

# Appendices

# Image-Based AI for Industrial Design

How aligning semantics among designers helps them  
use AI tools more effectively

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# APPENDICES

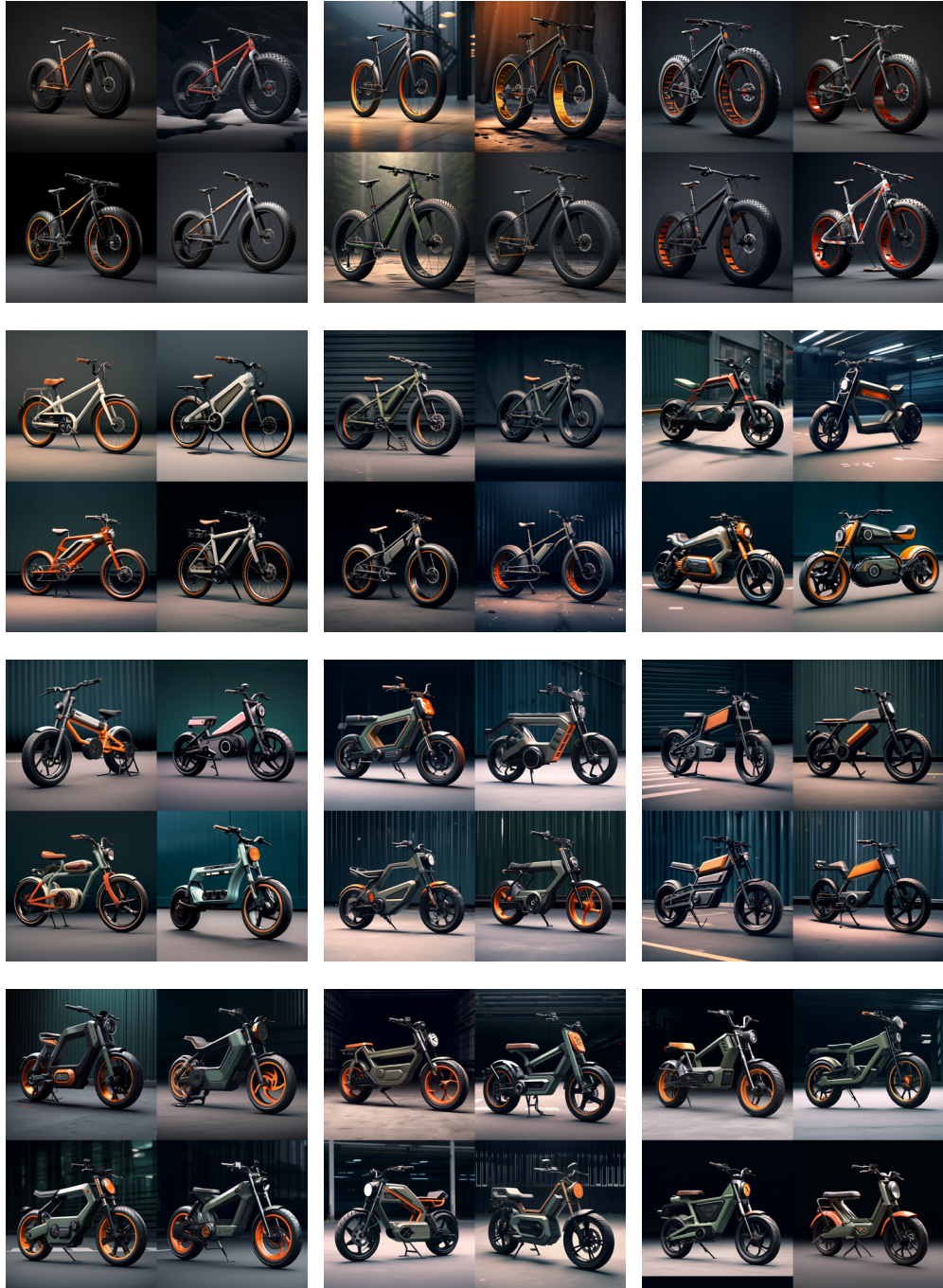
|  |    |
|--|----|
| A. MIDJOURNEY                              | 4  |
| B. GPT-4                                   | 6  |
| C. VIZCOM EXPERIMENT                       | 8  |
| D. KREA EXPERIMENT                         | 10 |
| E. LUMA LABS EXPERIMENT                    | 12 |
| F. STABLE DIFFUSION - DREAMBOOTH           | 14 |
| G. STABLE DIFFUSION - CONTROLNET           | 16 |
| H. PROBLEM FINDING CHOICE                  | 20 |
| I. MOOD BOARDS                             | 24 |
| J. EXCEL IMAGE TYPE QUESTIONNAIRE          | 26 |
| K. EXCEL PRE- POST- LONGTERM QUESTIONNAIRE | 28 |
| L. EXCEL REFLECTION QUESTIONNAIRE          | 30 |
| M. LORA OUTPUT INITIAL TESTS               | 32 |
| N. LORA OUTPUT LABELLING SESSION           | 34 |
| O. LORA OUTPUT SINGLE DESIGNER SESSION     | 36 |
| P. GRADUATION PROPOSAL                     | 38 |

