the resistances for each of the resistors and after doing that, clicking the button ”calculate” will automatically calculate the value for the unknown resistor.
- The next slides will take you through the some of the different scenarios and outcomes of the program.

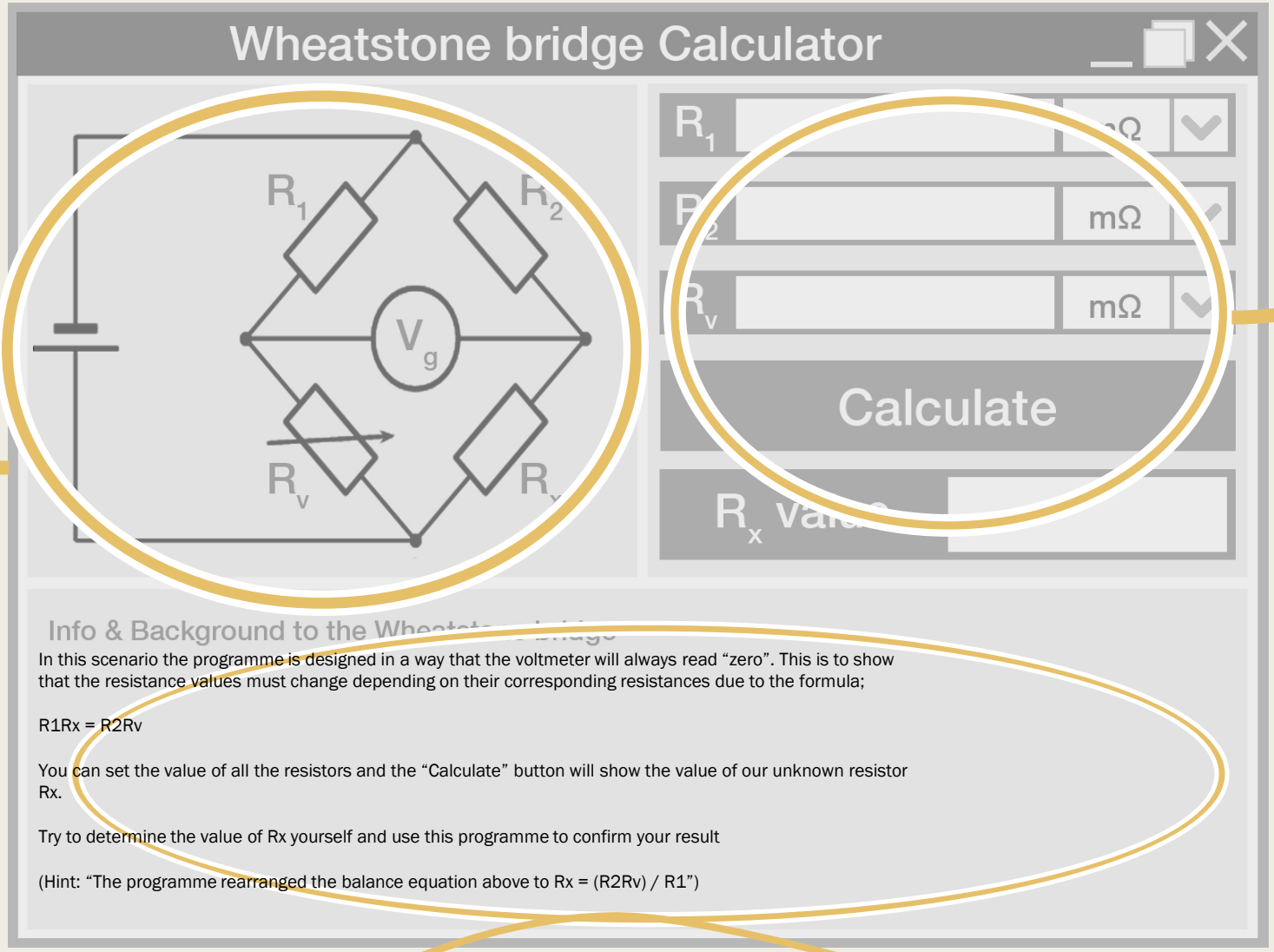
Example

Main window that you will be presented when opening the program



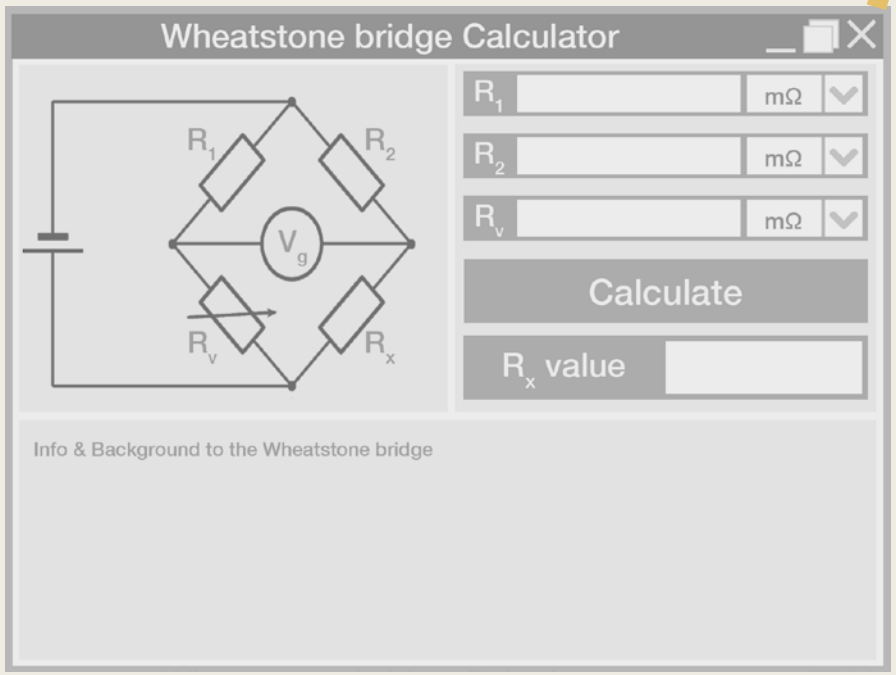
Graphic representation of a Wheatstone bridge

