Report Development
Product Development
Video Development

PDR

DNB311: ID 7 Capstone

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TS Industrial Designer

LECTURE NOTES: STUDIO 1

DDR should be filled with inspiration (mood board)
Be Captivated by area of project

Look at:
- RMIT ID Gradex
- Monash ID
- Loughborough University
- CCS Design Project
- RISD Design
- NUS ID
- Core 77
- QUT Projects

What will you target for improvement?
What do you want to achieve by the end of this year?
How will you take advantage of this as a steppingstone towards your future?

Project Options:
a) Self initiated
b) Scientific led projects
c) Industry linked project
*Try to avoid hobbies or areas with large amounts of knowledge
Make it something that interests you, and that you want to learn more about

Assignment Due Dates:
AI – Part I: Sunday WK6 (report)
AI – Part 2: Tuesday (Initial Concept)
A2: Friday Ist November (Final Presentation)

Project Ideation:

Instrument Cases – storage cases with space for stands, made from sustainable materials, concealed pockets, built-in accessories (music stands, tuners, etc)

Carbon Sequestration – measurement, storage, extraction from air. With the world moving to decarbonisation, accurate measurement of soil CO2 will both be important for soil health, food security, and a cleaner atmosphere.

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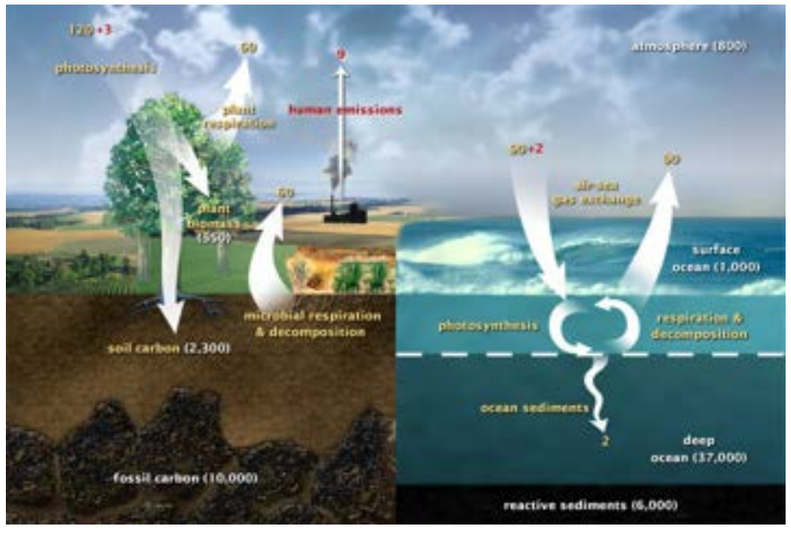
CARBON SEQUESTRATION

What is Carbon Sequestration?

Carbon Sequestration is the removal and storage of atmospheric Carbon Dioxide in the soil, water, or even porous rock formations underground (Department for Environment and Water, 2024), (United States Department of Energy, 2024).

How is Carbon Sequestered?

Carbon Dioxide can be captured through the means of both natural and "forced" methods. Natural soil based carbon capture occurs during the process of photosynthesis, predominantly in trees, grass varieties, and farmed crops. Other natural "sinks" for CO2 are the oceans, or large, nutrient rich, bodies of water. Although natural, extensive amounts of Carbon Dioxide has the potential to lower PH levels and create widespread acidity (University of California Davis, 2019).
"Forced" or Geologic methods of Carbon Sequestration entails compressing CO2 into a liquid form, and then injecting that material into the pores of rock formations deep underground. By doing so, the material is forced to solidify and remains dormant underground therefore removing it from the atmosphere and carbon cycle (University of California Davis, 2019).



Department for Environment and Water. (2024). Carbon sequestration. Department for Environment and Water. https://www.environment.sa.gov.au/topics/climate-change/government-action-on-climate-change/carbon-sequestration.

United States Department of Energy. (2024). DOE Explains...Carbon Sequestration. Energy.gov. https://www.energy.gov/science/doe-explainscarbon-sequestration

University of California, Davis. (2019, September 20). What is Carbon Sequestration and How Does it Work? CLEAR Center. https://clear.ucdavis.edu/explainers/what-carbon-sequestration

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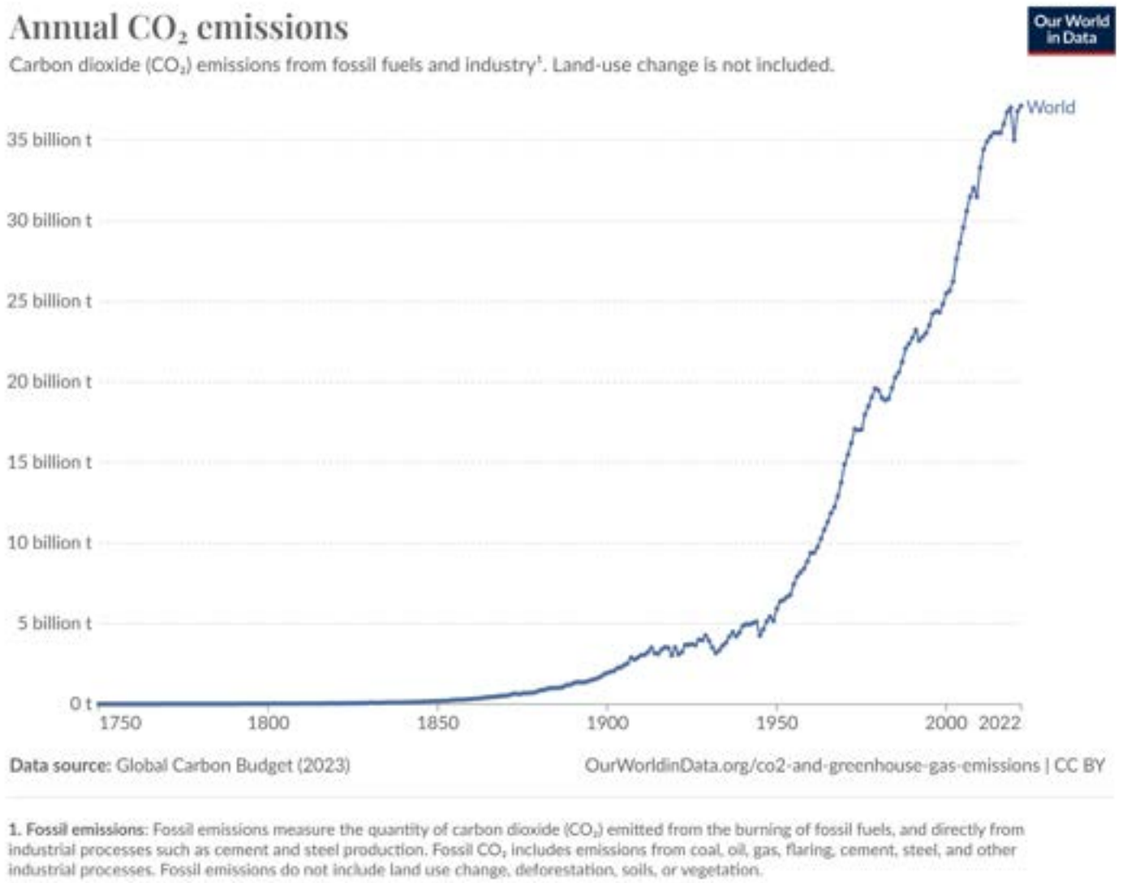
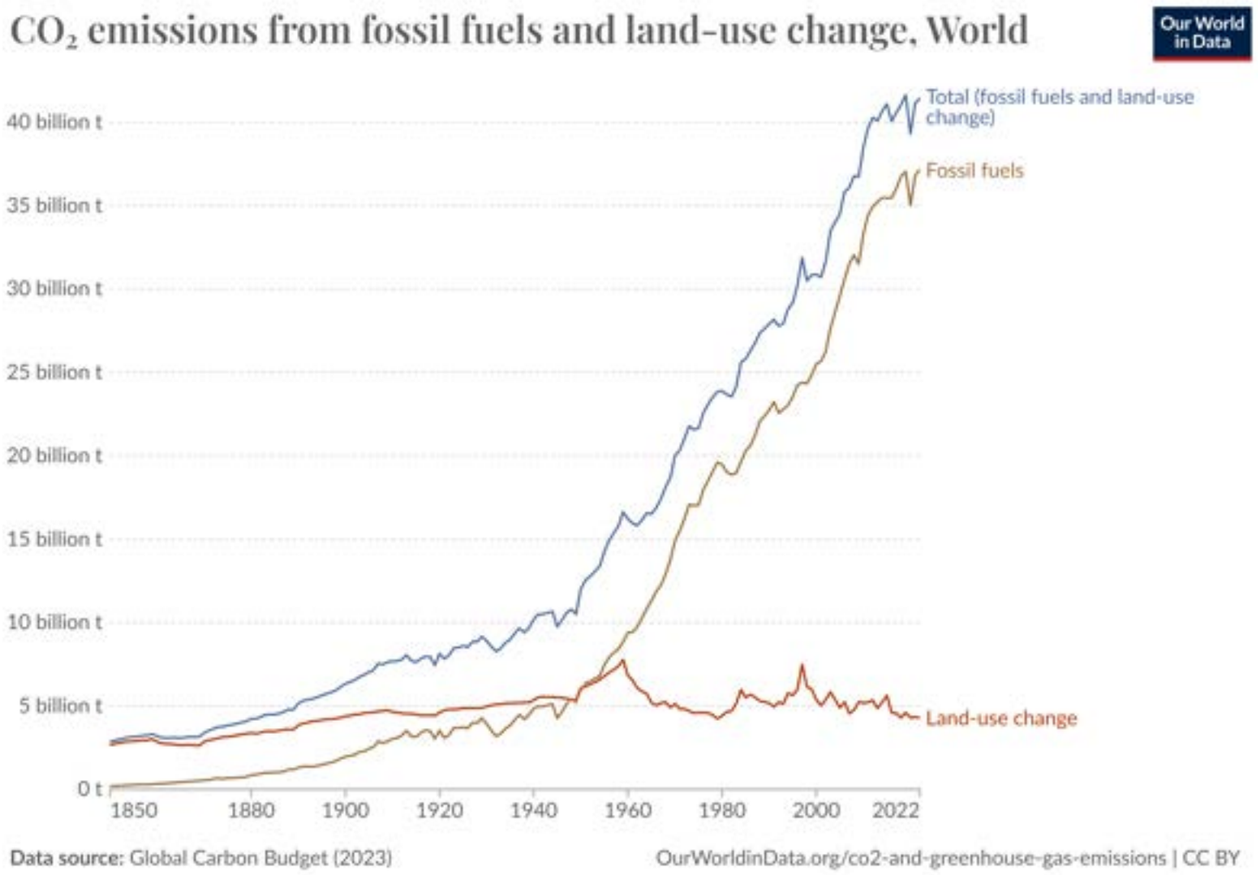
CO2 Pollution Globally

Why is reducing CO2 important?

In 1950 the world emitted 6 billion tonnes of CO2. By 1990 this had almost quadrupled, reaching more than 20 billion tonnes. Emissions have continued to grow rapidly; we now emit over 35 billion tonnes each year. Emissions growth has slowed over the last few years, but they have yet to reach their peak.





Ritchie, H., & Roser, M. (2024). CO2 emissions. Our World in Data. https://doi.org/10.4155/cmt.11.10).

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LECTURE NOTES: STUDIO 3

Qualitative Research & Design Process

Focusing on:
Design Process
Qualitative Research
Ethics

What: What is the value I am gaining from this experience?
Perspective, Process, Approach, Technique, Skills
Why: Why are you doing what you're doing?

Design Process:
- Deal with complexity/Ambiguity
- Iterative
- User focused*
- Systems focused
- Visual Communication
- Re-frames Problem
- Visionary
- Double Diamond
- Consider Feasibility, Desirability, Viability

Think of Design as a pendulum – Constantly changing state within process
*Henry Drayfuss (Designing for People & Measure of Man & Women)

Qualitative research:
- Understand limitations of sampling and data methodology
- What questions are you answering?
- How does your experiment answer these questions?
- Qualitative methods
- Triangulation of results (use 2 or more methods)*
- Participants
- Conduct Pilot study
- Show Methodology Graphically
- Record everything for later reference

*Methods include:
- Interviews (1-3 Participants)
- Surveys (5-10+ Participants)
- Observations (1-3 Participants)
- Think/Talk aloud protocols (1-2 Participants)
- Focus Groups

Should be done together to know what, why, and how

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INTERNATIONAL INITIATIVES

UN SDGs

Established in 2015, the United Nations Sustainable Development Goals (UN SDGs) are guiding checkpoints for global governments and organisations to meet (United Nations, 2015). These goals are designed to tackle the global issues of equitable health, education, general equality, economic growth and development, all whilst reversing the effects of climate change and globalisation on the planet and oceans (United Nations, 2015).

Project Relevant Goals

In regards to this project, there are TWO main goals that can be targeted:

Goal 13 (Climate Action): This goal aims to combat climate change and the impacts it has on the planet. The key targets of this goal include:
- Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.
- Integrate climate change measures into national policies, strategies and planning.
- Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning. (United Nations 2023)

Specifically mentioned within the atmospheric goals, is holding the increase in global average temperature below 2°C or 1.5°C above pre-industrial levels (United Nations, 2020).
Pre-Industrial levels refers to the period of global industrialisation during the late 18th Century, where such modern processes had not significantly contributed to atmospheric CO2 concentrations (Intergovernmental Panel on Climate Change, 2017). Using this time period as a baseline, the aim of the SDG goals is to ensure global temperatures do not increase (on average) 1.5°C to 2°C higher. A 2°C increase in global temperature is reported to cause irreversible damage to rising sea levels, severity of natural disasters (flooding, fires, droughts), and the elimination of plant and animal species (Intergovernmental Panel on Climate Change, 2017).

(United Nations, 2024)

United Nations. (2015). THE 17 GOALS | Sustainable Development. Un.org. https://sdgs.un.org/goals
United Nations. (2024, July 18). Communications materials - United Nations Sustainable Development. United Nations Sustainable Development. https://www.un.org/sustainabledevelopment/news/communications-material/
United Nations. (2023). Goal 13 | Department of Economic and Social Affairs. Un.org. https://sdgs.un.org/goals/goal13#targets_and_indicators
United Nations. (2020). Atmosphere | Department of Economic and Social Affairs. Un.org. https://sdgs.un.org/topics/atmosphere
Intergovernmental Panel on Climate Change. (2017). Global Warming of 1.5 oC —. Ipcc.ch; Global Warming of 1.5 oC. https://www.ipcc.ch/sr15/

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INTERNATIONAL INITIATIVES

4 per 1000

Its primary goal is to enhance soil health and increase soil organic carbon (SOC) storage, thereby addressing climate change and food security challenges. The initiative advocates for the idea that an annual increase of just 0.4% in global SOC stocks could significantly mitigate greenhouse gas emissions while improving agricultural productivity.

Key Objectives and Structure

Vision: The initiative envisions "worldwide healthy and carbon-rich soils" by 2050, aimed at combating climate change and ending hunger.
Membership: It comprises over 550 members, including countries, international organizations, research institutions, NGOs, and private sector partners. This multi-stakeholder approach promotes collaboration across various sectors to implement sustainable agricultural practices.

Strategic Plan: In 2020, a strategic plan for 2030–2050 was adopted, outlining 24 objectives focused on fostering innovative projects related to soil health and sustainability.

Implementation and Actions

The initiative emphasizes the development of practical actions that benefit farmers and herders, who are often the first affected by land degradation. It promotes various sustainable agricultural practices such as:
- Agroecology
- Agroforestry
- Conservation agriculture
- Landscape management

These practices are tailored to local conditions to ensure resilience against climate change while enhancing food security.

4P1000. (2021). The international "4 per 1000" Initiative Soils for food security and climate. https://4p1000.org/?lang=en#

INTERNATIONAL INITIATIVES

Paris Agreement

Key Objectives

Temperature Goals: The primary aim is to limit global warming to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C. This target is critical as it seeks to reduce the risks and impacts associated with climate change.

Net Zero Emissions: The agreement calls for achieving net zero emissions by mid-century, meaning that any greenhouse gases emitted should be balanced by an equivalent amount removed from the atmosphere.

Nationally Determined Contributions (NDCs): Each country is required to set its own emissions reduction targets, known as NDCs, which must be communicated and updated every five years to reflect increased ambition.

The agreement includes provisions for:

Transparency Framework: Countries must regularly report on their emissions and progress toward their NDCs, enhancing accountability and trust among nations.

Global Stocktake: Every five years, a global stocktake will assess collective progress towards achieving the agreement's objectives and inform future actions

Unfccc.int. (2020). The Paris Agreement | UNFCCC. https://unfccc.int/process-and-meetings/the-paris-agreement

INTERNATIONAL INITIATIVES

Kyoto Accord

Binding Commitments: The Kyoto Protocol introduced legally binding targets for developed countries (referred to as Annex I Parties) to reduce their GHG emissions. Specifically, it mandated an overall reduction of 5.2% from 1990 levels during the first commitment period from 2008 to 2012.

Differentiated Responsibilities: The treaty operates on the principle of "common but differentiated responsibilities," acknowledging that developed nations have historically contributed more to climate change and thus bear a greater responsibility for emissions reductions.

Mechanisms for Compliance: To facilitate compliance, the Protocol established mechanisms such as:
- Emissions Trading: Allowing countries to buy and sell emission allowances.
- Clean Development Mechanism (CDM): Enabling developed countries to invest in emission reduction projects in developing countries as a way to meet their own targets.
- Joint Implementation: Allowing countries to invest in projects in other developed countries to earn emission reduction credits.

United Nations. (1997). Kyoto Protocol to the United Nations Framework Convention on Climate Change. https://unfccc.int/resource/docs/convkp/kpeng.pdf

INTERNATIONAL INITIATIVES

1987 Montreal Protocol

Key Features

Initial Adoption and Ratification: The Protocol was initially signed by 46 countries and has since gained nearly 200 signatories, making it one of the most universally ratified treaties in history. It entered into force on January 1, 1989.

Phasing Out Ozone-Depleting Substances: The treaty set specific targets for reducing the production and consumption of various ODS. Developed countries were required to reduce their use of CFCs and halons by 80% from 1986 levels by 1994, with further reductions scheduled for subsequent years. Developing countries were given longer timelines to comply, reflecting their economic constraints.

Amendments and Updates: The Montreal Protocol has been amended multiple times to strengthen its provisions, including the notable Kigali Amendment in 2016, which aims to phase down hydrofluorocarbons (HFCs), potent greenhouse gases that were initially used as substitutes for CFCs.

Global Cooperation and Funding: The Protocol established a financial mechanism to assist developing countries in meeting their obligations, including the Montreal Protocol Fund, which provides resources for technology transfer and capacity building.

Unep.org. (2016). The Montreal Protocol on Substances that Deplete the Ozone Layer | Ozone Secretariat. https://ozone.unep.org/treaties/montreal-protocol

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INTERNATIONAL INITIATIVES

Global Methane Pledge

Emission Reduction Target: The primary goal of the GMP is to collectively reduce global methane emissions by at least 30% from 2020 levels by 2030. This target is crucial for limiting global temperature rise and keeping the goals of the Paris Agreement within reach.

Participation and Scope: As of March 2024, the GMP has garnered participation from 158 countries, representing over 50% of global anthropogenic methane emissions. This includes major emitters across various sectors such as energy, agriculture, and waste management.

Rationale and Benefits

Climate Impact: Methane is significantly more effective than carbon dioxide at trapping heat in the atmosphere—approximately 80 times more potent over a 20-year period. Reducing methane emissions could potentially lower global warming by at least 0.2°C by 2050, while also preventing numerous health-related issues and agricultural losses.

Co-Benefits: The pledge not only aims to address climate change but also offers co-benefits such as improved public health, enhanced food security, and economic advantages through better agricultural practices.

Implementation Framework

Action Areas: The GMP focuses on six key pathways for action:
- Energy
- Waste
- Food and Agriculture
- Methane Plans and Policies
- Data for Methane Action
- Finance for Methane Abatement

Voluntary Commitment: Participation in the GMP is voluntary and non-binding; countries are encouraged to develop national methane reduction action plans and report on their progress regularly.

Dcceew.gov.au. (2022). Australia joins Global Methane Pledge | Ministers. https://minister.dcceew.gov.au/bowen/media-releases/australia-joins-global-methane-pledge

GOVERNMENT INITIATIVES

Why is Carbon Sequestration Important to the Australian Government?

Key Components – AUS Net Zero Plan

Government Operations Target: A specific target is set for the Australian Public Service (APS) to achieve net zero emissions in government operations by 2030. This includes scope I and scope 2 emissions, focusing on direct emissions and those from purchased electricity.

Implementation Strategy: The Net Zero in Government Operations Strategy, launched in November 2023, provides a roadmap for achieving the net zero target. It emphasizes energy efficiency, transitioning to renewable energy, and implementing practical actions across various sectors, such as buildings, vehicle fleets, and procurement processes.

Financial Commitment: The government has allocated significant funding for climate initiatives, including approximately $4.6 billion in new climate-related spending as part of the 2023-24 budget, aimed at supporting the transition to a net zero economy.

Reporting and Accountability: The plan includes provisions for annual reporting on emissions reductions and progress towards targets, ensuring transparency and accountability among government entities.

Sectoral Focus: The strategy encompasses various sectors, including energy, transport, waste management, and agriculture, with specific actions designed to reduce emissions across these areas.

Other adjoining schemes include:
- AUS Gov Net Zero Plan
- Safeguarding AUS
- Export abilities
- Australian Carbon Credit Unit Scheme
- Aus Government Clean energy regulator
- National Greenhouse and Energy reporting scheme

https://www.dcceew.gov.au/climate-change/emissions-reduction/net-zero
https://www.dcceew.gov.au/climate-change/emissions-reduction/agricultural-land-sectors
https://www.dcceew.gov.au/climate-change/emissions-reduction/accu-scheme
https://www.dcceew.gov.au/climate-change/emissions-reporting/national-greenhouse-energy-reporting-scheme
https://cer.gov.au/
https://www.dcceew.gov.au/climate-change/emissions-reduction/emissions-reduction-fund/cca-review-carbon-credits-act-2011

AGRICULTURAL CONTEXT

Why is Carbon Sequestration important?

Importance for Agriculture

Carbon Farming: In agricultural contexts, practices such as cover cropping, reduced tillage, and agroforestry enhance soil carbon storage. These practices not only sequester carbon but also improve soil health and agricultural productivity.

Economic Incentives: Farmers can benefit economically from carbon farming through participation in carbon credit markets, where they can sell credits earned by implementing practices that sequester carbon.

Government Initiatives

Policy Frameworks: Various governments are developing policies to promote carbon sequestration as part of their climate action strategies. This includes funding for research, incentives for farmers, and regulations to encourage sustainable land management practices.

Department for Environment and Water. (2024). Carbon sequestration. Department for Environment and Water. https://www.environment.sa.gov.au/topics/climate-change/government-action-on-climate-change/carbon-sequestration.

United States Department of Energy. (2024). DOE Explains...Carbon Sequestration. Energy.gov. https://www.energy.gov/science/doe-explainscarbon-sequestration

University of California, Davis. (2019, September 20). What is Carbon Sequestration and How Does it Work? CLEAR Center. https://clear.ucdavis.edu/explainers/what-carbon-sequestration

Wa.gov.au. (2022). Carbon Farming on Agricultural Land in WA | Agriculture and Food. https://www.agric.wa.gov.au/carbon-farming/carbon-farming-agricultural-land-wa

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DECARBONISATION BY INDUSTRY

Why is Carbon Sequestration important?

Companies such as Mars are implementing CO2 reducing practices throughout their supply chain to ensure all facets of their business meet with environmental standards, international standards, as well as social standards for modern companies.

Other incentives include financial efficiency, government incentives, innovative advantage against competitors, greater brand reputation, and improved ability to access finances for innovation practices.

Mars. (2023). Achieving Net Zero emissions by 2050. Mars.com; https://www.mars.com/sustainability-plan/healthy-planet/net-zero-2050

LECTURE NOTES: STUDIO 5 - Part I

Benchmarking & Research Methods

Objectives of Research
- Strategic position of human centred design research.
- Relevance of qualitative research approach.
- Importance of research within design context

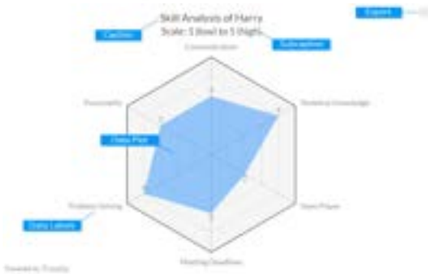
Benchmarking
- Process of measuring products, services & processes against those of organisations known to be leaders/competitors in I or more aspects.
- Learning everything you can about competition.
- Not just reviewing & taking inspiration from other products.

Why Benchmark?
I. Identifying strengths & weaknesses of idea.
2. Set aims/objectives/goals & track progress
3. Identify innovations against industry standards
4. Learn from the best in industry
5. Avoid recreating existing designs
6. Stay competitive

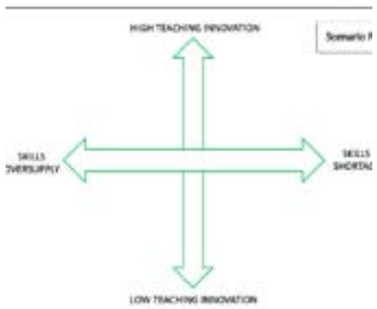
How?
- Determine what product category/technology you are designing for.
- Determine existing products in context.
- Collect relevant images of products/services - try to test product if possible.
- Collect information about product
- Identify functions, features, aesthetic analysis.
- Identify gaps in market
- Generate visual representation of benchmarking

Visualisation of Benchmarking
- Table (ranking product areas: quality, usability)

- Radar (Maps same categories in visual form, think video game stats map)



- Matrix/Graph (maps out competitors based on fit to 2 metrics, e.g. innovation & usability)



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LECTURE NOTES: STUDIO 5 - Part 2

Benchmarking & Research Methods

Research Methods

Surveys (Qualtrics, Survey Monkey, Google Forms)
*Need to always inform about ethics
- Define clear goal for survey
- Try and use both qualitative & quantitative data
- Ask basic demographic questions (age, experience in field)
- Make it only 5-10 minutes to complete
- Don't ask leading questions
- Don't use absolutes (never, always)
- Don't ask two questions in one

Interviews

- Structured (only questions & answers)
- Semi structured (in between - set of questions, but following interesting leads)
- Open ended (No questions, just broad conversation about topic, going with the flow)

- Define clear goal
- Build rapport (interview is a personal discussion)
- Ask basic demographic questions (age, experience)
- Talk less & listen more
- Prompt for more information if need be
- Prepare to handle unexpected emotions
- Don't make interview too long (be clear how long it might take)
- Transcribe interview promptly (otter ai, etc)
- Don't ask leading questions
- Consent needs to be recorded (signature or email)

Observations

- Naturalistic: Observing subject in their environment
- Participant
- Structured: Asking to perform activity especially for observation
- Archived

- Establish recording method (notes, video, audio)
- Collect basic demographic info
- Record context & process (where, what is it & what are they doing)

What to do

- Select methods
- Recruit participants
- Deploy research

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STUDIO NOTES: STUDIO 6 - DAN

Report & Research Development

Why are we doing research this way?
- Secondary Research (existing research)
- Analysis of research
- Generation of questions

- Some interesting questions need to be answered through interviews, observations, and surveys
- Analysis of results
- Opportunities arise
- Opportunities become design solution areas

Research Questions:
- Looking more at how?
- Research on experience more than data
- Why do you do it?
- How do you do it?
- What makes a good sample?

Search QUT for CO2 measurement, soil sampling, carbon sequestration

Possible Contacts:
- Dr Cassandra Schefe
- Centre for Agriculture & Bioeconomy
- Genivieve Dixon
- Marcus Yates - SERF
- Ella DeWilde - SERF

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SOIL CO2 MEASUREMENT METHODS

Baseline SOC Measurement Process

The general core process involved with measuring Soil Organic Carbon (SOC) is:

- Sampling*
- Transportation of soil to testing facility
- Dehydration
- Initial weighing
- Sieve and separate sample
- Mix the sample
- Grind samples for testing
- Undertake testing
- Output and recording of results

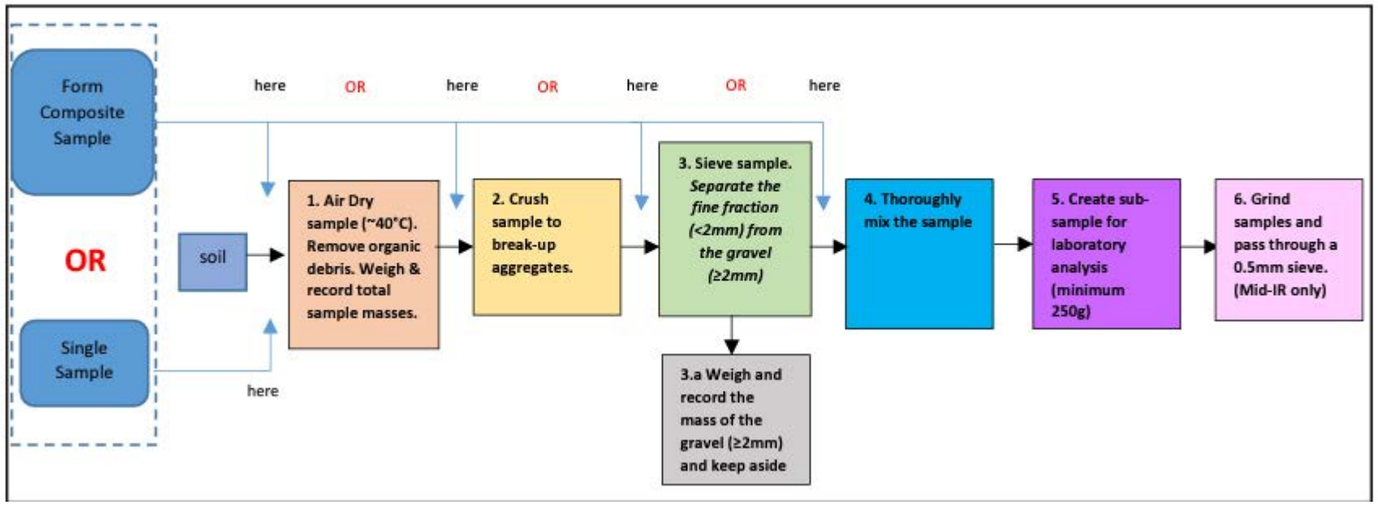

Diagram shows process (DCCEEW, 2020)

This process is very broad and general as there are a range of specific measurement techniques

The basic process of measuring Soil Organic Carbon (SOC) content typically involves the following steps:
1. Soil sampling: Collect representative soil samples from the area of interest, usually to a depth of 30cm[1][2].
2. Sample preparation: Dry the soil samples in an oven at 105°C and grind them to a fine powder[1].
3. Carbon measurement: The most common and accurate method is dry combustion:
   - A small soil sample (around 30mg) is placed in a capsule[3].
   - The sample is combusted at high temperature (around 975°C)[3].
   - The resulting CO2 is measured using an automatic analyzer with a thermal conductivity detector[3].
4. Inorganic carbon removal: For soils with pH above 7.2, inorganic carbon (carbonates) may be present. These samples are typically split in two:

   - One sample is treated with acid to remove carbonates.
   - Both samples are analyzed, and organic carbon is calculated by subtracting inorganic carbon from total carbon[1].
5. Bulk density measurement: This involves taking a known volume of soil, drying it, and dividing the dry weight by the volume[1].
6. Calculations: Convert the percentage SOC to mass per unit area (e.g., tonnes per hectare) using the bulk density and sampling depth[2].
Additional Considerations
- Timing and rotation position are important for consistent measurements[1].
- Multiple samples (5-10 cores) are often combined for a more representative measurement[1].
- It typically takes at least five years to reliably measure changes in SOC due to management practices[1].
While dry combustion is considered the gold standard, other methods like the Walkley-Black wet oxidation method are also commonly used, especially in Australia[2][3]. New technologies, such as spectroscopy and proximal soil sensing, are being developed to make SOC measurements faster and more cost-effective[1][2].
Citations:
[1] https://www.fwi.co.uk/arable/land-preparation/soils/how-to-accurately-measure-the-organic-carbon-content-of-soil
[2] https://soilquality knowledgebase.org.au/measuring-soil-organic-carbon/
[3] https://soiloptix.com/our-blog/what-are-the-different-methods-of-measuring-soil-organic-carbon/
[4] https://www.environment.nsw.gov.au/resources/soils/testmethods/oc.pdf
[5] https://www.agric.wa.gov.au/soil-carbon/measuring-and-reporting-soil-organic-carbon

Australian Government - Department of Industry, Science, Energy and Resources (DCCEEW) (2020). Supplement to the Carbon Credits (Carbon Farming Initiative- Measurement of Soil Carbon Sequestration in Agricultural Systems) Methodology Determination 2018 Version 1.2 -July 2020 Document revision history. https://www.dcceew.gov.au/sites/default/files/documents/supplement-soil-carbon-agricultural-systems.pdf

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SOIL CO2 MEASUREMENT METHODS

CO2 Absorption - Alkali Method

The CO2 Absorption method consists of water baths with inserted hermetically closed vessels for soil incubation. Each vessel includes a smaller open vessel with KOH* solution and platinum electrodes inserted into the solution. Each set of electrodes is connected to a digital volt-/amperemeter and a source of constant current (Figure I). The CO2 released from the soil sample is absorbed by the KOH solution. The amount of absorbed CO2 is determined by measuring changes in conductivity of the KOH solution. Data from each vessel are collected in hourly increments and analyzed (Smirnova et al., 2014). This method however does have its limitations as CO2 levels can be underestimated if not fully absorbed by the alkaline solution, and also overestimated when the CO2 concentration is too low to encourage microbial activity (Watanabe, 1997).

*The absorption of CO2 by an electrolyte, such as potassium hydroxide (KOH), produces a change in the conductance of the solution (Chapman, 1971).

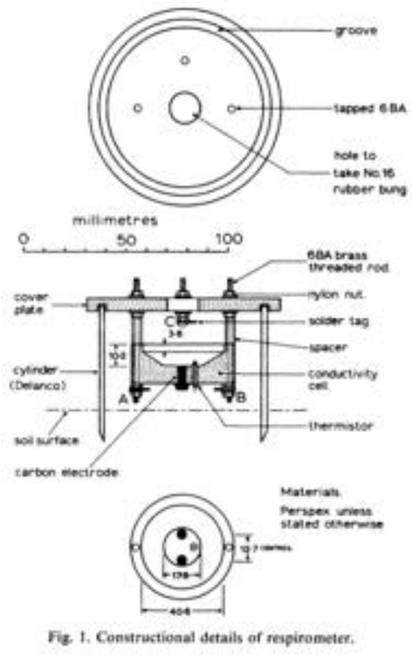

Fig. 1. Constructional details of respirometer.

Device pictured (left) is inserted directly into the ground or onto container, and demonstrates the inner-workings of the method (Chapman, 1971)

Device pictured (right) is a modern adaptation of the tech that measures CO2, as well as other vital soil health metrics such as soil respiration and decay rate (solutions, 2024).

Chapman, S.B. (1971) A Simple Conductimetric Soil Respirometer for FIELD Use. Oikos, 22, 348-353. http://dx.doi.org/10.2307/3543857

Smirnova, N., Michael Scott Demyan, Rasche, F., Georg Cadisch, & Torsten Müller. (2014). Calibration of CO2 Trapping in Alkaline Solutions during Soil Incubation at Varying Temperatures Using a Respicond VI. Open Journal of Soil Science, 04(05), 161–167. https://doi.org/10.4236/ojss.2014.45019

Solvita Solutions (2024, June 13). IRTH CO2 Respirometer - Solvita Solutions for Soil Carbon Cycling. Solvita. https://solvita.com/irth/

Mikiya Hiroki & Makoto M. Watanabe (1997) Field measurement of carbon dioxide evolution from soil by a flow-through chamber method using a portable photosynthesis meter, Soil Science and Plant Nutrition, 43:1, 255-260, DOI: 10.1080/00380768.1997.10414733

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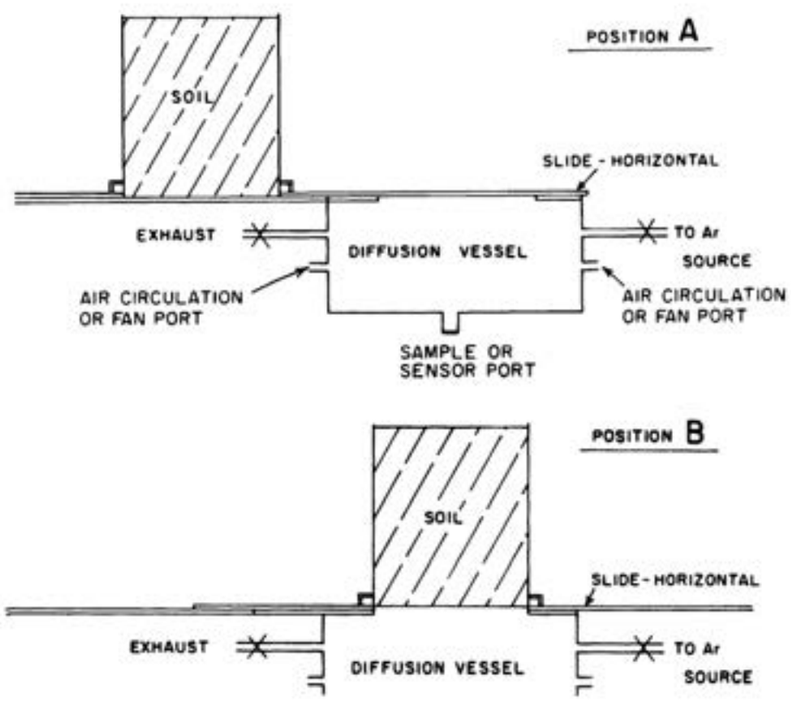
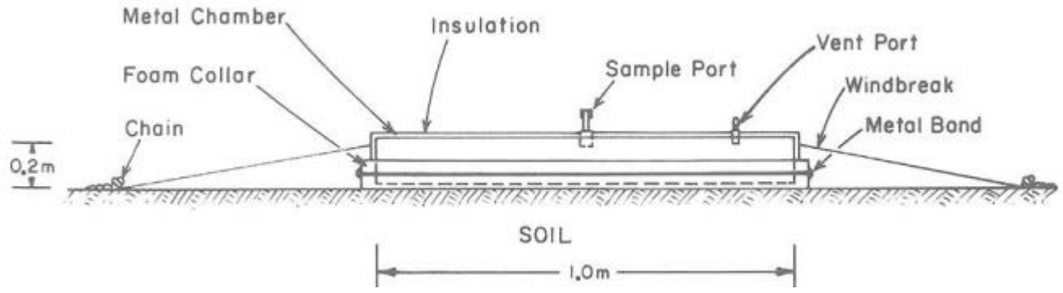
SOIL CO2 MEASUREMENT METHODS

Closed Chamber

Closed chamber in which the CO2 evolution rate is calculated from the increase of the CO2 concentration in a closed chamber covering the soil surface (Watanabe, 1997). Using the principle of diffusion, the laboratory method is based upon establishing gas of concentration CO2 within a chamber. One end of a soil core of concentration cs is placed in contact with the gas within the chamber. The other end of the soil core is maintained at concentration cs. The gas of interest diffuses either into or out of the chamber depending upon the concentration CO2 with respect to that outside the core (Rolston, 1986).