Scan the QR code for or click [here](#) for additional files



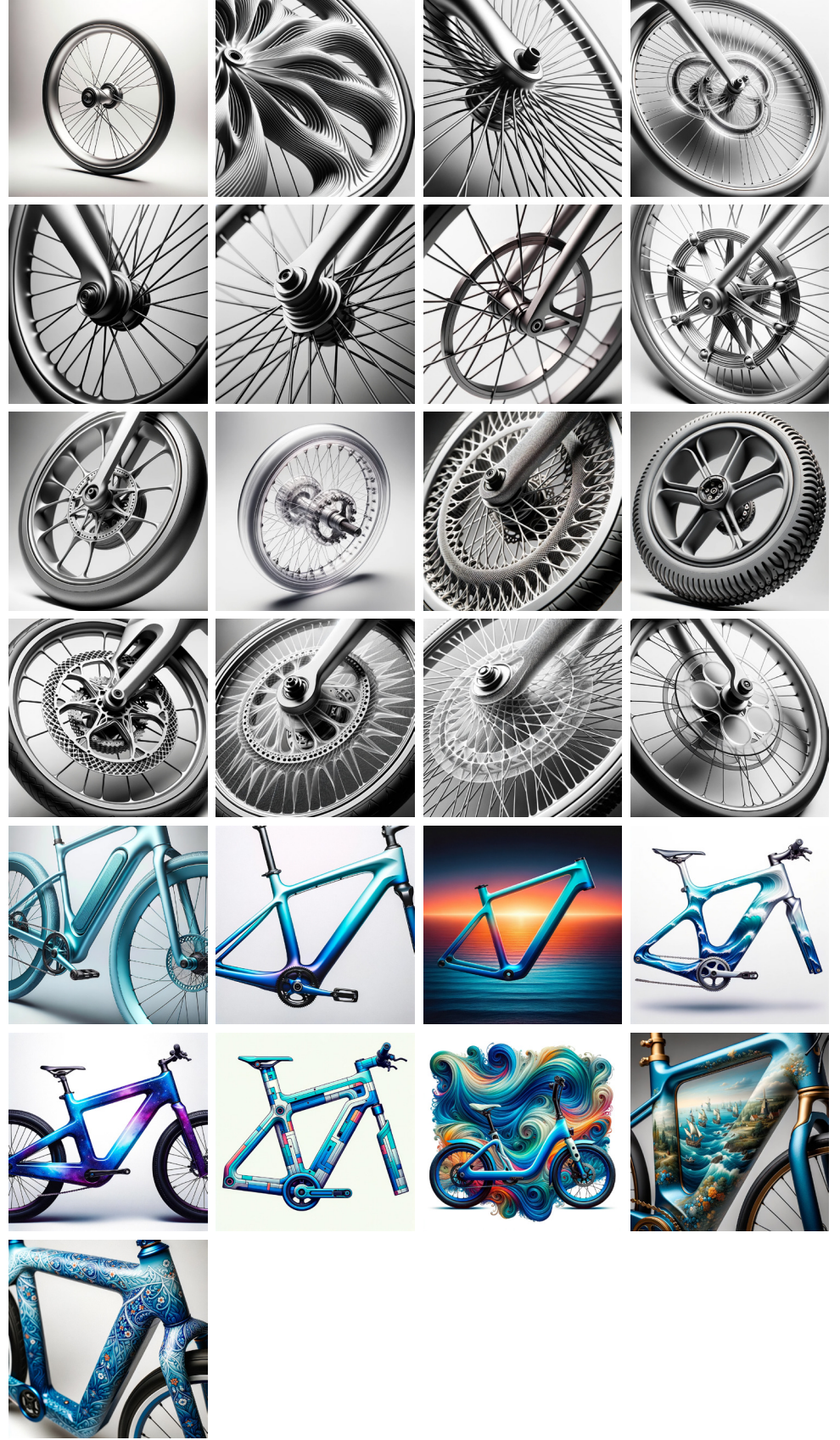
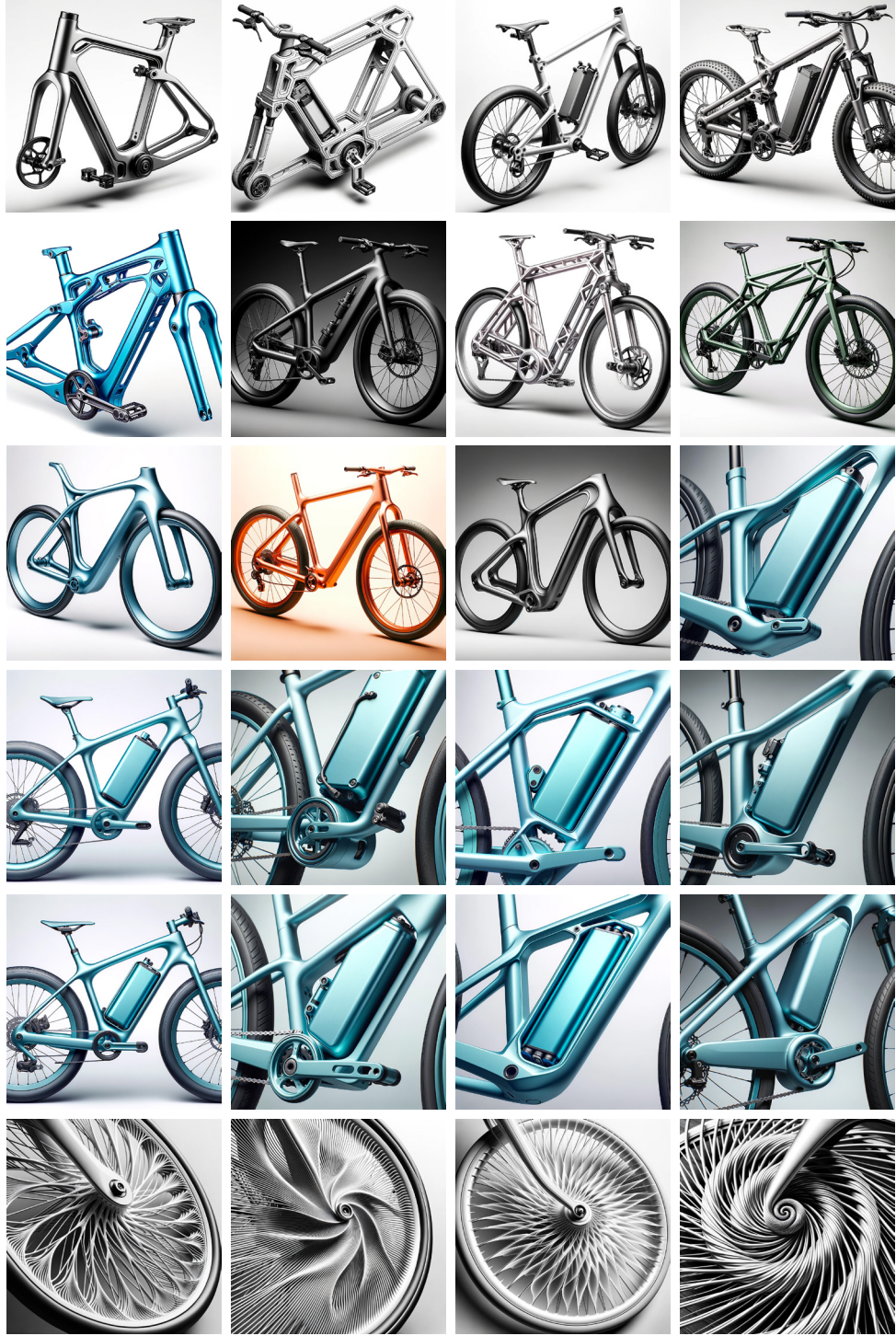


