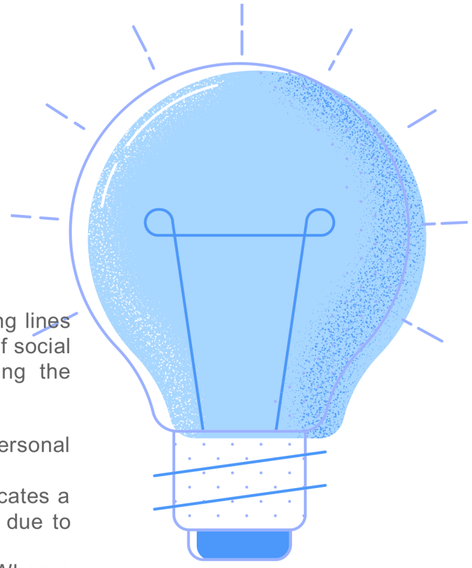
INTRODUCTION

Inspirations & Design Decisions



INSPIRATIONS

Our design inspiration originates first and foremost from a profound contemplation of the COVID-19 pandemic, which has had an awe-inspiring impact on life in Australia and globally. The evolution of the pandemic is like a silent war, sweeping across our lives and changing our behaviours and lifestyle.

We will use the concept of Emergence Design to depict this process that seems chaotic yet brimming with vitality. Emergence refers to the phenomenon of complex behaviours arising from simple rules. Its characteristic aligns perfectly with the pandemic's trajectory, making it an apt representation of the impact of COVID-19.

DESIGN DECISIONS

In our design, we've decided to represent each individual as a sphere. We use spheres and connecting lines to visually represent interpersonal connections, the transmission of the pandemic, and the importance of social distancing. The colors of the spheres and lines are highly symbolic elements, intuitively reflecting the development and changes of the pandemic.

- Spheres: Each sphere stands for an individual, connected by lines to others, symbolizing interpersonal interactions and the pathways of virus transmission.
- Colors: Color is our primary tool for expressing pandemic status. When a sphere turns yellow, it indicates a mild infection; when it turns red, it indicates severe infection; when it turns black, it signifies death due to COVID-19.
- Lines: The color changes of the lines reflect whether individuals maintain proper social distancing. When a line turns red, it signifies that the distance between two individuals is too close, surpassing the safe distance. When it turns green, it signifies that individuals have been vaccinated and the virus is under control, and they are maintaining a safe social distance.
- Interactivity: Our design is also filled with interactivity. When a sphere is clicked with the mouse, it represents that the individual has been vaccinated. The connected lines will then turn green, symbolizing the power of the vaccine and the receding of the virus.

Through this design, we hope to intuitively and vividly present the impact of COVID-19 on human society. Simultaneously, we wish to guide people to recognize the importance of vaccines, encouraging everyone to get vaccinated actively to combat the pandemic collectively.

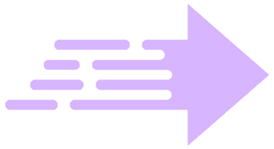
Pictures: (ABC News: Brendan Esposito)

Historical Background & Logic Rules

Background

Source of infection (SARS-CoV-2)

- Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a strain of coronavirus that causes COVID-19 (CDC, 2017).
- Virus particles of SARS-CoV-2 are usually depicted as round or nearly round in shape, with some crown-like protrusions.
- Viruses spread randomly (CDC, 2017).



The speed and form of Covid-19 transmission

- People will move around, there will be massive rapid infections, and the chance of being infected after spreading is 40% (Agency for Clinical Innovation, 2022).
- Crowded places are more likely to be infected. Keep a distance of at least 1 meter from other people, even if they don't appear sick, as people can catch the virus without showing symptoms (Agency for Clinical Innovation, 2022).

