Report - Chain Reaction

Mastering Tinkering

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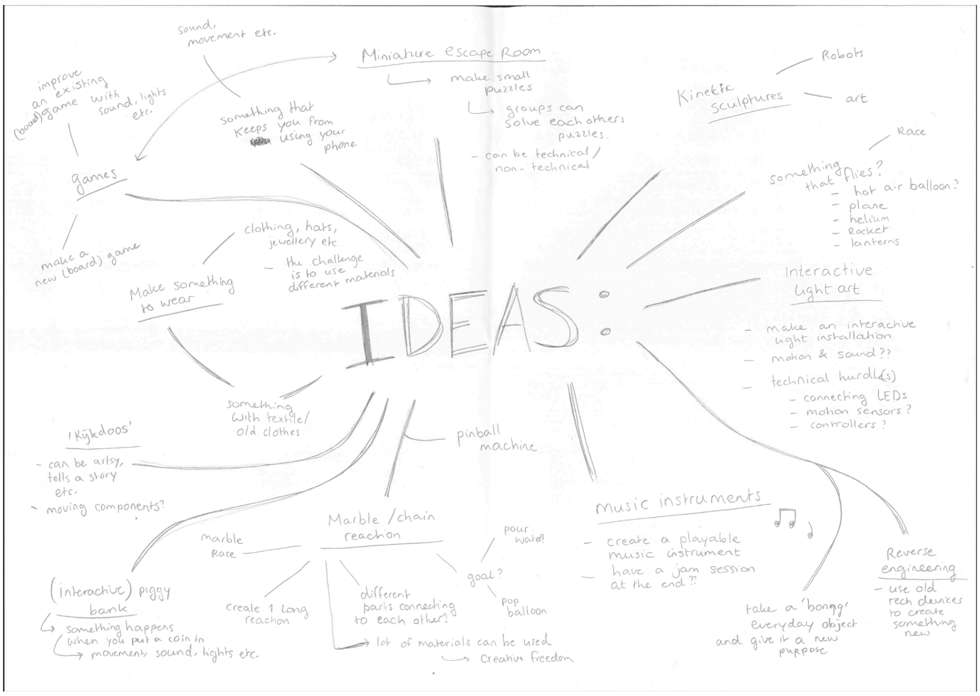
Tinkering is a great way of hands-on experimenting and playing. It is a creative and iterative process that can lead to interesting outcomes. For this group project, tinkering has been used to tackle the challenge of creating a playground, and this playground allows for even more tinkering.

The following sections show the process, final concept and some evaluation. As mentioned, tinkering is a very iterative process. While the following sections are mostly in chronological order, some adjustments were needed to refine the idea and make it work.

Ideation Process

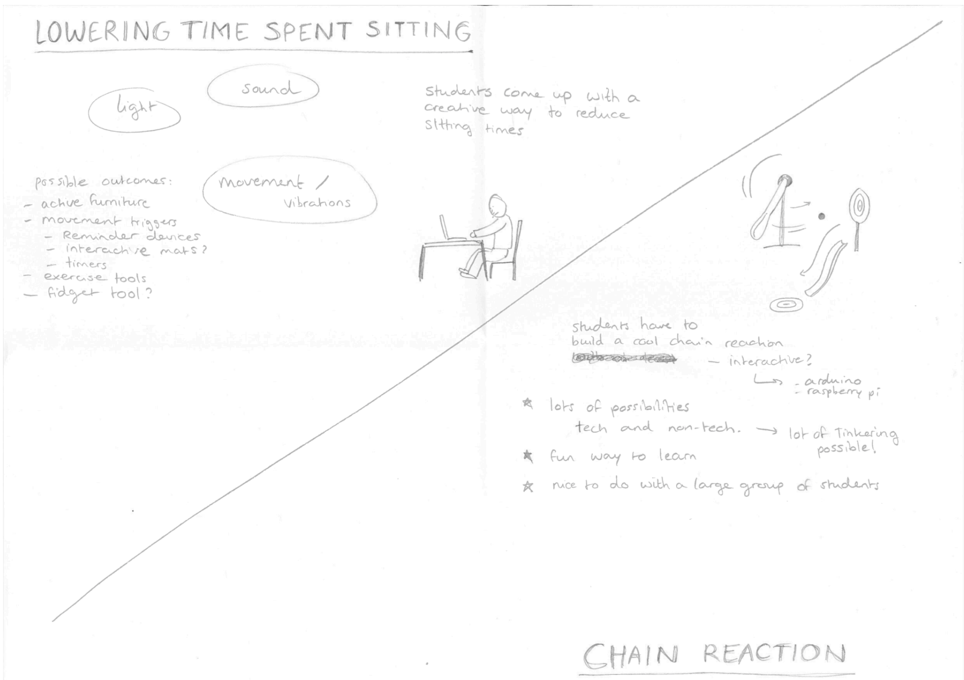
To generate a lot of different concepts, a group brainstorming session was held. Before the session, every team member was tasked to come up with at least one idea. This kickstarted the creative process and led to a diverse range of playground concepts.