# A. MIDJOURNEY





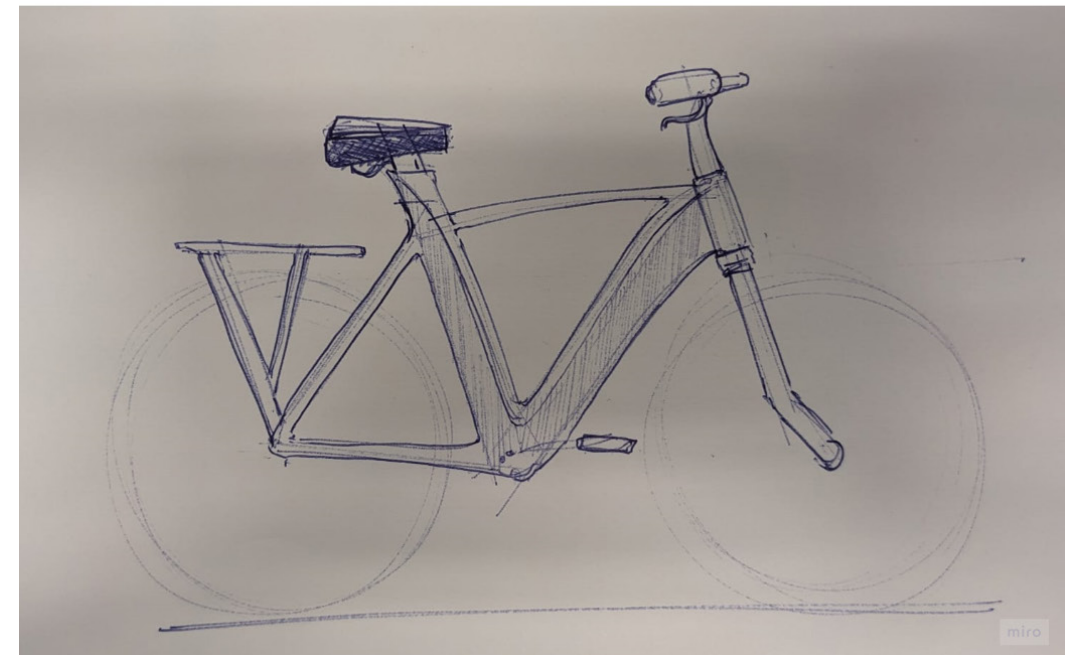
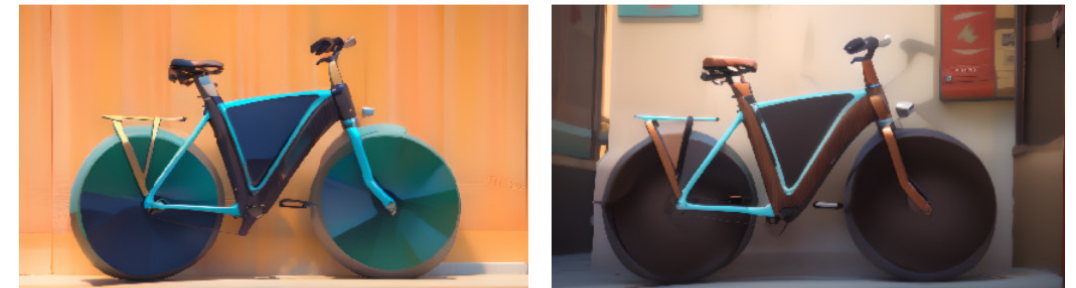