After vaccination

- The maximum level of protection from the COVID-19 vaccine is not reached until weeks after full vaccination. If people get two doses of the vaccine, that means they don't become fully immune until 2-4 weeks after the second dose. People can still get infected and get sick during this time (The Children's Hospital of Philadelphia, 2021).
- Protected for at least six months after vaccination with the primary series of COVID-19 vaccines, and usually for longer (World Health Organization, 2021).
- All vaccines available in Australia have been shown to prevent hospitalization (severe illness and death) from COVID-19 in 71%-%98 of COVID-19 cases (World Health Organization, 2021).

Logic rules

- Design a circle-like graphic to represent SARS-CoV-2.
- When this graphic comes into contact with another graphic representing a human cell, it may "infect" that cell, changing the color of that cell.
- The path of this graph may be straight, it may be curved, or it may have some random elements.

- Each circle representing a human can move randomly in the picture according to certain rules.
- When a shape representing a virus touched a circle representing a human, the circle would change color, indicating that it was infected (P(infected) = max((80% - (infectedTimes * 40%)), 10%)). In crowded places, due to the greater density of the circle, the circle and the circle will also infect each other, and the chance of infection will also increase.
- Each circle can draw a line with other circles, and the length of this line represents the distance between them. When this distance is less than a certain threshold (e.g. representing 1 meter), the color of that circle may change to indicate that it is in a higher risk environment.
- Infected circles may return to their original color after a period of time, indicating that they have returned to health. This time can be fixed or random.

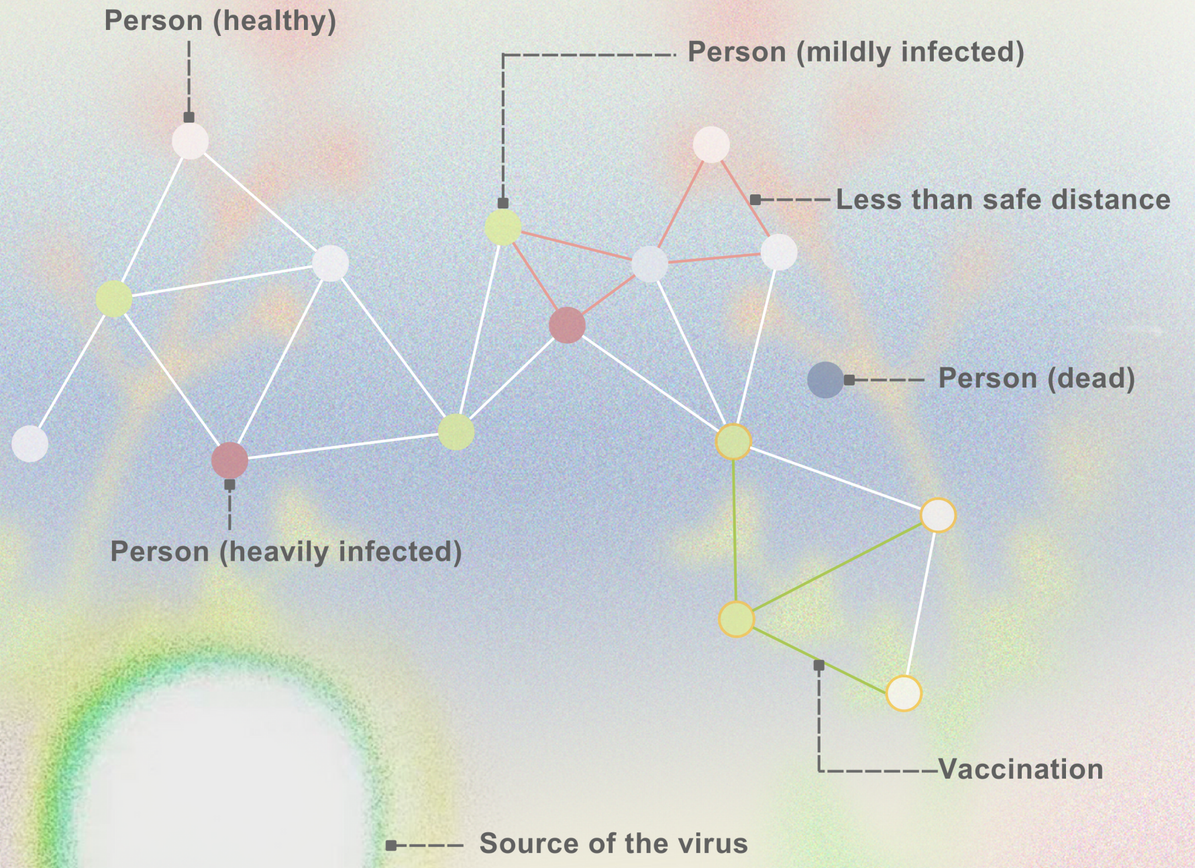
- It is possible for humans to be vaccinated after a certain period of time. This can be indicated by changing the color of the circle or adding a logo around the circle.
- The vaccinated human circle may still change color (indicating infection) within 2-4 weeks after vaccination, but the probability of discoloration will be greatly reduced (P(infected) = max((60% - (infectedTimes * 40%)), 10%)). This reduced probability remains constant for the first 6 months after vaccination and may gradually increase thereafter.
- Even if a vaccinated human becomes discolored (indicating infection), there is a very small probability that the color or shape will change further, indicating a serious illness or even death (P(dead) = max((40% - (infectedTimes * 50%)), 5%)).