The image below demonstrates the process of Closed Chamber testing. Rolston also outlines the equipment needed to do the test.





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TS

LECTURE NOTES: STUDIO 7

Data Analysis

- Go back to topic
- What are you interested in?
- Is there a problem / opportunity?

Identify Variables
- Age, context, time of day, weather, experience, action, choices, preferences, etc.

Data collection varies in control
- High control: Surveys
- Low control: Observations
- Interviews middle ground

Data analysis works to apply structure and order

Quantitative Analysis
Data collection -> Analysis -> Findings -> Write results

Qualitative Analysis
Data collection -> Analysis -> Findings -> Write results -> data sorting

Eight Steps to consider:
I. Get a sense of the whole -> Jot down notes
2. Pick one document and study in detail
3. Make list of topics that have arisen, cluster topics into lists and develop codes
4. Take codes and go back to data
5. Find descriptions for topics & turn into categories
6. Make a final decision on abbreviation for categories
7. Assemble data material belonging to each category and perform preliminary analysis
8. If necessary, recode existing data

Qualitative rigor & verification
Systematic approach
Meticulous record keeping
Collect quotes that reflect evolving narrative
Identify themes that might be contrary to emerging themes
Iteration of methods
Consider having more than I researcher review
Consider 'member checks' - talk to someone external to you.
Identify the limitations of the study.

Discuss limitations of data (e.g. only done in Australia, limited # of participants).

TS

LECTURE NOTES: STUDIO 7 - Cont.

Surveys

Questions & Data Type

Levels of measurement

- Nominal / Categorical (different categories, no order to categories)
  - Show as # of responses to each category or %
  - Mean & Median is meaningless
  - Collapsing can help (condensing where makes sense - Apple vs Android

- Ordinal (Categories have order, distance between categories not known)
  - Options included (S,M,L / Likely, Unlikely)
  - Report similar to nominal

- Interval / Ratio (ordered, distance between, response known)(e.g. How satisfied are you I-5?)
  - Numerical Data
  - # of data
  - % of data
  - Collapsing
  - Descriptive statistics

Multivariate Analysis

- Relationship between a categorical & numerical variable
- Visualise (bar graph, number / graphic matrix)

Interviews

Code themes and concepts that emerge
- Apply structure to data
- Identify common themes
- Identify patterns & relationships

Analysis Methods
- Content / thematic analysis*
- Affinity diagramming

*Identifies meaning and patterns
- Requires coding
- Like annotating a document with comments
- Develop coding scheme
  - Link back to research question
  - Apply a coding scheme from an existing framework or method
- Coding schemes involve multiple levels

e.g. Category
Code
Sub Code
Examples of Code

Consider mix of subjective & objective codes
Use software such as Nvivo, Atlas.ti, etc.

Once text is coded it can be analysed
Conceptual analysis
- Frequency of coded concepts (themes, issues, words)
- Frequency can be expressed as total #, Probability, %

Relational analysis
- Relationship between codes can be inferred by proximity
- Co-occurance, two overlapping codes have a relationship

TS

LECTURE NOTES: STUDIO 7 - Cont.

Affinity Diagramming

- Involves identifying & sorting individual data points into themes
- Use of recording or transcription
- Record timestamps for later reference of quote
- Concepts arranged into themes
- Do manually or via miro

Reporting

- Show coding scheme
- Show interpretation in text
- Supporting quotes

Find coding scheme in body of report
Working out & development of coding scheme in appendix
Appendix needs raw data, screenshots from observations, interview transcripts

Observations

- Video
- Field notes
- Analysis very similar to interview
- Annotating temporal events

Software: noldusObserver

Temporal events
- sequence of events
- Duration of events

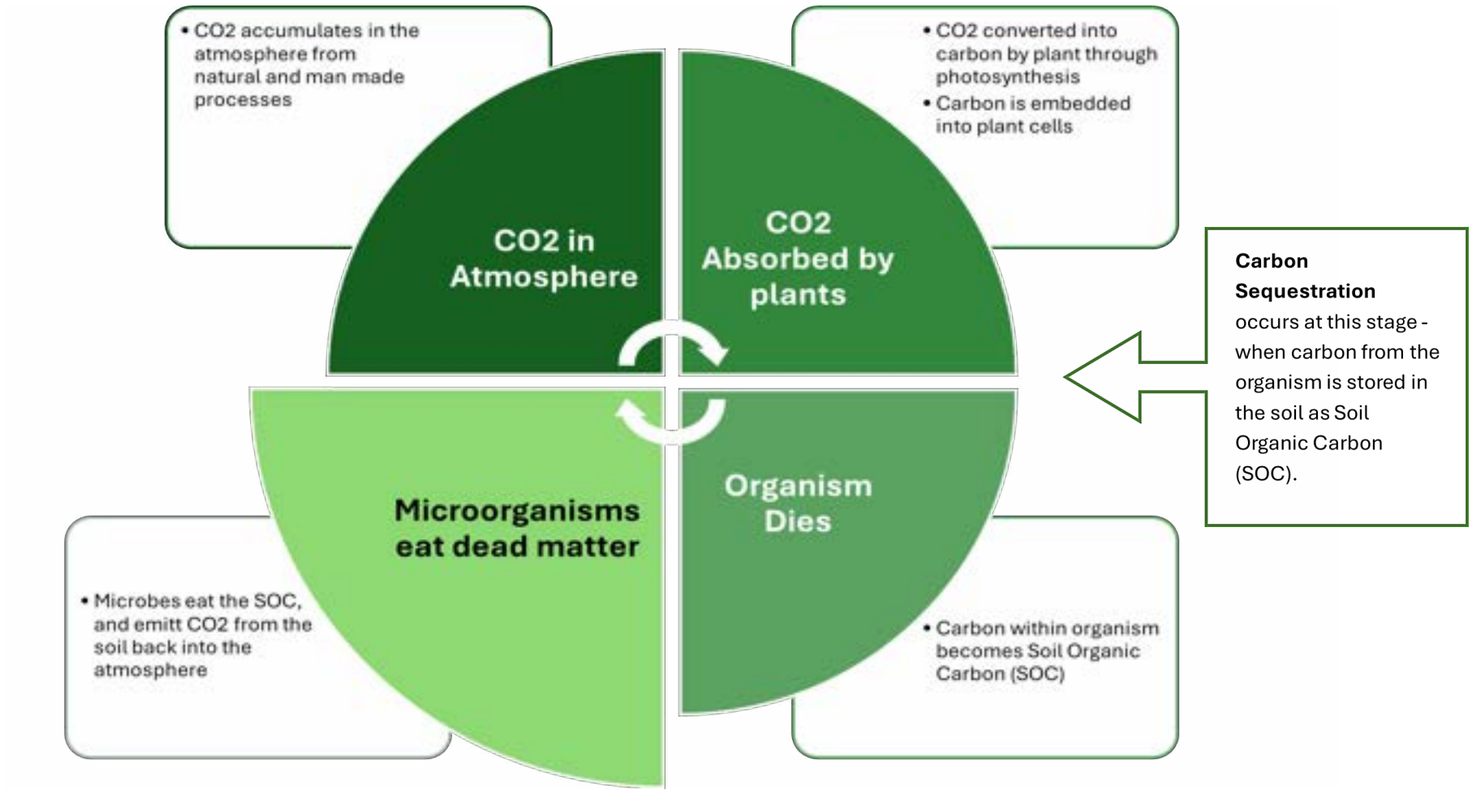
Thoroughly describe evidence simply & direct

Present evidence of relevance, quality & integrity
You shouldn't omit results that contradict what you expect/want.

Data visualisation programs
- Serial mentor
- Flowing data
- Data to vis
- Rawgraphs
- Affinity designer
- Illustrator

TS

THE CARBON CYCLE



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EMERGING TECHNOLOGY

Why is Carbon Sequestration important?

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chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://grdc.com.au/__data/assets/pdf_file/0039/585669/GRDC_ProximalSoilSS_FS22II_Screen.pdf?utm_source=website&utm_medium=download_link&utm_campaign=pdf_download&utm_term=National&utm_content=Proximal%20soil%20sensing%20systems

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University of California, Davis. (2019, September 20). What is Carbon Sequestration and How Does it Work? CLEAR Center. https://clear.ucdavis.edu/explainers/what-carbon-sequestration

TS

LECTURE NOTES: STUDIO 8 - Dan Feedback

Search Centre for Agriculture & Bio-economy and find people directly

Approaches
- Find what doesn't work
- Think kid asking a million questions
- Look for gaps, parallels
- Look at process
- Dig into process
- Cost? Why cost?
  - Materials
  - Volume of production
  - Calibration

Influence of materials on data (e.g. plastic fumes)

Methods
- Where do they come from?
- Why do you do it that way?

Government standards for measurement -> will dictate industry

Government standards soil sampling

Soil samples / testing sites need to be GPS recorded to highest degree possible (minimum +/- 4 metres difference)

Sampling: Site needs to be cleared of plants, litter & surface rocks

Depth 0-30cm (I core)
Core Diameter 38mm
Minimum I year between test -> max 5 years

Walkley & Black Method
Photometric Method
Gravimetric Method (ignition Test)
Dry Combustion

TS

RESEARCH QUESTIONS - ELLA DEWILDE

Ella Dewilde – PHD Student School of Biology & Environmental Science

Questions:

Introductory/scene setting

1. Who are you?
2. What is your current employment position?
3. What is your age?
4. How many years of experience have you had in this field?
5. What lead you to studying in this area?
6. What is your area of expertise/passion?

Process questions

7. Why do you think measuring carbon is important? What reasons have you needed to measure carbon?
8. What process do you use?
9. Why do you use it?
10. Where does the method come from?
11. How easy do you find the method?

Start from beginning

12. What makes a good soil sample?
13. How is the sample collected?
14. What tools are used in retrieving soil samples
15. What conditions do the samples need to be transported under (e.g. temperature, light sensitivity)?
16. How is the sample prepared for testing?
17. What equipment is used?
18. What time constraints are there for testing?
19. How is the sample tested?
20. What equipment is used?
21. What is the process
22. How long does the process take?
23. What then? How is data collected?
24. How is data formatted and analysed?
25. What then?

Use of equipment:

26. How user friendly is this equipment?

TS

OBSERVATION TRANSCRIPT - ELLA DEWILDE

Spatial scale, a kind of measurement, so we have everything from highly specific microsites where you're looking at covering only a few square or cubic centimetres, all the way up to what we call flux towers, we are measuring over several hectares. So here obviously we're looking at smaller scales. So this is where we bring soil from the field, put it in cores and then measure fluxes over time. The other method that our research group is most widely known for is chambers. So how it works is, this steel base here gets pushed into the ground

So it's level with the ground and then these chambers clip onto it. And so it's flush. It creates a seal. This is the lid that opens and closes. And that's how we measure our fluxes. So we assume that it's a linear increase over time. So what it's measuring is the increase or potentially the decrease in carbon dioxide, methane and nitrous oxide from the soil over normally an hour to 90 minutes.

So if it stays closed for too much longer, then you have issues with the thermal stuff. And I don't want to get into all that. So this is what we use in the field. And they're built here and at the pilot facility in Banyo. So that's the is that a flow through method? Or is that a? I'm trying to think of it. So you're more capturing the gas rather than the

Yeah. So we've got this is the power cord, which basically sends instructions to the chamber when to open, when to close. Then if you come around here, you can see. Here's an example. There's this second little hole here. And that's where the sample line connects into our Teflon tube. And that's where the sample gets drawn up from. So it. Sucks a sample of greenhouse gas at zero minutes.

So when it closes at 30 minutes and at 60 minutes, and if we're doing a longer period, either 90 or 120 minutes. Yeah. And then that line connects. Follow me all the way to something like this, a sample unit. Wow, OK. Don't ask me to explain. So this is where the sample lines connect into the same sort of port. Rightio. We've got eight chambers, one sample line per chamber. Runs through here. One, two, three, four, five, six, seven, eight. This is now.

So the sample is being held here and one by one, the sample gets fed through here into this tube. And this is a needle that comes forward and pushes the sample into a vial. OK. And then this carousel turns. Next one, next one, next one, next one. Until we end up with two hundred and forty vials over a period of time. Yeah, this gets brought. Well, only this gets brought from the field to the lab. And we analyze it with a gas chromatograph. Yeah, right.

So that's what you say that this is the industry standard way of doing it? Research standard yeah. So if you're doing field trials. So the furthest you can put a chamber from the sample unit. So if you have a hundred meter long sample line, obviously, by the time it gets from the chamber here, it's completely diluted. Yeah. So the farthest away they can be is about twenty five / thirty meters. So it's ideal for smaller scale trials. Yeah. From there, you can then extrapolate upwards and upscale your results. Does that make sense? Yeah. Yeah. So anything I've said that you're like, oh, no. No, I don't think so.

just quickly backtracking I guess yeah I just get a bit of a who you are that makes more sense we should have started that's all right yeah so I guess can you give us your name and your profession sure my name is Ella Dewilde I am a PhD student in soil science and environmental economics. I've been working in soil research since 2019 and my first job was to carry around a little sensor that measures soil CO2 all over the Samford Ecological Research Facility so I did that for a very long time and that's how I sort of started to learn lots about soil greenhouse gases and measurement techniques. Now I do a bit of other stuff but it's always fun to come back to my roots and do this. If it's okay can I get your age please 25 awesome it's more so I can if uh with other interviews so I can sort of see oh yeah different perceptions yep um what I guess led you to studying this like similar question that you asked me what led you um do you mean okay so I studied science and economics in my undergrad and in third year, you're required to take a science unit called soils and the environment and I fell in love with soils I thought it was the coolest thing ever um because I'd never really thought about it before as being this whole world that you could study and so about halfway through the semester I went to the unit coordinator and said I love this stuff can I get involved he said yes and now he has been my work supervisor honours a supervisor and now PhD supervisor as well so I've had the privilege of working with this team for a very long time and this is definitely this research group's specialty we're one of the we're at the forefront basically of greenhouse gas research in agriculture in Australia so it's really cool to get to learn from the best.

Yeah awesome um so it's why at least what is your perception of why CO2 measuring CO2 is important um if we think about so I suppose a more contemporary reason for it being important is over the past few years industry and the federal government has really put an emphasis on soil carbon as being the thing that's going to save us from climate change like we're going to sequester so much soil carbon it's going to be awesome um but in Australia because our soils are so old and so variable as well we really don't have enough information on the mechanisms behind how soil carbon is sequestered so obviously the flip side of that is soil CO2 emission so we need to be measuring it to see are we actually sequestering or are we still losing because it's not it's not fixed it will change over time yeah and I suppose people are always a bit too excited to jump on a bandwagon like this especially when there's money to be made from carbon credits so what we're trying to do is utilize all these different measurement techniques from those really small scale chambers all the way to flux towers to sort of say well let's pump the brakes a bit let's see what's actually happening in these systems are we sequestering carbon or are we not

TS

OBSERVATION TRANSCRIPT - ELLA DEWILDE

. Does that answer your question yeah no that does that's awesome um so I guess in I don't know academic terms what would you say the method is that you're using because at least from doing research they quote all these different methods yeah like a um alkaline method or the blackly kind of the other one method um is there a is there an academic name for your method? I suppose so the way in which you can collect your greenhouse gas measurements can change but once you do what um how you calculate what we call a flux so a change in concentration over time we use the linear flux method okay which was I suppose it's not really something I can say has been recently developed because it's just a principle of science that we use but it was popularized by one of the researchers that used to work here so where you use the concentration of your gas the volume in which it exists over time and also the molecular weight of the gas to make sure that you're expressing it in the right terms yeah is that nice one yeah yeah um the method will obviously change depending on what we're doing so this with the sample unit and the chambers we refer to as the chamber method we're talking about flux towers and I can show you some photos and videos I did see the articles from yeah big big towers right so that's eddy covariance method where we're basically measuring 3d wind so eddies they pass through a 3d anemometer so we can basically see the direction and speed of the wind yeah and then next to that on the tower is a co2 analyser so we can see the movement of co2 in those little parcels of wind yeah calculate that extrapolate over a large area depending on the landscape factors so we can see okay the area around us is it um losing co2 so is respiration greater than photosynthesis or the other way around yeah um so those are the two big methods that we work with um so I guess in the case of this method how recent would you say at least like the uh measurement the more so the sampling devices yeah that's good like as in do you come from my research like when I've looked at chamber methods the only real pictures I can find are tech drawings from the 60s oh really okay um what they actually look like and what they're supposed to do so um this chamber method so first of all, all this equipment is built by our engineers yeah obviously the bits and pieces we buy but we assemble it um within our group and we also export them to other research groups so because of that I suppose we are always innovating and trying to look for the most efficient system um what I did want to stress as well is obviously for us because we're scientists and looking at measurements accuracy comes before anything else yeah doesn't matter how like an ergonomic it is or whatever if it's not accurate it won't do yeah um so this system for for us we really started looking at this mid 2000s that was when my supervisor Dave did his phd and that was using a fully automated system so that's what you have in the field it sits in like a little trailer like you'd think it's carrying horses it's not it's got that stuff so where it goes chamber straight into a chromatograph so it's everything in the field rather than having to bring it back to uni so that was I think like 2009 2010. maybe yep that was I think the earliest instance of us using that like you said it's a tried and tested technique that's been around for a while same with the flux towers they've been around since the 80s but only in the last 10 to 15 years have they've been used in agricultural settings they're traditionally used in forest ecosystems because they're the only thing you can put above the canopy right to measure yeah what the forest is doing so then our research group came along and said hey we can put this in grasslands so we did that 2010 I think it started and now we've got over 30 of them oh yeah where about are they over Queensland really yes so our network is Queensland and northern New South Wales then there's a government agency called the terrestrial ecosystem research network they have a branch called osflux and they have their own tower network and that's across Australia and a bit of New Zealand as well a couple of our sites are shared so we share a flux tower in Longreach so western Queensland and at Samford so that QUT owned research facility yeah so we do a lot of collaboration with them yeah I got a bit off track there but I hope that answers your question okay um you spoke about accuracy is there a um what's the sort of accuracy that you need it to be like is there a acceptable amount of error um it's less about acceptable amount of error and more making sure we're doing quality control tests consistently to make sure if there is you know a bit of drifter or we're going off track that we're catching it and we know where we need to look further that's why that linear method is really useful because if you have measurements and the concentration is going like this yeah you know some funky is going on um problems with accuracy with this chamber method in particular is because we're in the fields those sample lines can often get damaged, clogged, we need to flush them with air to get the water out frequently because the water vapor builds up that can be a problem with accuracy and it's also resource and time intensive at times yeah it doesn't help when they get run over by tractors either which happens more often than you think um and that's what the the good thing is about having a fully automated system as you can see it in real time you don't have to wait until the samples come back to the lab and then you realize it actually screwed up 100 vials ago yeah um yeah so it can be very challenging yeah also so um and it's a lot of my questions were based on if you were then do you do much we physically take the soil from the ground and bring it back or is it all just sort of more chamber no no we've certainly done a lot of experiments that's what my honors was in was bringing soil back from the field and testing it here um it is still a really useful experiment to do um especially if you're looking at specific processes so I was looking at really specific nitrogen transformations using isotopic traces which is really hard to do in the field yeah so for that reason we might bring it back to the lab if we want to measure every hour that's the time when you bring it back to the lab instead of sitting in the field for days on end yeah um which I have done as well so it's humbled me you just sit there with oh yeah I forgot to say so there's another method we sometimes do if none of this stuff works which is manual sampling which is where you have a couple of hundred of those vials this is what we make like all the capstones do because it's good for them yep so we have the tap that screws onto this.

TS

OBSERVATION TRANSCRIPT - ELLA DEWILDE

Through this into that, take a sample, close it up, put it into a needle-on, put it into a vial, put it in there and you do that over and over and over again. So that's sort of the manual principle behind the chamber techniques. It's the same thing. You're sampling with time intervals to see the increase, it's just more labor.

Um, yes. So I have a good friend who spent literally years in the lab doing incubations, so when we create like a modified soil core in something like that, um, it's really useful for treatment experiments if we're, so she was always comparing different types of fertilizers to see which ones would retain the most nitrogen, which ones would be lost as nitrous oxide. Yeah. So it's really useful for those types of experiments.

Um, yeah, it sort of just depends on what your research question is, which method you would adopt. Yeah. Yeah, that's right. Um, so I guess you probably already covered it, but what makes a good sample? So whether that's through your gas, through your chamber method or if it's through another method? Um, what makes a good sample? I mean, other than it just having to be free of, being free of other contaminants? Yeah. Yeah. So no contamination. Um, making sure you've adjusted your sampling regime to the conditions. So if you've just, if we've set this up in the field and we see there's a big rainfall event coming, so greenhouse gas, emissions always spike after a rainfall event because there's water so the microbes get really excited and they're like, oh my God, I can eat so much carbon. So they start respiring like crazy.

So if we see there's a big rainfall event coming, we can then modify our sampling regime to make sure that we're capturing the effects of that. So it's really important to see, it's basically like your maximum potential of greenhouse gas emissions. We need to know what that is. I guess that's part of what makes a good sample is the adaptability of the system. If it's really clunky and hard to change, so it's got to be quite, it's a word like agile, almost

Which is something that's sort of eliminated with things like flux towers because then they never stop measuring. They measure it 20 times a second. So with massive, massive influx of data all the time that obviously needs to be processed. So depending on what kind of system you're with, the bottleneck might be in different places. So with things like flux towers, the bottleneck is obviously in data analysis. With something like the chamber system, the bottleneck is more making sure it's functioning in the field. And yes, it's got to be agile, resilient because we're in, you know, we're outdoors. So if you can't handle rain, if it can't handle intense heat, forget it. We did have an instance once. So do you see in the blue box, there's that like insulator and the lid? Yeah, yeah. Once the glue holding that to it melted all over it. Pests, we get animals nibbling the lines. We get ants and spiders trying to make their homes in literally everything. At SERF. This was actually the first time I spoke to Dan Cook at SERF.

The chambers were basically turning into like mass bee killing machines the plants would be really warm because they've just been like insulated, right? So the bees would go and sit on there and drink the water that had accumulated on the plants and then it would close and they'd get trapped and it would just kill the bees. I'm not sure that helped his research.

Yeah, so because of that, I then had to change when I was sampling to make sure that they, I wasn't sampling right when the bees were at their most active. So, there's always like so many more things that you need to think of. It depends on what system you're in as well. So we use them in cropping, grasslands and we've also used them in horticulture.

So in horticulture you have to decide, okay, do I put it under the black, for instance, mango tree? Do I put it in the interow? What do I do? And for one of our guys, the answer came down to where's the most shade, which he should not have done, but that was a practical consideration because it was in Darwin, so it's hot. Yeah. So that's why we need to have like a background, obviously, to where, what systems are most conducive to greenhouse gas emissions.

I'm just thinking of other things that are sometimes problems with these systems. Is that helpful at all? No. Yeah, yeah, that is. Okay. With the chambers, another, it's not a problem, but it's just something we have to be aware of. Remember how I spoke about those steel bases that we have to put into the soil for the things to clip on? Obviously, when you're doing that, you're compacting the soil around it, which affects gas diffusion, which is essentially what we're looking at. So that's a problem we sometimes have, we need to figure out a way to get those bases in without causing too much of a disturbance to the soil around it.

And that's another big difference between when you're in the field versus when you're in the lab. In the field, you have the soil as it is. In the lab, you've dug it up with a shovel or whatever, you've put it into a bin, it's been jumbled around, it's lost its structure, and then you've repacked it. So you might see different results for that reason. But again, it depends on what you're looking at. Yep. How much does temperature affect sampling? Yes, very much so.
Yeah. So obviously, that's why the chambers can't stay closed for too long. That's why we have to insulate the sample unit so the samples don't overheat. We also have to consider at what time we want to collect our samples. I wonder if there's a way I can show you the diurnal fluctuations because they're really cool. So there's obviously a big difference in emissions at night versus during the day because your plants aren't photosynthesizing. So a lot of the carbon that was taken up during the day is then lost. But then during the day, you need to decide, okay, do I do it early in the morning? Rule of thumb, we normally try and stay 25-ish degrees in southeast Queensland.

TS

OBSERVATION TRANSCRIPT - ELLA DEWILDE

Obviously, the further north you get, the harder it is to do that. But again, that's accounted for in our method, in our linear flux method. You have to put in the rough temperature when you sampled.

So that's a big factor here. And there'll be so many studies on that. You can look at, you don't have to take my word for it. So I guess once you've got your samples and you've tested them, what happens then? What happens then? Okay, come with me.

So we use this vial belt, looks like a big like ammo belt that gets brought in from the field to here, we load it in here and it gets basically, not automatically someone still has to be here to set it up but once it's up and running it gets analysed automatically um with one of these fancy machines that i want to try to know how it works so yeah you can see there's a vial in there it's the same system as in the sample unit now it's just here connected to an analyzer same thing needle, extract. the other option is so before we had this so that's a chromatograph that we use in the field sometimes the other option is if that's not working or if we have a high sample volume we'll send it to one of the labs here at the central analytical research facility so they always get analyzed um with a chromatograph so that involves packing them up into cute little cardboard boxes and sending them to a researcher and she runs everything for us and then you get a spreadsheet with your concentrations yep you plug it into a different spreadsheet that then calculates it using that linear flux method which I can show you at my computer if you want yeah that would be great yeah um yeah so that's pretty much what happens and then so say we've analyzed the vials then have to be evacuated so that there's no air in them so a sample can be pumped in yep we do that using this little thing so vial goes onto nozzle, when it's up and running you turn it on sucks all the air out for about 20 seconds and then it's ready to go so we're just recycling vials so they're just a little over and over um a little silicon bits or something in the top yes yeah little silicon seals yeah so it looks like that and then little rubber seal at the top yeah that's awesome yeah so they're only 12 mil i think onlly small um but because the gases i suppose compacted and we still get about 30-40 mils a sample yep um yeah that's pretty much it in here i think yeah awesome this is sometimes something we sometimes use in conjunction with our greenhouse gas samples it's a soil moisture probe okay so obviously moisture is another big determinator of greenhouse gas fluxes so they're stuck in the soil close to the chambers and they're recording soil moisture at the time as well so we can see okay so there was a rainfall event, soil moisture has spiked and then we also see oh there was a spike in co2 as well yep it's useful to see what the environmental conditions are doing to the greenhouse gases.

So the last real burning question is how easy or hard do you find it from what How long does the process generally take from collecting the samples to getting the data back? It can be pretty quick actually so say we've got that vial belt they all they fit 240 vials we've got eight chambers going at all times so that means we can have a few like different sample events yep so yeah each chamber uses 24 vials so at 0 minutes 30 and 60 so they'll last us 10 sample events during peak season so in the summer if there's rain we'll try and sample every day so it will last 10 days so the turnaround can actually be pretty quick from setting it up getting your samples and getting them analyzed maybe about two weeks but depending on how accessible the site is obviously we can't be driving to Longreach every day yeah so perhaps then we'll only set the sample unit to sample every week / every two weeks so then we have a longer period in between needing to collect the vial belts and switch them over yep flip side of that is again if something goes wrong we don't immediately know so that's why it's really useful to have lab facilities and pilot facilities to make sure it's working before it goes out yep and when something goes wrong it is horrendous. I was running one of the fully automated systems at Samford for about a year it was I felt like every other day something was going wrong cords were either broken they're getting tangled mud everywhere the equipment obviously need to be run and that was during that really like wet autumn and winter so the solar panel wasn't working so the generator had to run and if I wasn't there to top up the diesel the generator would obviously run dry and stuff it up so that was a pain so when everything going well really easy yeah if there's a problem with the power supply that's where a lot of big issues come with yeah yeah all the other stuff we can plan for like you know we we can use ant sand to keep pests away sometimes we bury the lines just under the soil so the animals can't get to them yeah so that stuff we can all deal with but you still always need manpower around to do troubleshooting and make sure it's up and running and that's it can be very intensive yeah so then when you're using the equipment, I know you said it's not about how ergonomic it is but how I don't know how ergonomic is it to use like how easy do you find it it's obviously like clunky and awkward because everything so big but it is quite simple everything sort of you've got your there's basically only three components that we need the steel bases the chambers and that (collection) yeah the only thing in that that's heavy is the battery which we can take out there is another method of analysis that I can show you except my desk and that's probably the least ergonomic that's what I started with so you have to carry around it's like an analyzer in a backpack you're gonna carry around it's really heavy yeah so you got it in a trolley now I didn't have that luxury I had it literally in a bag that I had to hoist over my shoulder but this stuff I mean the furthest you have to manually carry it is from the car to whatever you want to put it yes so it's not too much trouble.

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OBSERVATION TRANSCRIPT - ELLA DEWILDE

That's right it's very helpful that's good far more insight than I can get from looking at online stuff so yeah so you said it's about two weeks how much change theoretically would there be in that like you've tested a patch of soil, you get the results back two weeks later, yeah theoretically how much like with the change that's happened in that patch of soil be mean that the results you have are no longer as relevant or is it no no because in the meantime when we've collected the old belt we put a new one out so we're still measuring it over time and like I said we know enough that we know the biggest change happens around rainfall events so if we know there's rain coming make sure we're measuring if it's a really dry period there's no reason to be measuring as intensely yep so it's really about yeah the climate and disturbance so say we've just I don't know plowed up the soil obviously that's a big disturbance so then we want to be measuring it again so no in the time it takes for the results to get analyzed they'll still always be relevant yep exceptions to the rule being if you know we've collected vials and in the meantime we've had other samples come in that have been like higher priority so it takes longer for us to get round to analyzing older ones yep but it's still useful because a lot of the information we collect we try and we share with the farmers whose land we're on and they're always really interested to see all that so even if you know it's not as dry or not as wet as it was a month two months prior yeah still interesting to know what was happening at that time mm-hmm that makes sense yeah you say you're working with farmers is that specifically cropping or is that also a bit of livestock? we're mostly in cattle now we've been in sugar, cropping , we do stuff with a company called GRDC so grains research and development corporation on that yeah a little bit of everything yeah and then normal staple stuff like sorghum, millet yeah that's stuff too well I think that is all the questions all right thank you for that oh pleasure um and if you go back and you think gee she really didn't answer this question just email me honestly it's fine and I can try and find something else it's more helpful to you no it will do awesome um did you want to have a look at any of like the data that that produces is that useful to you would you want to know what the output is or not yeah sure yeah that'd be great

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STUDIO NOTES: STUDIO 10

QUT Automated Closed Chamber Method

- Measures CO2, N20, CH4 (Carbon Dioxide, Nitrous Oxide, Methane)
- Measures soil CO2 influxes over testing period

Soil CO2 or Soil Organic Carbon?

Soil CO2 measurement is tracking the gas emitted by the soil through the means of chambers.
Soil Organic Carbon is the testing of samples to find SOC in soil composition.

"We don't have enough info on how CO2 is sequestered, so we're looking at CO2 emission to see are we sequestering, or are we losing CO2."

Can look at other soil measurement methods for benchmarking (e.g. measurement of soil carbon).

KSU soil testing robot
Veris Tractor pulled sensor

Carbon Balance Equation (in-situ measurements)

I=P+R+E

I) Injection of carbon - incorporation of carbon in the sponge
P) Biomass Production
R)Respiration
E) Disposal of Waste (Excretion & Egestion)
A) Assimilation (absorption of food & nutrients)

Net Growth Efficiency (NGE) P/(P+R)

Total C input - CO2 emission

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CO2 CALCULATION (TAKEN FROM PERPLEXITY)

To calculate soil CO2 sequestration when soil CO2 emission is being measured, you need to consider the net carbon balance in the soil. Here's a basic approach:
Measure soil CO2 emissions: Use techniques like chamber measurements or eddy covariance to quantify the CO2 being released from the soil.
Estimate carbon inputs: Determine the amount of carbon entering the soil system through:
- Plant residues
- Root exudates
- Organic amendments (e.g., compost, manure)

Calculate net carbon sequestration: Subtract the measured CO2 emissions from the estimated carbon inputs.
Key Steps
I. Measure soil CO2 emissions over time (e.g., in g CO2/m2/day)
2. Convert plant biomass and other organic inputs to carbon equivalents
3. Sum all carbon inputs to the soil system
Calculate the difference:
Net C sequestration = Total C inputs - Measured CO2 emissions
Convert the result to CO2 equivalent by multiplying by 3.67 (the ratio of molecular weights of CO2 to C)
Considerations
Temporal scale: Measurements should be taken over extended periods (seasons to years) to account for variability.
Spatial variability: Multiple sampling points are needed for accurate representation.
Depth: Consider the entire soil profile, not just surface emissions.
Other greenhouse gases: Account for CH4 and N2O emissions for a complete picture.
Advanced Techniques
For more precise calculations:
Use isotope tracing to differentiate between old and new carbon in the soil
Employ models like RothC or CENTURY to simulate long-term carbon dynamics
Utilize remote sensing and spectroscopy for large-scale assessments
Remember that soil carbon sequestration is a slow process, and changes may only be detectable over several years. Long-term monitoring is crucial for accurate assessment of carbon sequestration rates in soils.

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INTERVIEW #1 TRANSCRIPT - DR SCHEFE

Righto. So what have you committed to? What have you written so far or what was your proposal? So I guess my topic is measuring CO2 in the soil, not carbon from our conversation the other day. I was looking at it and I guess made a decision that way because I did a interview on Tuesday with a PhD student here at uni. She took me into the lab and showed me at least how they measure CO2 respiration from the soil. So the sort of route I'm going down at this point, the research project is just looking at what it is, how it's done and looking at I guess different methods of how it's done. I have to do product benchmarking so do a comparison of different methods already existing and see if there's any gaps. So what method was she using in the lab? So they were using a, They called it a GC, gas chromatography.

So this was with a chamber. So then probably just easier to explain it. Like the bit of metal in the ground, clip the chamber on the top and the chamber sends air samples, sorry gas samples through to a central point, the central point then puts it all through, puts all the samples into vials. So that's the collection process. So this is probably key part of the design piece is there's the collection of the gas and then there's the analysis of the gas. So that's probably something that you can start to actually tease apart a bit more as well. The method that she's using is standard. There's a whole lot of variation in the quality and the scale of that kind of stuff, but it even goes to like from really small laboratory type stuff all the way through to like in-field we use even down pipe for drains eg a PVC down pipe. Actually just cutting that into sections like that big chamfering the edge to create a bit of a cutting edge on the bottom and then actually pushing that into the soil and then putting a cap again, a PVC cap over top, drilling a hole in the cap to then stick a septum in it, which then the needle for the vial, the syringe needle can punch through and then extract the gas from there and then you end up with gas in basically think of like a 10 or 20 mil syringe and then that can be taken away to a gas chromatography system and literally then that needle can be injected into that gear and then that CO2 sample is caught up in a gas flow which then goes through a analysis system which then measures the concentration of CO2 and then other gases as well.

So the quality of that gear is highly variable according to how much funding you've got, but I should have some photos somewhere of how this stuff's been done. It's been used a lot in the field more for nitrous oxide measurements, so they measure CO2 as well, but nitrous oxide being one of the key greenhouse gases that are emitted from soils, means that something that they focus on. Because I know she showed me a data set that they had from testing they'd done out at Samford and they had the CO2, so that CO2 they had methane and they had, is it nitrogen or nitrous oxide, that N2O? N2O nitrous oxide. So, you're at QUT, aren't you? Yeah. So, there's this massive amount of work happening at QUT and it's quite a small field, so I can probably guess who her supervisors might be. Well yeah, so her supervisor is David Rowlings, David Rowlings. Who actually has a connection to the Schefes. Oh really? Yeah, it's a stupidly small world in that.

So he knows, have you heard of a guy, um, uh, Dave? No, not Dave. Oh, another one. Have you heard of Mount Binger? Binger. Camp, an outdoor Ed camp, Near Toowoomba. Oh, Mount Binger, is that? That's where pop goes sometimes to ride horses, it's where your dad and I went on school and church camps a heap when we were young. Anyway, one of my cousins now and his wife run Mount Binger.