All results were written down and connected - see Figure X for the results. A lot of ideas were brought up, for example, kinetic sculptures, a miniature escape room and marble/ chain reaction.



All ideas were discussed among the group and discussed along the requirements of tinkerability, feasibility and creativity. After discussing, two concepts were picked: the chain reaction & something that keeps you off your phone. From there, a new brainstorming mindmap was created with more practical elaborations and what could serve as a seed for that concept.

While doing this, the concept of something that keeps you off your phone was slightly adapted. A more physical approach was taken since tinkering is also a hands-on method. The change was made to connect it to sitting behaviour and find a way to change this behaviour. See Figure X for the results of this brainstorm.



Both of these concepts were pitched during session 3 to get initial feedback. As feedback, the comment was made that both playgrounds should allow for more unpredictability. The provided materials could restrict the tinkerability and lead to predicting outcomes.

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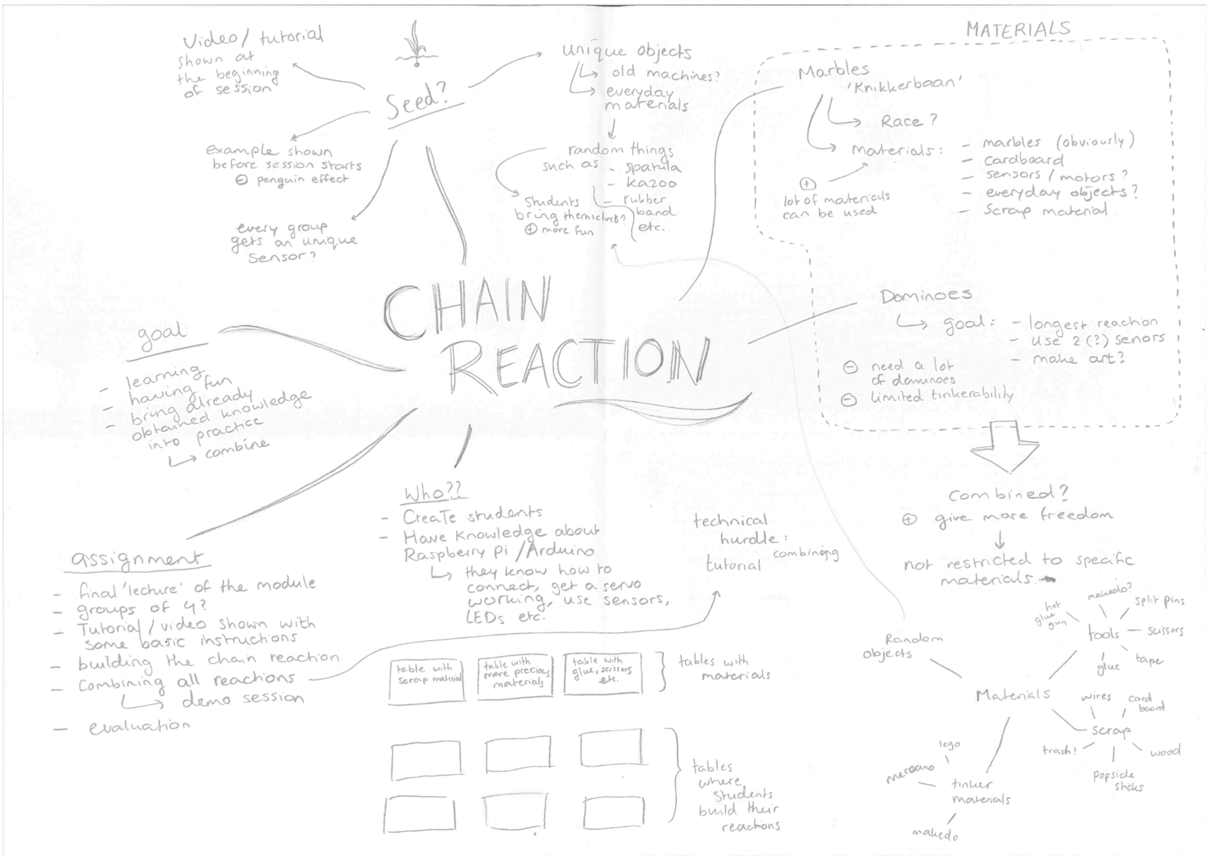
This feedback was discussed among the group, and from there, the decision was made to continue with the chain reaction playground. In our opinion, that concept allows for more creativity and tinkering.