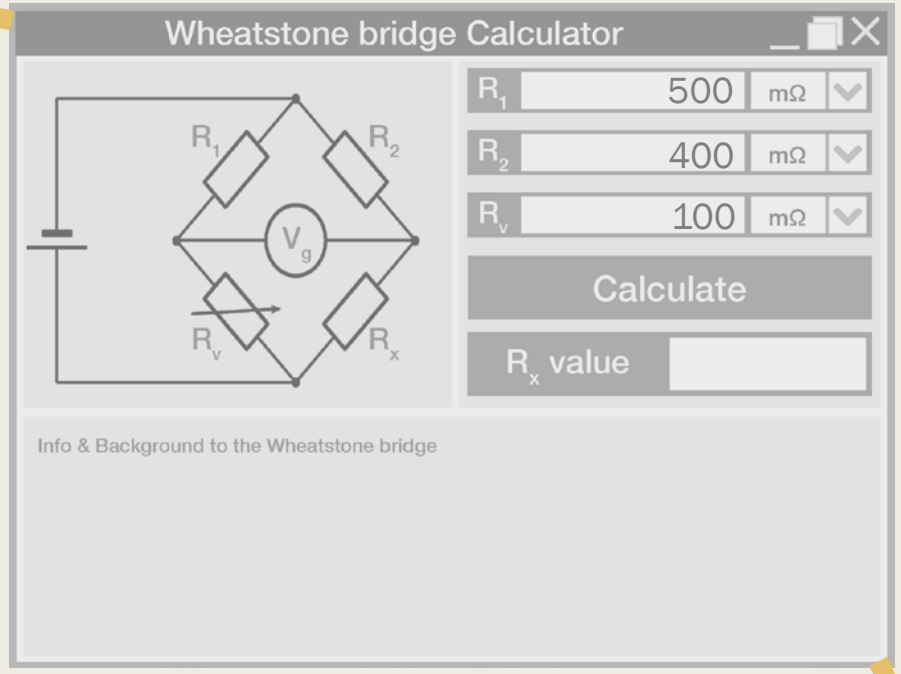
User interaction with the program



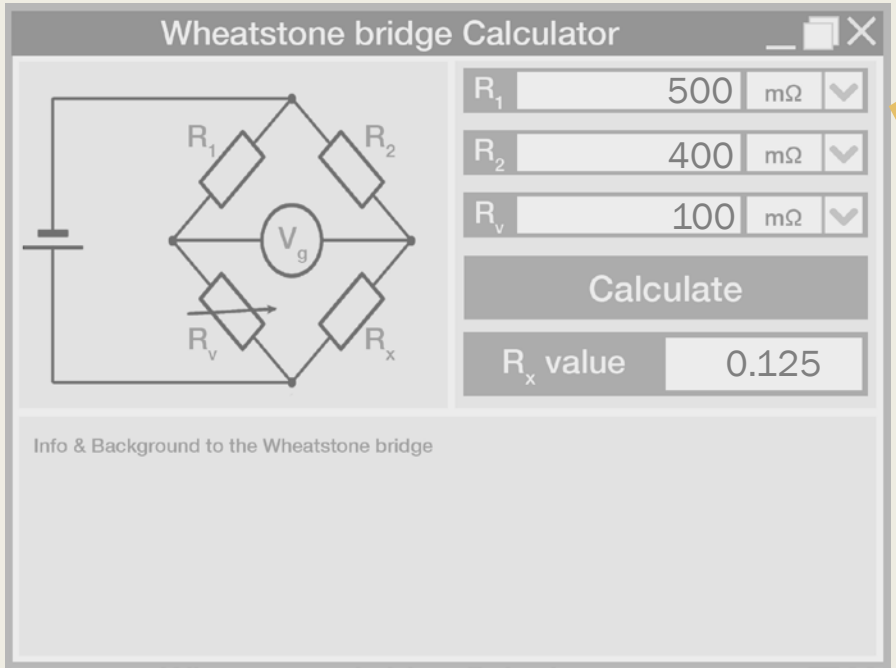
Info and background to the Wheatstone bridge and the theory behind it