Oh yeah. So Schefes have being involved in that area for a long time. Yeah. David Rowling's family own the property next door. Oh, okay. So I met Dave online, you know about six months ago, we're chatting through his stuff, a bit of work stuff, and then he comes out, oh, Schefe, we're probably related somehow. Nice. I think you do. Yeah. Anyway, yeah, it is, it's a small world.

Okay, now I can't find the, I can't find the pictures, but yeah, look, you would have, you'd be across all that. If you're checking out what Dave Rowling is doing, and also see what Peter Grace, just do a Google search for Peter Grace. I saw that David was doing work with the flux towers. Yeah. So that's kind of a landscape scale. Mm hmm. Peter's kind of, he has been working in the space forever, and he developed a lot of the methods that are now being used. Oh, okay. So he's like, he's the senior who bar in this work behind, behind what Dave's doing. Mm hmm. So if you Google stalk a nice type of hit, I've actually found his academic profile at QUT.

He's, yeah, you'll see crap loads of stuff. And yeah, he's involved in one of the international work as well. So what they're doing with the flux towers, and then the infield sampling pieces, that's kind of the, amongst the most technical, there's also a lot of automated chambers. So, the PVC tube, things stuck in the ground are what we call static chambers, because you only put them on for a small period of time. You wait for them to fill up with CO2 and then you suck it out. You can't leave those static chambers in place for too long, because otherwise, it shifts the, as you get a buildup of CO2 in that environment, it shifts the system.

It's like if, you know, if we're stuck in a small room sealed for too long, and our CO2 concentrations increase too much, then our systems, our biological systems will change. And eventually it will die, right? Similar thing with the small microbes in that, we want to capture that, their homeostatic state, not actually create a buildup of CO2 to the level where they're changing what they're doing. So those static chambers, you put them on maybe for 10 or 10 minutes up to an hour, depending on how biologically active your system are, suck out the gas, and then get rid of the, well actually what you do is you put them on, you do an initial ambient to see what it is right now, and then you let it build up again, take another sample, and then look at the difference between the two, and that gives you a time series.

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INTERVIEW #1 TRANSCRIPT - DR SCHEFE

And stuff how much CO2 is accumulated within half an hour or an hour, and that gives you a rate measurement. And then you take the chambers off and come back tomorrow, or you might do it before and during and after a rain event, because that's when you'll get our biggest fluxing, the particularly nitrous oxide and CO2 will shift the amount that's produced according to how much water is in the system. So if they get water lot, and they run out of the air, then a lot of microbes will actually switch to producing nitrous oxide, which is when we get our big greenhouse gas emission issues. So you kind of, static chambers, you put them on, you do your thing, and then you take them off. There's other things called automated chambers, which are as fancy as they come. Which I think is possibly what the system was I was being shown the other day, because they're more sort of, they're almost sort of more like a steel box, the lid automatically goes up and down, and it automatically sends samples to the, I can't remember what she called that, it just looked like a big yellow esky with some techno tech inside it. Well, there's, I've just found a really nice paper that I can't remember my passwords, so I can't access it right now. I think it's a good paper. Oh, here we go. Use this.

You've got journal access through QUT. Yeah. So that's, yeah, compare some different chamber techniques, hopefully there's some good pictures and stuff for how they all work. So there's that level, right? So that's the, that's the scientific methods around, you know, you've got different doc designs of chambers into the field and sucking out samples, you're injecting those samples into what's called a gas chromatography system, a GC, which is the actual analytical kit instrument that's used to actually do the measurement of those things. And that way you get precise numbers, you have all your standards in place, you can talk about concentrations, you know, it's that's the, that's the high-end science angle. The other approach is the low-tech in-field farmer relevant piece around is, is it good or bad? If I do something and I make a change, can I see a difference in microbial respiration, right? Now, in that, in that context, microbial respiration is a, is basically a surrogate for saying, are the microbes in my soil functional and are they doing their thing, you know, gives it a, you know, healthy system? Yes. So for that, there's a, a method called the Solvita test. Have you heard of that one? Yeah, I have. Is that using a color spectrum? Sorry. I have sort of seen so many different things. So of, of the different stuff out there, the soil health test is, is pretty good.

I've used it for stuff I do with land care groups and that, where you've got farmers who, who they want to measure micro stuff, you know, they don't just want to measure the chemistry and what's happening. They actually want to measure the bugs. Yeah. And the kicker is that most of the, the microbial tests that you can do to measure the amount of bacteria or fungi and everything else in the soil gives you a lot of numbers and gives you a lot of detail, but you actually can't, you can't use that information at all because none of the, none of that biological stuff around, you've got this many bacteria, that's been fungi, whatever. So when you get to the so what, what, what can I do with that? There, there isn't actually a clear pathway for that.

So we actually recommend farmers not measuring their bacteria and fungi and everything else because it gives all this information. Most of the labs who do those tests don't have standard national accreditation. So they're kind of a bit rogue anyway. They're not aligned with any national methods. They will then give recommendations about what worm juice you should put on and what kind of, what things you could put on to feed the bugs and stuff, but that generally comes back to what they're, what their marketing or, you know, what products they're trying to sell. So the biological testing for farmers isn't as objective or as standardized as what we have in the chemical testing. So we actually say to farmers, really don't worry about that if you get the big things right. So if you set up your soil, chemical and physical properties, which you can manage and measure, or there, those are, the microbes will actually do their thing. So, you know, you build the house, they'll come, kind of jazz. But if you want to do something just because that's what you want to do, then a Solvita test is a nice way just to see how you're functioning, really.

Yeah, so the, of the different tests that they've got, these, the field test, Solvita field test is the best one. And it says, so I've used this quite a lot. It's completely as simple as, you know, what the pictures show around, you put dirt in a container, you put in a color thing, a color indicator. Yeah. Hang on, I forgot to copy that across.

And you leave it for 24 hours, the tag changes color, and then that gives you a number. And it's kind of fuzzy enough that it's not something that you grab hold of and try and manipulate, but it's enough to say, okay, well, I'm, I'm pretty good. I'm kind of in the middle, or I'm, you know, it's super crap. So that's a nice, nice approach.

There is a lab standard of that that actually then puts that paddle into a, an actual reader to actually create a number rather than just a plus or minus two and a half, three, whatever, you'll actually get a, a number out of it. Oh, really? So that's kind of the, the next bit up. And that's there, particularly with the CO2 burst test, which is the lab test. So it's exactly the same deal, but they, they actually put that color into a color reader and it might come out as 2.75 rather than a plus or minus 2.5 to three or something like that. So same principle, just a little bit more numbers. So I've done stuff like that to demonstrate that farmers think they're doing the right thing, but this is kind of like goat country farmers, you know, not really more lifestyle dudes who watch podcasts and, you know, not actually read anything or listen to old farts, you know, so I do like old science. They're into the new science.

So I do that kind of stuff to show that, look, they think that if I put anything on the soil, that it's going to poison the land and it's all going to go to shit and that they want to do everything natural. And they've got quite good soil carbon numbers because of that, right? So they might have a soil carbon value of 4%, which is massive.

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INTERVIEW #1 TRANSCRIPT - DR SCHEFE

Yep. But then when you actually do the contexting information, you find out that that soil is so degraded that the microbes actually aren't functioning. So then you do a Solvita test and the microbial respiration comes out as almost zero. Oh, okay. You've got high carbon levels there and high organic matter, specifically because your microbes aren't functioning. So they're not turning everything over. Yeah, right. Kind of got, it's like a wasteland system that you're just accumulating rubbish on top. Yeah.

The microbial test is the CO2 test through Solvita is just a nice way to say, look, it's not all their own skittles. There's enough there that gives them a reason to have a bit of a think about what they're doing. Yeah. So like I was reading your, it was a cool soils thing. You said that the farmers that you tested had 4% carbon. Is that a, like, is there a situation where you can have that high carbon and then also have a good microbe health? Or is it sort of? No, you're exactly right. We only had a few who are up at those levels.

Is this a webinar or something? Or? It was. Yeah, definitely with the websites going. The, it's, what's just saying on the website? Don't believe everything you read about them. Oh yeah. One. I know it was one of those things. I was reading something and it was, I was reading the Mars. I was trying to look through Mars to see what they mentioned about their, what they're trying to do. And it mentioned cool soil and then sent me to this website. So. This was a few years ago. I've changed you since then. Yeah. I did, I did see the ute. I was like, well, I think that's Cassie's. Yeah. So that's the Navarra. I've got, I've got a Mazda now.

Yeah. No, that's all good. So this is a few years old now, but the numbers or the messaging is still the same. We've got about 200 farms in the program. We've got about 1800 soil tests. What those numbers are showing is that they're actually where farmers are doing everything right. You know, so in that situation to have high carbon levels in a functional food production system is quite, it's quite surprising when we first started this work, but then we actually delved into it. And because we have all the other numbers, production numbers, soil health stuff, you know, the whole yields, the whole thing, we were actually able to say, look, there's, there is a really nice novel story around, if you do everything else right, then soil carbon levels can increase, but it's not, it's not a given. And it's certainly soil type and, and rainfall dependent and stuff. So it's not a given, but it's to say, look, we have some variation. So a key part of what we're actually doing now is actually doing a heap of data interrogation work to see, well, what can we learn from the, you know, the 2000 plus data points that we've got? Are there some trends that we can pull up those farmers who have higher soil carbon levels? Are they using less fertilizer to get the same yield response because they've got better fertility? You know, what their crop rotations look like? You know, all that kind of thing.

And that's, that's pretty cool. So, but that's a bit of a learning piece, because none of us expected to find that. Yeah. Yeah. And then, like you mentioned, that 4% is high. What's the sort of scaling? It's very much soil type and rainfall dependent. So there are the two, two limiting factors for soil carbon. If we don't have moisture in the system, we can't grow plants, which means we can't have biomass, which means we don't have organic matter residues coming in, which means we can't cycle organic matter, right? So that's one thing. So, and actually the, the tweak with that is the key driver is actually humidity. So that's the humidity within that soil environment.

So your subtropical tropical regions have a much better capacity to hold carbon. And, and build that, build that back. The other thing is with the soil types, I've actually got a shitload of carbon respiration data. Well, CO2 respiration stuff that I did, which showed in a clay soil, clay soils have a lot of chemical charge. So the actual clay themselves are highly charged, which is measured by what's called the catalytic chain capacity, the CEC of the soil. That high charge means that it can actually chemically bind with organic matter and carbon. Which means that you can actually hold a lot more organic matter in that system.

Whereas in a sand soil, you don't have a lot of charge. I think a sand is like, you know, think about beach sand. It's like a star-pum-volt. It has very little chemical interaction with its environment. So that means that any carbon or organic matter that's in that system is basically they're adjacent to those soils, but they're not chemically interacting with them. Which means that they're a lot more vulnerable to exposure and loss compared to those that are in a heavy clay soil. The other thing with clay soils can also hold and build greater microbial populations because, again, they've got a lot of cracks and crevices. They hold a lot more moisture. There's a lot of places in micro habitats for microbes to live in clay soils.

And because of the organic matter binding, there's a lot more food for microbes. Microbes are already there. Whereas, again, in a sandy soil, there's less physical habitat for microbes. They themselves are a lot more exposed. They don't have places to hide. You know, when a sandy soil dries out, it's kind of like it's a windstorm. Everything gets sucked out really quickly. Microbes are quite vulnerable for desiccation and stuff. So a sandy soil is going to be a lot more fluxing. It might build a bit of carbon, but then it could lose it really quickly. Whereas, a clay soil has, you know, it's a lot more of a robust city, I guess, for microbes to live in and that kind of thing. So then the last thing that the total carbon and the CO2 thing is they're kind of competing in a way. So we want microbes in the system to break down organic matter, release the nutrients that are in organic matter for plant use. They compete against pathogens and stuff in the system. We want microbes have a lot of different beneficial impacts. They fix nitrogen, they do all this cool stuff. So we want a lot of microbes and want diverse microbes.

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INTERVIEW #1 TRANSCRIPT - DR SCHEFE

But microbes eat organic matter, right? And when they eat organic matter and break it down, which is the key function of their job, they breathe out carbon dioxide, which is what you're measuring, which is how we determine how healthy our soil is because we've got lots of microbes in the system. Now, remembering that they eat organic matter, carbon is a key part of organic matter, they breathe out CO2. So by default, microbes kill carbon.

Although they then result in more of that soil carbon being released back to the atmosphere of CO2. But on the other hand, we want carbon, but we want microbes. Can you see the challenge? So if you've got the organic matter in the system that the net measure of carbon of that, and just by default, I'll just write a little equation in here, which may have come across soil organic matter equals soil carbon times 1.72. So the soil carbon in the system multiplied by 1.72 is about the mass of organic matter. So organic matter is not just carbon, but it's the key fundamental driver piece, okay? So we want carbon in the system, we want organic matter in the system. If we put in lots of residues or composts or manures and all these wonderful things that are basically like ice cream with syrup on top, the microbes love it. So they breed up, they multiply, we get increased microbial activity, we increase populations, we get a massive lift in the amount of microbes in the system because there's all this food for them to eat, which means that we actually lose most of that added food through microbial respiration in CO2. So when we add compost or manures to a soil, microbes spark up and we actually have a high rate of loss. So we can't just say let's add organic amendments to the soils and that will increase our soil carbon and will save the world, right? So what we need to be talking about is knowing that the soil organic matter is doing this all the time, we may increase that if we do a fundamental shift in the system that we can sustain, right? We do something differently and then we commit to that change over time, we can result in a lift, but if we don't maintain that, we'll actually drop back again because the microbes will eat it all and then we'll be gone.

So it's as much around maintaining soil carbon values with a healthy microbial population is a healthy functional soil. So we can't assume that we'll do great things and will increase carbon because we're at the same time bringing along all the microbes are bringing in the uncles and aunties and they're all running along for the ride. But it's kind of the microbial piece in a way is verifying that that soil is functioning and organic matter is functioning through high CO2 respiration levels.

But we can't say we want to increase soil carbon and increase microbial populations at the same time because that one kind of can cancel out the other if we don't do it right. Does that kind of make sense? It's like CO2 respiration is the measure of microbial activity and if they're doing really and if they're doing really well, then they're eating a lot of organic matter. We always need to be replacing the system to keep it functional.

I did see when measuring CO2 respiration from what I've seen in theory, you're then supposed to be able to calculate the approximate amount of soil organic carbon. What is the sort of equation? No? Not really. You can estimate the microbial biomass carbon. So knowing that carbon is in every cell, every molecule, right? Every part of a microbe, let's just talk about bacteria, for example. They're very small little bugs. There's key carbon in every part of their cell.

And so when they die and they get eaten by other microbes and then they die and everything else, you get residual biomass in that system. So by sort of using microbial respiration to estimate the amount of microbes there, we can estimate that pool of organic matter, but we can't use that to determine the mass of the total bucket of carbon in the system.

So this is kind of standard. Some people use techie things. I use drawings. So this is your total carbon bucket, right? Of that, we might have a bucket down the bottom that will call a resistant or recalcitrant organic carbon. And this is like charcoal. It's carbonates and stuff in soil, stuff that isn't really going to change or interact with any of the microbial process.

Then we have a bucket which we call our humic organic matter or our humus, which is a really wanky term because the term humus gets misused everywhere. So if you say humus carbon, then everyone pictures beautiful compost and stuff, but it's not. So this is carbon that has been kind of processed. It's been through microbial decomposition. It's kind of like the last remaining products that them themselves are quite stable. So that's kind of a pool of carbon that is a slow, slow flux. Then we've got the next bucket, which we call particulate organic carbon. And this is our decomposing organic matter. And this is the cycling bit.

So this is the stuff that's going round and round around because it's been broken down by microbes. It's inactive decomposition. And then at the top we have our microbial biomass carbon, which is the carbon specifically associated with microbial cellular activity. That's probably not to scale, but relatively, it's either that or it's even less, kind of depending on what kind of system you're in. But that's like the, that's like the hamster wheel stuff. That stuff's being cycled incredibly quickly. Whereas kind of as you get, as you go down the layers, it's kind of like the slow motion stuff. So the challenge we have is most of our measurement, I mean, we can measure these pools in research settings. We break all these down and we can do all that. Most of the lab tests give a total carbon. So it's just one measure for everything. So if you've got, um, that won't tell you how functional this is. If it's actually working for you, if it's all just sitting there because the bugs are dead and, you know, go on elsewhere because it's so crap.

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INTERVIEW #1 TRANSCRIPT - DR SCHEFE

Right. So that'll just give you your full number. So the microbial respiration piece then becomes quite a nice way to kind of get a suggestion of variable quality, according to if you're using like a Solvita or something in the field, all through to the high end analytical stuff that Dave Rowling's and Peter Grace are doing, to see how, how much function or activity you've got in that soil. So in that way, it does give a really nice, um, yeah, give an idea of that, you know, what's in the tank, what are they doing? Which if that's not going so well, or that's doing the wrong things, such as nitrous oxide emissions, then that's something that we can actually make change around. Yep. Yeah. So yeah, that's, oh, and I forgot, there's actually a little bit below the microbial, um, which is generally measured, measures both of these buckets. It's called labile carbon. Um, it measures the microbial biomass and kind of the highly dissolvable, like water dissolvable carbon in this. Okay. So the, the definition of labile carbon sometimes gets a bit murky, according to who's telling the story, but it's, it's generally, basically, um, yeah, putting dirt or organic matter in water, seeing what dissolves and, and measuring that kind of say, well, if it's dissolvable, then it's likely to be, you know, doing something. Yeah. Yeah. So that's about it. How's that for a soil carbon 101? That's pretty good. Thank you. That's all right. Um, yes, I guess you've got two angles with your design. You know, as we mentioned, you could look at the, the sampling, like how you capture the gas from soil, and then how you measure that gas. So if you consider them to be very discrete, um, requirements, because you can, there's a whole heap of different ways you can capture gas from soil. Probably don't want to get into the chemistry of exactly how you measure it at a GC level, but kind of what indicators or, or other things can be used, or even kind of working through what these gels are and stuff that Solvita use. Um, yeah, what the go is.

Yes. So what do you, what are you thinking so far? We're not really sure. Um, not really sure. That's the, the next part of the project after, after the report's done, then it's well, have to think about it now. Yeah. Um, yeah, no, I know after the meeting on Tuesday, I am like after seeing the equipment used and what not I did sort of start to think about, um, like that is a lot of equipment and was a sort of thinking about, you know, it's more just like, what if, no, is there a way to make it smaller? Is there a way to make it, you know, so you don't have to wait two weeks to get results back? There's all that sort of so. Now that there, there is another way, which I actually just remembered because it's been so long, but, um, I actually measured CO2 respiration in my PhD time and I actually came up with my own design for a sample vial because this was like the dark ages, none of this had been done before, you know, rocks. Um, I've not got a, I've got a photo of it somewhere.

Um, just got to find my PhD files. So my PhD work was on, um, organic carbon products, um, and how they interacted with soil, but specifically how they changed the ability of phosphorus, uh, fertilizer to react with soil. So did they improve the ability of, did they decrease the binding of that phosphorus? So that the plant had more time to take that phosphorus up. So another concept, um, phosphorus is like, um, as a, as a compound is when it hits the soil, it will, it's like those, um, it will stick with anything. I'm just thinking of like, you know, those glob things that you throw and they splatter on or something and they, like alien goop, right? Um, when phosphorus dissolves out of a fertilizer granule, it will, but it's, it's highly charged and wants to bind. It wants to bind right now. So the first highly charged surface it sees, which generally is a clay particle, it'll bind really strongly to it, which means that of the pit that we applied to soil, generally only about 5% of that is available to that plant in that season. So the efficiency is really low. And so I was looking at how carbon compounds can actually compete with that phosphorus for binding. So it can, if those carbon compounds can hit that clay first, and if that just puts the phosphorus in basically a holding pattern, which, you know, it may keep it in that available form for, you know, 20 minutes an hour, whatever, that just gives that a little bit more opportunity for the plant to take it up. So as part of that, I did a heap of microbial respiration and stuff. But, yeah, so back to do that, I had to effectively design my own system.

To do that, this is a pretty crappy photo, but I'll see if I can share it. So I wanted to measure, can you see that? Yep. Now I've lost everything else. Anyway, I wanted to actually capture the CO2 in that system in a way that is kind of representing the soil environment. But in a way, I could do heaps of analysis. So what I did was I had these plastic containers and had dirt and water in there, organic materials and everything else.

And then I actually found these little glass vials that were, I think they were old instrument vials from like the precursor to gas chromatography, like really, you know, 1970s or so version. And then I ran a bit of tie wire. Around the lip of it to create a hook. Right. And then I used, you know, that plumbing tape, you know, the stretchy white tape that you put to stop leaks. I then got a loop of that and hooked the tire wire and then brought the plumbing tape over the lip of the plastic bottle and then sealed it. And then in the glass vial, you can't really see, but there's a clear liquid in there.

I actually had a barium sulfate trap. So I think it's barium sulfate. It's in my phd actually anyway. So this is a liquid that absorbs CO2. So because this vial inside the larger vials open all the time and I changed it every day initially. And then, you know, as time went on, the microbes got less, I then changed it less and less. So then because it sucked up CO2, it didn't change the oxygen balance in the system because it wasn't actually just holding that gas there.

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INTERVIEW #1 TRANSCRIPT - DR SCHEFE

It was actually, and then I took those files out and then did what's called a back titration with another chemical and worked out the other chemical I needed to offset the CO2 that was in there and then calculated the amount of CO2 that I'd captured. Does that make sense?

Kind of. So you just moved where the CO2 was being stored and then... Yeah, I stored it in a liquid phase rather than in a gas phase. I can't really remember that time. It was pretty crazy. Apparently, I did all this cool stuff, but I actually can't remember it. Seriously. Oh, there we go. I found the actual thing. So can you see that document? Yeah. Yeah, this is just the chapter on my thesis. So that's right. So that was the...

I said, that's right. It was actually Sodium Hydroxide I had in there, which then when CO2 reacted with that, it then turned into a carbonate. And then... Then what did I do? Yeah, I actually can't remember a lot of this stuff. I did some cool respiration stuff though. I do remember that. Here we are. So then I was finally doing all this stuff. I was able to calculate the CO2 rate of respiration on an hourly basis. And so then this is all published, by the way. So this is in papers that you can access. Just do a journal stalk. Actually, I've got most of them, I think. So it's all publicly referenced and everything else. I've done the journal papers.

So this kind of stuff down here is when you had soil by itself, where you had lignite, which is a brown coal. And I was using that as a stable carbon addition, whereas these two bars for the addition of carbon is compost. So a lot of labile, microbially active carbon, basically sugar. So then you can see how quickly the microbes responded to those high levels of easily eatable carbon. And so then the respiration levels went through the roof initially and then they came back. The other cool thing is that we know that bacteria responds really quickly to a change in carbon source. So this is mostly bacterial dominant, whereas this is starting to show the fungi kicking in. So this is a fungal dominant response here. Okay. There's a lot of literature behind that as well.

But yeah, that's... I don't even know what else I did. Did I do stuff? Yeah. So that's kind of why... So that's kind of old school. But that design that I had with my little glass vials and the tie wire and the plumbing tape, I literally made that up. So I don't know if that's anything that's of any interest to but. Feel free. There's no IP associated with that. Yeah. It's amazing what you can create in...

Yeah. When you literally just need to do something. Yeah. But the great thing about that was that then when I pulled the vials out, I sealed them because they had little caps. So every day when I'd swap them over, I'd seal them and then I'd set up like a hundred of those vials on the bench and then I'd run them through as a batch, through the back titration work.

So that way I was able to batch the work rather than having to do every pull a vial out and do something with it immediately. I got RSI in my wrist because of it, because I was titrating for days on end. Yeah. But that was kind of how I went about it. But anyway, yeah. My thesis is public knowledge. My paper's are public knowledge. So if there's anything there that you can use, knock your socks off. Yeah, ready. There you go. All right. Let's give me a bit of... A bit of food for thought. Yeah, it has. No. Thank you.

It's okay. Yeah. And let us know when you want to catch up with Dave and I and like an interview thing, if you like, if you still want to do that. Yep. No, that would be good. Are there any days or whatnot that work better? I did see that you're supposed to be a bit busy in this next week with presentations. Yeah. In desperation, I turned to Facebook. We recently lost our local comms ability, which meant that I lost all the the ability to send out bulk information and everything else. It's like, I'm just going to put this on Facebook. It's on Twitter. Yeah. Hopefully get some get some farmers there.

Okay. What about? How soon do you need to do it? I guess ideally having interviews done by next Friday. Okay. Well, what about Monday? Yep. Is that about it really for me? Even nine on Monday? Nine on Monday. Yep. That works. That works. We send an invite through to Dave and I. Do you have a Dave's email? No, I don't. Dave at agrisseye.com.au What do you do? No, that sounds good. I will send through forms that I need you guys, we need you guys to fill out. Just the standard. Yes. Just the very standard. Ethics forms. Oh, no, that sounds good. Thank you for that. All right. Well, if you send that through and yeah, we'll catch up with you on Monday. Yeah. Awesome. Before we go to crap, which is pretty standard. And then the fine rings or something.

54:01 Speaker: Yeah. Yeah. All right. Well, thanks, Thomas. And I'll see you. Have a good weekend. Yes, you too. Yeah. Cheers. Bye. Bye.

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INTERVIEW #1 NOTES - DR CASSANDRA SCHEFE

N2O is Nitrous Oxide

Peter Grace developed methods used in research today such as the Automated chamber

Look at Solvita Field Tests
- Soil sample goes into jar
- Colour paddle goes into jar with sample
- Let jar sit for 24 hours, and paddle will change colour
- Colour will match provided colour chart to provide soil health insight (like PH test)
Test designed to be easy for farmers

Soil type & rainfall two biggest factors (humidity in soil is a big driver of respiration)

- Clay soils -> high chemical charge, binds with carbon to keep it in the soil, better growing conditions for microbes
- Sand -> Low chemical charge, no ability to bind carbon, high flux rate of temperature and moisture

Soil Organic Matter (SOM)
Soil Organic Carbon (SOC)
SOM=SOC x 1.72

We want microbes in the soil to ensure health, however, microbes eat Carbon reducing sequestration capabilities.

Look at:

"Comparison of manual & automated chambers for field measurements of N2O, CH4, CO2 fluxes from cultivated land" (2004) Yao, Zheng

"Integrated Probe System" Article

"Soil CO2 emission in response to organic amendments"

Understanding Soil Carbon Project" (CER)

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INTERVIEW #2 TRANSCRIPT - DR SCHEFE & DAVE HAWKEY

Speaker 1: Dr Cassandra Schefe
Speaker 2: Dave Hawkey
Speaker 3: Thomas Schefe

Speaker 1: So, my name is Dr. Cassandra Schefe. I'm a soil scientist in soil chemistry and focus on soil carbon work and one of the parts of AGRISCI
Speaker 2: One part from major parts And I'm Dave Hawkey and I'm an agronomist and I run the soil sampling side of AGRISCI and put Cassie in line somehow
If it's alright I'd like to know what your ages are so I can see if there's any disparity between interviewees.
Speaker 1: Yeah, so I just turned 46. Which you should know I'm four years younger than your dad exactly pretty much.
Speaker 2: I'm 51
How many years of experience have you both had?
Speaker 2: I'm at 30
Speaker 1: So I'm 20 I'm 25 years of experience. So that's post uni. So collectively we've got I guess 55 years of experience
What I guess led you to soil as your profession?
Speaker 1: Well, I fell in love with it pretty early. So I was I when I started uni. I was full bent on going into animal nutrition and biochem and I spent my first year thinking that's where I'd be going. And then at the first year of uni, I did some work placements because I was a cadet with DPI So I was contracted to them for eight years when I finished school. So four years of uni four years of work and my first work placement was down in Hamilton working with beef cattle, which I loved my second placement in the following January was up here in Rutherglen doing soil's work. So it was, the actual work itself was pretty like there's nothing sexy about it at all. Um, it's hot days. It's, It's hard work. Um But something about it kind of clicked and um, Yeah, I was fully dirt focused since then pretty much so then the rest of my degree was um, you know focus on going into soils, but I wanted to hedge my bets. So I kind of did a double I guess you call it a double major. So I did all the soil subjects I could do and additional so I found some engineering subjects that I could do as well and then I also did additional biochemistry work for animal stuff just in case I change my mind. So yeah, so then when I finished uni, because I was a cadet with the department. I then had a placement and I chose to do my honours work up here at Rutherglen and then moved up here as a guess a graduate research scientist in soils. So Um, that's pretty much where it started
Speaker 2: I'll just say Cassie
Speaker 1: Got a convert!
Speaker 2: I was more broad Thomas in agronomy, I guess, um initially You know working in the cotton and wheat so soils is part of the whole system and part of the equation. So didn't probably have as in depth of knowledge as Cassie and then when I was working with heritage seeds with uh, yeah Variety development, um again soils are still just the matrix that we used to grow everything in So but uh, yeah, and the opportunity came up that you know, what Cassie was doing needed more support. So people did And yeah, for some reason I seem to like jackhammering cores out of the ground. Hot noisy dirty work. Not sure like is right But someone's got to do it
Speaker 1: It's like anything though like you think the lab coat world is you know, sexy and you know see it the shows like CSI and all that stuff, Betrays science is this glamorous thing It's everything but you know, it doesn't matter what you're doing most of the time You're just doing crappy work. Like my phd was mostly washing up glassware in acid baths like The week designing experiments three days running it and two weeks cleaning up afterwards And then from the more field-based perspective The actual work is never any fun You know, it's all it's all physical work. It's um getting bogged. It's hot, dusty. It's like many jobs the actual activity Is never a I mean, it's sometimes it's fun. I enjoy going out when I go out. I just do what I'm told But the actual work itself is not amazing, but it's the knowing what the reason for it is it's like any job, you know, you can slave your guts out and it seems like you're just spending your day at the computer or spending your day doing whatever but Knowing that you're providing insights and and learning everyone's learning That then helps solve A problem that actually has a key You know that somebody's lively hood and bottom line and ability to continue to create food is impacted Yeah so Yeah, anyway, so we I think we provide a good We do provide a good balance. So I'm more theoretical um, you know, I think in equations and structures Dave thinks in reality and How are we actually going to do this? What does that actually mean? so I think and then the stuff that you find in the field then I kind of help try and work out what's happening Yeah, so we I think we provide a good basis and there's no better aspect. It's you know, without practicality theory is a waste of space And without theory practicality can tell you what you see but not why you see it.
Speaker 3: Dave I'm not sure how much Cassie's told you but the topic. I guess I'm looking at is uh, soil-based co2 and the whole process around measuring it, seeing what it's doing. I guess all I guess under the umbrella of try of uh, sequestration, but of course as my as my meeting with Cassie the other day And the other research I've done knowing how much is coming out of the soil is sort of at least where at least where we're at the moment.
Speaker 1: So that's the Solvita tests

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INTERVIEW #2 TRANSCRIPT - DR SCHEFE & DAVE HAWKEY

What's your perception of why measuring soil co2 is important? I find it's interesting to hear perceptions of it in comparison to other stuff you see or read

Speaker I: So it's as we spoke about the other day the co2 measurement piece is around flux and it's around loss so it's around knowing what's happening in that system that either means it's highly functional in terms of microbial activity that we have something cycling and The um, the soil system itself is is what we call healthy or functioning Or and/or a measure of that. So how good or bad it could be so that's the That's where we do most of our co2 measurement. the other piece is around Understanding what loss pathways there are in the system Which doesn't tend to be specifically co2 but more targeted towards some of the other gases that contribute to greenhouse gas emissions and that but co2 is kind of like a benchmark standard So it doesn't tell us a measure of sequestration as such but it can tell us how much of What's there is is stable or is fluxing so for example a compost or a manure that we've put on the soil. We may think that we're putting on a high carbon Value but then because the measurement of co2 then tells us that That's then ramping up the soil microbiota. It's creating a lot bigger microbial community Which means that there's a lot more things eating that biomass Which then creates a very low efficiency of additional carbon into that system So that's Yeah, pretty much. So with that in mind what is your I guess general process of Measuring soil co2?

Speaker I: So we don't measure co2 as such we measure we can measure carbon . So that's so we we measure what's left Which is the yeah, yeah

Speaker 2: Well, I guess we do the Solvita test at times. We do which is a soil health check really Yeah, that that what the process we've been doing that on the zero to I0s. Yes, yeah, yeah, so just collecting Uh, we collect them by hand actually just cause from zero down to I0 centimetres just using a hand core It's just a tube You push into the ground and then pull back out and hopefully the soil comes with it. Sometimes it doesn't In which case you do it again. You do it again And what you don't do is get frustrated and throw you probe Lose it in the cotton paddock Which I learned when I was very new to the industry Yeah, so and then that goes into the jars and You explain the process from there

Speaker I: The piece that we do in field And this is what we also use I've used for workshops in that with the dairy industry and dairy farmers and others who are interested is that Actually to collect the soil from the field then putting that into the jars getting one of those color change paddles Uh that come with it that gets placed into the jar with the field-moist soil And then the lid gets sealed for 24 hours and that's the accumulated co2 in that system that then changes the paddle color Which then indicates the concentration of co2 in the system And gives it an indication of activity So that's the that's the field based kind of approach to say well this do you have anything there or not?

And then the refined approach on that is what's called the co2 burst method where that soil goes to the lab It gets re-wet So every time the soil gets wet gets wet up from a dry state You get a massive spark or massive burst of microbial activity Which then creates this increased co2 So that's kind of looking at the potential or the capacity of that system and it's that increased co2 respiration that comes from being wet up again that then Will change the that they also use the paddles for a 24 hour test The change in that color of the paddle then gets measured using a digital color reader, which means that there's more sensitivity of concentration or amounts And then that number Can then be used to see how how well that soil is performing on the scale So the key difference between that test that's done in the lab and the field based test Is that that the lab based test is under standard conditions so you can actually compare soils or treatments or whatever else that you want to do

Speaker 2: So probably should also say we don't just go and pull one core. We usually pull you know I0 to 25 in it in an area and mix it up well so that we're not just You know because soils are a variable Um, so if we just pull one core, we don't know whether we've hit a high or low sort of patch. So by taking more, that averages I guess and takes out any any variability But we still also work on a GPS based approach. Yeah. Yeah So it would be Yeah, I5-20 cores around the ute for instance of that GPS location Yeah And by default that's the around the ute is actually a pretty standard ag based sampling method Yeah, highly technical So you're not allowed if you're an environmentalist, you're not allowed to have a Suzuki Jimny because they're just too small You can't go to a Unimog because they're too big

Speaker I: Yeah, but when you're trying to describe to people the the method that you want them to use Um, rather than say pick a GPS point and then to take all the samples within You know a two meter radius Whatever everyone's version of what two meters looks like is quite variable Infield and so if you just say Just go around the ute You'll find that everyone adopts a very similar similar method And what's really nice about that method is that you can actually you end up placing your cores Pretty much in the same locations You know the first core might be at the driver's side door. Then it's the front of the bull bar Then it's the front of the lights then it's you know, so you actually get standard reference points It's highly technical So that's the I guess that's the field-based co2 methods that we use because this Well, there's no reason for us to be doing Anything more technical um compared to what you'd see from the QUT labs So Yeah But then we also do the the key thing about any carbon co2 method Is by itself It's a measure of activity, but it doesn't give you any indication of the total bank of carbon in the soil And so that's something that we always want to be measuring as well And to do that we we would be doing um You know the soil samples that we we take would also be measuring those for carbon as well and nitrogen and some other key Parameters that then give a context behind those co2 measures. So a co2 measure by itself is actually quite useless. We don't know kind of what the capacity of that system is or or what kind of measures we might be looking for as a good measure if we don't know what its background story looks like.