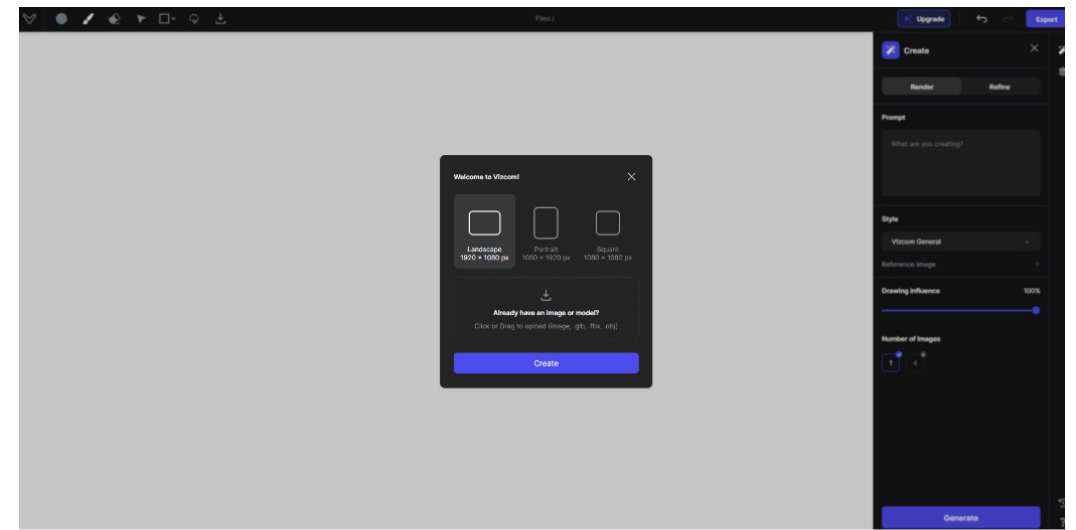
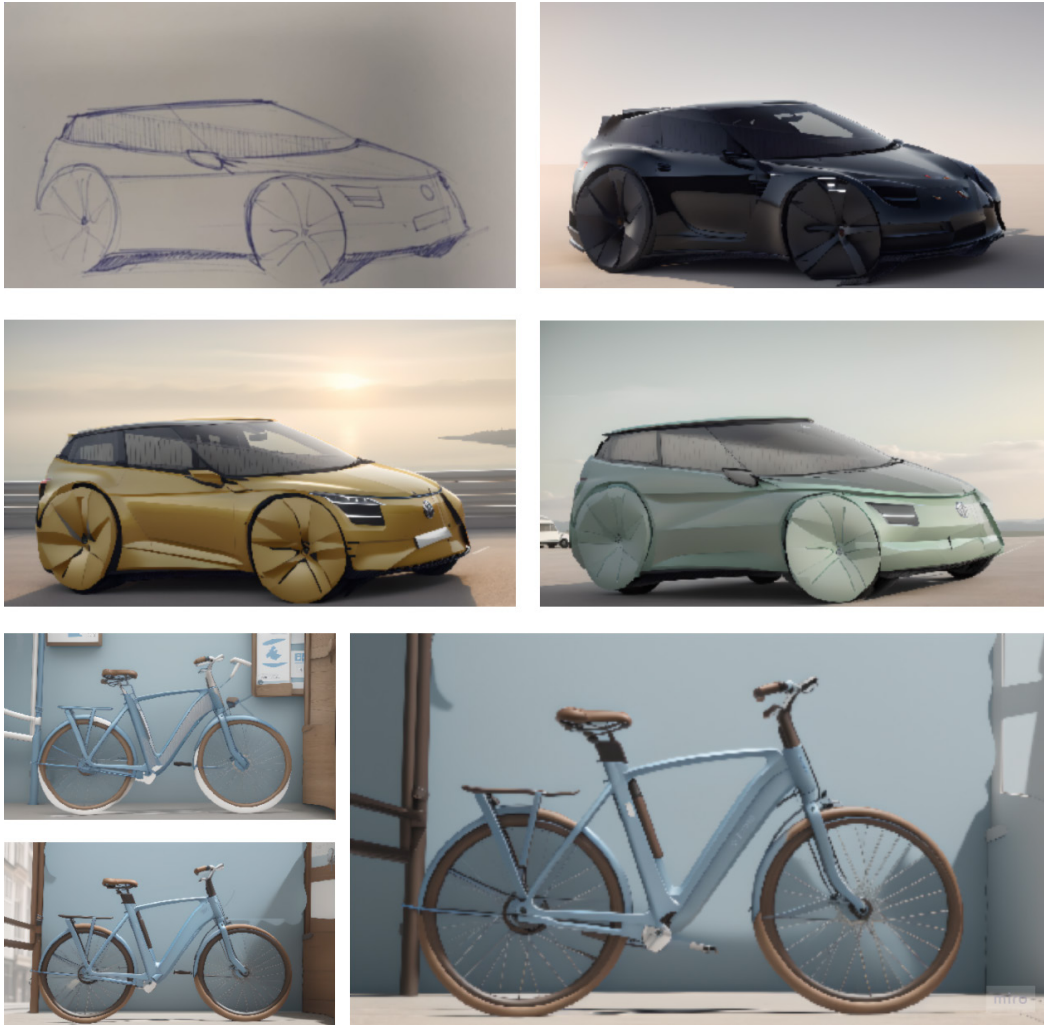
## B. GPT-4