Icon: (Freepik Company S.L., 2021)

PROJECT DESIGN

Emergence In The Project

What is the emergence in our project



How does it work?

- When this white graphic touches another graphic representing a human cell, it may "infect" that cell, changing the color of that cell (green circles for mild infection, red circles for severe infection, and black for death).
  - When a shape representing a source of the virus (a gradient circle) touches a white circle, there is a 40% chance that the circle will change color, indicating that it is infected. In crowded places, due to the greater density of the circle, the circle and the circle will also infect each other, and the chance of infection will also increase.
    - Each circle can draw a line with other circles, and the length of this line represents the distance between them. When this distance is less than a certain threshold (for example, representing 1 meter), the line between the circles will turn red, indicating that it is in a higher risk environment.
      - Click the line between the circles with the mouse to represent the vaccination, and the line turns green. The human circle may be vaccinated after a certain period of time, and there will be a yellow ring mosaic around the "circle" after vaccination.
        - Vaccinated human circles may still change color (indicating infection) for 2-4 weeks after vaccination, but the probability of discoloration will be greatly reduced (20% probability).
          - The human circles that have been vaccinated greatly reduce the infection rate and mortality rate. There is a 20% probability that the "circle" will change color, and 5% of the "circle" will die.

Classes of Emergent Behaviour

In our project, classes of emergent behaviour can be divided into the following categories:

- **Change in Infection Status**: This is an emergent behavior based on changes in individual states. Each sphere (representing an individual) changes its color according to its infection status (mild infection, severe infection, death). This behavior demonstrates the pattern of how the pandemic spreads and evolves among the population.
- **Vaccination**: This is an emergent behavior based on user interaction. When the mouse clicks on a sphere, it signifies that the sphere (representing an individual) has received the vaccine, causing the color of its connected lines to turn green. This behavior highlights the importance of vaccination in controlling the pandemic.
- **Violation of Social Distancing**: This is an emergent behavior based on group interaction. The color changes of the lines (red and green) indicate whether the distance between individuals is maintained within a safe range. Red denotes that the distance between two individuals is too close, surpassing the safe distance, while green signifies that they are maintaining appropriate social distancing. This behavior reveals the importance of social distancing in controlling the pandemic.