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INTERVIEW #2 TRANSCRIPT - DR SCHEFE & DAVE HAWKEY

Speaker 2: Yeah, we did some stuff quite a while ago for a Landcare group And they had high carbon levels in their soil and low co2 levels. Yeah, so it didn't make a lot of sense why there was such high carbon We weren't getting high co2 levels till we looked at all the results and it was highly acidic. So the bugs can't survive in in The acidic soil so basically the carbon was staying there and if you just looked at The one in isolation you'd go either oh wait up it's healthy soil because that's high carbon or it's a really unhealthy soil because you've got low co2 Uh, you need all the other information to sort of go. Well, yeah, no, this is why it's actually unhealthy soil but it's nothing to do with the carbon or such it's to do with the pH. It's a system. it's a parts to the system that make it all work and One gets out of kilter everything gets out. You know, it just has flow on effects

I just had a question with the Solvita test you were doing you were taking 10 centimetre samples? Why 10 centimetres because I guess everywhere I've read for soil sampling is up to 30cm

Speaker 1: So you've been reading papers around all information about carbon stocks. Have you? Yeah, you look up tons of carbon per hectare Yeah, that kind of thing. Yeah So there's there's two So this gets into the measurement of soil carbon So the zero to 10 is pretty much the it's at least the Australian standard depth sampling. Actually, it might be a bit different in some parts of Queensland like in the sugar cane and that but as a as a standard method Um, the zero to 10 is the what we'd call the most microbial active layer Most of our soils are completely crap, right? So across the country unless you're in the Darling Downs and some parts of You know the yeah gold coast hinterland and then up the coast. Most of our soils are a little quite pathetic Um Because of the they're very ancient So a lot of our soils were exposed to weathering through wind and rain while the rest of the world was under glaciers So that's our soils are kind of the worst possible scenario Yep, and so in that We've only got a very small amount of topsoil in most of our systems and it's that That kind of 10 and as a general rule our depth of topsoil is maybe five to 10 centimeters really That's where a lot of our active root growth is initially we've got deeper roots that go down obviously to search for water and nutrients but our root matter mostly is in that layer and that's also the layer that gets impacted by Residues so dead plant material gets back into that layer cultivation seeding all those operations are all in that generally in that top 10 centimeters So that's kind of the zone that we we focus on in terms of our soil health and fertility so that's um So anything around soil microbiology will be focused in that surface So that's where the co2 stock comes in Anything around soil health fertility All of our calibrations that have been done over the last 30 years about how much of each nutrient we need to be Adding to grow a certain biomass of plant or crop They've all been done based on those 0 of 10 measurements So that's what gives us the confidence around You know in terms of our system approach does our system have all the things necessary to produce the plant? That that farmer is expecting to grow or if not, what do we need to add and everything else? So that's so everything around soil fertility and soil health Aspects are all 0 to 10. The 0 to 30 measurements are relatively new and they came about When we first started talking about carbon sequestration or storage of carbon in soil specifically to assign a value to that carbon as a dollar value or as a tonnage so Yeah, a lot of the 0 to 30 stuff only came in probably about 20 years ago And there's that specifically around capturing the total stock or total tonnage of carbon in a In a set depth To say okay, I've got this that much carbon to depth per hectare And I'm going to use those as my baselines and then measure my increases against that for carbon credit status and that kind of thing So have you heard of ACCUs Australian carbon credit units? So any other carbon trading carbon Carbon projects, you know your dad actually is quite up with all this stuff So, you know if you're looking for a topic on a long road trip This 30 centimeter piece is around the the bulk storage The reason why 30 centimeters was chosen was it was Had better representation of root Contributions to carbon But it wasn't so deep that it was incredibly expensive to sample Stuff there are some sampling down to depth, but most of our root biomass You know is most of it is within that 30 centimeter bucket and then there's kind of the The long roots that go down kind of on a mission for for water and you know everything else So but that carbon that 30 centimeter measures are specifically around quantifying the tonnage And that's done by measuring so sinking your cores Down to 30 centimeters And then measuring the bulk density of the soil which gives you a mass of soil per volume Right and then measuring that the percentage of carbon per mass of soil And then doing the calculations to then work out well if you've got this much concentration of carbon In this weight of soil you've got this weight per volume of core You can then calculate out tonnage, you know how much You know milligrams or grams of carbon you've got in that core then multiply that up to a hectare basis And then you get tons of carbon per hectare So that's specifically what the that method's for That method has really very limited Interpolation through to microbial activity and co2 measurements So anything that you did in co2 to measure the losses of carbon or the Respiration of carbon in that topsoil Yeah, it's not really on the same scaling as what's used at depth. I know it's probably a bit convoluted, but does that make sense? We come back to very different measures specifically for very different reasons And cost as well. Yeah Yep Yeah,

Speaker 2: it's probably fair to say there's massive confusion in the whole carbon space and It's not by the fact that there's a lot of shonky people out there trying to Yeah, tie farmers up with carbon and credit credits and things like that that don't fully understand everything themselves And the I guess soil health the term soil health gets mixed up with carbon storage and, healthy microbial soil, they're not necessarily related um, so yeah, that's a lot and and the fact that co2 is the greenhouse gas, but we want to store carbon And I think that's where some of that confusion comes from as well

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INTERVIEW #2 TRANSCRIPT - DR SCHEFE & DAVE HAWKEY

Speaker 1: Yeah, we talked a bit the other day around the kind of oxymoron approach of we want high Carbon in our soils But we want healthy microbially active soils. Yeah, and how sometimes actually may not Yeah, and
Speaker 2: I guess the thing is is you know our example where we're saying we did the soil tests and they they had high carbon levels But low CO2 so basically an unhealthy soil They could probably get carbon credits for this What they've got it? Well, they can't because you've got to show that you're increasing But you know, you've got a high base level of carbon But your ability to actually probably increase that carbon because your soils aren't healthy, new plants aren't going to grow well Is is pretty limited so it's Yeah,
Speaker 1: and then the other thing is um Something that we talked a lot with with that landcare group about was that If we fix up that soil so that it was actually functioning That would then increase the microbial activity in that soil, which would then actually potentially eat through a lot of the stored carbon that was there because that carbon that was stored was mostly residue derived carbon that was just sitting So there's actually the risk that if you if you improve the system you can actually reduce your total carbon levels through improving the microbial activity Which then means that everything's functioning
Speaker 2: so not a good look if you've just sold your carbon and need an increase Yeah, yeah,
Speaker 1: because the whole thing with the carbon credit approaches. It's additionality. So It's not around selling the carbon that's in your soil at the moment It's around saying well, this is my baseline and then this is what I'm going to do differently To improve that carbon level And then it's the difference between your starting point and then your new point, which they all hope will be higher Yeah, and it's that's that that's what is sold Which has a heap of risk and a heap of challenges with that as well Not to mention as Dave mentioned, the variability in that system and how it's done You can you can screw the results very easily based on how you actually do the measurements so Probably if possible try and separate those two things in terms of your project work the co2 measures as such of soil are More key around soil function And an efficiency piece rather than a Carbon stock piece and I know at the big picture peter grace and the QUT guys are connecting the dots with those around losses of emissions and that kind of thing but at a at a basic level You know as a measuring co2 as a derivative of microbial function Is a big enough topic in its own right? Yeah to not get it confused with the carbon stock piece which depends on the quality of the stuff that you read is You know variable And causes us a lot of frustration Yeah I've gone through all the There's all the legal stuff from the Australian government around how that the methods and actually work so I've got the all the That the acts of of parliament and everything in there and then supplements which then talk about methods Now all the way through and we've actually gone through that line by line and at a technical level the challenge that we have is that all the all this um All the protocols that are used for the carbon credit work We're all designed by academics So sole scientists who live in in universities Which is fine and great from a a technical science-based perspective where you're looking for designing everything specifically to do the best outcome, right? The challenge is that those people who wrote that document and the experts They have teams of technical staff That go out in the field and do all the work for them So they don't care if it takes four people A week to pull the cores and do everything exactly right Because they that's what they're looking for so they designed The act specifically to cover that approach But in reality, it's commercial providers who are going out and doing that work for carbon credit for carbon companies and and to you know to get all this stuff done And when we actually look through it and you know from the you know practicality is king perspective We have the best pretty much the best set up soil sampling rig that you can get commercially Um We we are running the the right tips and tube sizes and you know like Dave's set up is Is as good as you can get right But when you look through all the methods because we've been asked by a few companies if we would and and Government providers if we would do stuff When you (dave) looked through the methods You actually couldn't guarantee that you (dave) could deliver to the standard that was required in the methods Yeah Well, yeah Speaker 2: With soil sampling, you try to be Probably as accurate as you can but there's so much it's field-based So there's so much variation that that creeps into it. Um You know, you can't Specifically go right back to the same point all the time because there's problems around that It might be there's a dung patch there when you get back the next time Or you can't keep going down the same hole Yeah, because you've already taken that now everything's fallen into the hole. So, you know, it doesn't allow for stuff like that For us I thought the risk was too high because you've if If we see that whole Carbon credit system you do baseline sampling then five years time we go get back and do another round of sampling um And in northeast victoria and southern New South Wales the variability in soil within 30 centimetres is Is massive So if you actually found that carbon had dropped in that period of time um Bearing in mind the people that are all going into this are lawyers and doctors and things like that that have bought some land My feeling was that the first place they're going to come looking is is us and start, you know questioning the methods and everything and and we're basically trying to Try to drive a sledgehammer drive a thumbtack with a sledgehammer is Yeah, it is this is the source the way our soil sampling works like it's yeah um The I don't know if that makes sense. It's it's as accurate as it can be in a field level, you know Practical sense, you know, like yeah, it's kind of it's yeah, there's variability that we know

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Speaker 1: It's like the accuracy and refinement of the methods Far outweighs the accuracy and refinement of what you can actually do in a field And to know that Yeah, Dave's approach to soil sampling is best possible when and then knowing that in reality all these commercial providers Are running teams of people around the country who literally are just told to sink a core and You know do as many as possible in a day You know, they'll smash out a hundred plus cores in a day and just you know They don't give a crap about the quality of what's going on and yeah, we know that Even things like you know the methods state specifically how the the core is taken out of the tube and photographed and then segmented and everything else That's perfectly fine if you're in the darling downs and you've got this beautiful deep black Heavy clay that will remain completely intact, right? Yeah, basically comes out like a sausage beautiful, right? If you're if you're in a deep sand Or you have a clay sand clay layer when you push that tube of of soil out of the metal tube onto the tray Anything that's high in sand completely collapses and so You're completely guessing Where you think your your depth increments actually land The other thing is what happens in again, probably more of the clay base soils is we can get really high compression. So The probes that go down in the ground We've got a cutting tip on the bottom and then there are a metal tube, right? The the more moisture in the system and you know potentially the more clay in the system As that probe goes down, you'll actually get a little bit of compression squashing of the soil within the probe

Speaker 2: There's a clay like our tips an arrow on the tube But the clay expands as it goes in. So then it starts to stick to the wall Oh, okay. Yeah, so yeah, that's The bigger the tube the less friction and everything but it still has its Limitation, so so yeah, there's that problem around the depths and everything as well. So Yeah, it all works quite well in When we're sampling for farmers for their nutritional needs their pH, etc When we're trying to be super accurate on carbon accumulation Yeah, it's not it's got a lot of flaws in it. So we We don't really do it for well not for the carbon trading system we do do it for farmers to give some background ideas of what their carbon stocks are like

Speaker 1: Yeah, it's just the the risk is just too high There's the the thing where the carbon piece comes into it is that Like in comparison with our soil constraint work, which we do a heap of where we're sinking calls to 60 centimetres plus If farmers want to know what's wrong and is what's stopping their plants from growing We can tell them that information really clearly because the the plus and minus of you know, two or three centimetre Variation in that depth of core is doesn't really matter and you know, it's a as much around visually what we see You know, as you know, if we're seeing roots at depth and everything else In comparison the carbon piece is as I mentioned, it's about carbon stocks tons per hectare Which means that the multiplier effect is massive So if you take a zero to 10 centimetre increments down to 30 And you have more carbon in the top 10s. You'll always have more carbon in the top 10s and is If the first time you do that measurement you assume it's zero to 10 right

The second time you do that measurement you actually do a zero to nine Centimetres so you add or or eight because you might get expansion or whatever the surface And then you you measure the concentration in that The the carbon concentration in that let's say eight centimetres will be higher because there's potentially less soil But you're still in that very carbon rich environment So there's because you as you go down to depth your carbon levels decrease. So if you're Doing a smaller depth increment and you're still hitting all the carbon rich material You might get a higher carbon value So it might be a you know 1.2 percent rather than 1.1 percent, which might not seem very big But then you multiply that out over a hectare That actually would give you a theoretical increase in carbon stocks per hectare Okay, because the multiple the multiplier effect is I mean it's about 10 zero is involved. So it's it's massive so The variation due to that sampling approach is and on the other hand if you went to 11 centimetres or 12 centimetres or You know what I'm saying like the Yeah, yeah And and that theoretical calculation variation um You put there's dollars put against that Yeah, and contracts legal contract signed and cut covenants on land and and You know then the banks get involved and you know, it's a massive thing. So it's just

Speaker 2: I think thing is at the moment. It's it's all in infancy. So we haven't seen these problems Start to hit. I think in the next couple of years Well, we'll we'll as they get back into their five-year checks We'll start to see yeah, what issues because we're probably digressed. We're off the CO2 thing.

I guess with the measurement of co2 like with your Solvita tests, um How I guess do you find the equipment to use as in you find it easy would it be better if it was less requiring of muscles or?

Speaker 2: Well, I think the soil coring Side things is all All good. It's we've got the best we can get at the moment There are people who can they've got more automated rigs um I guess we haven't gone down that track. Cost is one but the other one is that um You don't get to see the sample as much and they tend to use much narrower cores so That that compression is is greater um So yeah, look, I think there's plenty of probably options out there in the sample collection type of stuff That's the actual kits themselves.

I guess Dave you were mentioning the equipment you have what uh, what equipment is that?

Speaker 2: Well that big gear so is a "Daybreak" Soil Corer made in Dalby So it's all hydraulic um with a hydraulic jackhammer on it. Uh, so we do use that. Probably gives us More accuracy um, and particularly if we go in below 10 centimeters we use it And the reason it gives more accuracy is we can drive a bigger tube in which uh reduces all that compression

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Speaker 1: So this is this is our one of our sampling probes So I actually designed this um helped with an engineer and New South Wales So this is it's just a kind of push probe. It's got a foot press The great thing about this is that it is actually has an open side so you can Um, when you you push it in and twist it to cut Oh, I know to cut asample and then it'll come out genuinely well So it's really it's very sharp there um I designed these ones to actually be able to get down 20 centimetres because we do a lot of subsurface acidity work as well And so this one's actually just got a plug in it that when you Unscrew here unscrew the foot press. You can then move that plug up and down. So you can either go down to If you pull this up, you've got a top full 20 centimetre depth of core, Down you've only got a 10 centimetre. So it kind of gives you an auto stop um So yeah having these kind of sample tubes are really good because you can actually clean them out really well So a lot of soils get stuck in tubes. So something like this means that you can see exactly what you've got at the time and But yeah, out of simple space this something like this is some kind of what you'd be using for microbial work And you can clean it up really well too. So you don't have contamination between different types of soils

Speaker 2: So this is another option for taking 10 centimetre core as Thomas and I'm not sure you can see it's so that's That's basically a bucket with a hole in the bottom of it Yep, and then we've got a drill with an auger on it with a stop That hits the the bottom of it And that's the depth the soil comes up into the uh into the bucket Yeah, and we've collected it so it's it's powdered it it works in sandy soils and dry Soils it doesn't work In wet clay soils because the clay just blinds on to the auger Whereas this one is really nice for moist soils or you know heavy clay base. It's sort of depends on the soil type and How wet and how dry it is um then these are The tubes that we're in driving with hydraulic jackhammer with different sizes. So This is the ones that for the carbon stocks we've got to use so they're They're meant to be 50 mil. Uh, the reality is is they're less than 50 mil Because it's actually 50 mil outside diameter and then The tip you can see is smaller So it takes actually a smaller core and then these are 38 mil OD tubes so It's what we use for most of our nutrient and constraint work Smaller tube is generally easier to Is it well It comes down sometimes to volume of soil sometimes we're trying to take We need more volume depending on the job we're doing other times we need less volume so um And yeah, generally it's easier to drive the thinner ones in obviously. Uh, so there's a company Uh in Toowoomba called Rimmick who we buy our tubes from And he's got a range of soil sampling stuff There's another company in Hamilton in Victoria called arborline that we get the auger one from um I don't know if there's another guy on at Lismore that builds Cassie's sampling probe . Yeah um Oh, yeah, So, yeah, it's sort of you need a whole range of things that depends what you're doing and what conditions um Yeah How wet it is obviously we when it's really wet We can't get the big core in um We try to avoid that because that means walking through wet sloppy paddocks and it's really hard work that you don't You don't get a good sample anyhow I've got the dig stick as well. Oh, yeah, but that's more deep.

You said it depends on Soil moisture do you do a separate test for that to start off with or it's more If it looks wet, it's wet?

Speaker 2: Oh, yeah, yeah, we've got a reasonable hand when you talk to the farmer. He'll tell you We said you know what the surface is going to be like we don't always know what the depth's going to be like because Obviously, you know, rain's water infiltrates and flows down so the thing is is Yeah, I think of the soil as a bucket It fills up with water now Evaporation will take it out of what the top five centimetres um, just you know pure evaporation But the only thing that pulls water out of the soil from depth is plants um, so What we find is if we've had uh a wet harvest for instance the soil will be really wet because After harvest we spray it and stop all the weed growth. So um The surface might be dry but the depth will be really wet. So think about if you've ever been under a house It's always moist under the house because it was when the house was built It was moist and it never sees the sun and there's nothing growing under there. So It always stays that way

Speaker 1: The other issue we have is that soils can have impermeable layers on them So um, a lot of the theoretical kind of dudes in science and more the engineering bent Soil scientists will come with these fancy equations around, you know, if you've got this water content at the surface This is what it's like. It's going to be a depth and you know, soil texture changes and stuff and even soil carbon There's a lot of the theory around soil carbon at depth based on surface measurements Again, that works really well in like the Darling Downs approach Where you do have consistent deep layers um, a lot of the country is actually a lot more variable than What we'd like it to be. Yeah, so we have circumstances where on the surface it may Look really Even but then at depth we have a lot of variation in clay content everything and on the flip It could be really variable on the surface, but then consistent at depth Um This comes down to it's the deposition processes that actually created that soil in the first place but that can also lead to kind of calcrete layers or kind of Layers where the water might get down 30 centimetres and then hit a hard pan and literally just go sideways So the surface will get completely waterlogged and bogged But it will be dry at depth You know, so So yeah, it's all that stuff. But in terms of co2 measurements And pretty much all soil sampling The rule is that we don't want to be sampling under waterlogged conditions or what would call anaerobic conditions Where there's the there's more the water content has exceeded what we call the water field or space So there's no air left in that system. It's just all that any air pockets get full of water When that happens microbial activity switches So our oxygen sucking microbes that then breathe in oxygen breathe out co2 They actually shut down because they can't breathe And we then swap to microbes that actually preferentially will breathe out methane and nitrous oxide Which are very potent greenhouse gases So most of our um, soil based greenhouse gas emissions kick in once we hit that kind of anaerobic conditions So that means any measurements of co2 We want to be doing on aerobic systems Because that presents more of a realistic picture of what our soil is doing 99 percent of time

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time So as a practical rule, um, you say if you can't drive on the paddock, then you shouldn't be sampling it because it's too wet But at a theoretical point with the same Any of our soil based measurements need to be done under aerobic conditions Because otherwise you'll be kicking into this non normal kind of Bit rando approach where things have just changed and Whatever you measure in those systems doesn't reflect the You know the overall soil function So yeah, so soil moisture is a key Key piece with any any co2 work. So you'll see in any of the literature. It's either field moist conditions Or it's wetting soil up to a constant Percentage of water field capacity so it's um Yeah, we'll ensure that we're measuring under those oxygen based conditions So probably a key thing for you to think about I don't know what it means, but that's one of your key Operational parameters for anything that you you design

If you're going to do the Solvita test or whatever are there any specific conditions those samples need to be under? As in how they're transported do they have to stay cool or kept out of the sun etc.

Speaker 2: We're probably different to most people doing soil coring. We run fridges in the in the ute. So as soon as the samples Oh within, you know, five ten minutes the sample is into the fridge and I'm starting to cool down Not such a big issue down here in the middle of winter. Um, but certainly On a sunny day, you'll get condensation in the bag Yeah, and that can happen really quickly even, you know within 30 seconds after I've bagged up You start to see condensation building, but it's probably at a very low level Um, and then yeah, we store in the fridge here. Um, generally then chill if we're going to send to the lab Um, we you know, they spend two or three days in the fridge to come get right the temperature And then we send them Monday or Tuesday So that they can get to the lab by the and we express post obviously Um, get to the lab. Hopefully by the weekend Because the last thing we got them doing is sitting in a semi-trailer somewhere over um over the weekend We can't do a lot of control once it leaves here. Um, if we want to be really pedantic about it, we would back into a polystyrene box with ice bricks With this soil health stuff the only time we've done that is when sending it to Geelong. Yeah. Yeah, so We've got a lab down at Geelolng where it'd be. Yeah on the out skirts of Melbourne. So Generally stuff will get there overnight Yeah, and if we had a really big job Um, we would probably even consider taking it down ourselves. That that does happen and there's a couple other organizations we work with that do that at times But that's a the key thing around the The moisture and temperature because as soon as if you think of you've got Even just at home um if you head out to the garden and Take a scoop of dirt, put it in a plastic ziploc bag And leave it for 10 minutes. You'll see that it will start to get condensation on the inside of the bag because it's a it's a A living thing. You've got bugs in there doing stuff if you've got um If you create warmth in that environment And it's you know, particularly saturated conditions, but you create warmth then the microbes will continue to do their thing um A lot of the parameters that we work on it's not such a big deal, but Nitrogen status will fluctuate significantly under those conditions

Um, and also obviously, you know co2 carbon Stuff the total carbon mass won't change a lot, but you'll you'll get the respiration piece But if you're if you're sending something to the lab for any biological or chemical testing then control of temperature and they're sampling under Unsaturated conditions so aerobic conditions is completely important So that's if you're sending the Solvita test to the lab to do the standard testing, Absolutely. If you're doing something yourself just using the jars and the paddle to see, you know field base. What does it look like? Um, it would just be important to get, you know, ideally Dig straight from the paddock into the jar put the paddle straight away shut the lid So you'd actually preferably do that out in the field And then you know that you're good So the big thing, and the labs tell us this all the time, is that they're really precise. They control environments They replicate things they Check things regularly in all machines That's what happens when we take the sample to get to the lab where all the error starts to creep in So how the samples handled from the point? Well included collecting the sample to how the samples Handled uh can have a big Big influence on the result that they get but their result with the soil that they receive will be Pretty good pretty accurate So yeah, so yeah, I guess if you if you look at a fault in the system where there needs Probably the refinement is that Almost the chain custody of the sample from the point it's taken from the paddock is probably a link and You know cost becomes an issue and obviously you start packing polystyrene with ice bricks polystyrene I don't think can go in express post because There's a problem with polystyrene in aircraft, but then I've seen it on the tarmac. So I don't know And they've come to that because of static electricity. Oh You don't have a plane out that would be bad So I'm not not a hundred percent sure on that one, but yeah at one point We weren't allowed to send polystyrene by express. Yeah so you have to cop different ways of getting stuff to labs. Yeah, it's probably a short fault.

Speaker 1: I mean really If you were if we could do it cost effectively as you can But if they were like micro micro loggers You need every batch of samples if once, you know a sample Somewhere had a temperature moisture Logger That you could actually see what temperature conditions that sample was subjected to over that travel time That would immediately be a really easy QA (quality assurance) check to say. Well, it's it's gone past You know 10 degrees bang. We'll just we have to discard that sample Yeah, yeah I mean That that's what you do. That's what you know, Dorovitch and you know, the blood color or the The people based stuff. Yeah, they run under very strict

Speaker 2: But you look at how they like samples it all goes into eskies and there's couriers that run around everywhere Moving it directly and and that's almost what we need, but it's not that's not cost effective. Yeah. Yeah Yeah,

Speaker 1: I mean how many tons of dirt you reckon you put through the post? We have a very good relationship with our local post office

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Speaker 2: I reckon there's well over a tonne goes through the post in express post schedules. That's Yeah, we've got a made up the fact that I saw him at the post office one day He said we he's an earth mover. He said what are you doing? I said, this is how I move earth, mate Yeah, so there's Yeah, that would probably if you're looking at design sort of thing. That's probably where there's a real shortfall in the system It's really interesting. You know, there's probably comes back to a lot of the reseller agronomists so you I was gonna say I can be probably like a nutrient and your elders and those guys They don't generally run fridges. We were lucky to see an esky in their ute to take the soil samples And it's really crazy because yeah, you can go and put a fridge set up with a battery for a bit over 2000 into a ute. And they're not you know, people look at it and say it's too expensive.

You know, but then when you think about it, then The the biggest cost Around soil testing is the physical travel to the paddock , Do the work, coming back from paddock, right? That's the biggest biggest cost and time From that point, you've got the small bag of dirt that then gets sent to a lab They then take out a smaller amount of stuff out of that and do the do the work Then and the actual analysis cost is, you know, maybe up to a hundred dollars depending on You know what you're doing, right? So and farms go shit. That's a lot of money But then from that test They may Dis determine their whole of farm fertilizer budget Which could be in excess of a million dollars So the better quality that testing is, can literally save them Thousands of of dollars. So we've got one farmer. We've been working with for a long time who reckons He's saving upwards of 40 or $50,000 a year because of better quality information. He's spending 30 Because he does massive amounts of soil sampling But he's doing more and more because he realises the You know, every every decision that he can make that's best on a based on a good quality number Is a much better business decision Then saying well, look, I'll just chuck 300 kilos of urea out per hectare. You know, I'll just do that across the whole lot

But we also have a really in-depth understanding of his soils so Every year inevitably he has a problem of some description Because he's got such variable soil types Yeah, the latest one is his fabeleens didn't nodulate so they're not producing nitrogen But we've got such an in-depth amount of data But fairly quickly we've been able to find out what the issue was for him And now a plan moving forward for years, you know, the next years. So You know, that's a pretty big problem for him that it didn't nodulate because he's not making free nitrogen out of the legume crops Um, but now we've got a solution for him next year. If we didn't have the depth of data, we would never have been able to solve it

So, you know, so I don't think this comes down to the whole soil testing thing Is that a lot of farmers know everything about what they put on their paddocks about how they manage everything above ground None of them dig holes to see what the roots are actually doing And only a few of them actually do soil testing.

So When things don't work the way they think they will They and their agronomist generally say I will just chuck some more fertilizer out Chuck some more nitrogen out or chuck or just chuck something out and then when that doesn't work then You know, they just chuck something else out But then then finally they give us a call and then we work out exactly what the problem is So we tend to find, you know, the better quality information we can give farmers the less money they actually spend Because they're spending that money on the right thing Which then means that everything else that they're putting into their system works as opposed to just cucking on more of the wrong thing. But I guess like CO2 testing on farm is quite a new thing and most farmers wouldn't be doing it at all um So I guess kind of just to finish up that piece that you've got the research world who are very good at doing that with their instrumentation It's only in the last few years that Things like the Solvita test and there may be others out there that I just haven't heard of so be interested to see if you pull out any other farm based testing But I guess the the question with that stuff is as we discussed that You know, some farmers just want to know that because they want to feel good about having a good biology A lot of farmers aren't at that point yet. They're still saying well I just need to know if I get if my house is right, you know, my chemistry is right and then the microbes will be right So the question with any kind of the CO2 testing is if you have a number Then what You know, it's it basically means that if that number is bad That there's something else wrong Like it's not okay to say and you've got a bad CO2 number So you need to do something about your biology, right? That's actually wrong But that's why a lot of farms will think Um, whereas in fact if you have a low CO2 number because you've got poor function Then there's an underlying issue that's happening Um in in your chemistry or physical structure that you need to address so your biology is kind of your Yeah, your red flag piece but it Um, yeah, it's it's not an under it's not a driver of your system. It's it's the product of a good system.

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I guess my now actual last question is you're talking about sending soil samples to Um, Geelong for example, how long does it generally take to get results back? Speaker I: Yeah about two weeks And two weeks is about the industry best practice Sometimes they do better. Sometimes they do worse. the Biology so that's for the soil chem stuff and that's the carbon values and stuff like that. Yeah The Solvita type things Look, I guess it probably takes still about two weeks to come back but um They're probably they should be doing them as you know, pretty much as soon as they hit the labs because they're A biological test would be the ideal yeah, so any kind of I guess like anything any kind of design stuff that gave more immediate results Knowing that you know would be helpful but knowing that there is a relatively good understanding in ag that you know If you can get something really quick, but it won't have the same quality peace like I guess in your design consider kind of what what are you offering if you're If the offering that you're looking to build is a Bit of a quick and dirty approach, but you know, it gives you an idea Where things are up to Or if it's a highly refined approach that gives you You know high quality information that is Um, you know able to be quantitatively assessed and statistically analyzed or whatever. So I guess there's always a trade-off between a quick and dirty thing that you know solves that what if versus a yeah, so Knowing your ability to solve for everything is probably limited But you know that might even help in terms of your design to say well what your parameters of quality look like and Who your intended uses of that would be

LECTURE NOTES: STUDIO 11

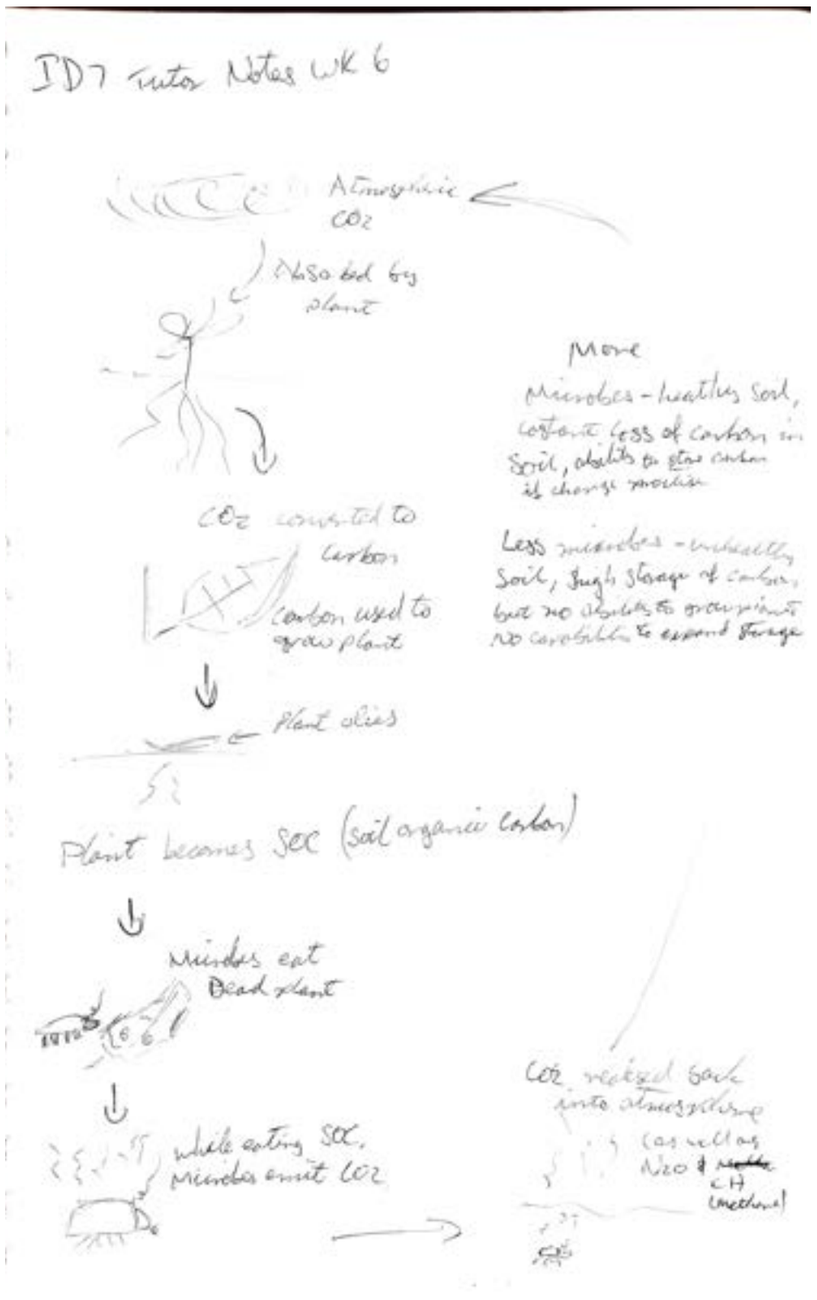
AI Part 1&2

Include
1. Word count (excludes tables, graphs, references & appendix)
2. Authenticity Statement (After abstract – copy statement on powerpoint)
3. Ai Use Statement (copy statment on ppt)
Table of contents guided by chapters
between 2,800–4,000 words
Design implications – describe, no images

AI Part 2

Due Thursday 12 September 11:59pm–48 hours apply
Use Ai to explore colour and material
Experiment w/form or aesthetic
In class presentation Thursday 12th September
Presentation not assessed – only slides
5+concepts -> all diverse
Show context, hero image/s, details, functions, text to explain product & context
Could be spread out over different timeframes (5–10 years into future) could also be spread across micro, intermediate, or macro (small item for now, large item for whole system)

Carbon Cycle



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INTERVIEW CODING

– Context (carbon vs co2, importance for ag, gov & soil health)
– CO2 management (techniques, tools)

Where to start:
Start with sub codes and work backwards
Find litte topics, group to find bigger codes

Conceptual analysis (e.g. # of times words are used)

Observation (temporal events – how long each step takes)
Put final code in findings section of report

How is soil Co2 measured?
Why is soil CO2 measured?
user perceptions
What is soil CO2 & its importance?

Ai coding output

Co2 vs Carbon
Equipment perception
Measurement Techniques
Puprose of measurment
Stakeholders
– Family farmer
– Commercial farmer
– Agronomist
– Academic

Tagboard–theme
Groups–Code
Tags–Sub Code

Appendix

Coded transcript in appendix
questions & ethics forms
research design

Co2 analysis methodology -> add chromatography to equipment

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LECTURE NOTES: STUDIO 13

End of year exhibition WEDNESDAY 13th November
AI.2 Presentation Thursday 12th September
Informal presentation -> not assessed

Design development. Is it....
1. Valuable
2. Innovative
3. Purposeful
4. Functional
5. Usable
6. Enjoyable
7. Manufacturable
8. Detailed
9. Presentable (Do you have a convincing presentation?)

Look at ppt slides for product standards
Labelling on product & packaging
Product in day & night
moving, transportation & storage
Before, during & after product use (whole use process)

UCD
- What are the features and functionality?
- How do people use it?
- Should be usable by all people, to the greatest degree possible without adaptation
- Physical, psychological, emotional requirements of product
- Design for unintended environments

DAN FEEDBACK
"What story am I trying to tell?"

Ethographic research approach
Tell story of what I saw, thoughts, process, photo recount of equipment

Methodology section
'Used observation to inform interviews'

Methodology
Considerations
Results
Users

Background structure
CO2 cycle
General measurement process
Soil health use
Carbon sequestration use

Results
Discuss considerations (temperature, soil, equipment - WARLUS maps)

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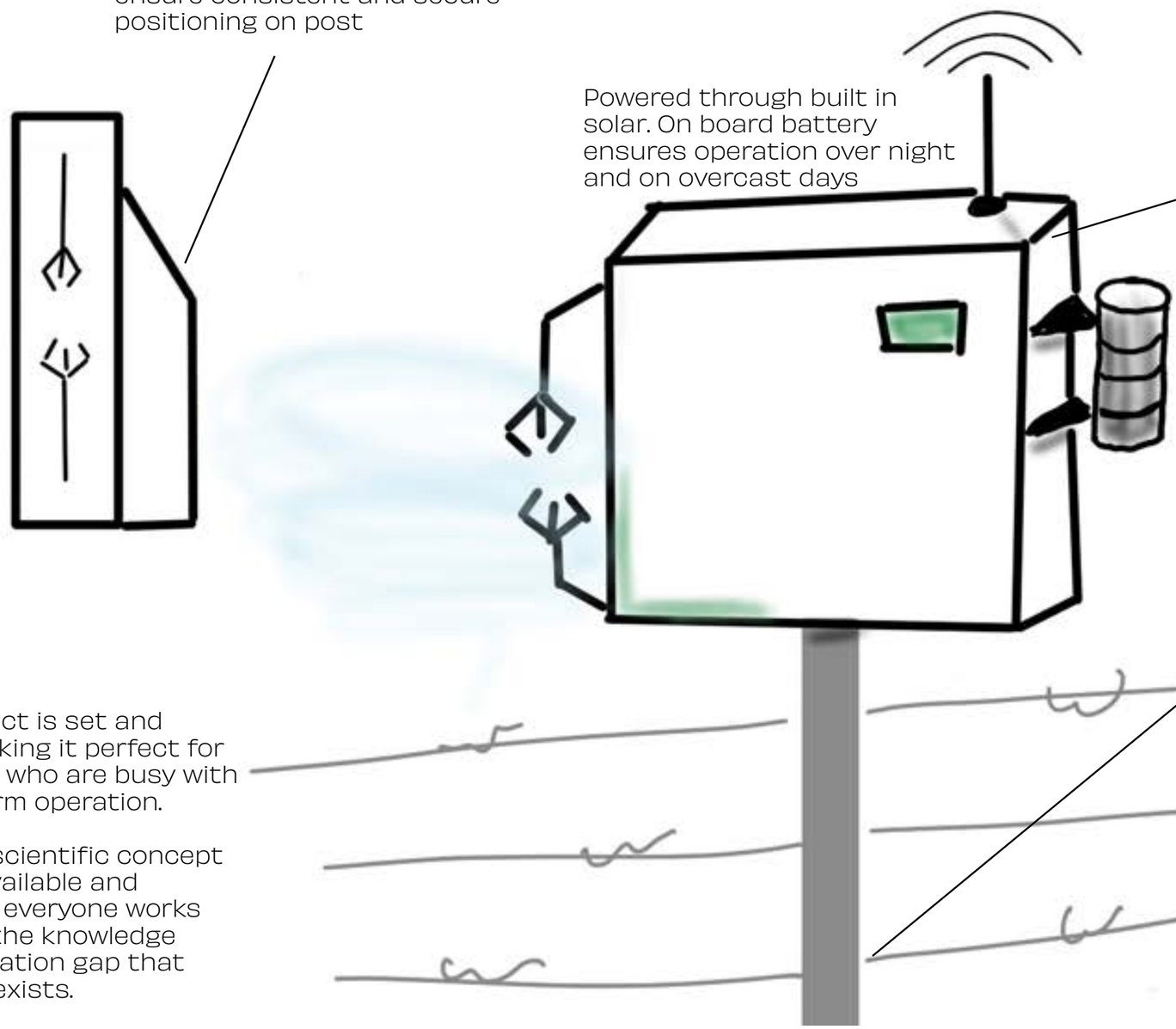
INITIAL CONCEPT 1: Eddy on the Fence

Integrated mounting point to ensure consistent and secure positioning on post

Powered through built in solar. On board battery ensures operation over night and on overcast days

Device measures Eddy Covariance, and transmits analysed data to provide recommendations.



Device mounts onto typical steel fence posts removing the need for expensive towers

This product is set and forget, making it perfect for producers who are busy with regular farm operation.