## C. VIZCOM EXPERIMENT

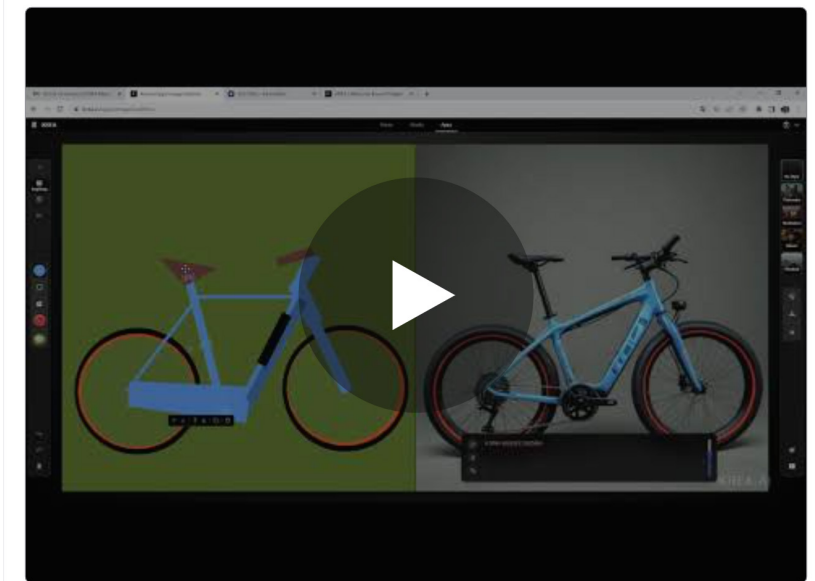
Most output from Vizcom cannot be shown because we tested with “to be released” designs.