The concept was further elaborated in a sort of brainstorming session. In this session, we wanted to get who the target audience would be, what the assignment could look like, what materials and what technical hurdles we could come across. See Figure X for these results.



This concept was presented in Session 4, which focused on Framing & Scope, Materials, Scaffolding & Facilitation and Process. Each of these elements was highlighted in a dedicated section, collectively forming the foundation of the concept.

Special attention was paid to what could serve as a seed for the project. Within that discussion, the idea was brought up to let students bring a random household object and incorporate that into their chain reaction.

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Final Concept

Assignment Description

Welcome, CreaTe students! You've spent the whole module delving into the world of Raspberry Pico and electronics, building your coding and hardware skills. Now, it is time to put those skills to the test in a collaborative, creative, and chaotic challenge. You are asked to build an interconnected chain reaction using all of your skills!

Playground

- Goal: Implement coding & hardware knowledge in a new, fun and creative environment through building a chain reaction. (learning & having fun)
- Seed: Raspberry Pi kit, General materials, household objects, connection tutorial
- Toolbox: Raspberry Pi kit, General materials
- Facilitation: One complete building day, including explanation, planning and testing

Audience

Creative Technology students who have experience coding and are familiar with Raspberry Pi through courses. The goal of the session is to implement this coding & hardware knowledge in a new and creative environment, making at least one component of a chain reaction using a Raspberry Pi Pico. In the end, all components will be put together as one chain reaction. The focus is on finding new creative, tangible and visible ways to trigger one Raspberry with another.

Objective

The goal is to design and build a section of a large, continuous chain reaction - also incorporating a random household object. Each group will build their part of the chain reaction on their own table. Your chain reaction must be triggered and controlled by a Raspberry Pi. The chains will all be connected, but more on that later. So, later today, we hope to have created a mesmerising sequence of actions.

Design Research Question

How can we facilitate rapid design and construction in combination with programmable components from the kit to help students build a mixed reality chain reaction?

Technical hurdle(s) to be solved:

- Designing a build capable of physical motion
- Construction of a chain reaction
- Setting up a Raspberry Pi kit for communication
- Programming actuators and sensors connected to the Raspberry Pi

Assignment Structure

1. Introduction & Assignment briefing (30 minutes)

2. Group formation & Object Exchange (20 minutes)

    2.1. Form groups of four and choose a team name
    2.2. Sign up through Canvas
    2.3. Each group hands their four objects to the next group (e.g., Group 1 gives their objects to Group 2, Group 2 to Group 3, etc.)

3. Raspberry Pi Pico Connection Tutorial (45 minutes)
    3.1. A tutorial will be provided to guide you through connecting your Raspberry Pi to the next group's Raspberry Pi.

4. Building the Chain Reaction (5 hours)
    4.1. Design and build your section of the chain reaction.
    4.2. Your chain reaction must include:
        4.2.1. At least one of the random household objects
        4.2.2. At least one of the following electronic components: (1) Servo motor, (2) Actuator, (3) Small DC motor
        4.2.3. At least one of the following components from the Arduino starter kit: (1) Button, (2) IR distance sensor, (3) Tilt switch, (4) Speaker, (5) LED

5. Final Demonstration (1 hour)

Materials & Resources

For the chain reaction tinkering session, we decided to give each group of students a kit consisting of a Pico starter kit, along with some additional components. As the target group is CreaTe students with plenty of experience in working with Picos, we also added some additional electrical components. These items form the basis of the chain reaction.