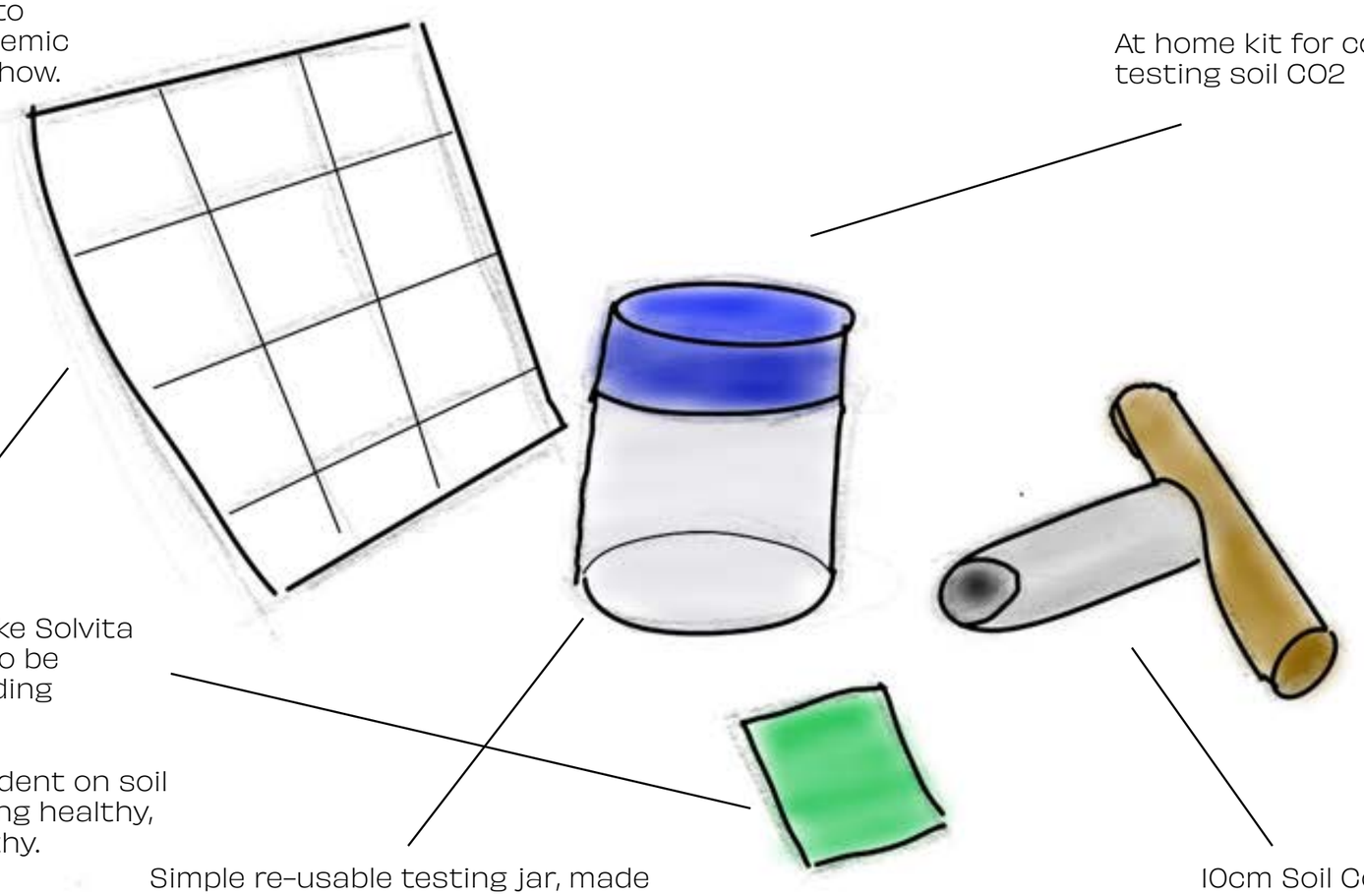
Making a scientific concept like this available and usable for everyone works to bridge the knowledge and application gap that currently exists.

TS

INITIAL CONCEPT 2: Soil Knowledge Kit

By giving producers the option to do this simple test at home, they can both save money on agronomists, as well as learn more about their soils to improve total yield and productivity.

The soil knowledge kit works to bridge the gap between academic knowledge and farmer know-how.



At home kit for collecting, and testing soil CO2

CO2 sensitive stickers. Like Solvita product, however made to be cheaper whilst still providing important results.

Colour will change dependent on soil health, with green meaning healthy, and red meaning unhealthy.

Simple re-usable testing jar, made from glass and recycled plastic

10cm Soil Corer to ensure consistent soil quantity from the top layer of soil

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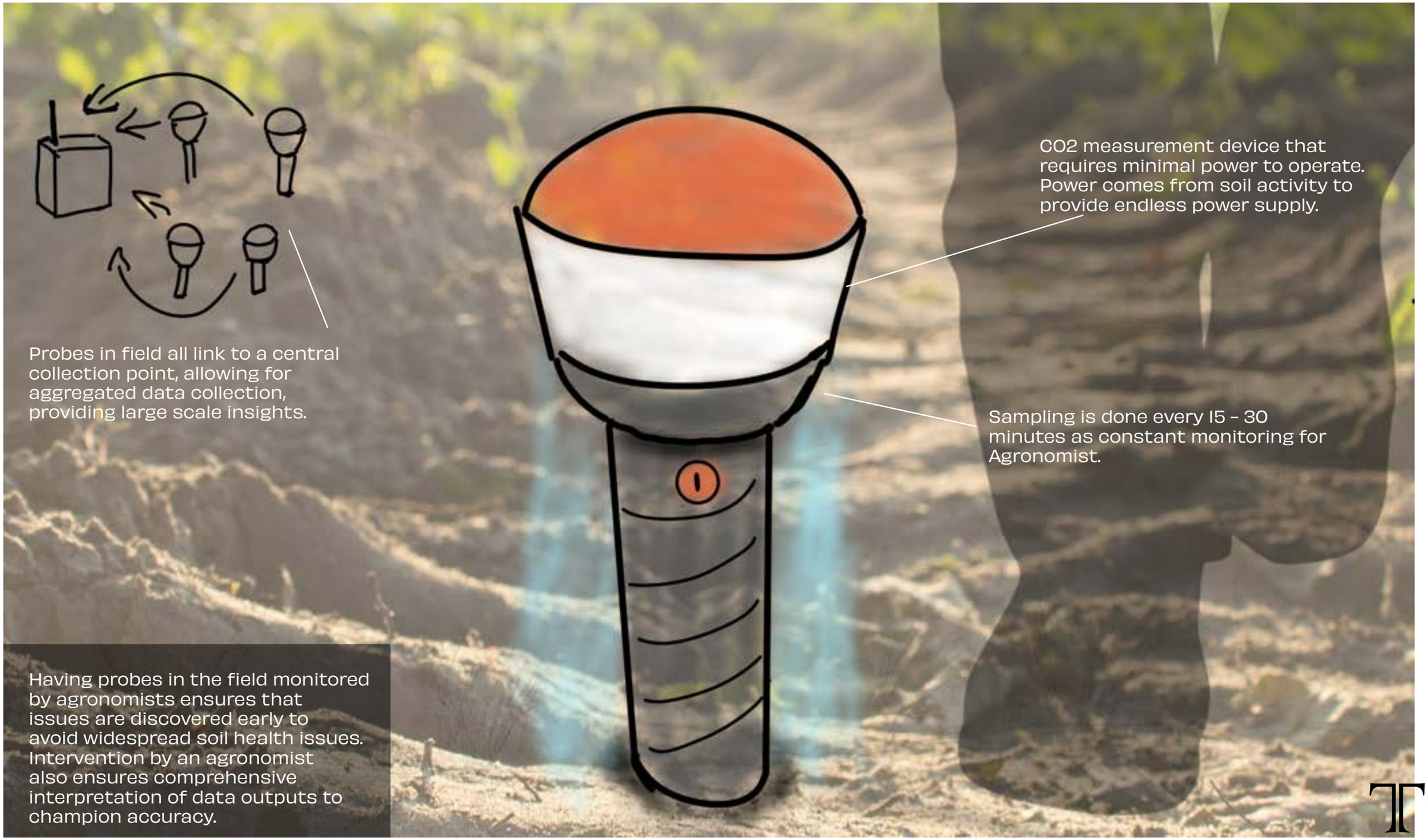
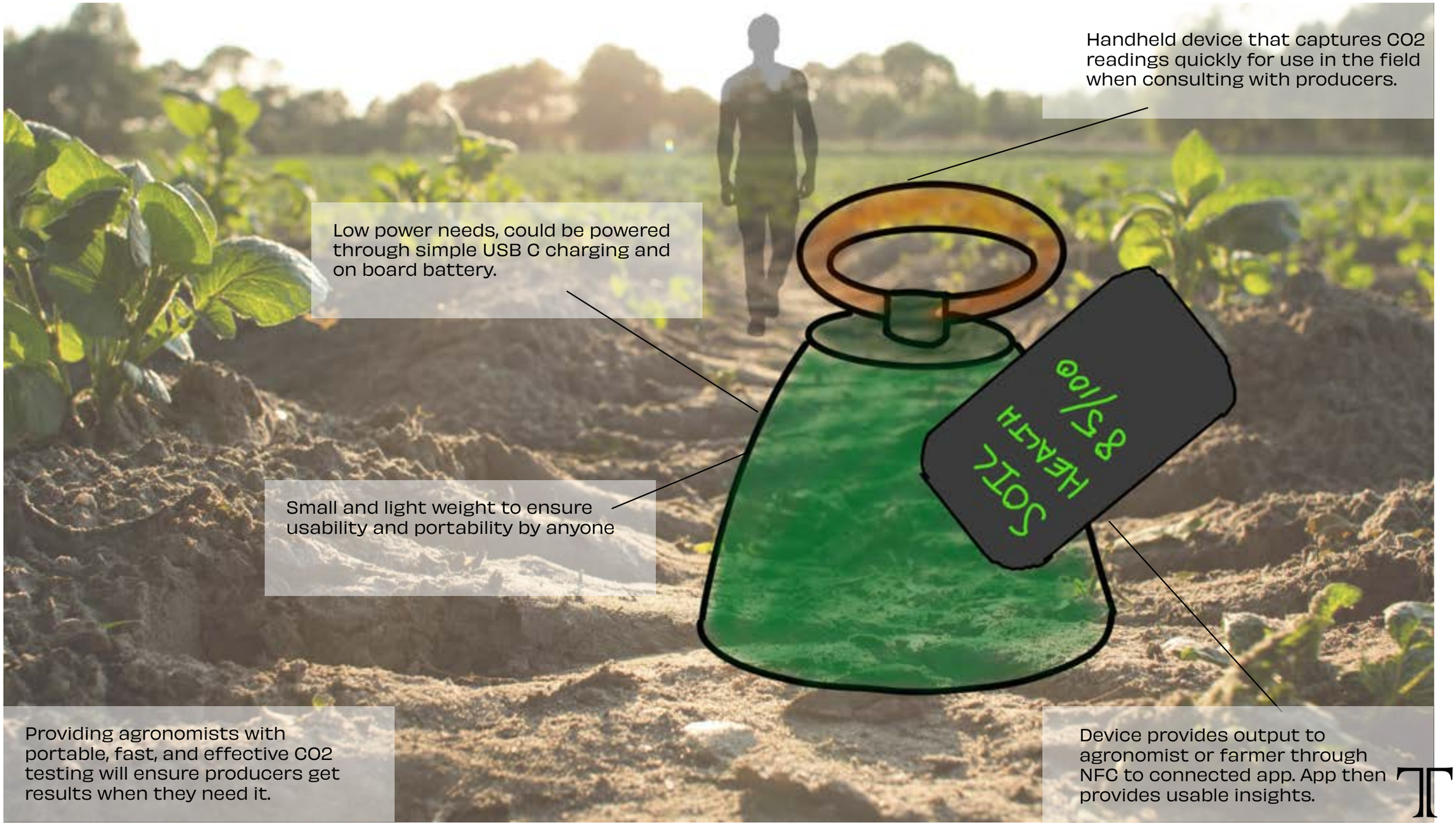
INITIAL CONCEPT 3: Soil Probe System



INITIAL CONCEPT 4: In-Field Chamber



Handheld device that captures CO2 readings quickly for use in the field when consulting with producers.

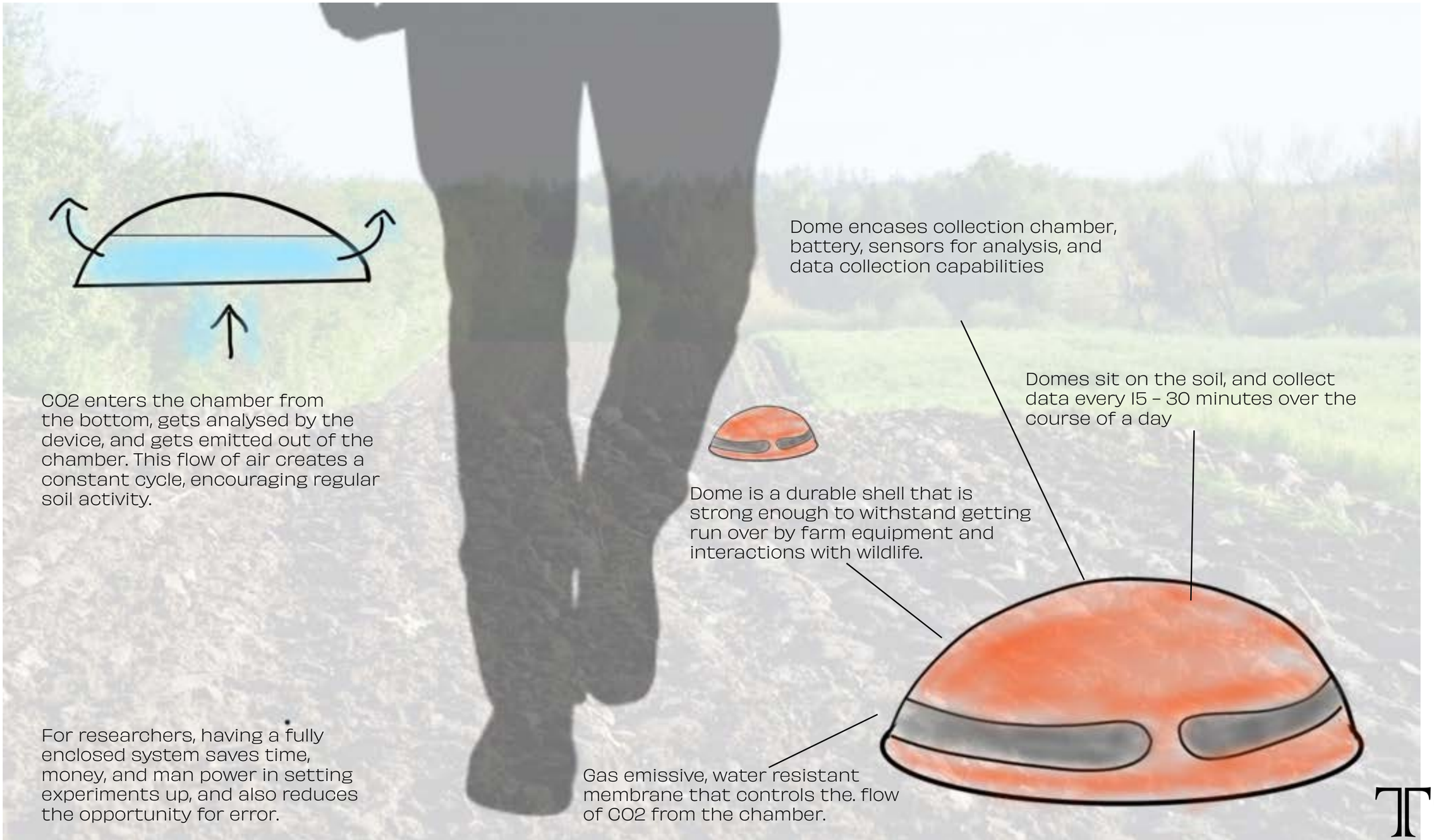
Low power needs, could be powered through simple USB C charging and on board battery.

Small and light weight to ensure usability and portability by anyone

Providing agronomists with portable, fast, and effective CO2 testing will ensure producers get results when they need it.

Device provides output to agronomist or farmer through NFC to connected app. App then provides usable insights.

INITIAL CONCEPT 5: Forced Diffusion Dome



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LECTURE NOTES: STUDIO 15

User experience & manufacturing
Presentations KG OC406/407

Experience design
– Approach that aims to create appropriate positive interaction before, during & after use

Need to understand & conceptualize user-product interaction in context

Principles of interaction:
– Affordances
– Signifiers
– Mapping (user experience, mapping the association/ relationship between action & event)
– Feedback
– Conceptual Models – Think layout of grocery store

Think about:
– Expectation
– Consistent design
– Functionality
– Cognition
– Engagement
– User control
– Percievability
– Learnability
– Error handling
– Afforability

Manufacturing
Bill of materials* – start now & evolve with design development
Standard parts (I)
Custom parts (2)
Drawings (3)
Quality assurance

*important for budgeting, quality control, quality assurance, specifications, legal assurance

I. off the shelf (e.g. fasteners, bearings, wheels, PCBs, motors, etc)
2. Custom parts (e.g. packaging, lables, mouldings & casing
Add stamps in plastic (e.g. type, part #, date & time of manufacture)
3. ASI100 drawing standards – demonstrates scale, size, product finishes, tolerances. Should include part # and part images

TS

LECTURE NOTES: STUDIO 19

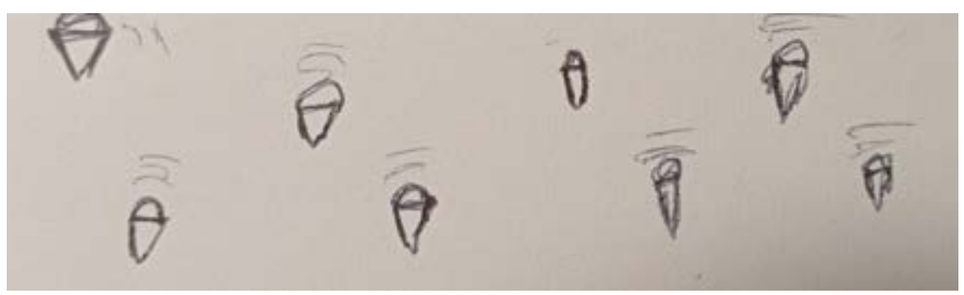
Final presentation – AI size
Need headshot

Either create new ecosystem for agronomists/ producer
or
Develop & condense research technique

Measuring soil health –> not sequestration
New ecosystem meaning possible creation of dedicated businesses that look after probes and process data for farmers to use.
Will also recommend soil testing and agronomist intervention where necessary. Wide range of probes will provide localised treatments improving treatment efficiency.
Possible subscription model

Would maybe need central wifi reciever to send data too and from field to farmer via software

Microbial powered "dirt fuel cell"
Bacterial wire power
Solar powered



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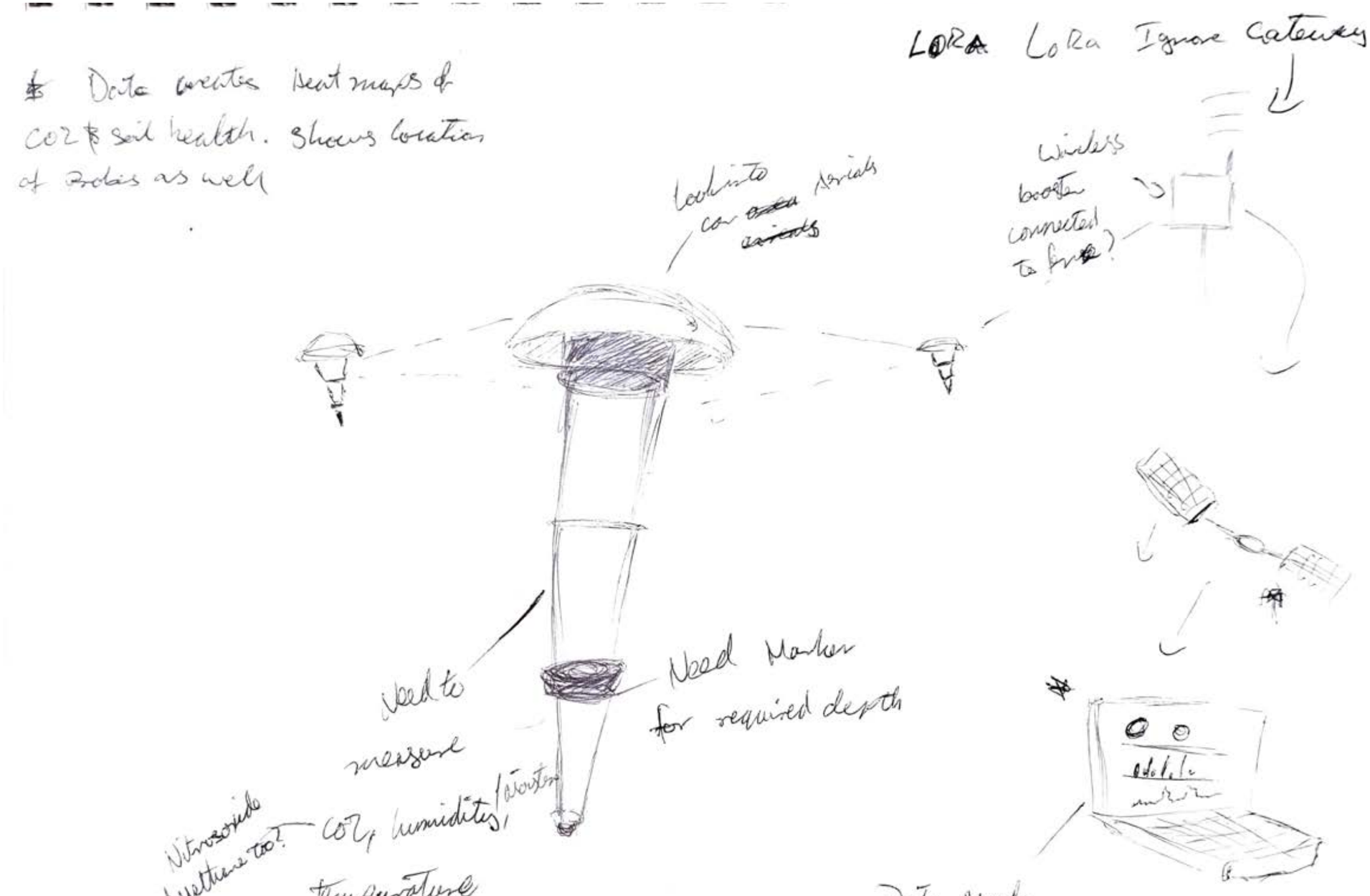
SOIL PROBE DEVELOPMENT



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LECTURE NOTES: STUDIO 21

Final submission review

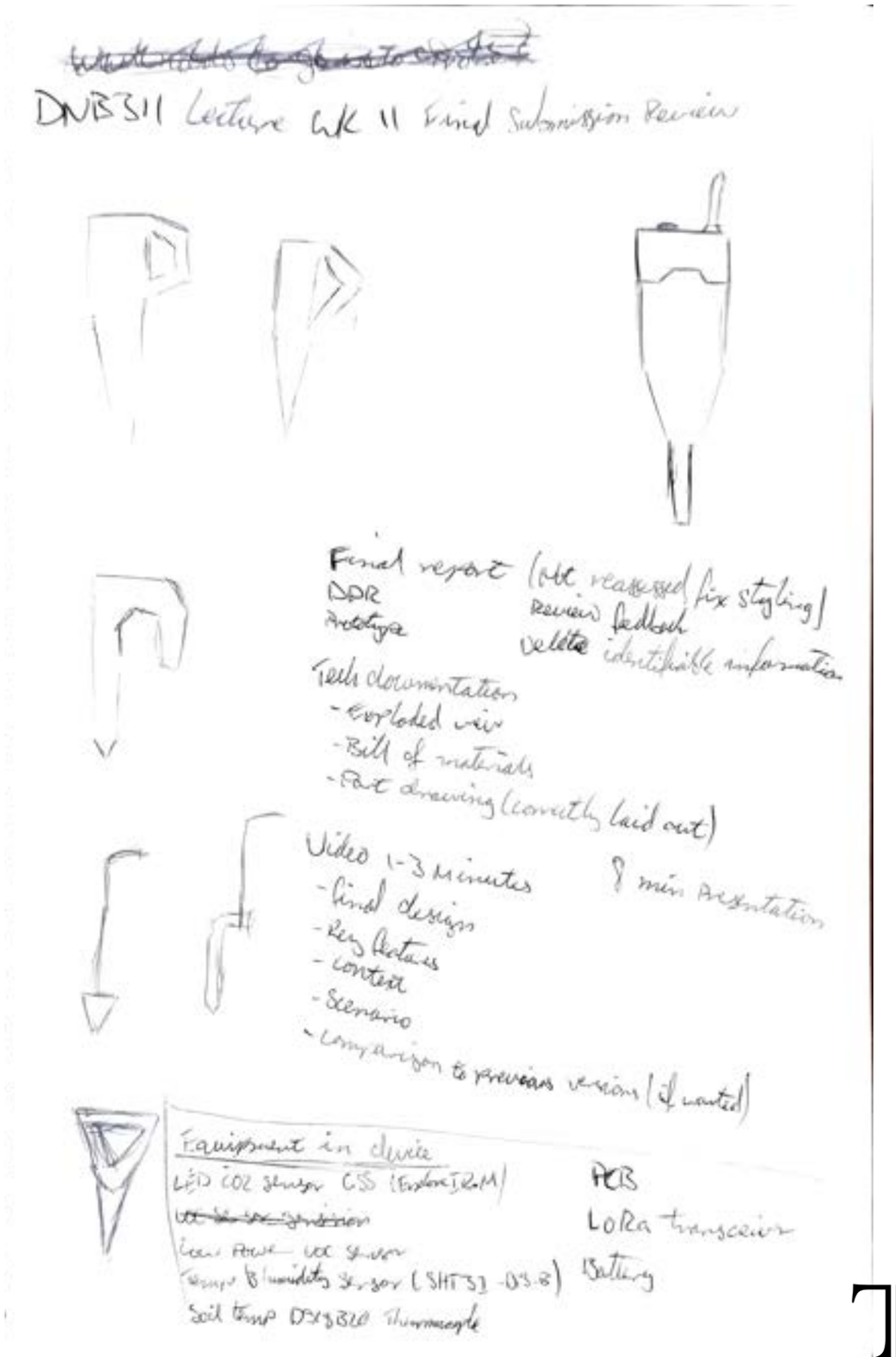
1. Final report (not reassessed, fix styling, review feedback, delete identifiable information)
2. DDR
3. Prototype
4. Technical Documentation
- Exploded view
- Bill of materials
- Part drawing (correctly laid out)

8 Minute presentation

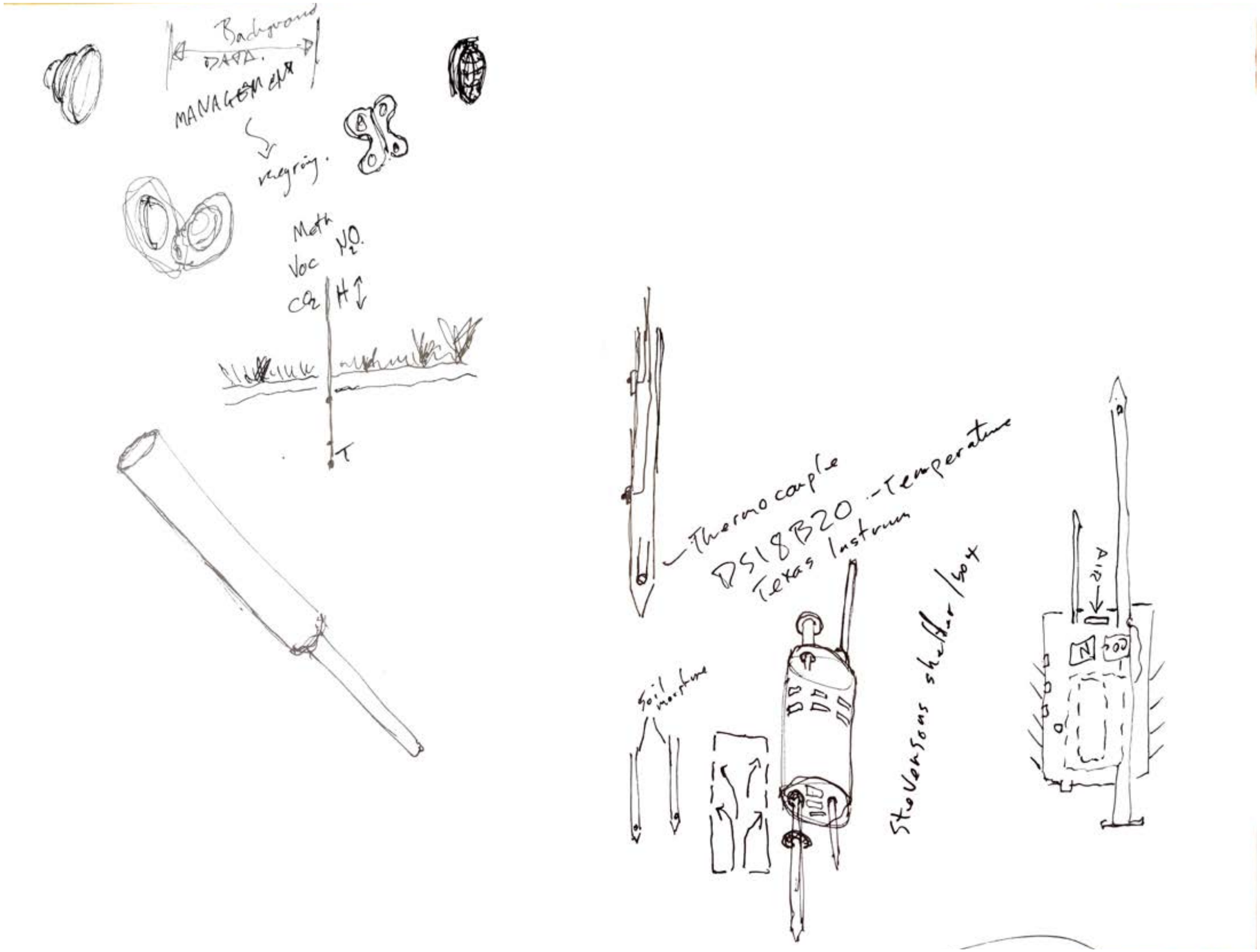
Video (1-3 minutes)
- Final design
- Key features
- Context
- Scenario

Comparison to previous versions (if wanted)

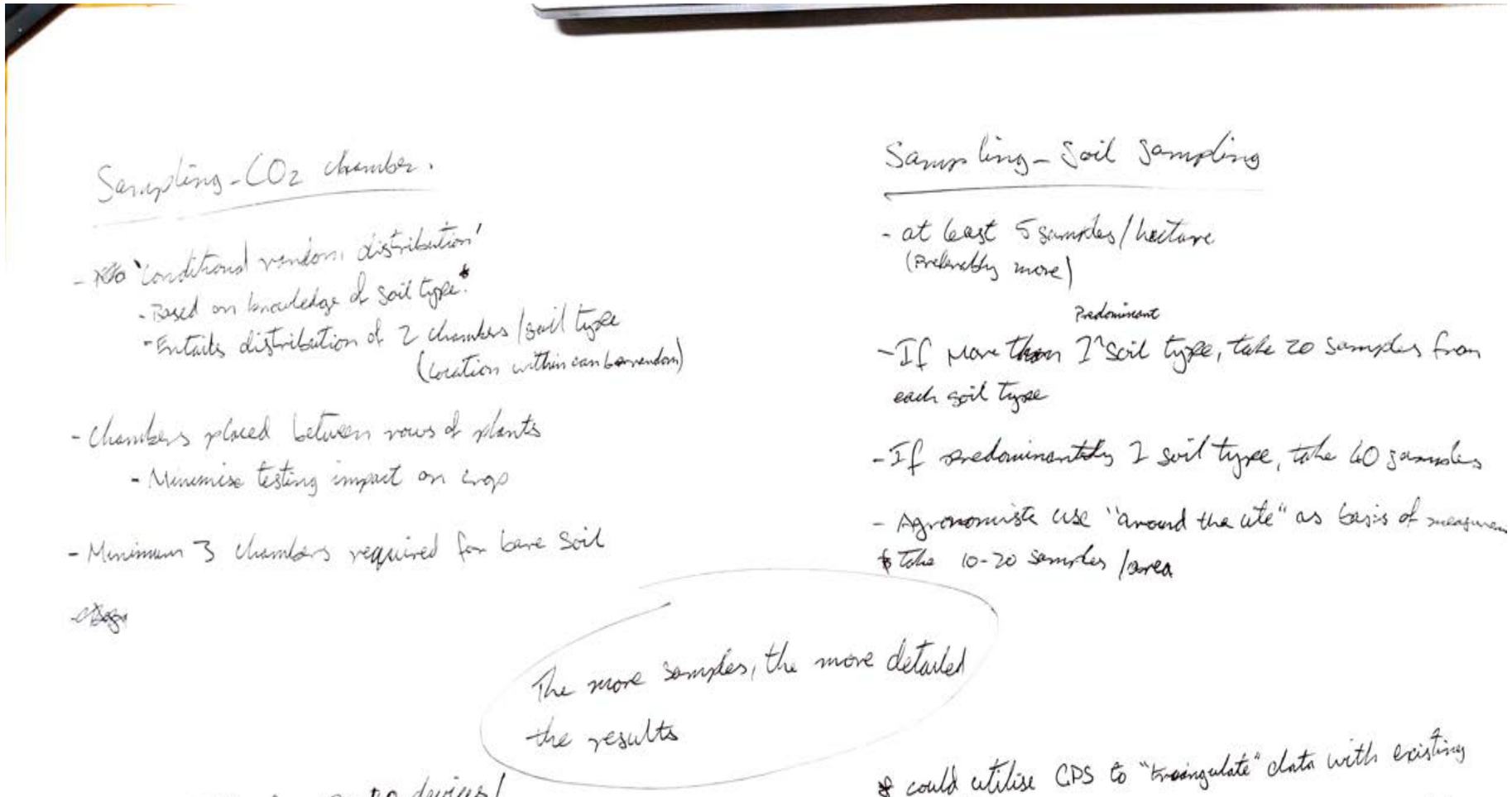
Equipment in device:
- LED CO2 sensor (GSS)
- Low power VOC sensor
- Temp & humidity sensor
- Soil temp DS18B20 Thermocouple
- PCB
- LoRa tranciever
- Battery



SOIL PROBE DEVELOPMENT - TUTOR IDEA



SOIL PROBE DEVELOPMENT



Sampling - CO_2 chamber.

- ~~Kba~~ 'conditional random distribution'
  - Based on knowledge of soil type.*
  - Entails distribution of 2 chambers / soil type (location within can be random)
- Chambers placed between rows of plants
  - Minimise testing impact on crop
- Minimum 3 chambers required for bare soil

The more samples, the more detailed the results

System suitable for 2-~~40~~ devices / paddock depending on need.