PROBLEM & SOLUTION

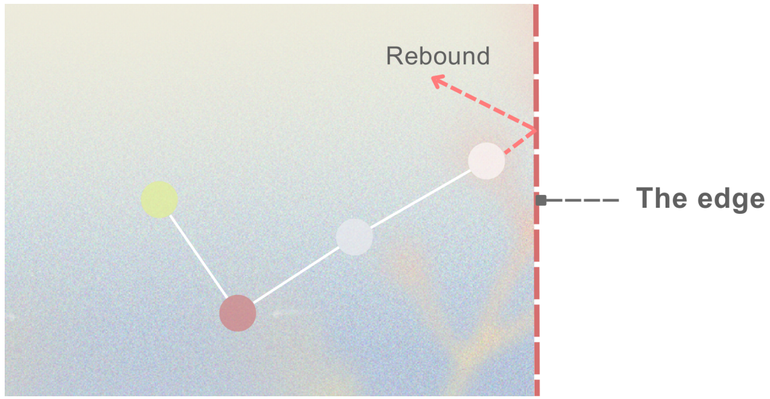
Issues & Problems

What issues and problems did you address in iteratively designing your rules and algorithms?

1. The rule that we original design is that all these people has only three status which are healthy, infected, and dead. The changing rules are:
   - Healthy people would become being infected.
   - Infected people would have 50% probability to become dead and 50% restore to healthy. However, we found this is not suitable and obey the real-world situation. We change this to the current rules list in GitHub (list them down here).

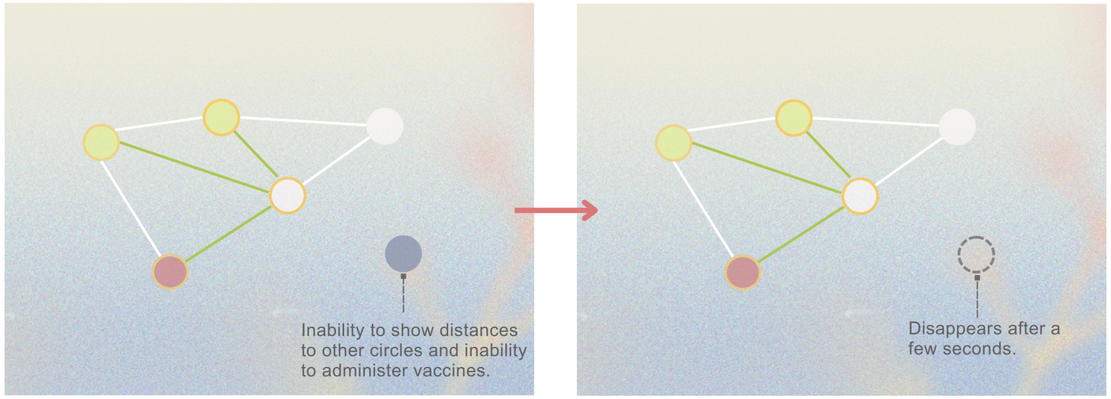
2. The original algorithms add all the circle inside and implement a big algorithm to calculate status of them and perform the change of them. After running the web page, it is quite slow for the change running so we reconstruct the algorithm to put all status changes in Particle class and optimize the algorithm to make it has less calculation in each second to make the page run smoothy.

Solution of Edge Cases or Undesirable Cases



The first issue: The visual elements (in this case the loops) are not restricted to the screen.

- This phenomenon causes the number of visible loops to decrease over time as they move out of the visible canvas. It presented significant challenges as it disrupted the viewer's experience and failed to deliver on our intended design. To address this issue, we revisited and modified our algorithm. The new algorithm ensures that all elements move within the bounds of the canvas size, effectively preventing them from disappearing off the edge of the screen. The specific method is to let those circles bounce directly when they move to the screen boundary, and the rebound moves in the opposite direction, so that those circles can be kept in the screen. In this way, we maintained the stability of the number of loops on the screen, enhancing the visual experience and ensuring the integrity of our design.



The second issue: The state of "death" does not correspond to reality.

- In the original implementation, all loops, regardless of their state, were instantiated with the same class. This leads to some unwanted behavior such as dead loops still being able to move and receive vaccinations. We think this is an inappropriate description of the "dead" state. To address this, we updated the design to incorporate state-specific behavior. When a cycle enters the dead state, it now stops moving and becomes ineligible for vaccination. Also, we have introduced an additional feature where infinite loops fade away and eventually disappear after a few seconds. This change adds a more realistic touch to the representation of the "death" state, making the simulation more accurate and intuitive.

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