User opens the program



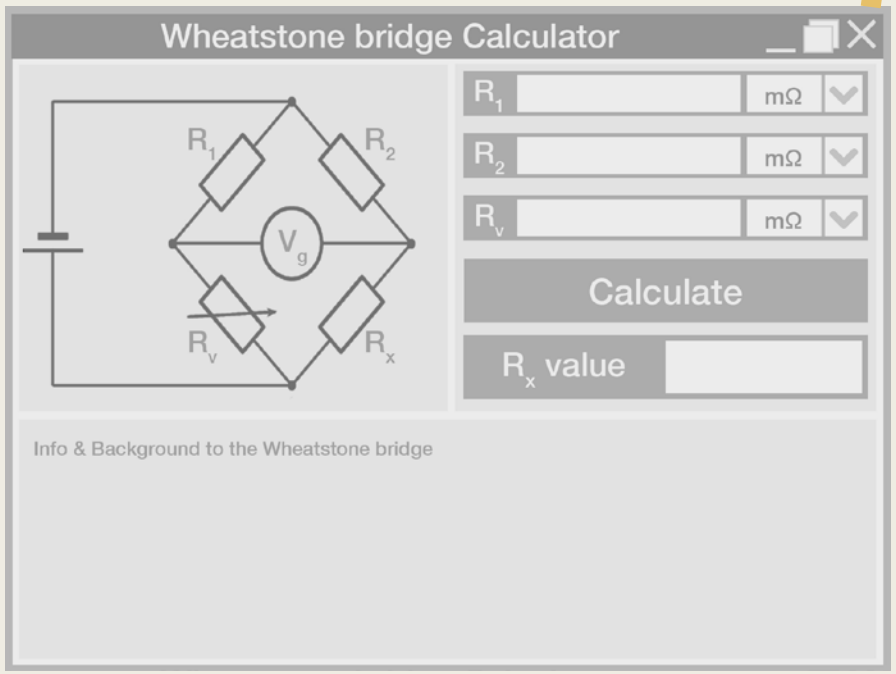


User inputs values and clicks calculate

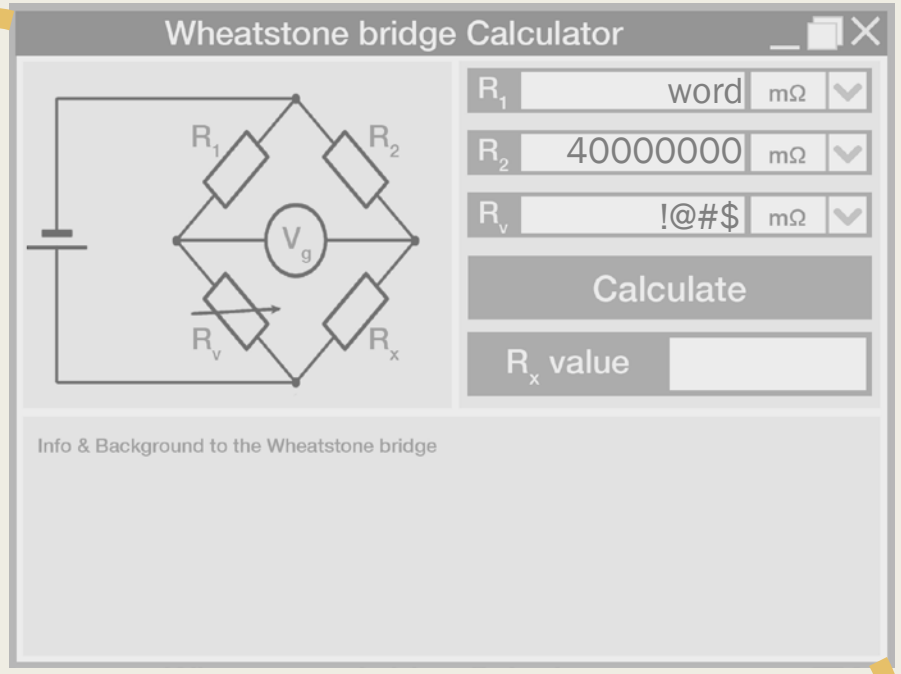


Program calculates the fourth resistor

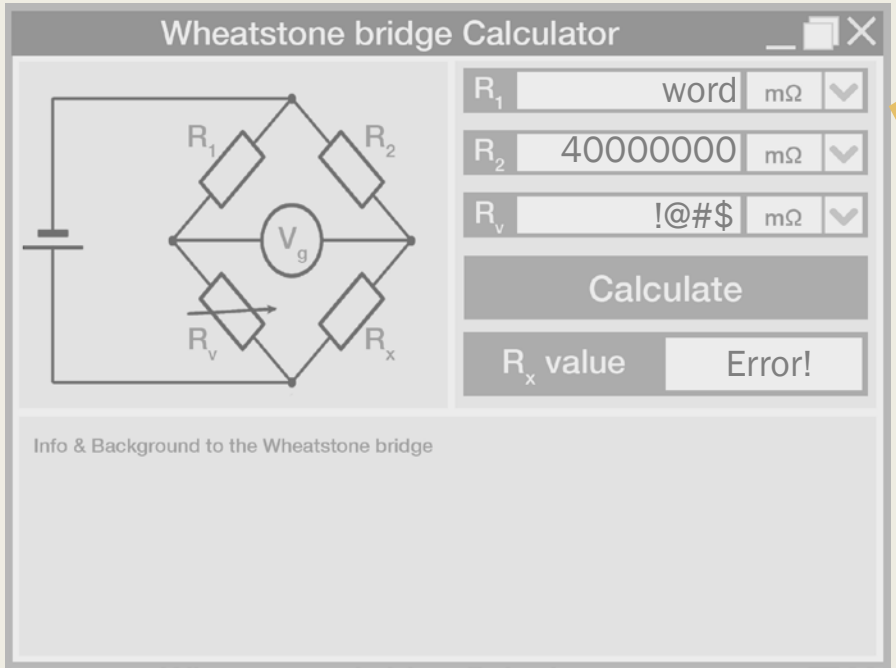
User opens the program



User inputs invalid values and clicks calculate



Program gives an error



Group 13

INCREMENT 2

Connor
Chittawat
Tom
Erik

This increment

- Changes from the storyboard
- User stories
- Features of the program
- Burndown chart
- Working application
- Error checks

Changes from the Storyboard

There were no major changes made to the Storyboard

User stories

- Technical side

- As a foundation year student I want to be able to understand how a balanced circuit is set up so that I can grasp the concepts electronics of potential dividers better.
- As an electronics enthusiast I want to use knowledge of the Wheatstone bridge to programme a thermostat in order to further my hobby.
- As a beginner electronics student, I want to have a clear instruction and help section so that I know how to use it

User Stories

- Functions

- As an apprentice electrician I want the resistor value to be in the appropriate engineering units (micro, mille, Killer, Mega, and Giga etc.)So that I can easily find the appropriate resistor to buy for my circuit.
- As a student I want to quickly calculate the numerical values to electrical problems so that I can check my own
- As a high school student, I want the program to work successfully without bugs or errors so that I can use it easily
- As a unix user I want something that works on all platforms so that I can use it on my computer
- As an owner of Raspberry pi I want something that can run on a machine with low specs

User Stories

- UI
- As a visual learner I want the programme to have a nice flow with reasonable instructions in order for me to gain the best understanding of the concepts.
- As a struggling student I don’t want a complicated user interface so I can concentrate my energy on understanding the electronics.
- As an easily distracted student I want the graphics to be very basic as to keep my attention on the programme and not unnecessary animations.
- As a grandparent I want something that is easy to use so that I wont need to ask anyone for help.
- As a visual learner I want something striking so that I can learn more efficiently.
- As a beginner programmer, I want to see a simple and clear graphics so that I can easily understand it.
- As a person who cannot see well, I want to have a clear large text so that I can see the text clearly.

