

Website Information

Website URL: <https://www.online-calculator.com/>

Website type: online calculator

Assessment

Aim and Execution

The website's target audience is users needing to do reasonably complicated arithmetic. Users requiring more complex functions would have likely searched for a scientific calculator. The website appeals to and suits the needs of this target audience reasonably well. However, some of its characteristics lead to a less than optimum user experience:

- The memory functionality is unnecessary - more in line with a scientific calculator's features, which most users do not need.
- While the above is not necessarily a drawback, the memory functions dominate a reasonable portion of the calculator's screen space which useful features one would expect from a basic calculator could have used. For example, the ability to delete a digit that a user enters without clearing the entire display.
- The calculator is small in proportion to the screen. While the website does have a fullscreen option - users would find it easier to use if this was the default.

Short-Term Memory Demand

Shneiderman's 8th Golden Rule for Interface Design states that designers should minimise short-term memory load. This calculator unnecessarily contributes to the user's memory load in several ways:

- The user must remember the value stored in the calculator's memory.
- The user must recall every equation they compute. For example, if a user adds 9 to 9, 18 is displayed on the screen, and so on. The user must remember each step they took to arrive at the current number - this will frequently toll on short-term memory because

most people using a calculator need to retrace their calculations to prevent errors in their results.

- Users have no external memory outlet for what button on the calculator they previously selected. If a user presses the Memory Recall button, they have to recall that the number now displayed on the screen was one stored in memory and not the result of a recent calculation.

Interaction Style Suitability

The website uses a combination of form fill-in and menu selection.

Form Fill-In

The website's search bar uses this style. This interaction style is suitable for this feature as it does not require interactivity. However, one criticism of the website's use of this style is that it does not lean on its advantages. Form fill-in allows a designer to rely on a user's recognition over their recall; there is no indication of what the user should search for - meaning they have to engage with it in trial and error - and eventually recall rather than recognise.

Menu-Selection

The website's navigation menus and the calculator itself use this style, which is appropriate as the functions of a calculator do not require a more complicated interface and a menu relies on recognition and not recall. The design would save screen space if the navigation options were grouped rather than in one big cluster.

Ease of Navigation

The website places several inconvenient obstacles in the user's way when it comes to information and feature discovery:

- Advertisements are very prominent in the centre of the screen, making it likely that a user will accidentally click them on occasion, especially when interacting with the calculator - which will open another browser tab that the user then has to close.

- The banner advertisements reload and change very frequently. Page content will move up and down as the advertisements disappear and render. The content you are focusing on will suddenly jump to a different location on the screen and further compounds the issue of accidentally opening an advertisement.
- A lot of the text on the page - especially the navigation button text - is too small. The navigation section also does not feature prominently enough on the page; the user must scroll to discover that there is a navigation section in the first place.

Learning Curve

Most features are reasonably easy to learn. The designer is likely correct in assuming that users will already understand a calculator's fundamental functions. However, the website does not sufficiently aid the user in learning some of its other features:

- The usefulness of the search bar is not apparent to someone just visiting the page. Most internet users are familiar with search bars for search engines, social media, and e-commerce - not for an online tool like a calculator. Most users would not know what kind of searches would yield results on first use.
- There is no indication that the user can interact with the calculator using a keyboard. Users must discover this on their own.
- The memory functions are not intuitive to a layperson. It would be helpful for there to be an expandable dialogue on the page (or a link to a separate page) explaining these more advanced features in-depth.

Widget Suitability

Most of the website's interaction widgets are clearly labelled. The search bar's hint designates it as a search bar, and the "Go" button executes a user's search, despite the search bar's faults discussed in other sections. The calculator's button labels are also quite clear. All operators have commonly used symbols for those mathematical operators "+" for addition, "-" for subtraction etc. The labels for the memory functions leave room for ambiguity. Granted, most users will likely deduce that "M" stands for memory - unaware users should be able to find this information somewhere.

Some widgets limit the functionality of the calculator significantly. For example, the "root" function is solely a square root; one can not calculate a cube root. The fraction button only works for fractions with a numerator of 1 - this is not very useful as users could achieve the same level of functionality by dividing one by their denominator of choice.

Accessibility

The website does a decent job of making the calculator accessible as it supports keyboard input. However, the calculator is inside a canvas element which makes it inaccessible to users with limited mobility - this is because one can not TAB through the buttons to make a selection. The website also has design flaws that impede screen reader use:

- The HTML tag does not have a lang attribute, so screen readers may assume that the user's language is the same as the page's language.
- The search bar is a HTML input element, but it does not have a label - meaning it may be difficult for some to discern that it is a search box.
- The navigation section includes non-list elements inside an unordered list - this makes the way a screen reader announces a list confusing.
- The search bar does not have sufficient colour contrast, making it difficult to read the hint.