Data based on national average ~~farm size~~ (WA 2201 ha, SA 517 ha, NSW 455* VIC 337 ha, QLD 210 ha), for measurement techniques & soil sampling methodologies

Sampling - Soil sampling

- at least 5 samples / hectare (Preferably more)
- If more than 1 Predominant soil type, take 20 samples from each soil type
- If predominantly 1 soil type, take 40 samples
- Agronomists use "around the site" as basis of measurement & take 10-20 samples / area

* could utilise CPS to "triangulate" data with existing soil databases.
- "triangulation" done ~~with~~ by computer that receives data

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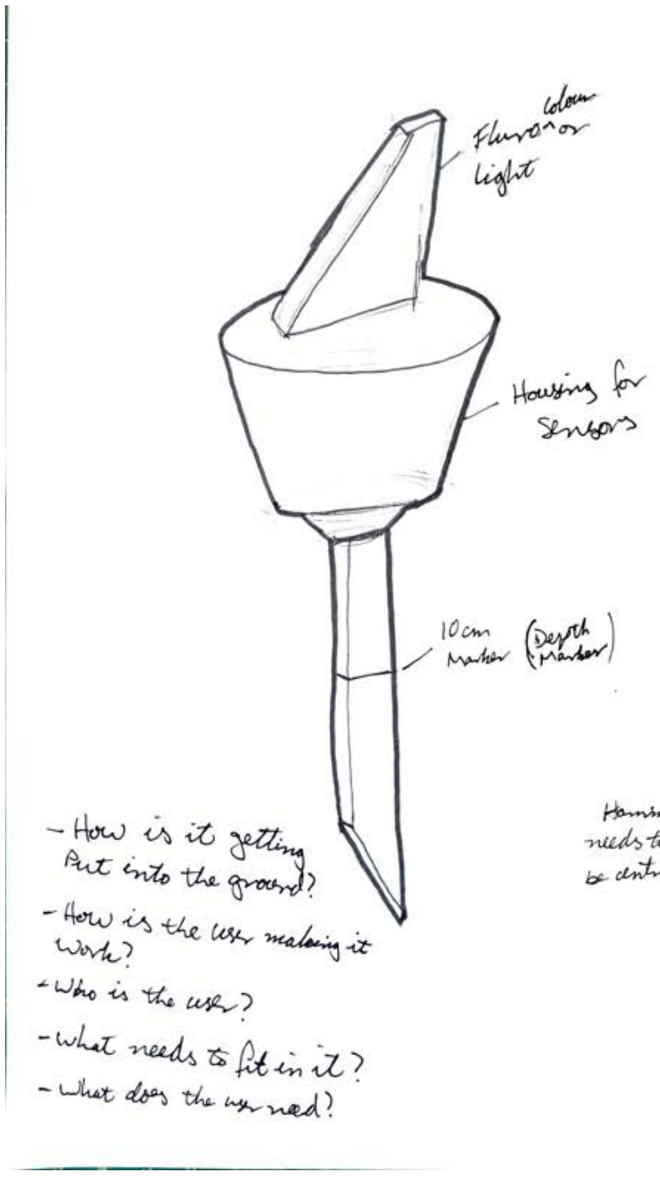
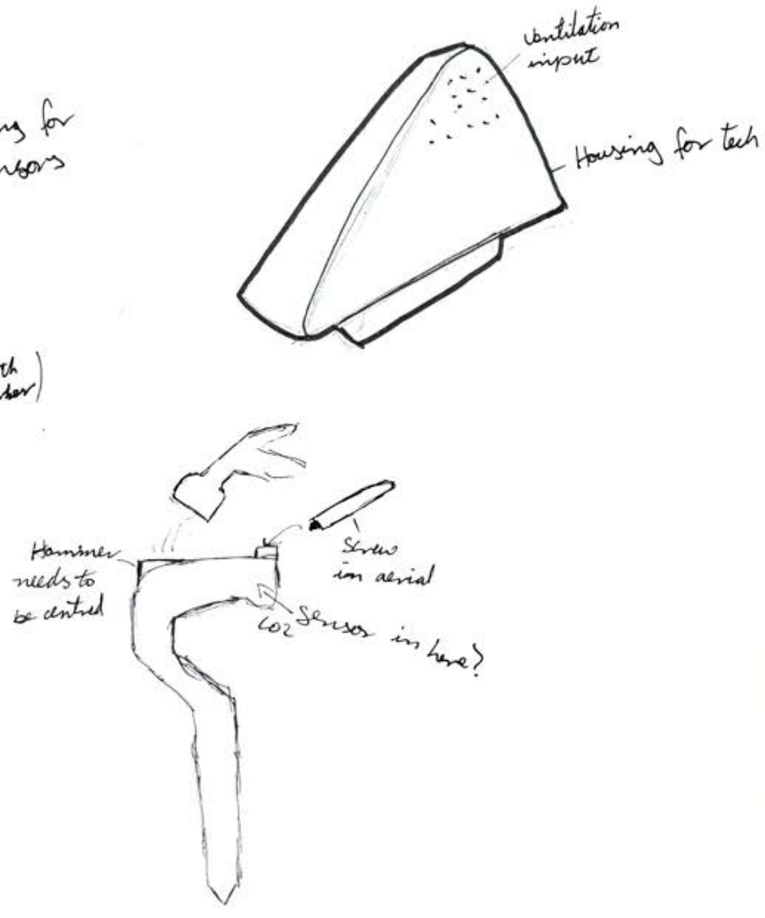
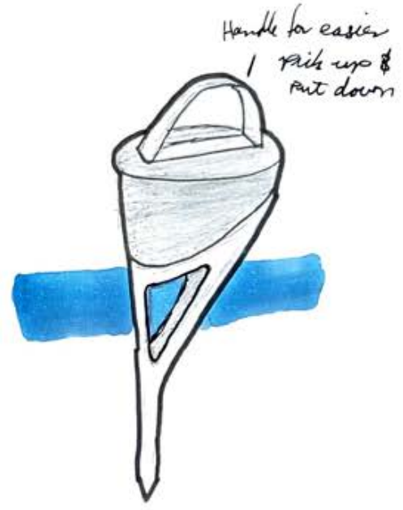
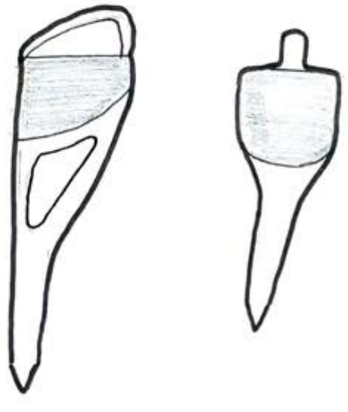
SOIL PROBE DEVELOPMENT









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VISCOM EXPLORATION

"I am creating a probe for testing soil CO2 respiration. It needs to have handles to push the probe into the ground, and a light to be seen in the paddock. I want everything to be as sleek as possible. This device is light and easily carried by an agronomist"

TS

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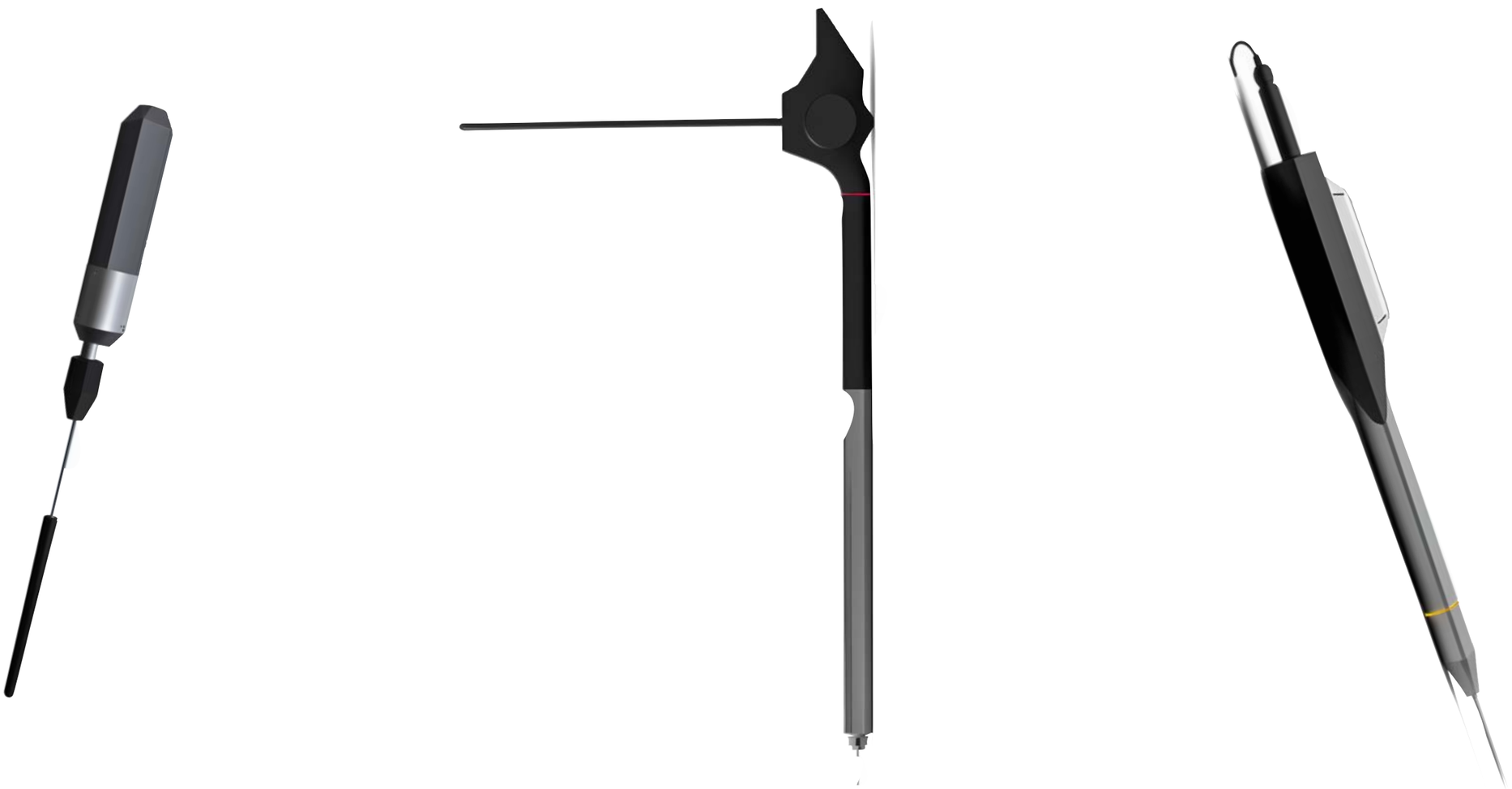

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SOIL PROBE DEVELOPMENT

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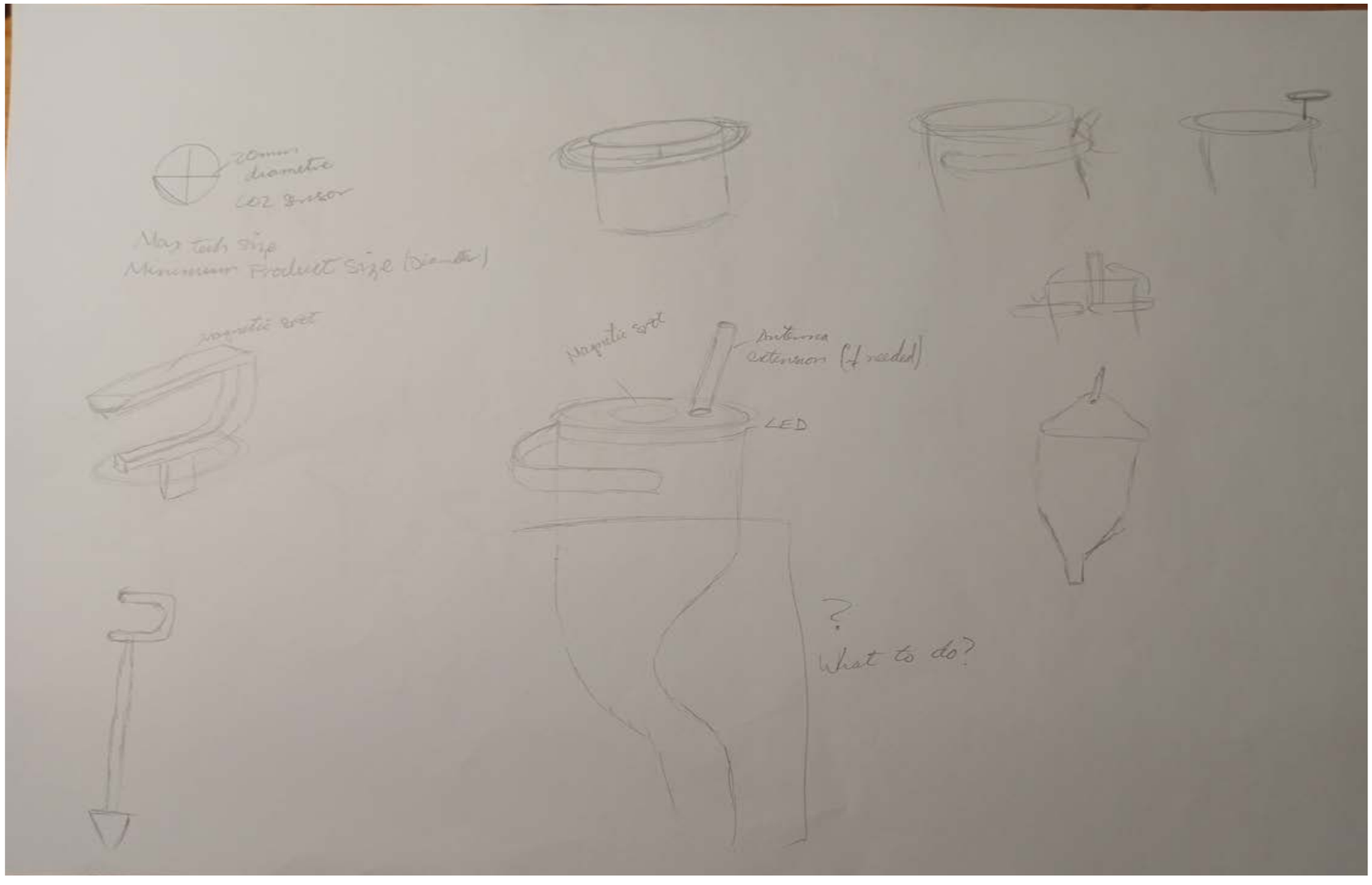

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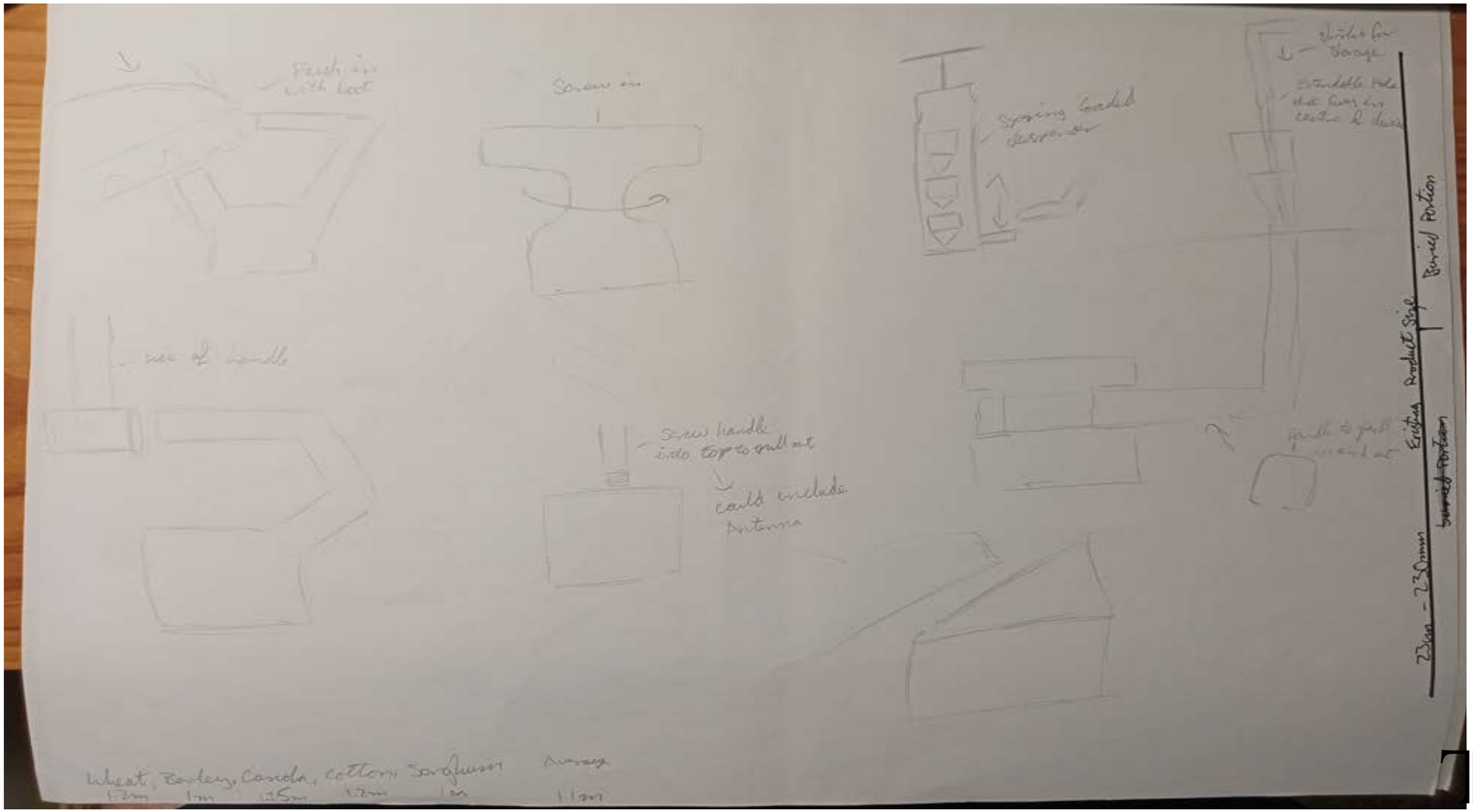

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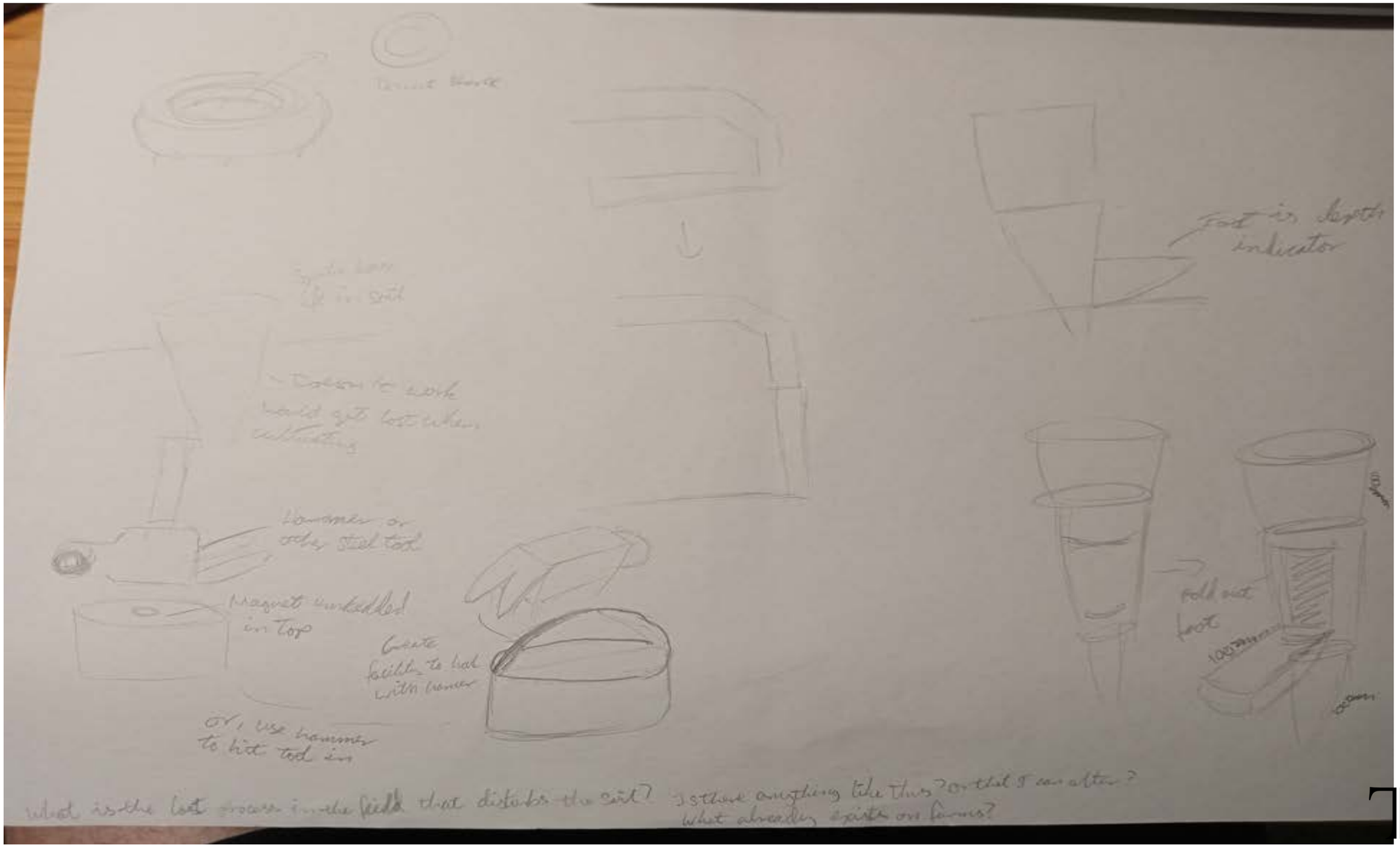

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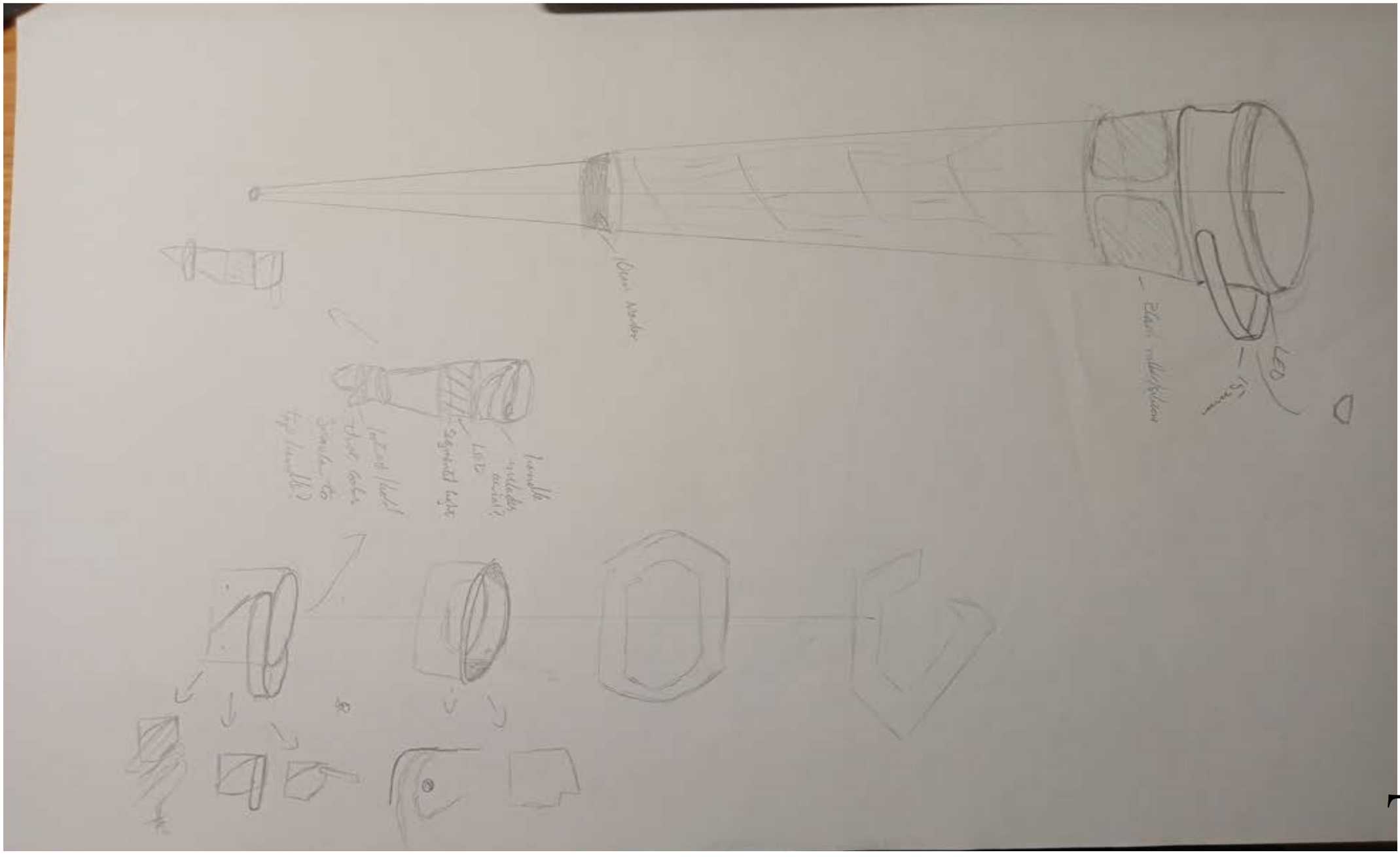

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BIO-MIMICRY EXPLORATION

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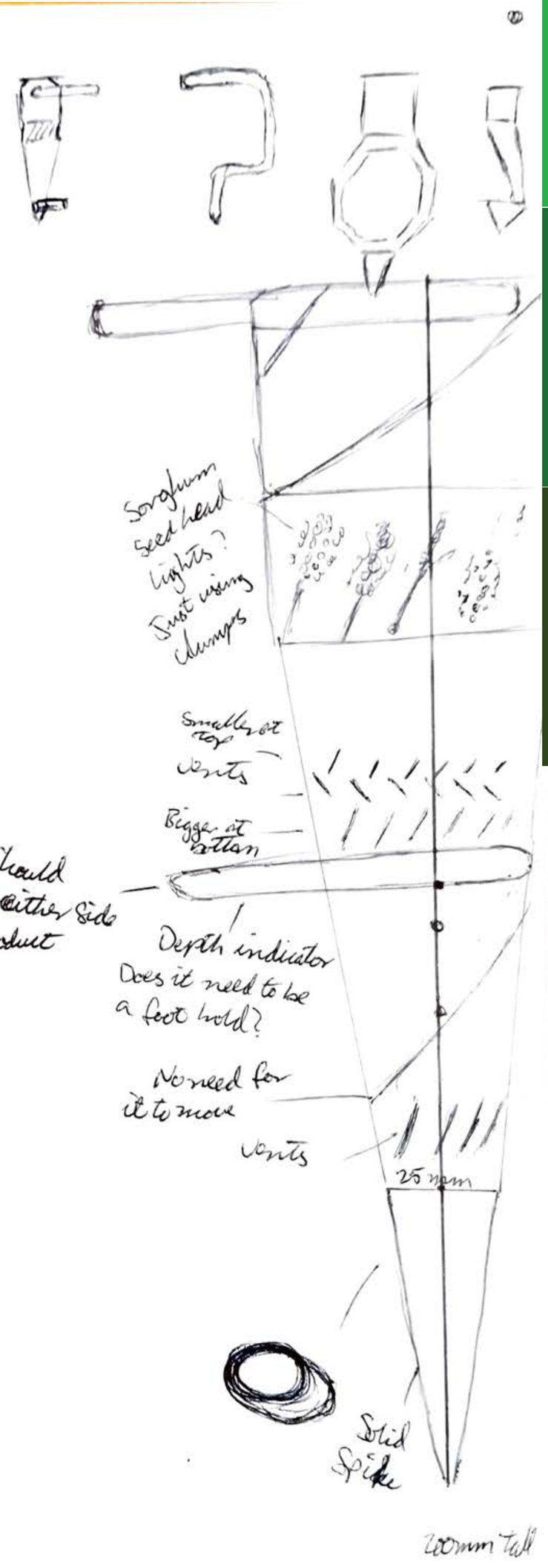

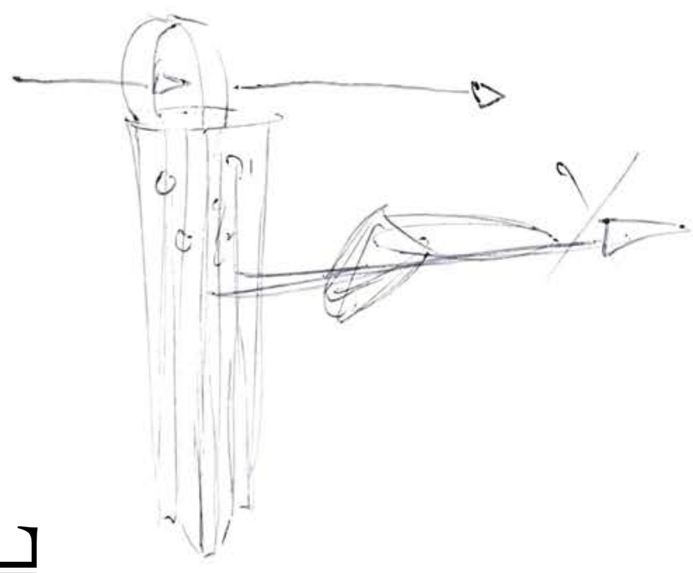

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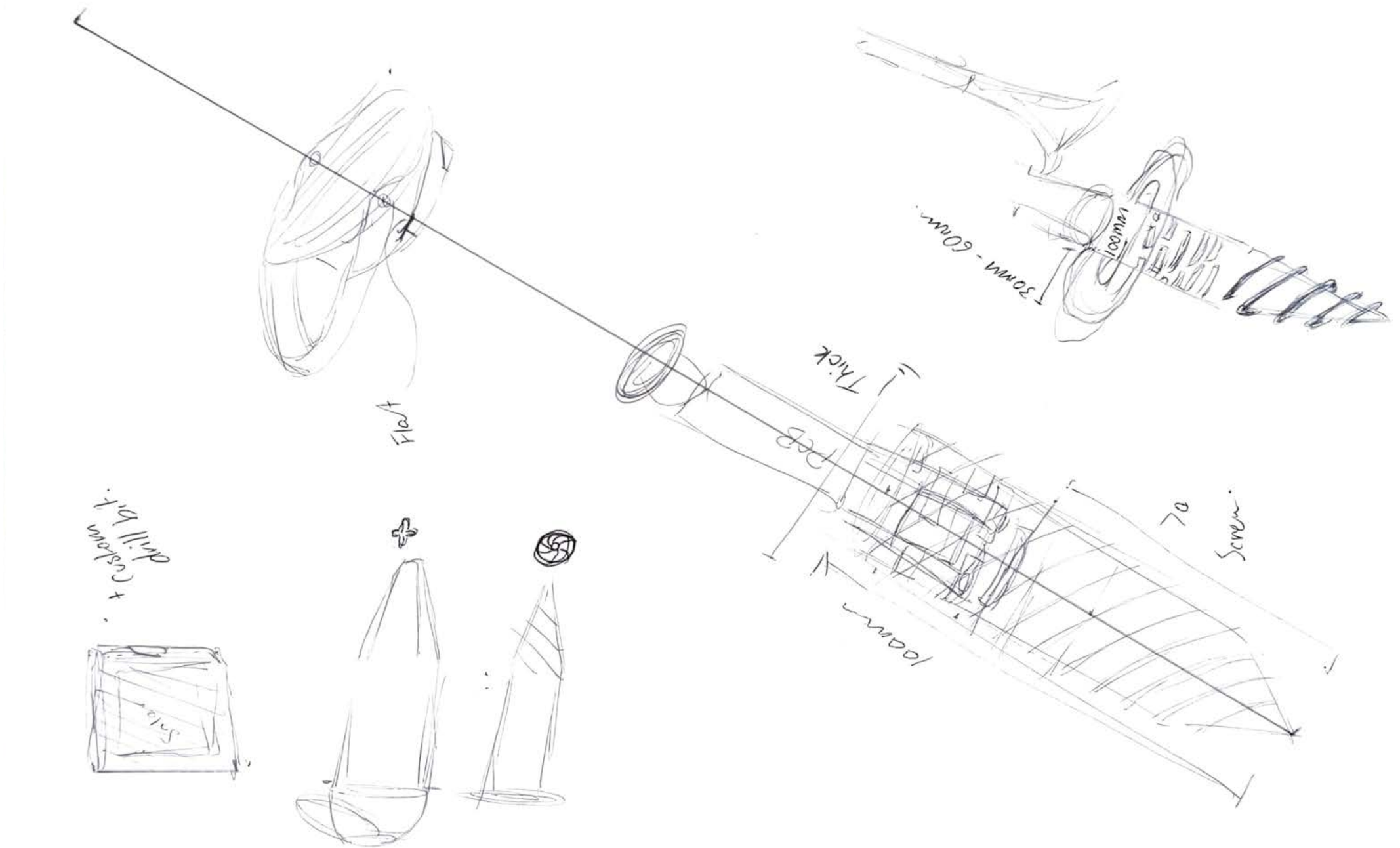

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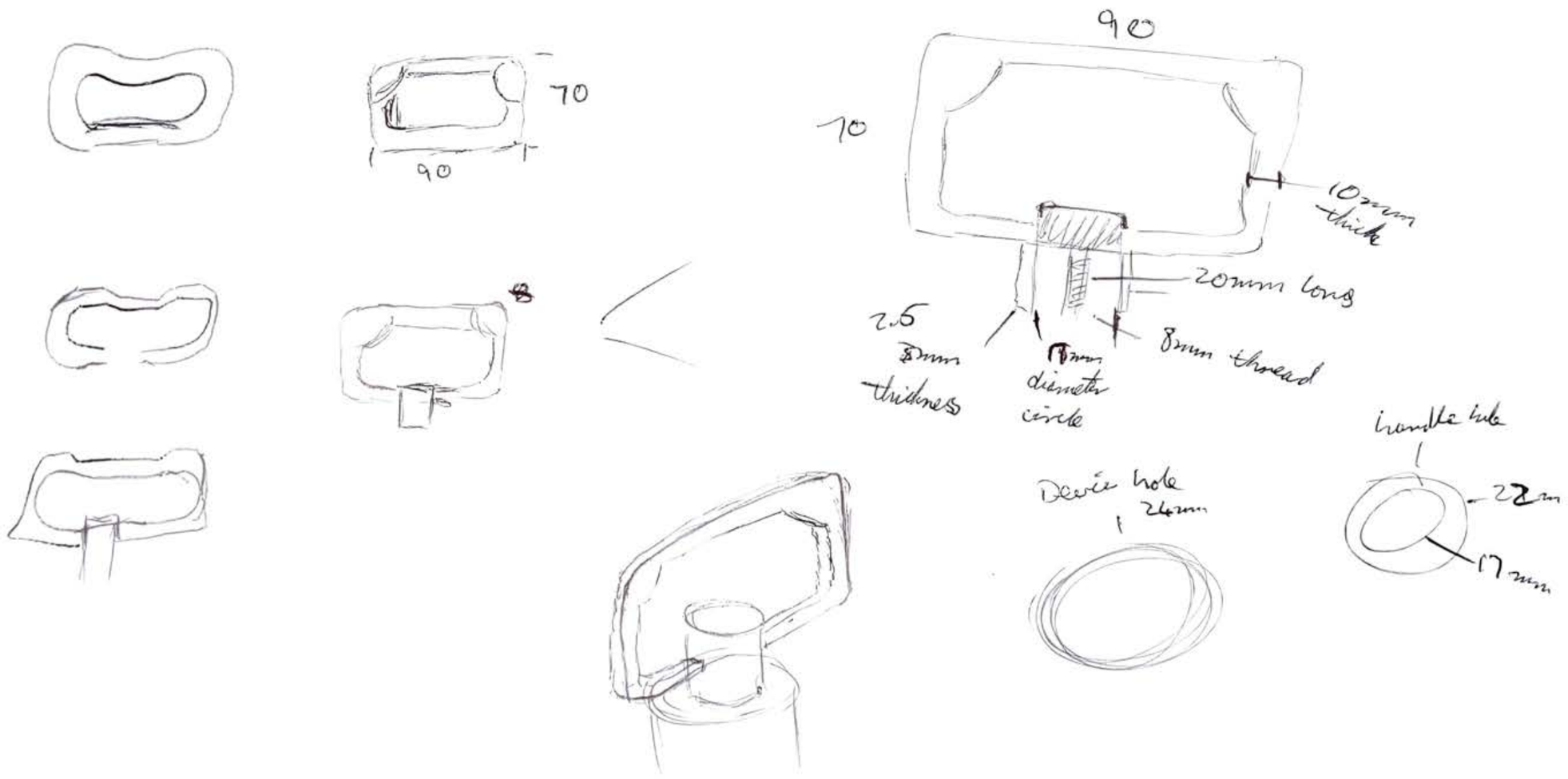

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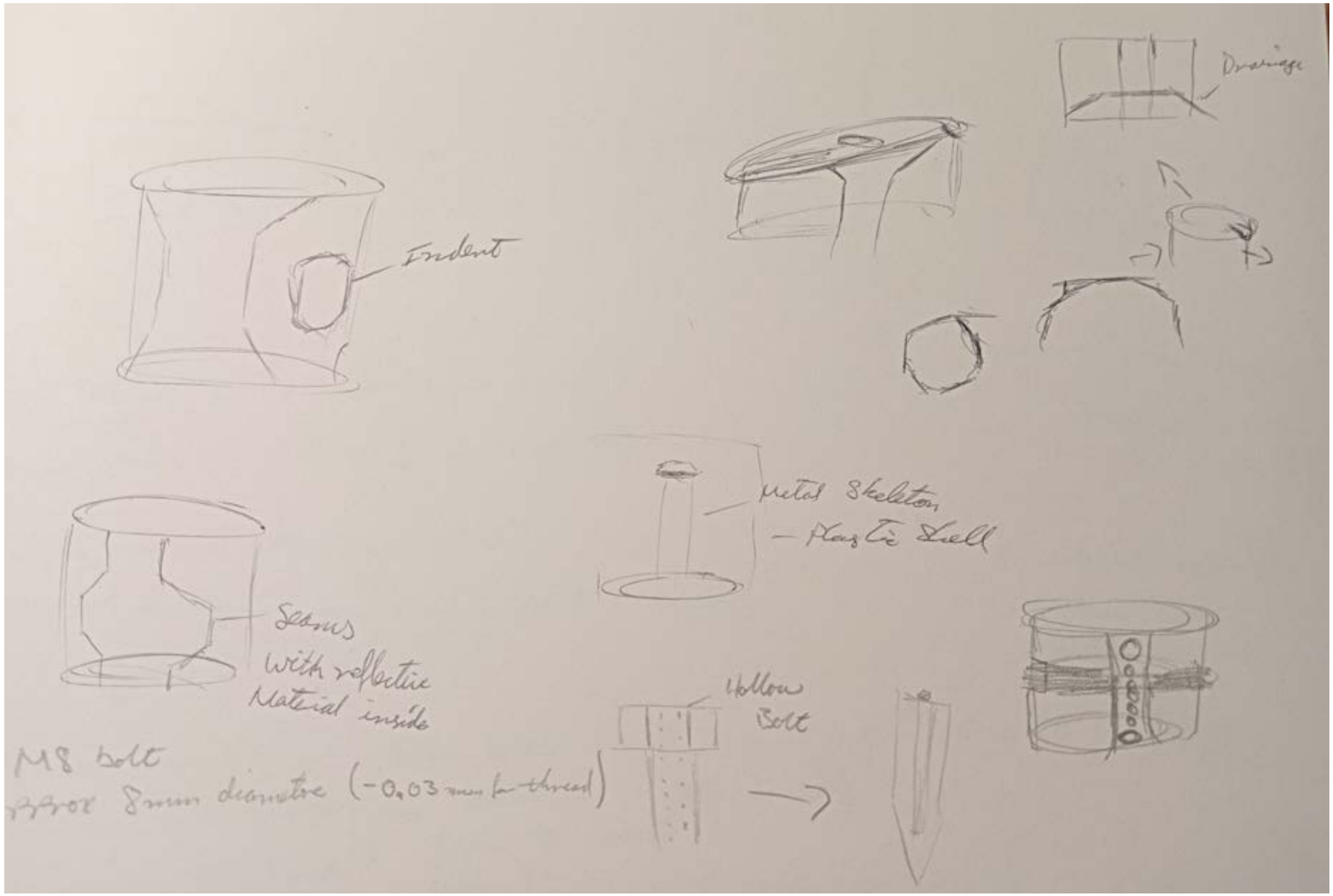