## D. KREA EXPERIMENT

Click the videos on the left for screenrecordings from KREA

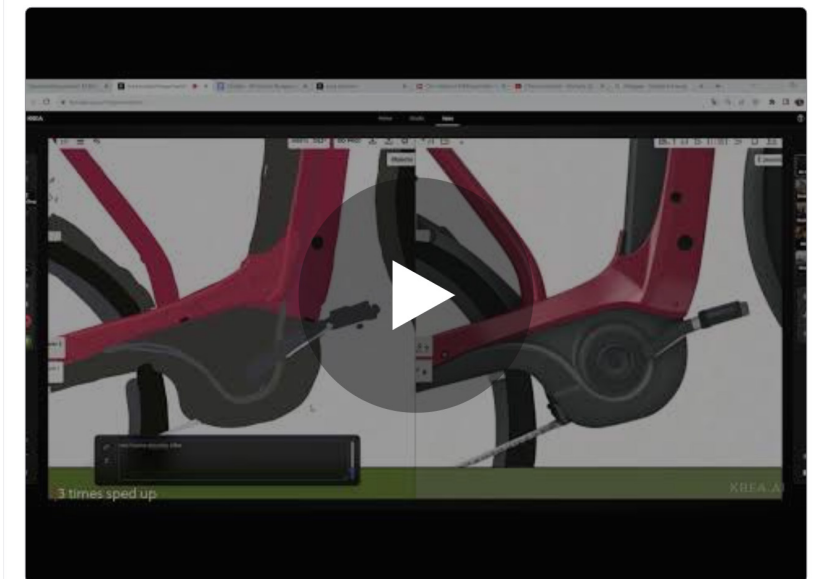


krea ai apps image realtime first experimentation

YouTube | Updated 08-12-2023 @ 16:20 GMT+01:00



miro



KREA AI experiment 2

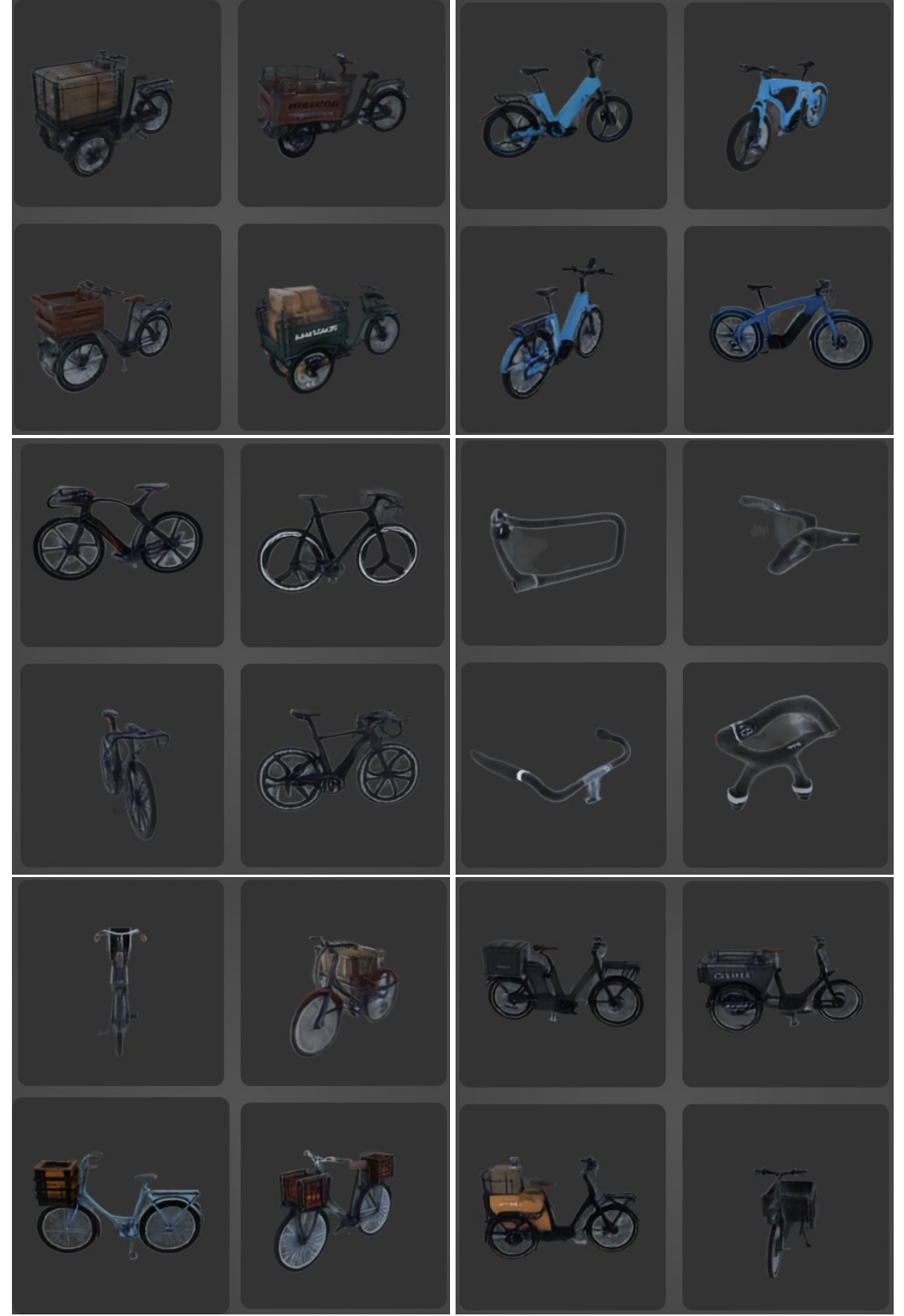
YouTube | Updated 08-12-2023 @ 16:20 GMT+01:00