Features

- Graphics

- Simple
- Coherent
- Readable
- Pleasant to the eye

Features

- Instructions

- Straight forward
- Easy to follow
- Not overly complex

Features

- Ease of use

- Appealing
- Logical
- Simple
- Unambiguous

Features

- Efficiency

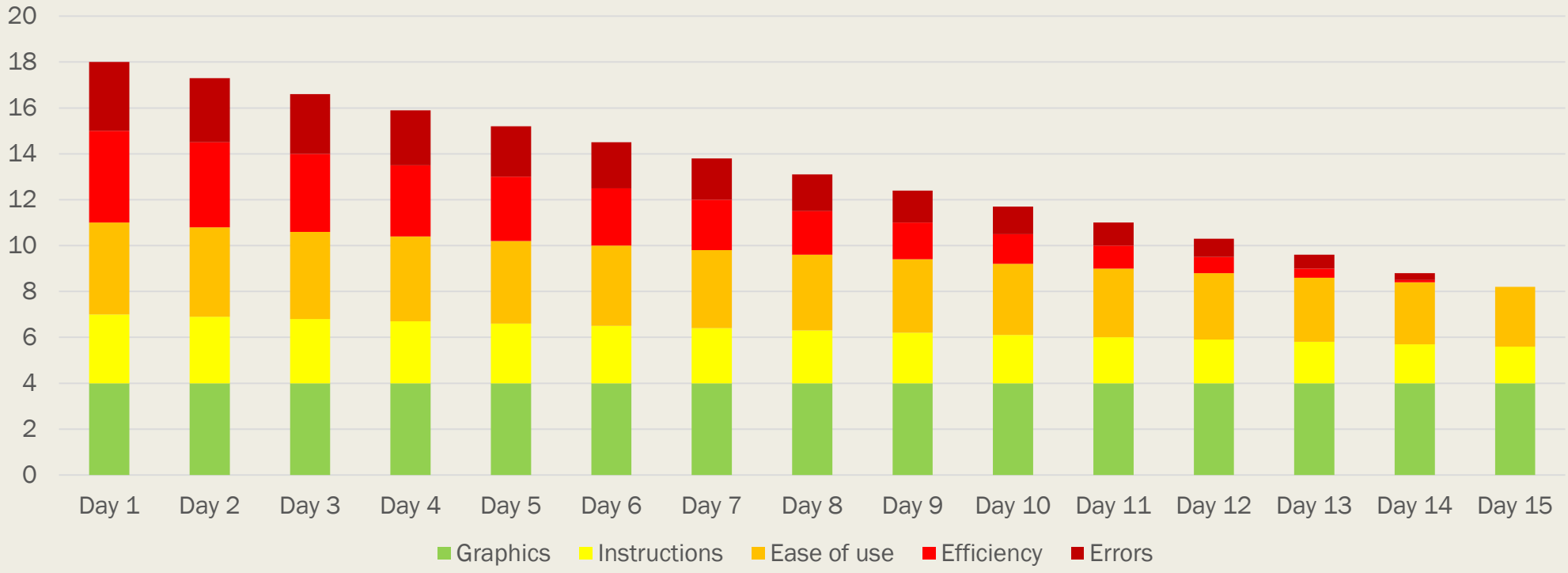
- Limits
- Smart coding
- Unit answers
- Not overly complex

Features

- Errors

- Bug-free
- Relevant error messages
- Crash-free

Burndown chart



Working application

- See the added .py file

```
Input resistor one value: 8
8.0

Input resistor second value: 16
16.0

Input resistor v value: 24
24.0

Select a unit value for resistor one 'm, none, k, M, G': k

Select a unit value for resistor two 'm, none, k, M, G': k

Select a unit value for the variable resistor 'm, none, k, M, G': k
12000.0
12k ohms
```

Error checks - Erik

ID	Description	Steps	Expected	Pass/Fail
EV1	inputting numbers to the resistance sizes	1. Input sensible numbers 2. Input numbers instead of letters	Error message saying to try again	Pass
EV2	inputting wrong letters to the resistance sizes	1. Input sensible numbers 2. Input different letters to the given ones	Error message saying to try again	Pass
EV3	inputting nothing to the resistance size	1. Input sensible numbers 2. input nothing and hit enter	error message saying to try again	Pass
EV4	Inputting variations of "none"	1. Input sensible numbers 2. try capitalizing on the word "none"	input Is accepted regardless of what letter is capitalized	Fail

Error checks - Chittawat

ID	Description	Expected	Pass/Fail
Wat 1	Input the number between 0 and 100	Input accept the value and print out in float form	Pass
Wat 2	Input the number out of the range between 0 and 100	Error message and print out “Please ensure your input is positive, and up to 100”	Pass
Wat 3	Input the non-numerical alphabet	Error message and print out “Please ensure your input is positive, and up to 100”	Pass
Wat 4	Input the negative number	Error message and print out “Please ensure your input is positive, and up to 100”	Pass