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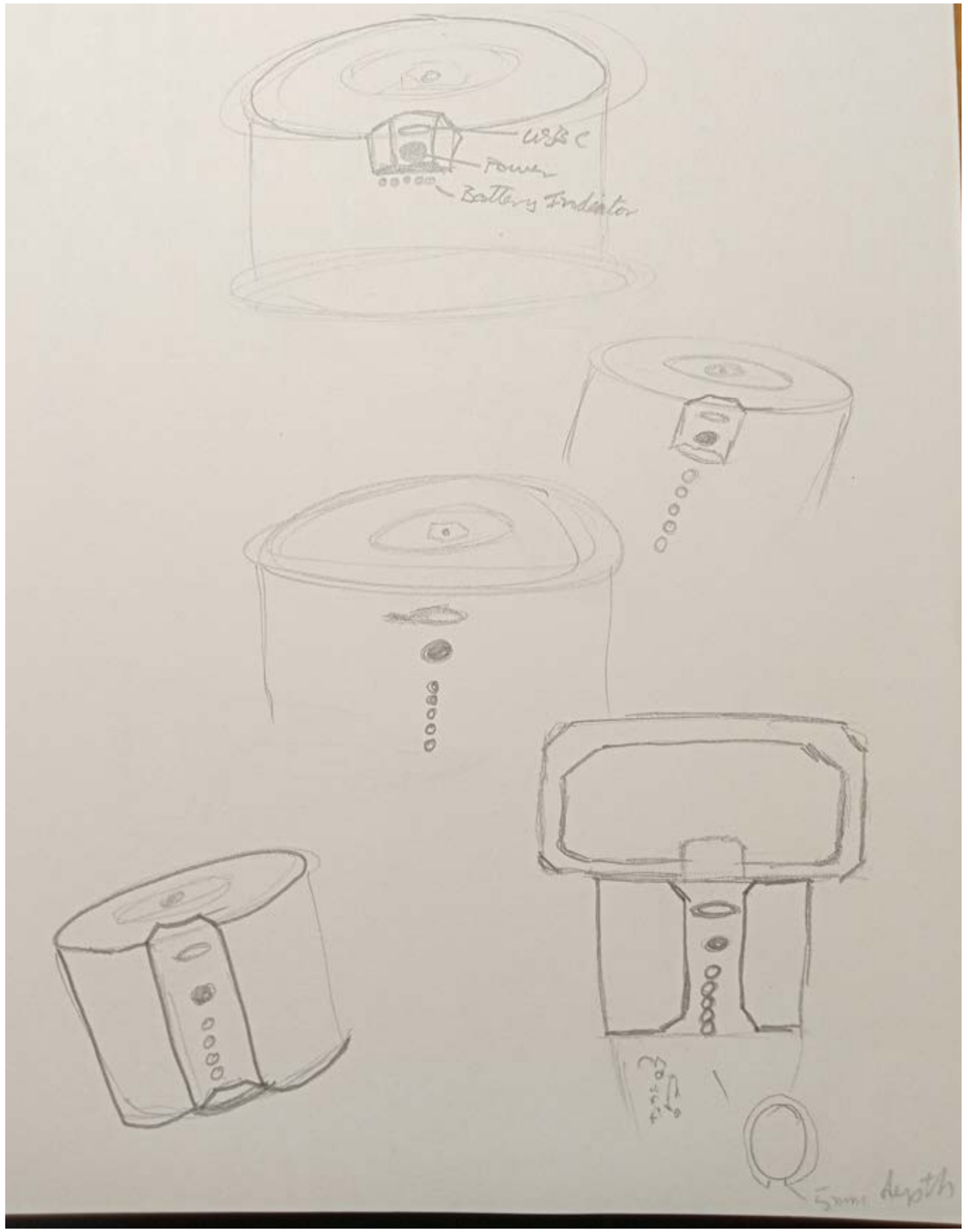

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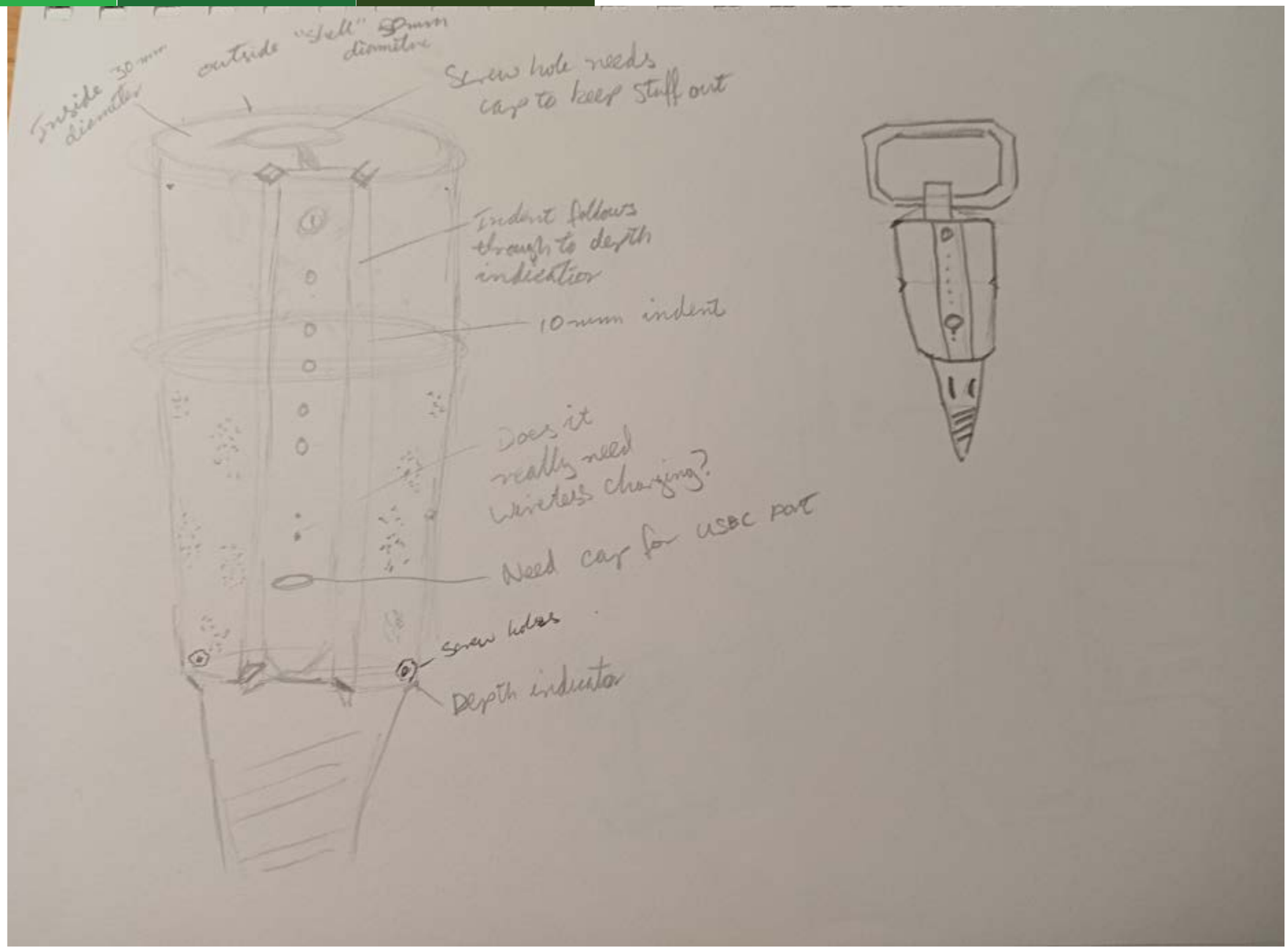

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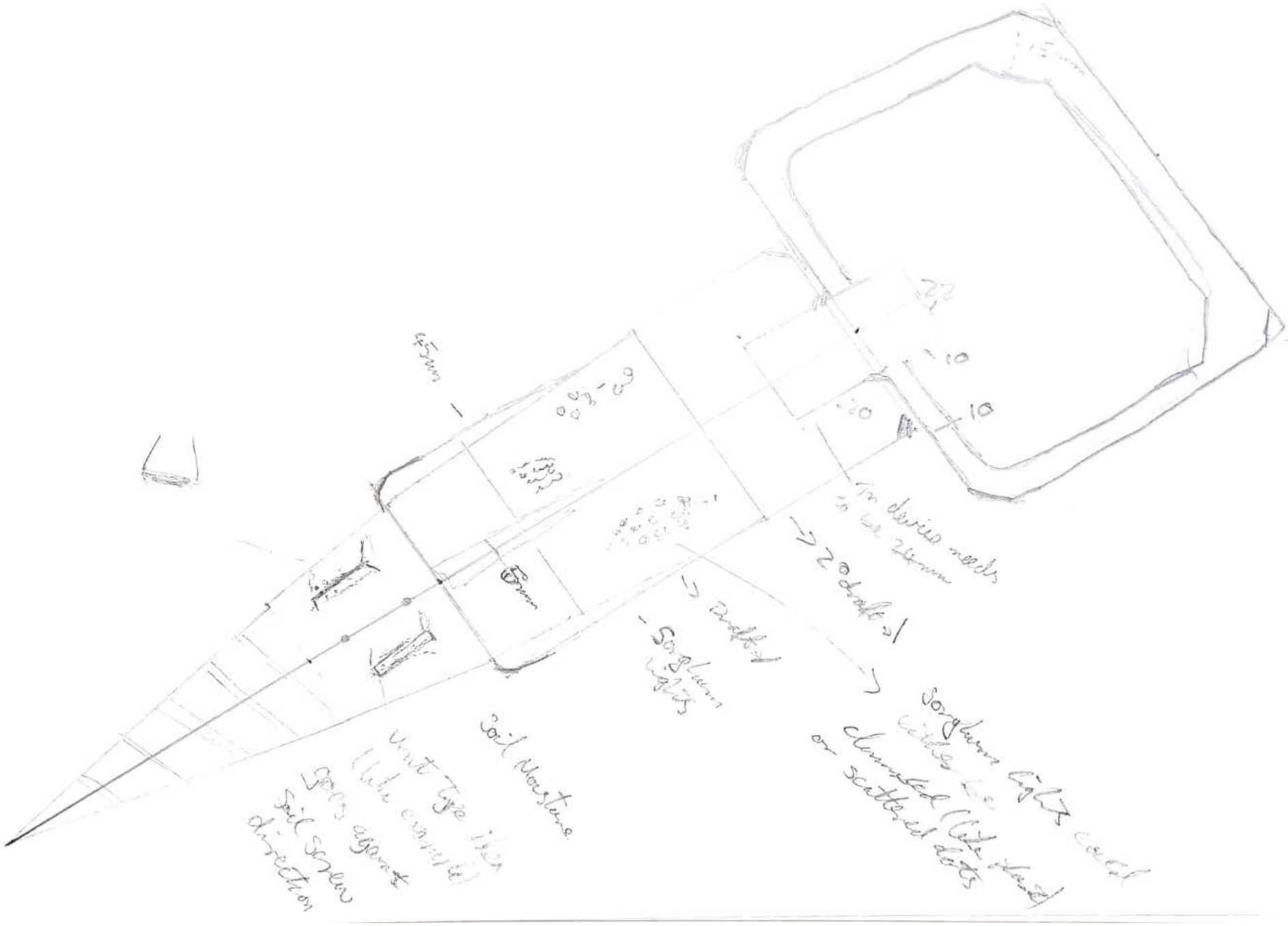


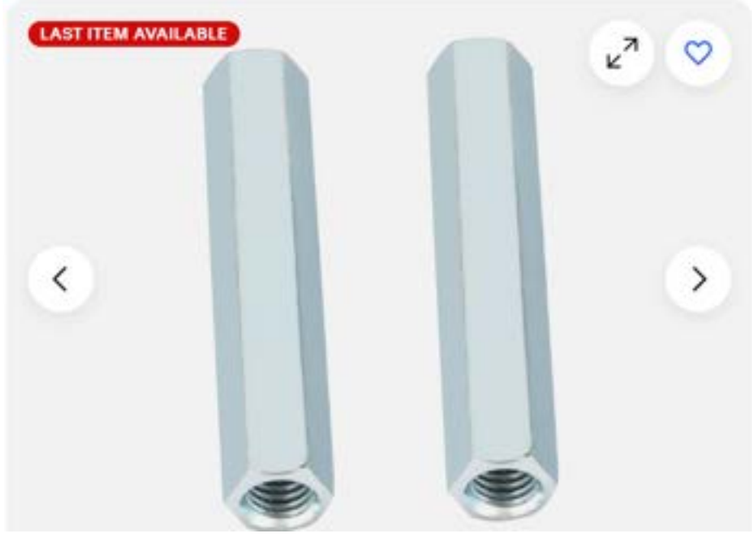
TS

EXISTING PRODUCT

https://www.amazon.com/Zidazlha-Removable-Securing-Canopies-Trampoline/dp/B0BRCPMW56?th=1

TS

CENTRAL BOLT???



2pcs M8 * 66 Long Rod Nut Hex Hexagonal Sleeve Nut Standoff Threaded Fastene GAW

giaowe (691)
98.6% positive · Seller's other items · Contact seller

AU $12.45
or Best Offer

Buy now, pay later available

Condition: **Brand New**

Quantity: 1 Last one · 2 sold

M10x60mm Hollow External Hexagon Screw, 2 Set Cylindrical Lamp Threading Socket Screws Through Hole Bolt With Nut 304 Stainless Steel

$7.21

Order ≥200+	Order ≥500+	Order ≥800+	Order ≥2000+	Order ≥5000+
5%OFF	10%OFF	15%OFF	25%OFF	35%OFF

About this item

- Application: Hollow hexagon screws and nuts are common connecting and fastening parts used on the pendant light, chandeliers, ceiling lamps. Furthermore, the cabinet and some DIY furniture might use it as well.
- NOTE: The thread size might need to be check whether it fit your need.
- Advantage: 1.The cylinder hollow hexagon screw and nut is made of 304 stainless steel, which has a good anti rust and anti corrosion performance, sturdy and durable to use, not easy to rust. 2.The inner side is hollow and the surface inside is smooth, good for threading or installing.
- Instruction: These standard external hexagon screws are easy to use, just screw them and fasten it with nuts.
- Material: 304 Stainless Steel; Thread: M10; Thread Pitch: 1.5mm; Thread Length: 60mm / 2.36 inch; Center Hole Dia.: 5.2mm / 0.2 inch; Screw Hex Width: 16mm / 0.63"; Total Length: 66mm / 2.6"; Nut Hex Width: 16mm / 0.63 inch; Nut Height: 8mm / 0.32 inch; Packing List: 2 x Hollow Hexagon Screws, 2 x Nuts

QTY: 1 + In stock, dispatch in 24 hours.

Add to Cart | Inquiry Now

Free Shipping over $20 Free upgraded to UPS over $200

M8 Male-Female 303 Stainless Steel Hex Standoff Screw Spacer Pillar Hex Support

liang (2415)
99.3% positive · Seller's other items · Contact seller

AU $33.94 each

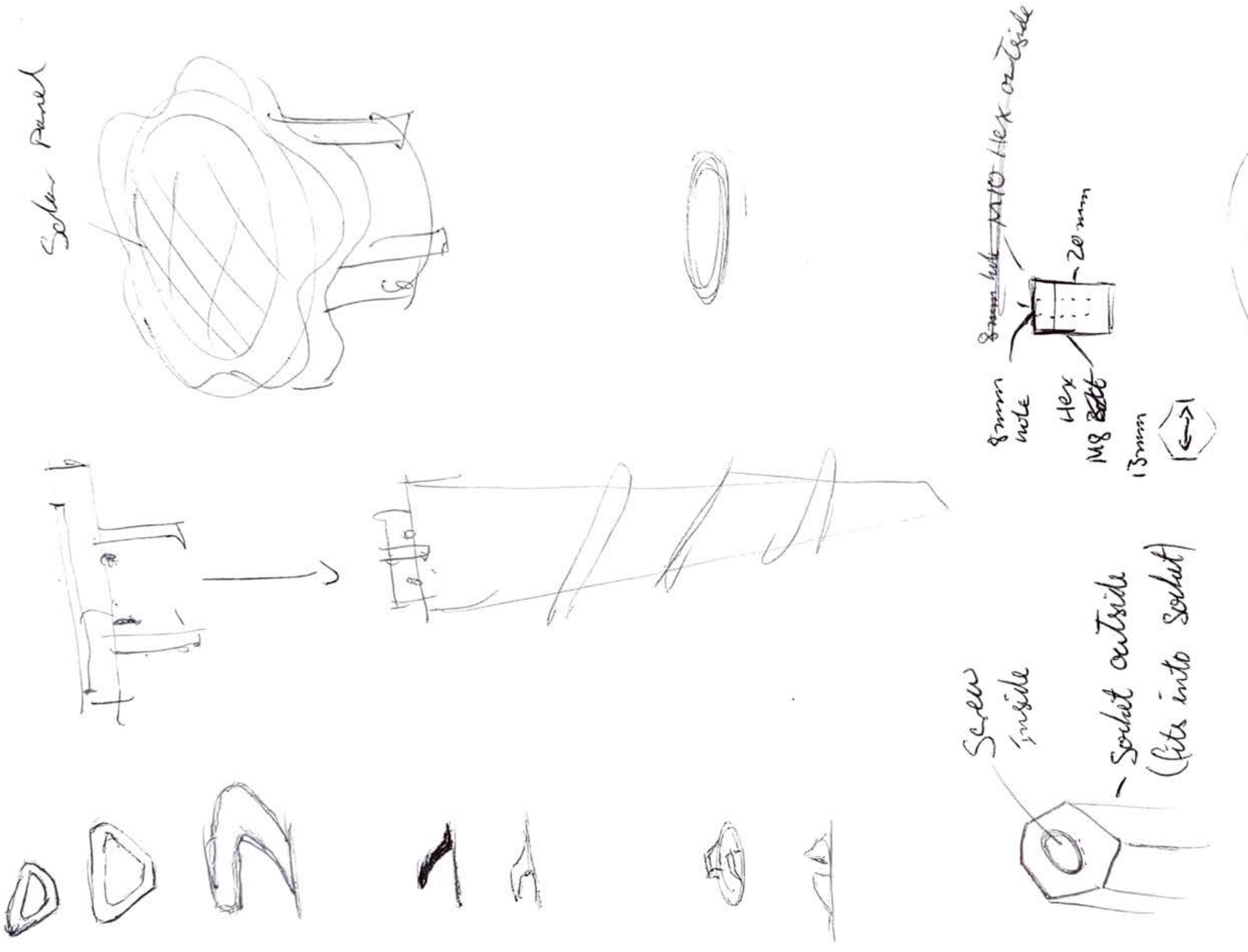
Buy now, pay later may be available

Condition: **Brand New**

Length: **100mm**

Pack Size: **5 Pcs**

SOIL PROBE DEVELOPMENT



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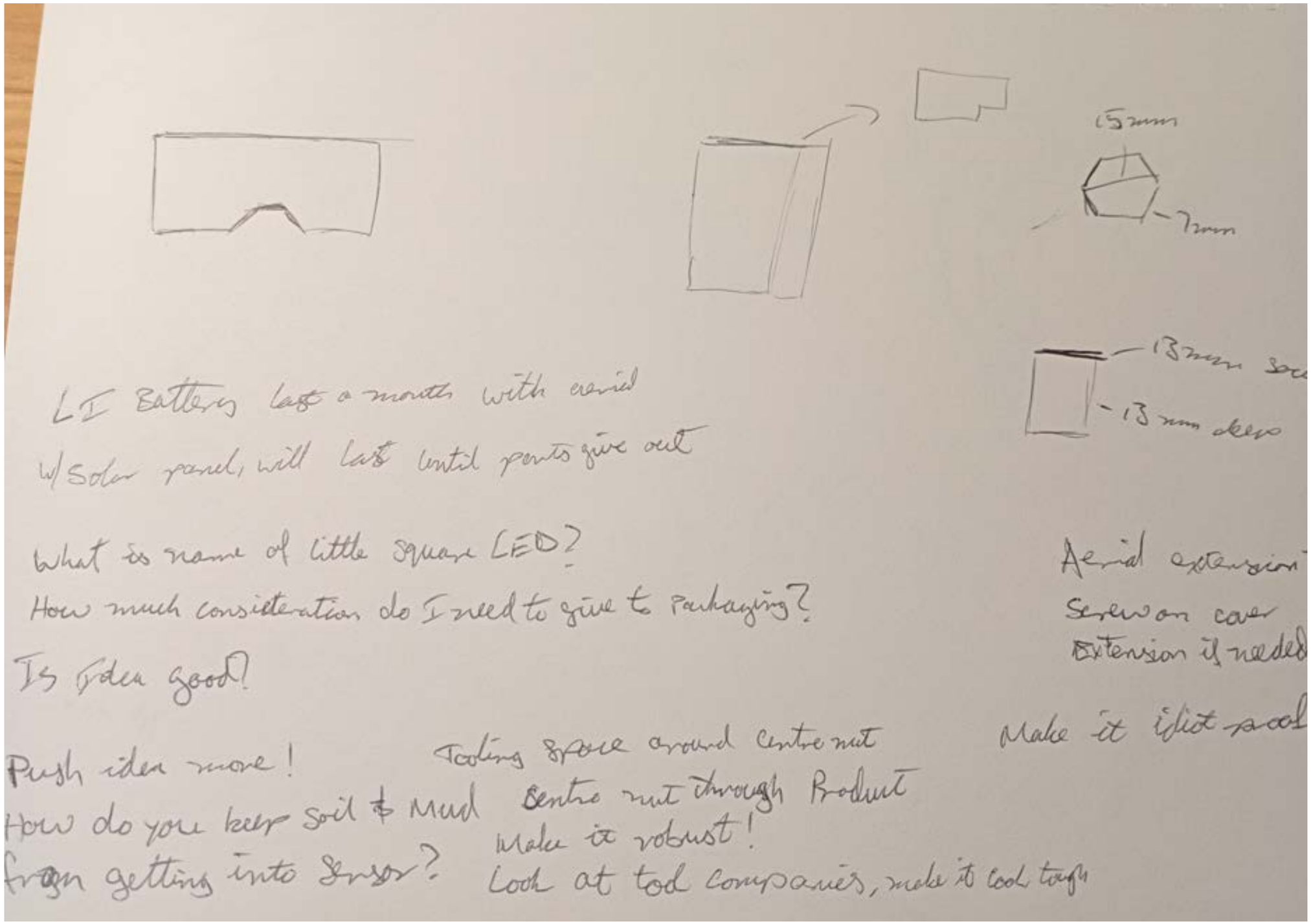

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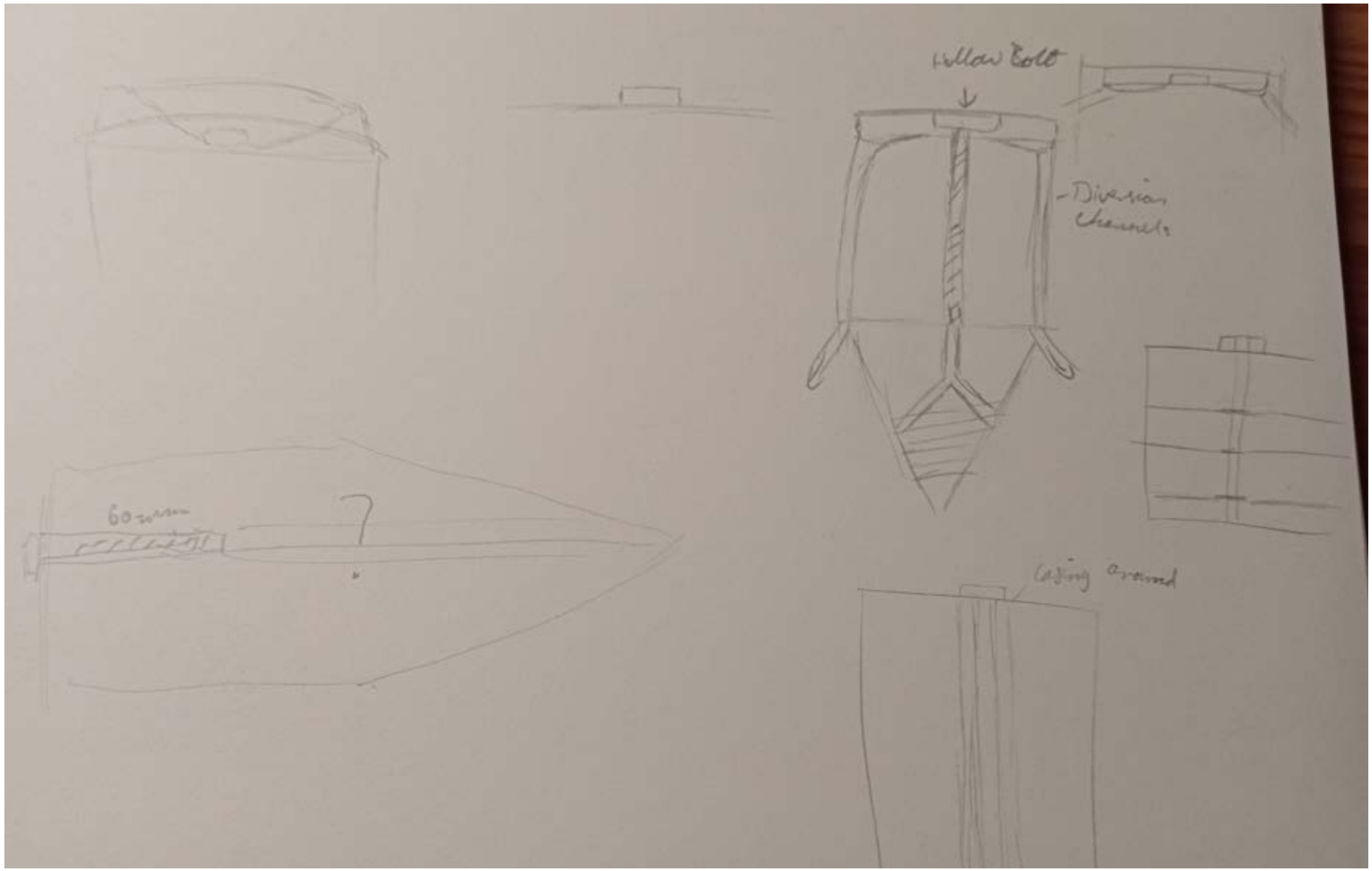

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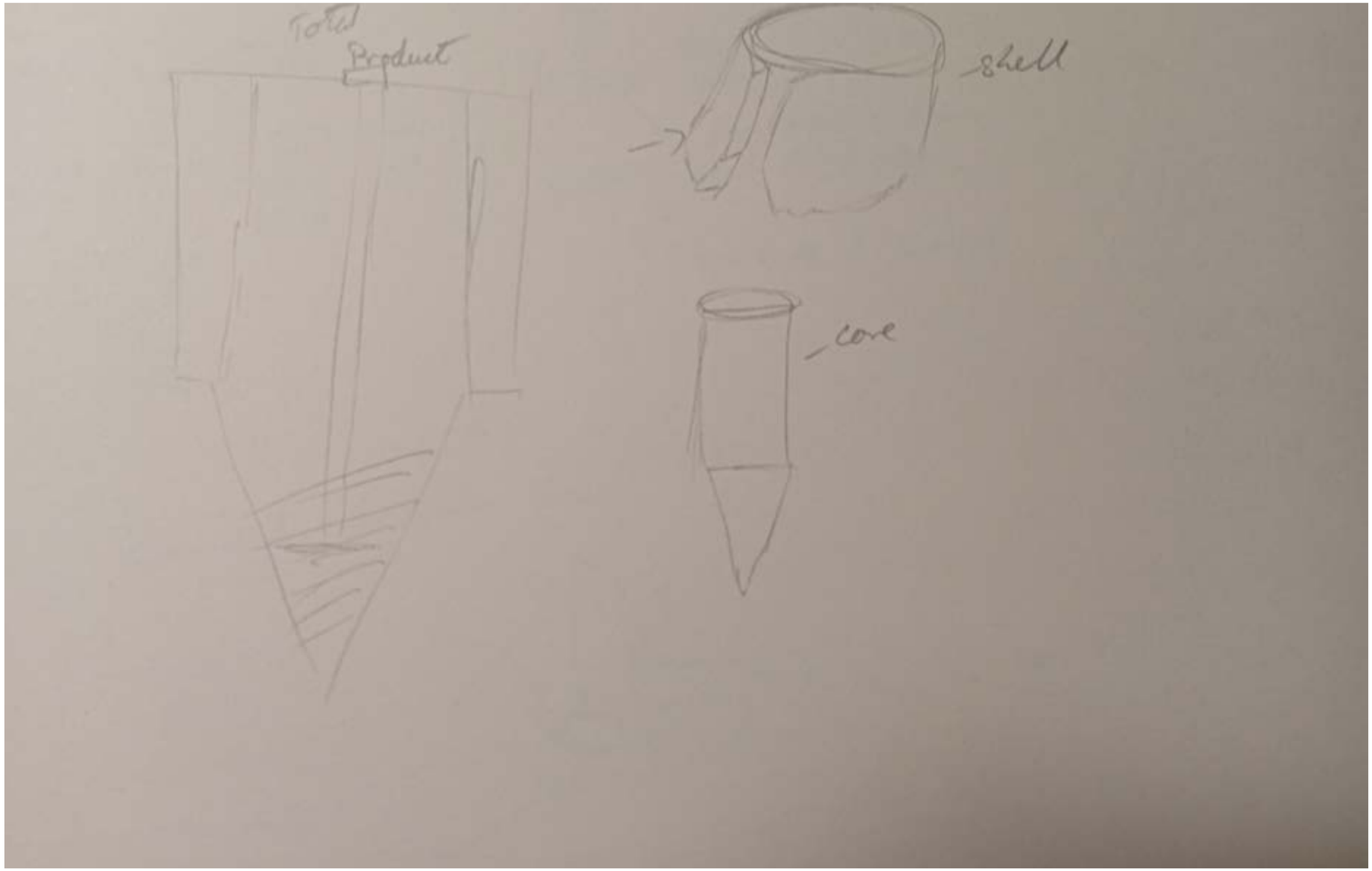

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EXISTING PRODUCT

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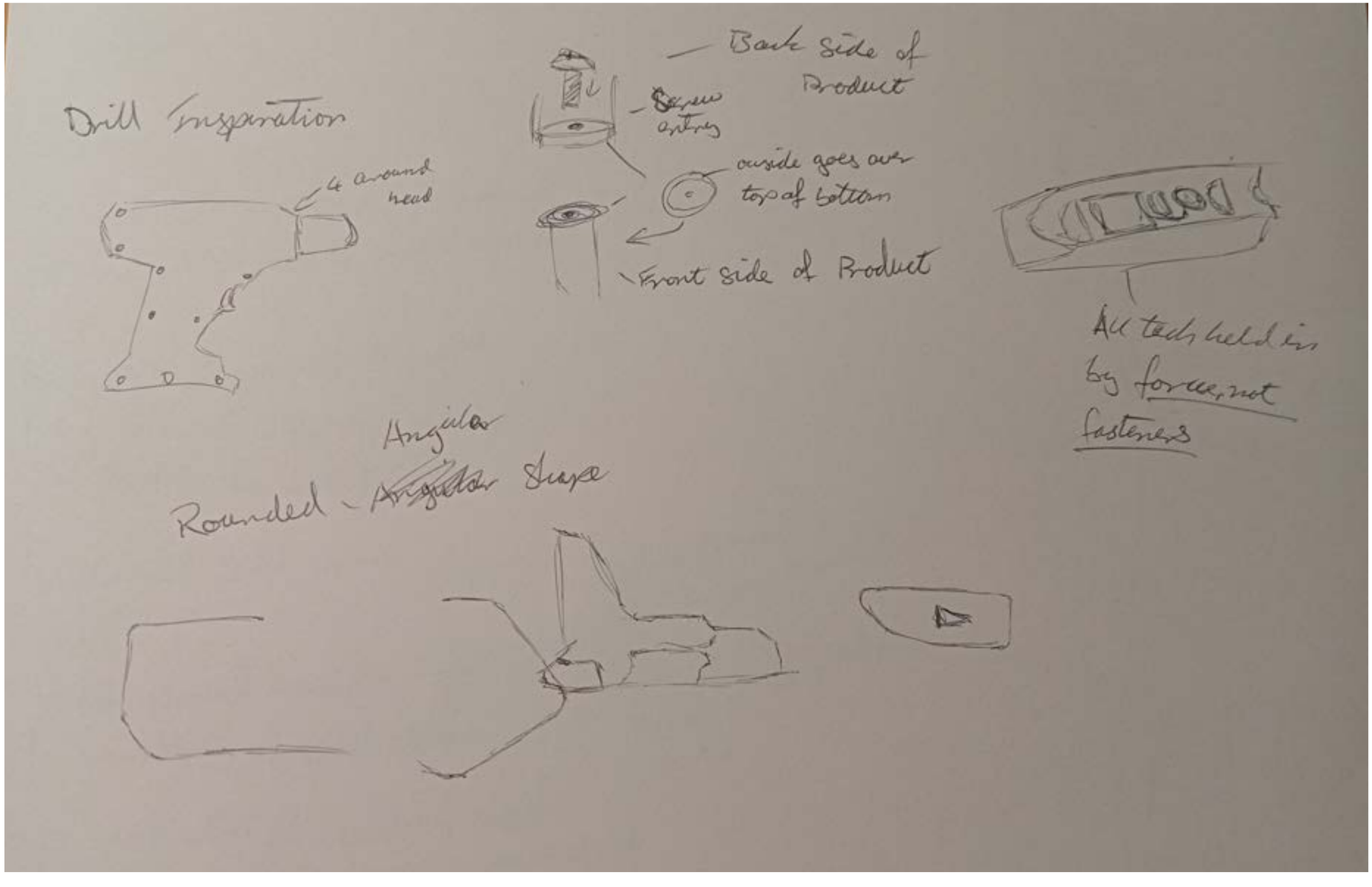
SOIL PROBE DEVELOPMENT



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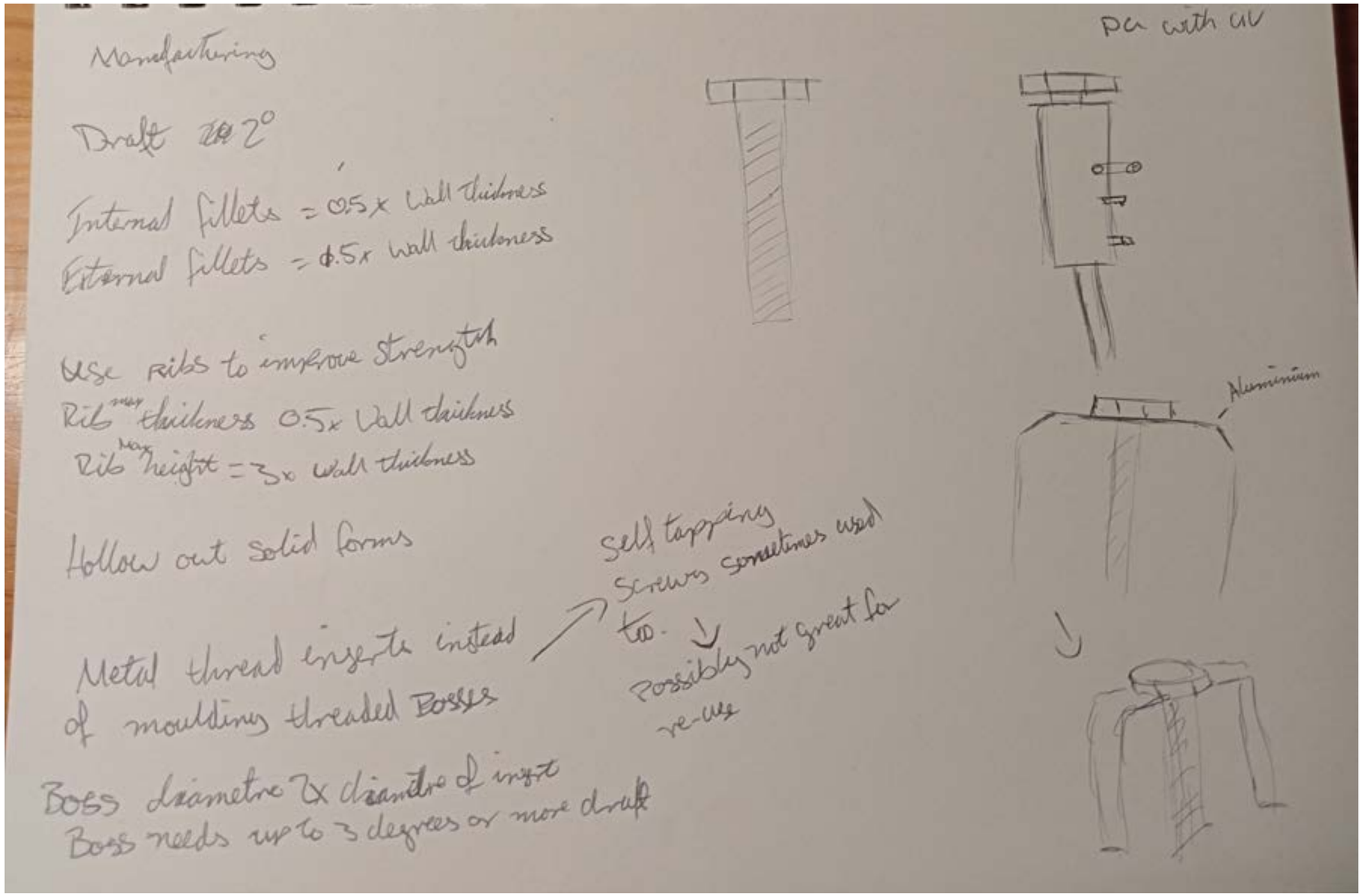