Kit for Each Group (Standardised Set)

Each group receives:

- 1 Raspberry Pi Pico starter kit, consisting of:
    - 1x Pico
    - 1x Micro USB cable
    - 1x Breadboard
    - Jumper wires
    - LEDs
    - Resistors
    - 1x Button
    - 1x IR distance sensor
    - 1x Tilt switch
    - 1x Speaker
- 2x Servo motors (with cables and mounting brackets)
- 1x Small DC motor
- 1x Actuator

- 1x Power supply (battery pack or USB adapter)

Additionally, a shared pool of general materials will be made available for the participants of the mixed reality chain reaction session. To keep the chain reaction sections as diverse as possible, and not steer the students in a certain direction, a lot of different building materials were chosen. The list was made based on the groups' positive experiences with the materials.

General Materials Available for all groups:

Physical Construction Materials

- Cardboard board
- LEGO (classic)
- LEGO Duplo
- K'nex
- Meccano
- Rubber bands
- String, yarn, and thin ropes
- Split pins
- MakeDo
- Scrap
- Popsicle sticks and straws
- Tape (masking, duct, electrical, and double-sided)
- Hot glue & glue sticks
- Scissors, box cutters, hole punchers (Makedo)
- Marbles
- Chenille wires
- Extra electrical components (upon request)

Evaluation Criteria

This assignment could serve as a final assignment in a course about Raspberry Pi & coding. In that situation, the following evaluation criteria should be considered.

- Requirements: Does your chain reaction component use:
    - At least one of the random household objects (4.2.1)?
    - At least one of the following electronic components: (1) Servo motor, (2) Actuator, (3) Small DC motor (4.2.2)?
    - At least one of the following components from the Arduino starter kit: (1) Button, (2) IR distance sensor, (3) Tilt switch, (4) Speaker, (5) LED (4.2.3)?
- Creativity: Originality of the design
- Functionality & Reliability: The smoothness and consistent operation of your design
- Integration of materials: The effective use of the provided materials
- Documentation: Clear documentation of your design process

Tutorial Communication

The project given to the Create students requires them to set up communication between two Raspberry Pis. Multiple setups exist to do this. Therefore, we give the students a tutorial file which specifies the steps needed to set up the communication. This file can be found in a separate file.

The communication aims to connect the different chain reactions to create one big chain reaction. We chose to use a Raspberry Pi for this purpose as it also allows the use of actuators and sensors. The communication between Pis adds an extra layer of complexity. The communication setup that we chose uses UDP (User Datagram Protocol) to send and receive messages between Raspberry Pis over a local network. By defining the communication protocol and providing a tutorial, we solve a technical hurdle. The supplied tutorial should offer sufficient support to limit the number of technical problems during the project day to a minimum.

We expect Create students to have sufficient knowledge to make a chain reaction using their ideas. Also, some (minor) prior understanding and experience with a Raspberry Pi is expected. The assignment and the tutorial are made with this idea in mind. During the project day, different project groups are stimulated to work together and test whether the communication works. This collaborative element is expected to help towards a cosy environment in which teams work together.

We successfully tested the communication protocol using two Raspberry Pis. We anticipate that some groups might have some minor troubleshooting issues. This, however, is to be expected. The goal here is not to hand the project groups a plug-and-play solution, but to guide them just enough so they can get started and solve the rest themselves. The basic purpose: a one-time trigger message should be doable by all groups. We are confident that this falls within the scope of the project and the abilities of the students.

Evaluation

During the test session of our self-designed tinkering activity, one group member took on the role of observer and paid close attention to what happened during the session and within the team: where frustrations arose, which moments sparked joy, and how people worked and what they did. The observer also kept track of how long different phases of the process took, offering insight into time management and pacing. Overall, the test session provided valuable feedback.

From the start of the tinkering session, a natural division of roles emerged within the team. Some members gravitated towards ideation and constructing the physical track, while others felt more comfortable handling the electronic components. This organic split allowed everyone to stay engaged and have something meaningful to work on throughout the session.