Error checks - Connor

ID	Description	Expected	Pass/Fail
Connor - 1	Does the programme give the right result with high and low integer values	Don’t want the programme to crash when entering big values	Pass
Connor - 2	Does the programme output something manageable for the user	Does the programme output value with units as to not overwhelm the user with huge numbers	Pass
Connor - 3	Does the programme have appropriate instructions from error inputs	Ease for user to know what they are doing wrong	Pass
Connor - 4	Does the programme run without crashing	Can the programme break?	Pass

Group 13

INCREMENT 3

Connor
Chittawat
Tom
Erik

This increment

- Changes from the storyboard
- Changes to the application
- Burndown chart
- Working application
- Error checks

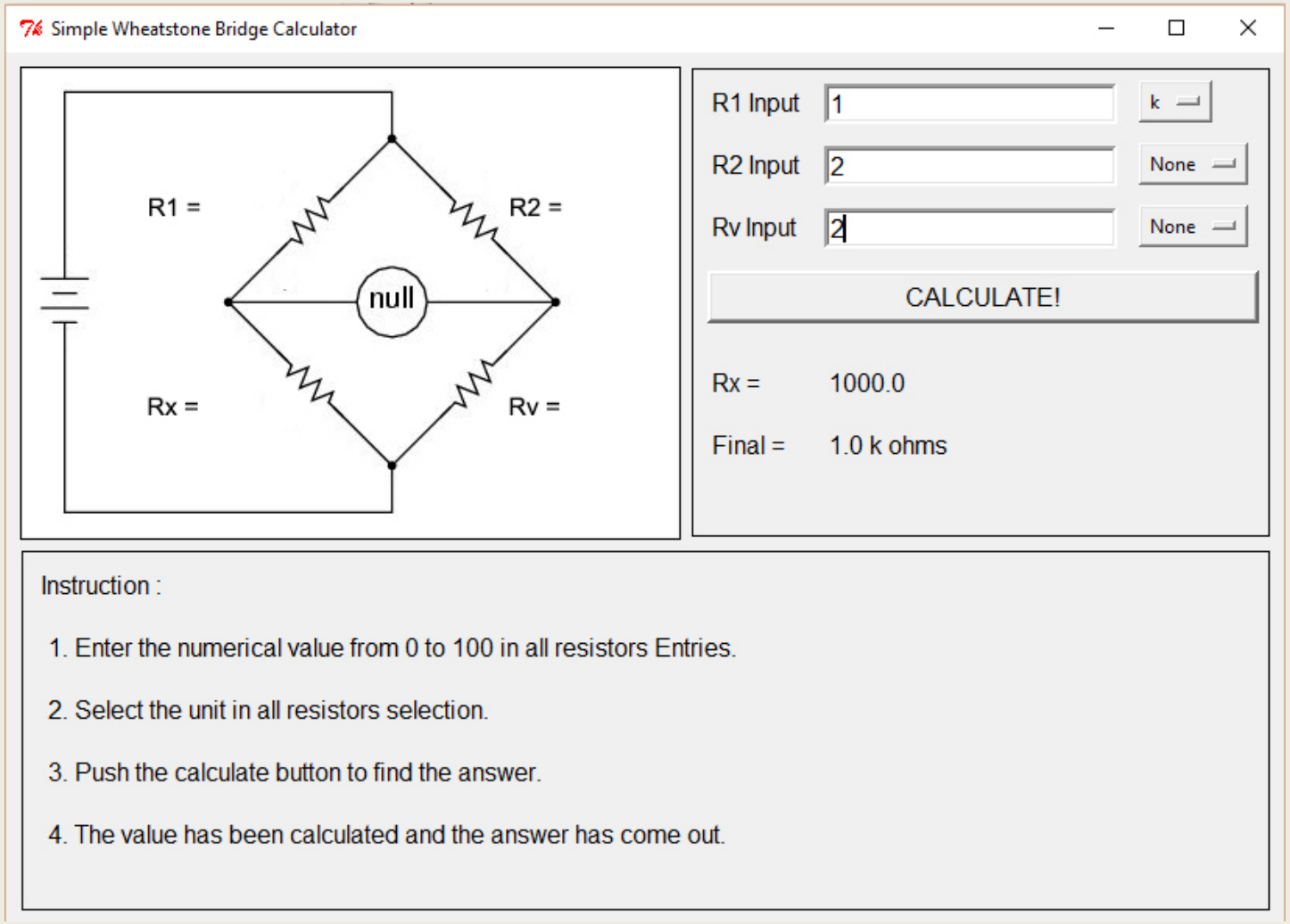
Changes from the Storyboard

- There were no major changes made to the Storyboard

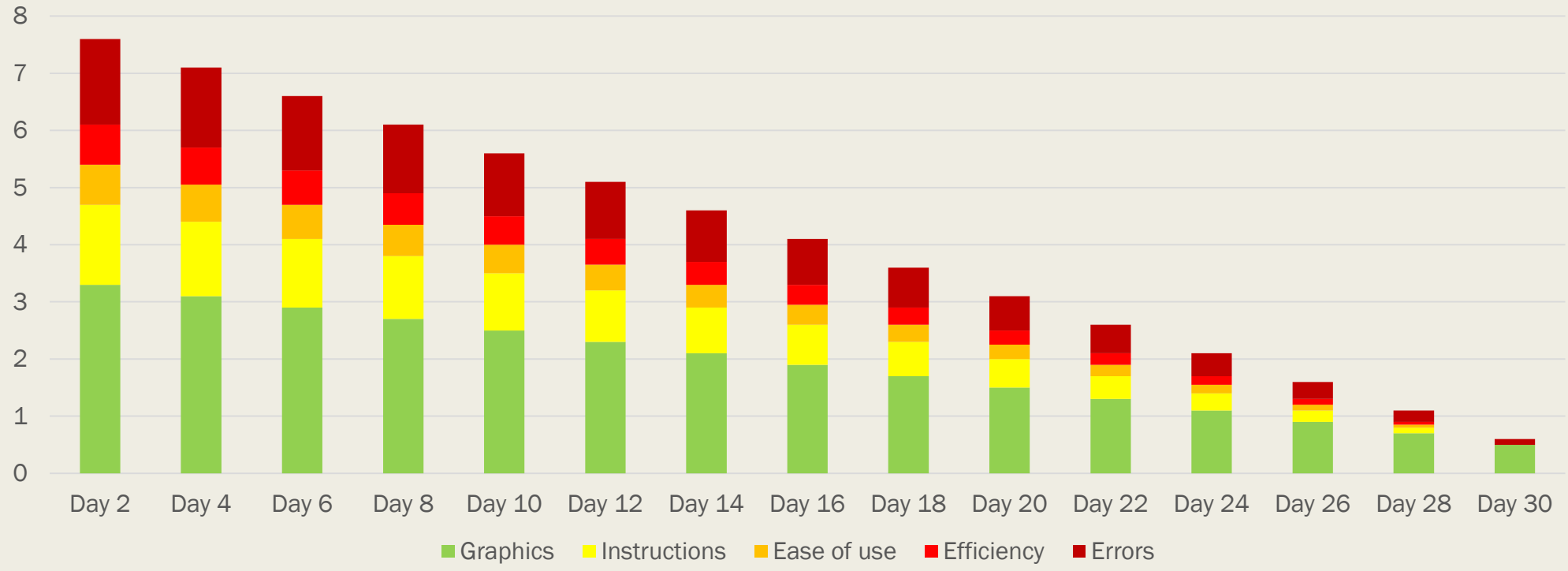
Changes to the application

- There were no major changes made to the Storyboard

Working Application



Burndown chart



Error Checks

ID	Description	Expected	Pass/Fail
1	Inputting numbers bigger than 1000	Error message saying to input a lower number	Pass
2	Inputting letters	Error message saying incorrect input	Pass
3	Leaving one or two inputs blank	Error message saying to input more variables	Pass
4			