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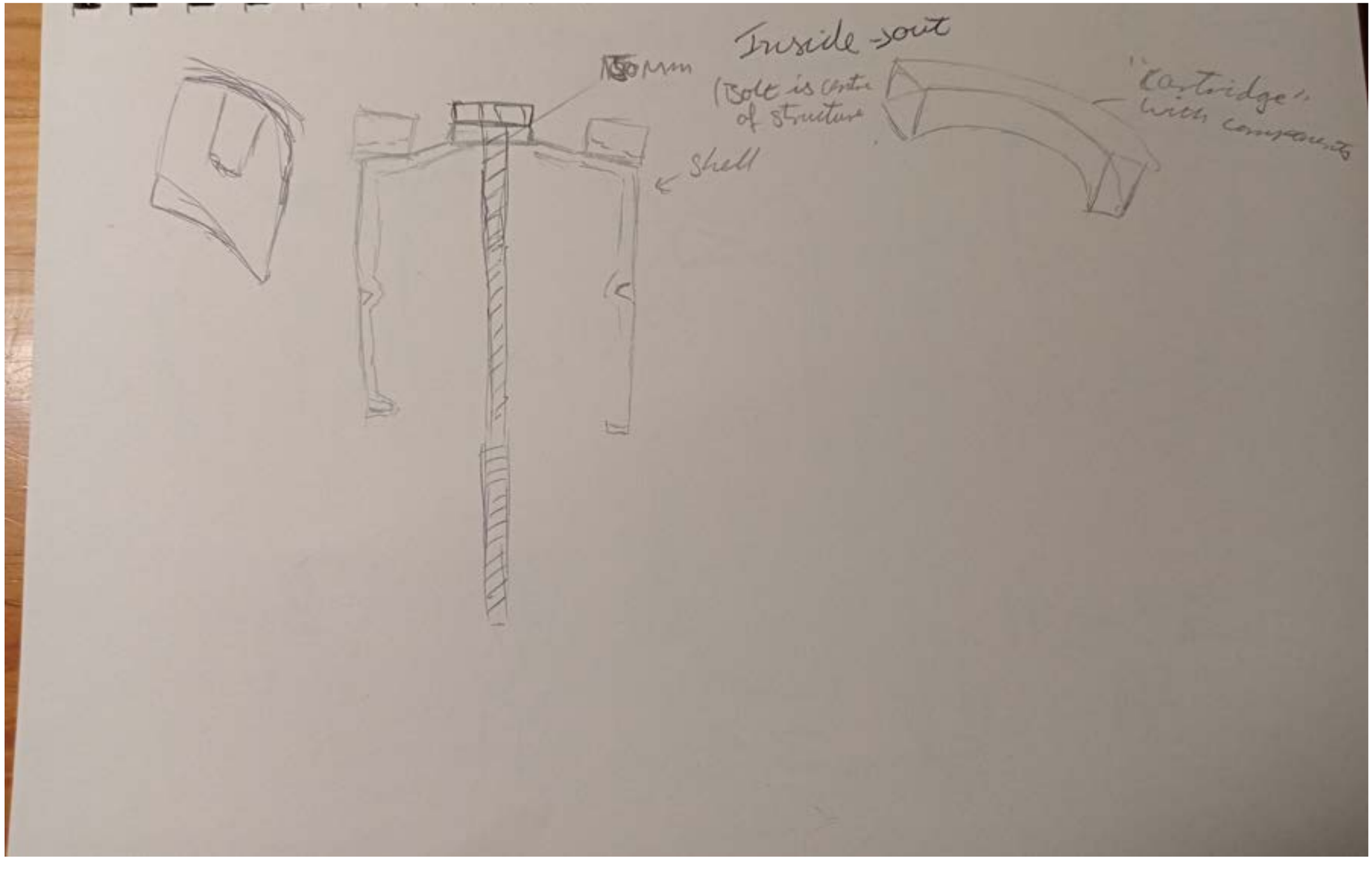

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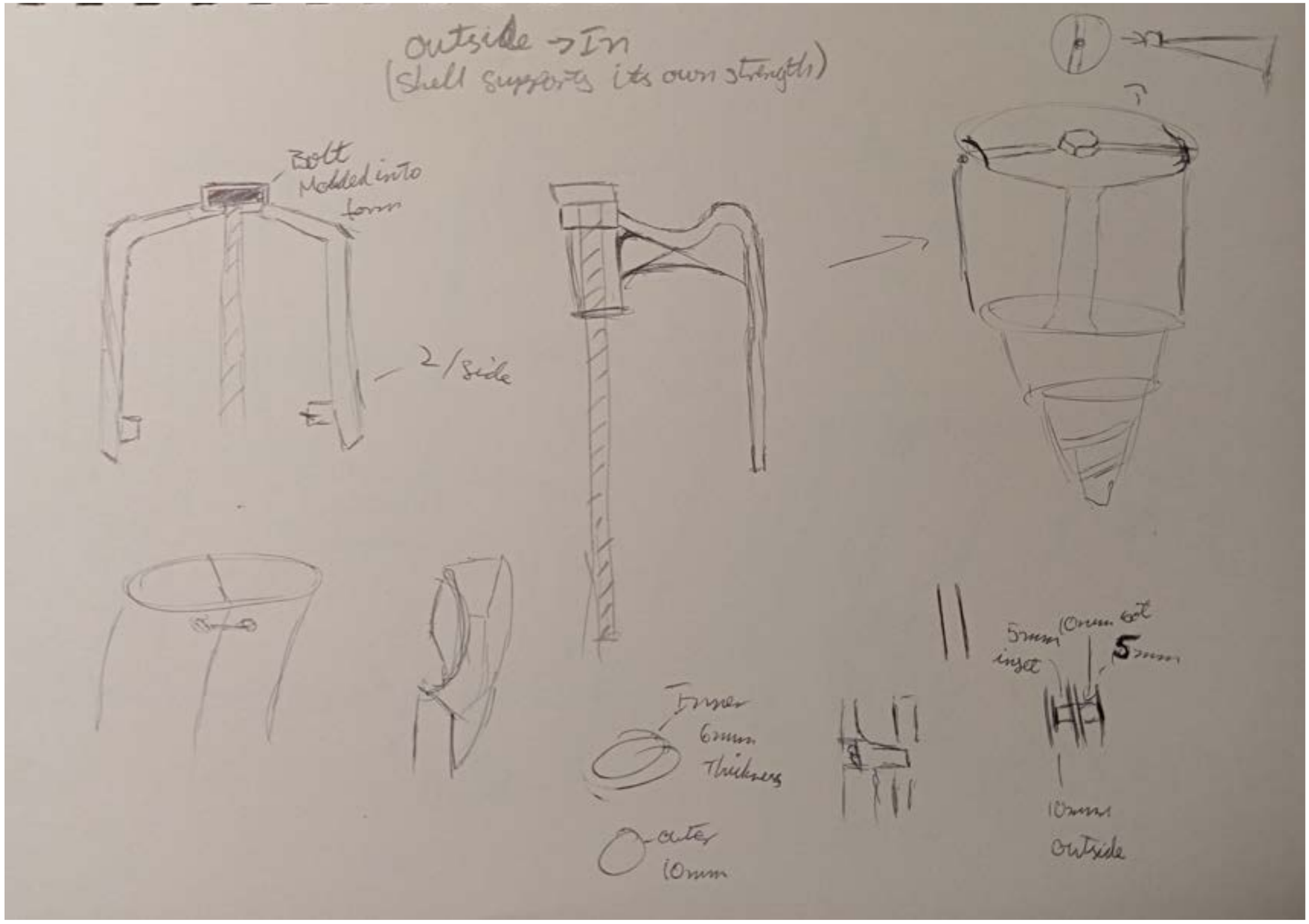

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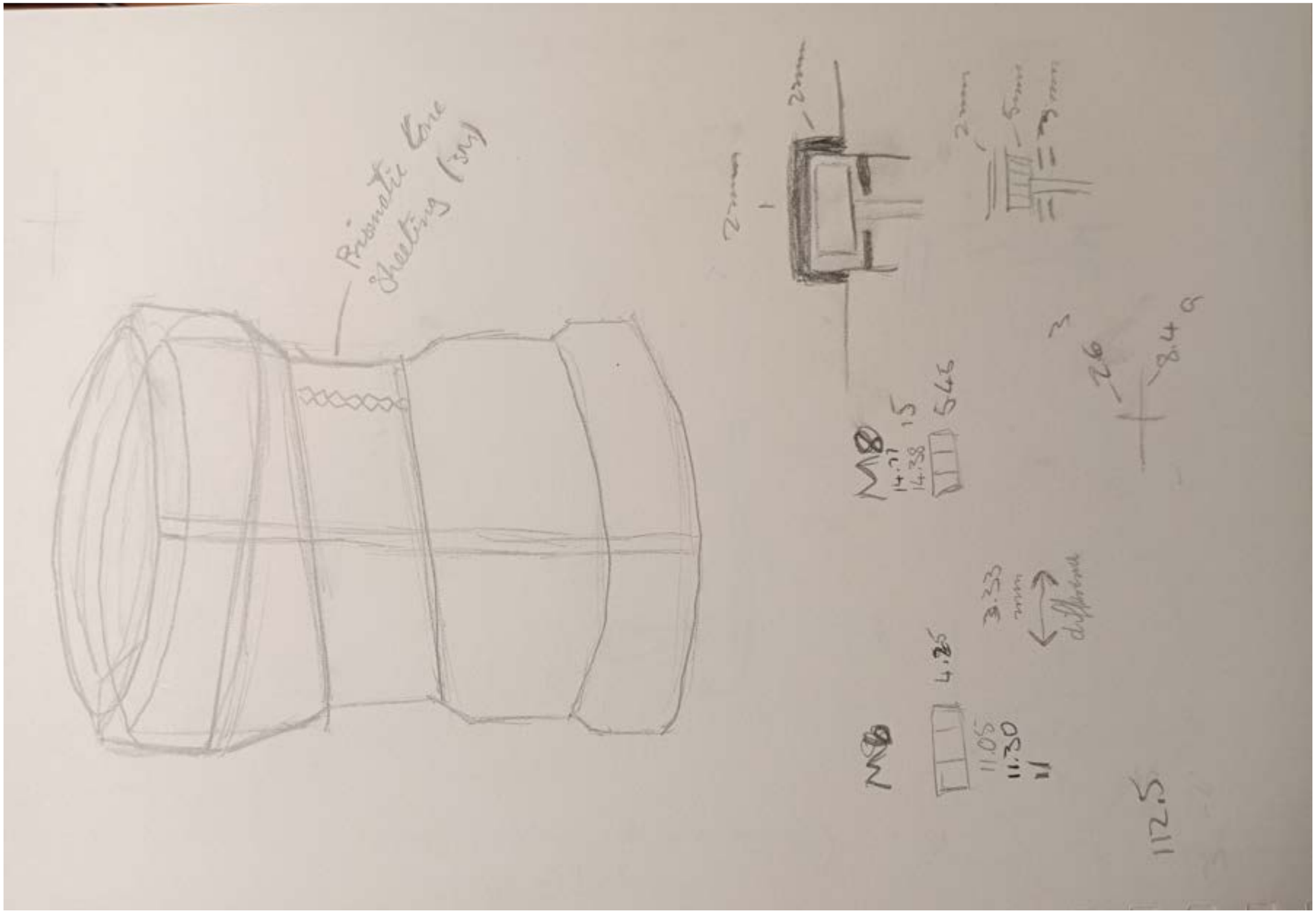

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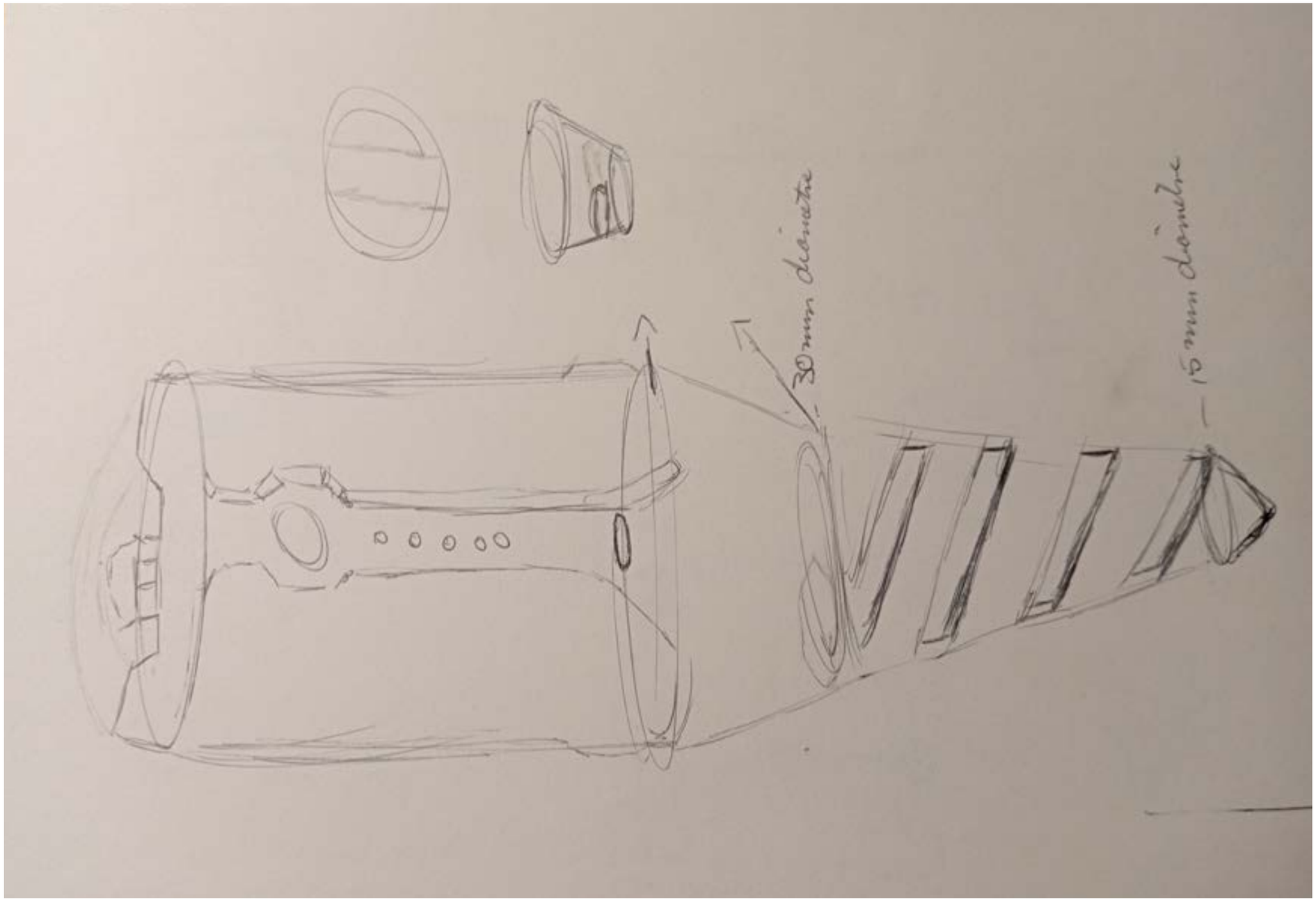

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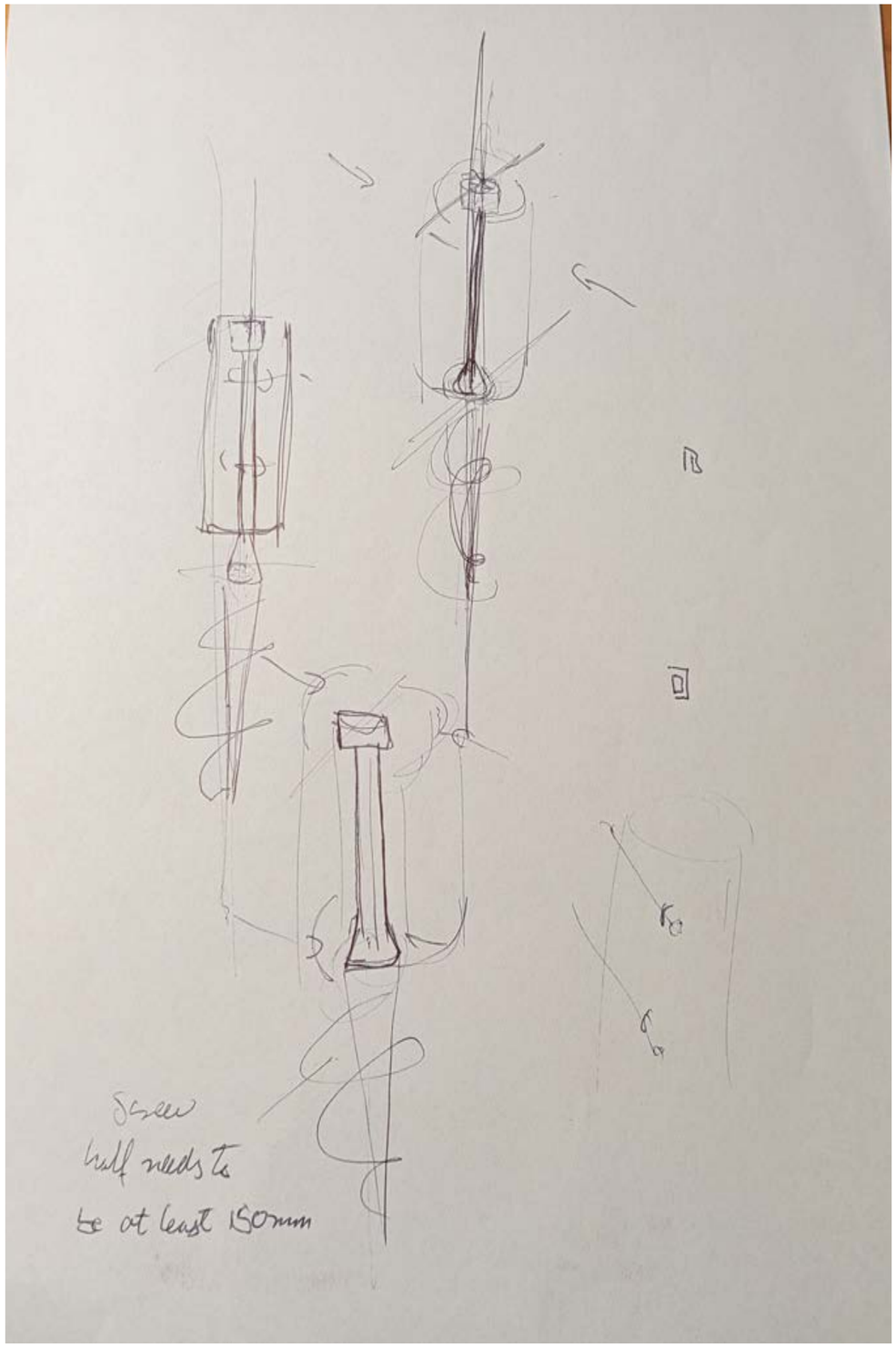
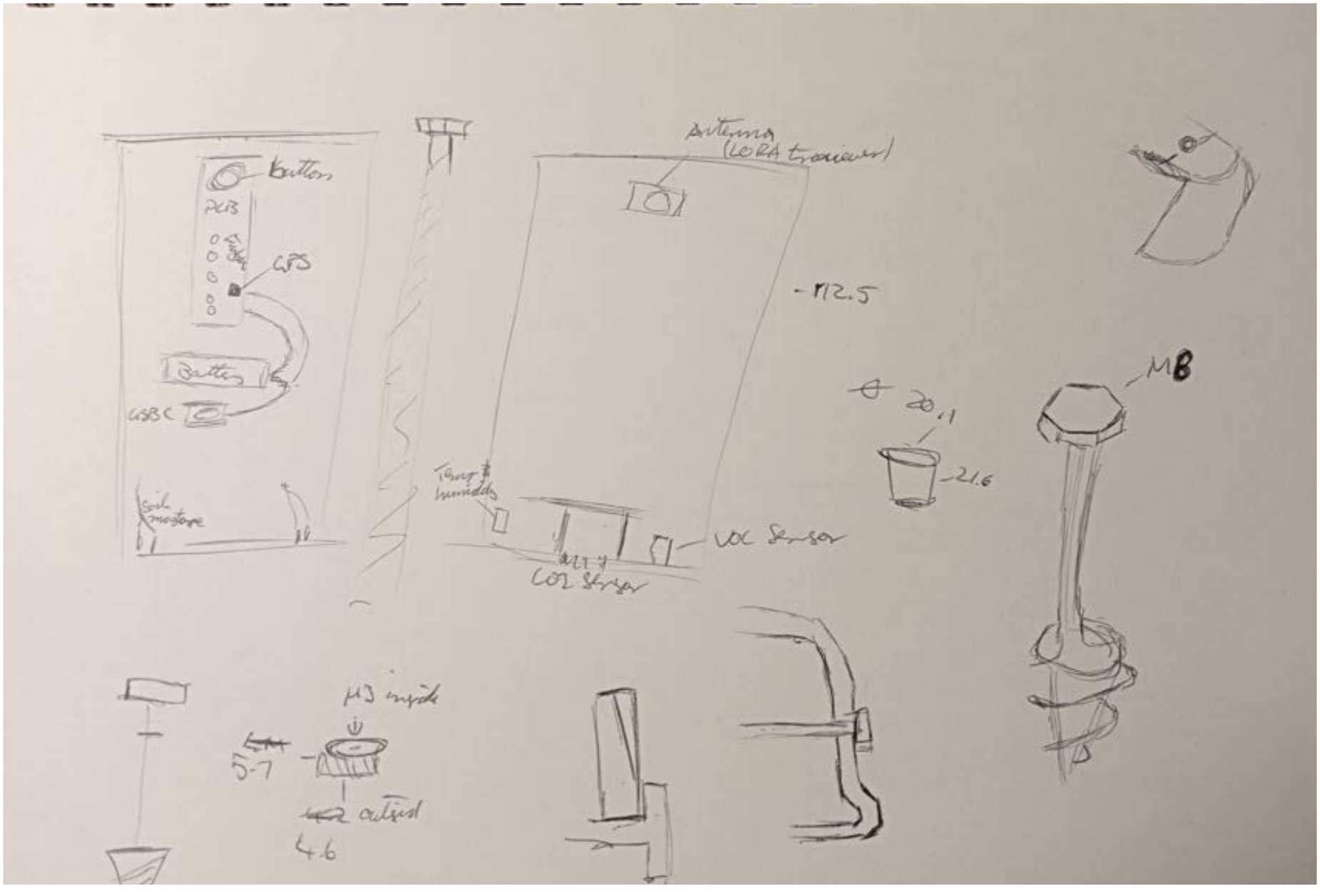
SOIL PROBE DEVELOPMENT - TUTOR INPUT



SCREW BASE

SOIL PROBE DEVELOPMENT



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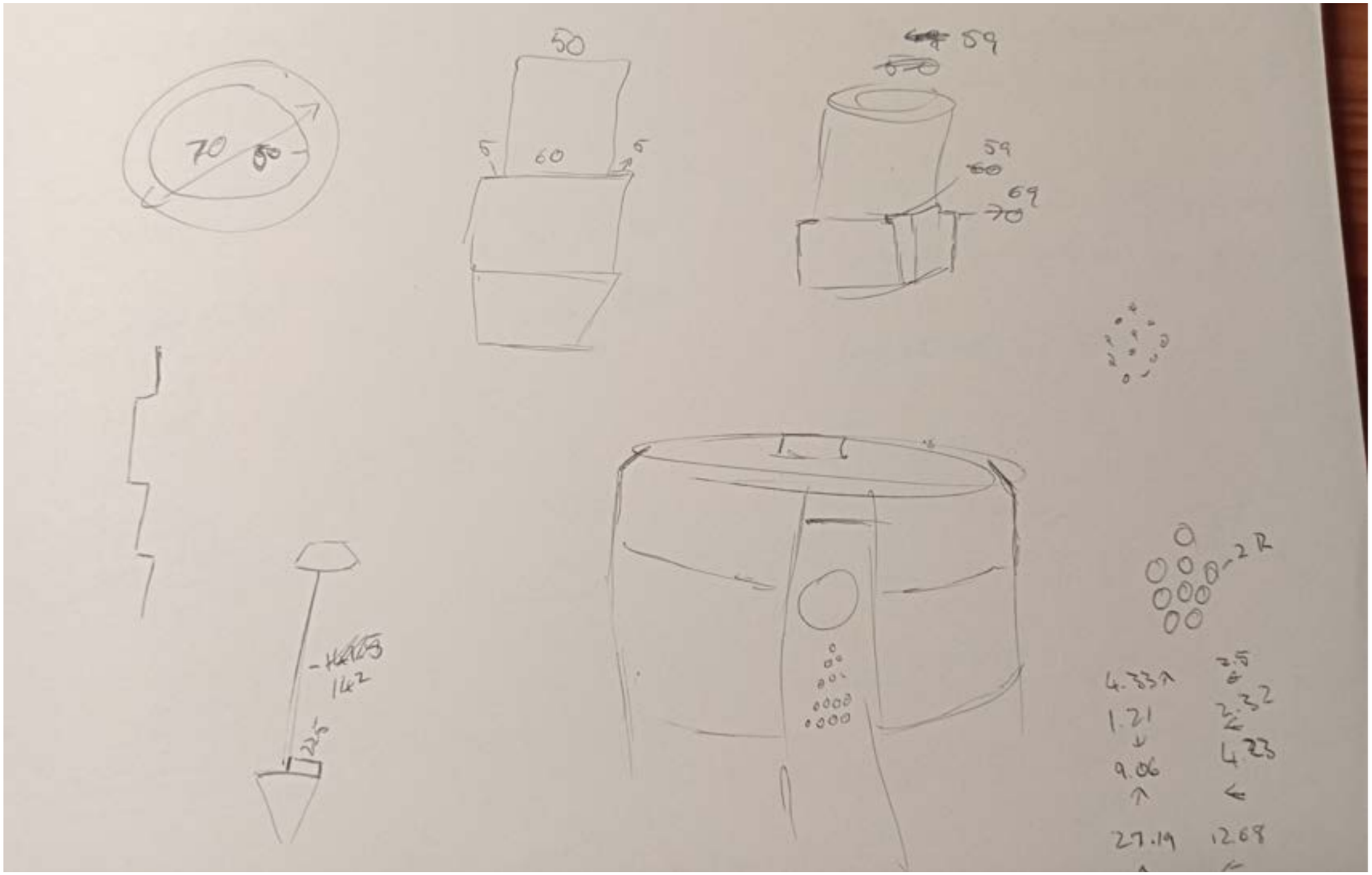

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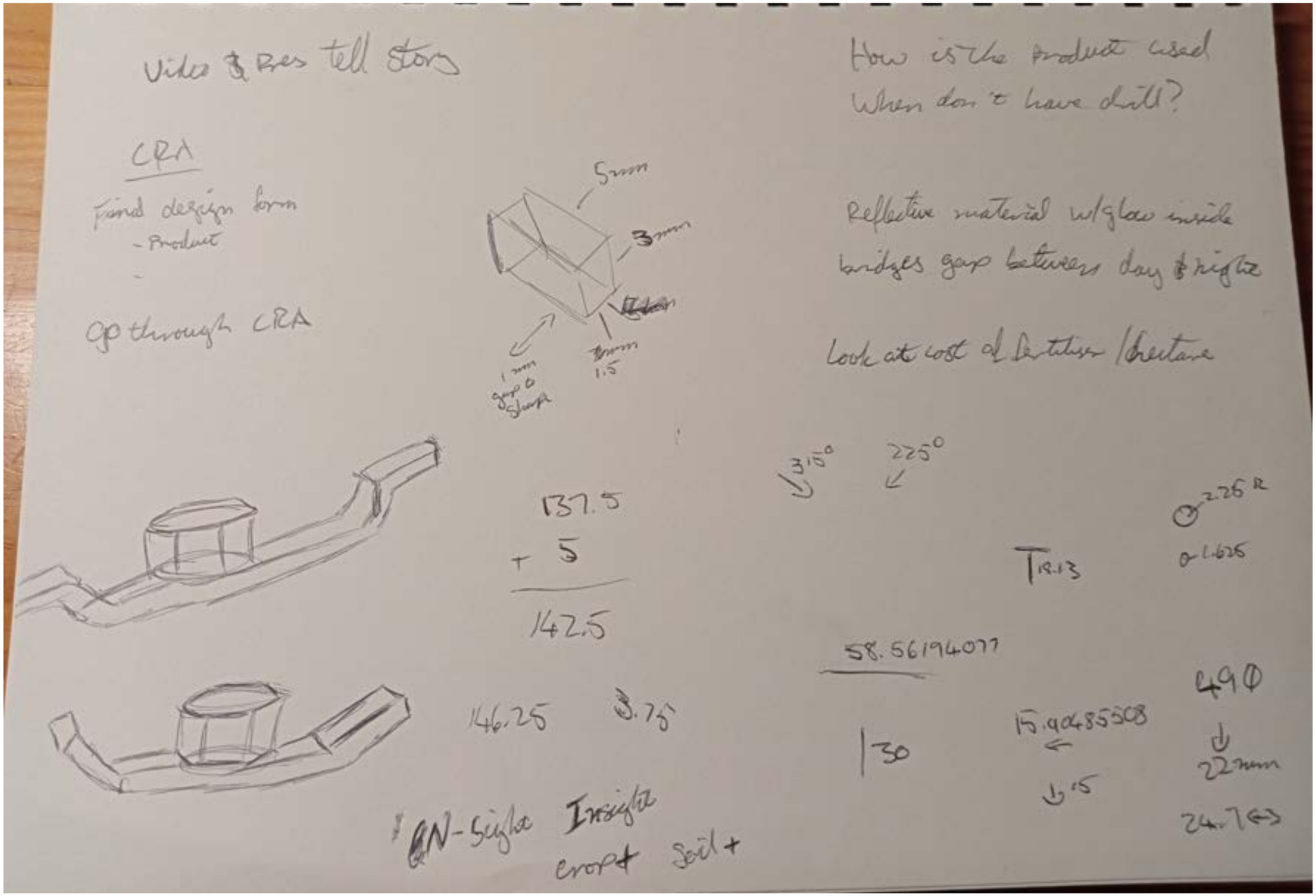
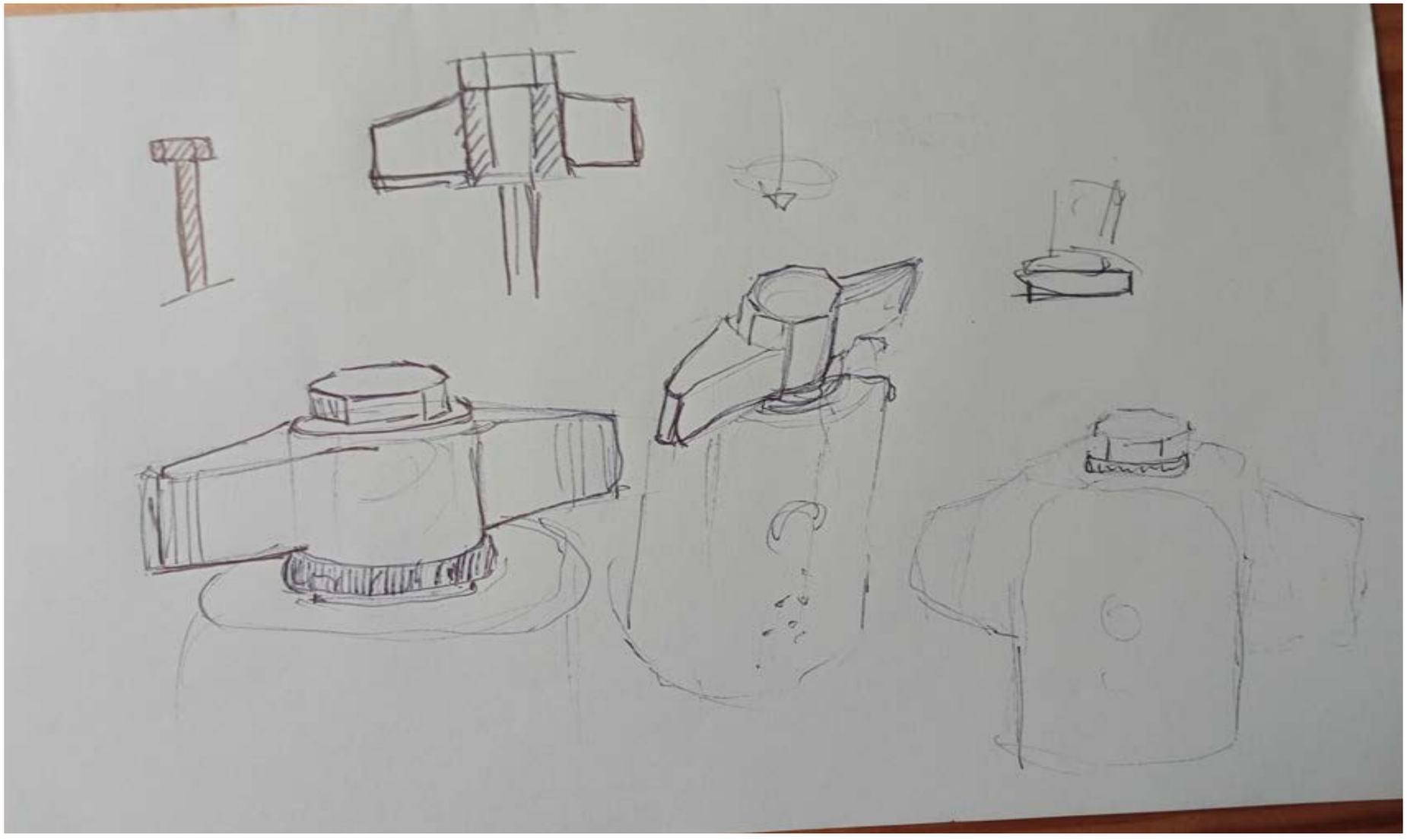
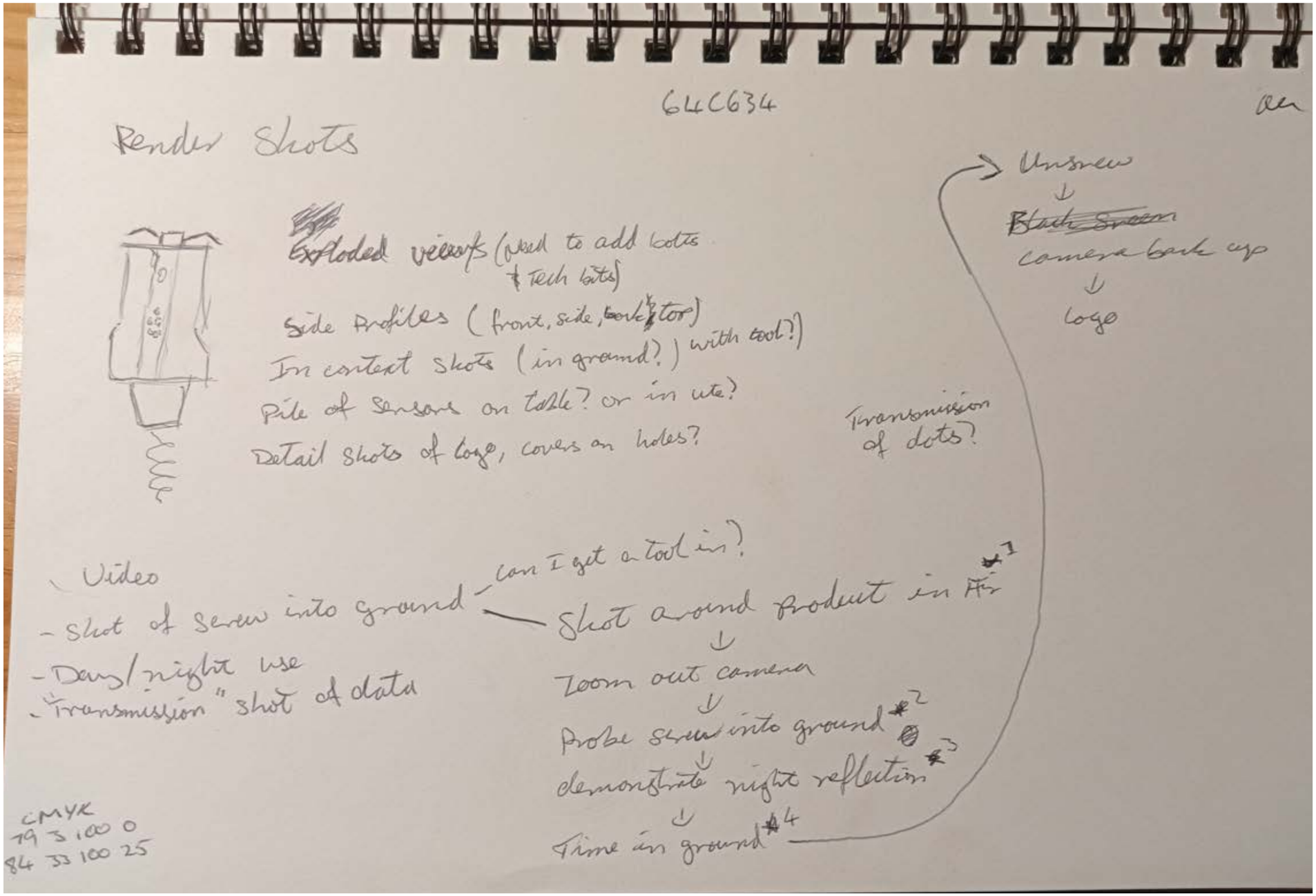


SOIL PROBE DEVELOPMENT - TUTOR INPUT



TS

SOIL PROBE DEVELOPMENT



TS

MODEL DEVELOPMENT

MODEL DEVELOPMENT

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