The materials chosen for the chain reaction worked well. Each person had brought a random object from home, which sparked creativity and provided inspiration for the setup. There was also a generous supply of scrap materials available, so we didn't feel too limited in what we could build. That said, having larger pieces of cardboard would have been helpful during the session. Many of the ones we had were quite small, which made it tricky at times to build a bigger piece. On the other hand, this limitation pushed us to be more inventive; for example, we ended up using playing cards as walls.

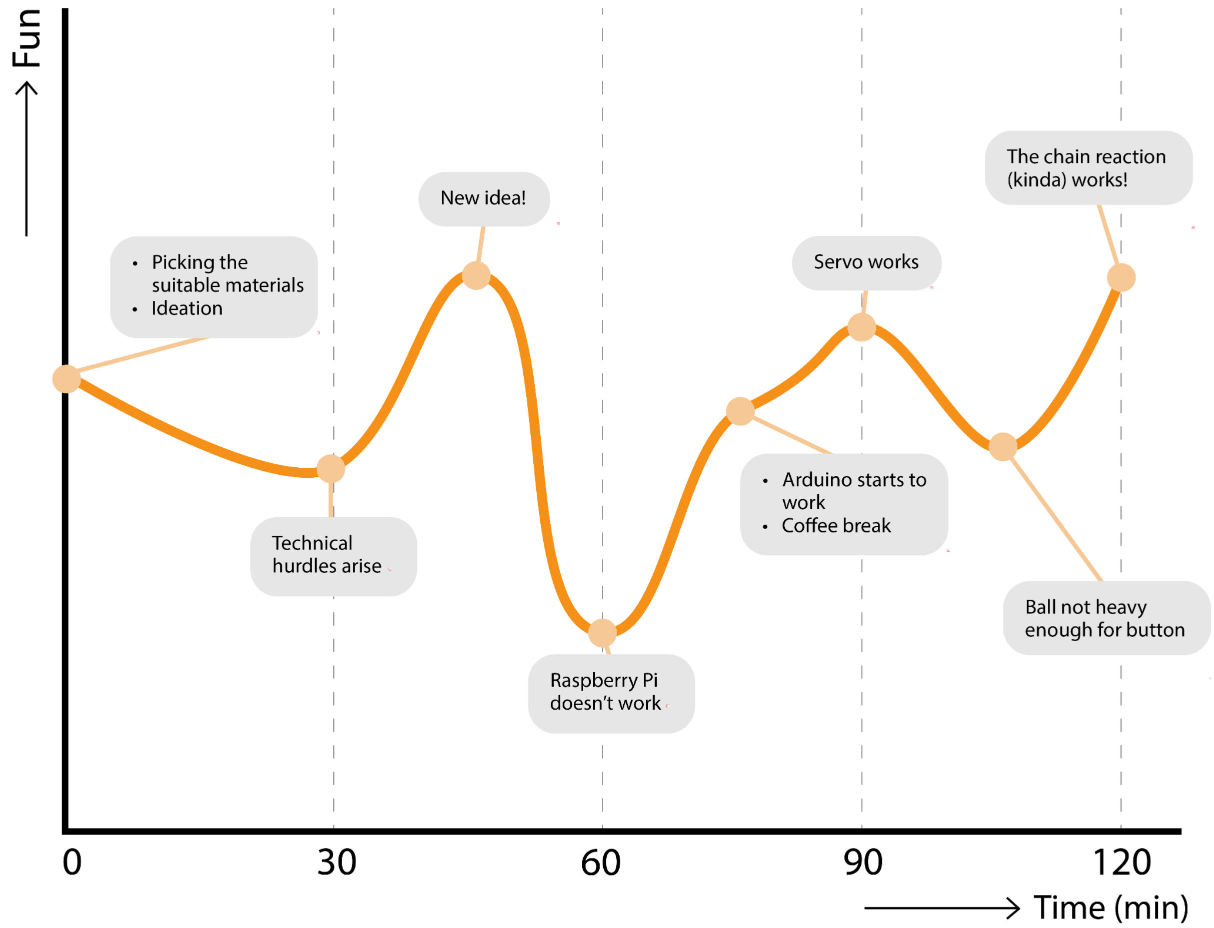
In terms of electronics, things were a bit more challenging. We lacked proper attachments for the DC motor, which made it difficult to integrate it into the chain reaction. It also would have been nice to have more sensors available. We mostly had to work with a servo and a single button, which limited our options slightly.