Consistency, Error Handling, and Feedback

Consistency

Schneiderman's first rule of interface design is "strive for consistency." All of the calculator's similar action sequences behave consistently. Basic operators all act in an "X operator Y EQUALS" fashion. More complex operations like square root behave in a "number first, then function" manner. Likewise, it is visually consistent with the green operator, blue number buttons etc.

Error Handling

Schneiderman's fifth rule of interface design is "prevent errors." Several illegal actions could be made legal. A user pressing "fraction" before a number will display "Error", but the inverse is legal - with additional logic, both actions are legal, preventing errors. The calculator should display descriptive error messages.

Feedback

Schneiderman's third golden rule of interface design is "offer informative feedback". This implementation follows this rule by displaying entered numbers and providing "hover" and "pressed" effects. However, users do not know the current result of their calculation until they finally press equals.

Redesign Proposal

Accessibility Improvements

Four changes will improve accessibility:

- A calculator made from "basic" elements such as buttons (rather than canvas drawn) will mean it is readable by assistive technologies. Users with additional needs will be better able to learn about the calculator's features and how they can use it. Furthermore, users

who are limited in mobility to the point that they can not use a keyboard fully can take advantage of TAB navigation.

- Setting the HTML element "lang" equal to "en" to clarify the language.
- Enclosing the navigation section in a nav element and making it only valid XHTML5. Both changes will improve the experience of visually impaired users.
- Use better-contrasting colours for the search bar to make its hint easier to read.

Calculator Functionality

Three functionality changes will make the calculator better suited to the needs of the target audience:

- Removing memory, fractions and roots. Most users will likely not need it for the arithmetic they are usually doing. The revised design moves this functionality to a more "advanced" scientific calculator that users can switch to by clicking a link to a separate page. This change is needed to create space for the functionality below.
- Allow the user to delete numbers one at a time that they have entered and that are now on-screen (the original design only supports clearing the whole screen) and allow the user to convert percentage points into decimals. These are ubiquitous features of calculators that users will likely expect and follows Shneiderman's 6th golden rule: "Permit easy reversal of actions".
- Allow the user to enter both opening and closing brackets to specify operator precedence - without this change, users will be frustrated by inconsistent calculation results. The new design also satisfies the needs of more users by altering the fraction and root functionality. Users can now choose any numerator they want and are not limited to square roots.

Calculator Visuals & Errors

Seven visual and error handling alterations to the calculator will make it better suited to the needs of users, reduce short-term memory load, prevent errors, and offer more informative feedback:

- The calculator will dominate the screen space by default, making the calculator easier to use all round for users using a mouse to interact with it.
- Some text shows the value currently stored in the advanced scientific calculator's memory.
- The screen displays calculations as the user types them until the user presses equals. Rather than a number at a time as in the original design.
- The design highlights the last digit or operator the user entered with a colour change.
- The new design prevents errors with additional logic - the order of operations will not matter.
- The error messages in the redesign will be more descriptive. Rather than just reading "Error", it will display what went wrong - for example, "Can not divide by 0".
- There will be a "running tally" on display. As the user enters numbers, they will display on the screen and under that will be the current result of the calculation. The maths will be larger than the running tally and in bold. Once the user presses equals, the maths shrinks and is unbolded, and the running total becomes the result and is grown and bolded.

Search Bar

Change the search bar's input hint to: "search for the other tools and calculators on our site, e.g. 'BMI calculator'" - this requires a slightly wider search bar.

Navigation

Four differences between the redesign and the original design make the website easier to navigate:

- The tools and calculators offered by the website will be categorised and grouped into drop-down menus - better use of the menu-selection interaction style.
- Any advertising in the redesign will feature on the margins of the page (and not prominently in the centre) to not interfere with the user's interaction with the calculator.
- Advertisements will only render once. Re-rendering causes the page content to shift, which is disorientating for users.

- Users will not have to scroll down to navigate because the navigation bar will be at the top of the screen rather than the bottom, and the text for the links will have a greater font size.

Tutorial

To reduce the learning curve of the website and calculator, a paragraph above the calculator will detail the fact that the user can interact with the calculator using a keyboard. That notice will be the same for the advanced calculator, except there will also be an expandable dialogue explaining how to use that calculator's more advanced features, such as the memory functions.

Prototype

Source files on canvas.

Live version: <https://cs1.ucc.ie/~mm55/usability/index.html>