Technically, we ran into a few problems. Connecting the Raspberry Pi turned out to be difficult and time-consuming, which took away some of the fun and created a bit of a divide in the group. Eventually, we decided to switch to an Arduino instead, which worked much better and allowed us to get things running more smoothly.

The takeaways:

- Provide clear instructions on how to use the Raspberry Pi!
- Provide an attachment for the DC motor
- Provide more technical components
- Provide bigger pieces of cardboard
- Provide sketching material and markers/pens
- Give the opportunity to take breaks

We tried to measure the fun of our tinker session in a graph to see whether the flow of the assignment was good.



Demo

During the demonstration, each group began with a one-minute pitch, intended as a brief introduction to what the students could expect from the demo. Communicating this effectively to the students in the room posed a small challenge, as our standard demonstration typically spans an entire day. However, the student trial version of the demo day was limited to just 5 to 10 minutes. This change introduced some critical thinking in changing our demonstration to the new 5-minute format.

To address this, our team pre-assembled a portion of the chain reaction in advance. As previously mentioned, we had constructed the setup ourselves and had already conducted an internal evaluation to identify potential strengths and weaknesses. This proved effective on the day of the demo. We were able to begin immediately without a lot of (technical) hurdles.

Throughout the demonstration sessions, several important observations were made. Firstly, it became clear that students often arrived without a clear understanding of what to expect. This resulted in a brief introduction by a facilitator to orient them and guide their initial interaction with the setup. Even after this introduction, students frequently remained uncertain about how to begin or what actions to take. While the pre-built chain reaction served as a source of inspiration, it did not fully close this gap in getting students to start.

A particularly effective strategy was the use of concrete examples provided by facilitators. For instance, a facilitator might say, “The previous student used the DC motor combined with a string to create a pulley system. This pulley then knocked over a piece of cardboard, which in turn pressed a button.” Providing such examples helped students visualise possible actions and understand how to engage with the materials provided.

Another recurring issue was confusion about the availability and permissible use of materials. Students were unsure whether all items laid out could be used freely in their designs. In hindsight, it became clear that we needed to communicate the session's structure, objectives, and boundaries more clearly.

To mitigate these challenges in future iterations, we propose the creation of a ‘tutorial sheet’. This document would outline the key elements of the activity, provide illustrative examples, and address frequently asked questions. Such a tutorial would reduce the importance of the facilitators, which is particularly important in real-world scenarios where staff may not have the capacity to provide one-on-one support for every group, as was possible in our small-scale demo.

The takeaways:

- Provide clear instructions on what students have to do
- Provide an example that is easy to understand so students can start
- The role of the facilitator is more important than expected

Conclusions & Recommendations

This project has shown the potential of tinkering as both a learning method and a design tool. By developing a chain reaction playground, we not only did a lot of tinkering ourselves, but we also designed a framework that encourages others (probably CreaTe students). The project allowed us to test ideas rapidly, iterate on feedback and reflect on both technical and user-centred aspects.

One of the main strengths of our concepts lies in its open-ended structure. The combination of programmable components, random household objects and the goal of a shared chain reaction encourages creativity and quick problem-solving. However, we also encountered some challenges that resulted in recommendations.

1. Clear instructions: Provide a structured tutorial sheet that also has visual examples and frequently asked questions. This helps students get started quicker and with more confidence
2. Stronger Technical support: Offer simplified and well-documented instructions for setting up the Raspberry Pi. Include some files for DC motors and other difficult elements to reduce frustration.
3. Expanded Material Kit: Add larger cardboard pieces, sketching materials, a larger variety of sensors and actuators. This will stimulate more creative builds.
4. Session breaks: Encourage pacing with optional break times and check-ins throughout the session. This promotes a more relaxed and playful atmosphere.

In conclusion, this project succeeded in delivering a fun, educational tinkering experience. With the mentioned recommendations, the chain reaction playground has great potential as a tinkering playground.