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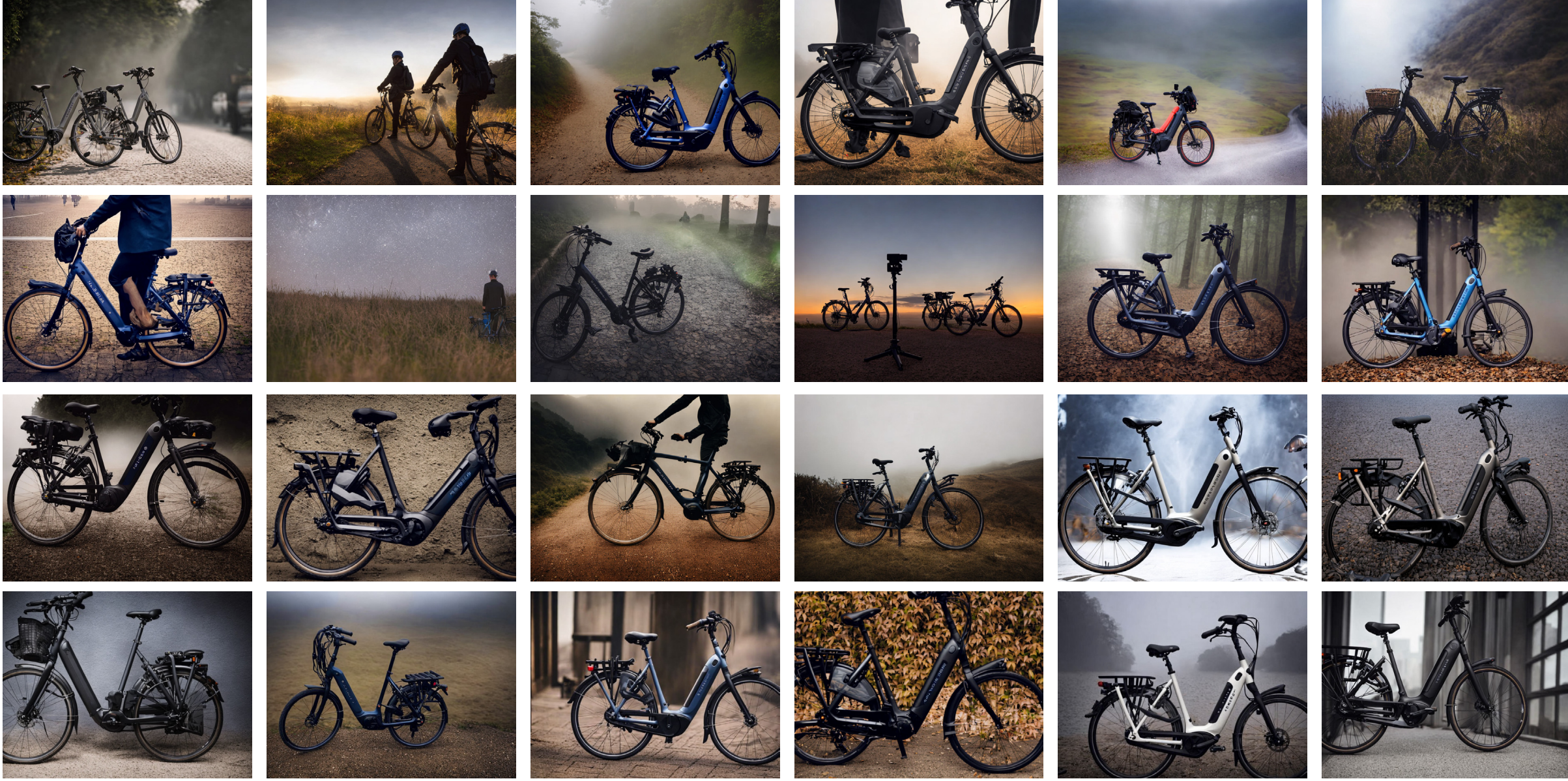


# E. LUMA LABS EXPERIMENT





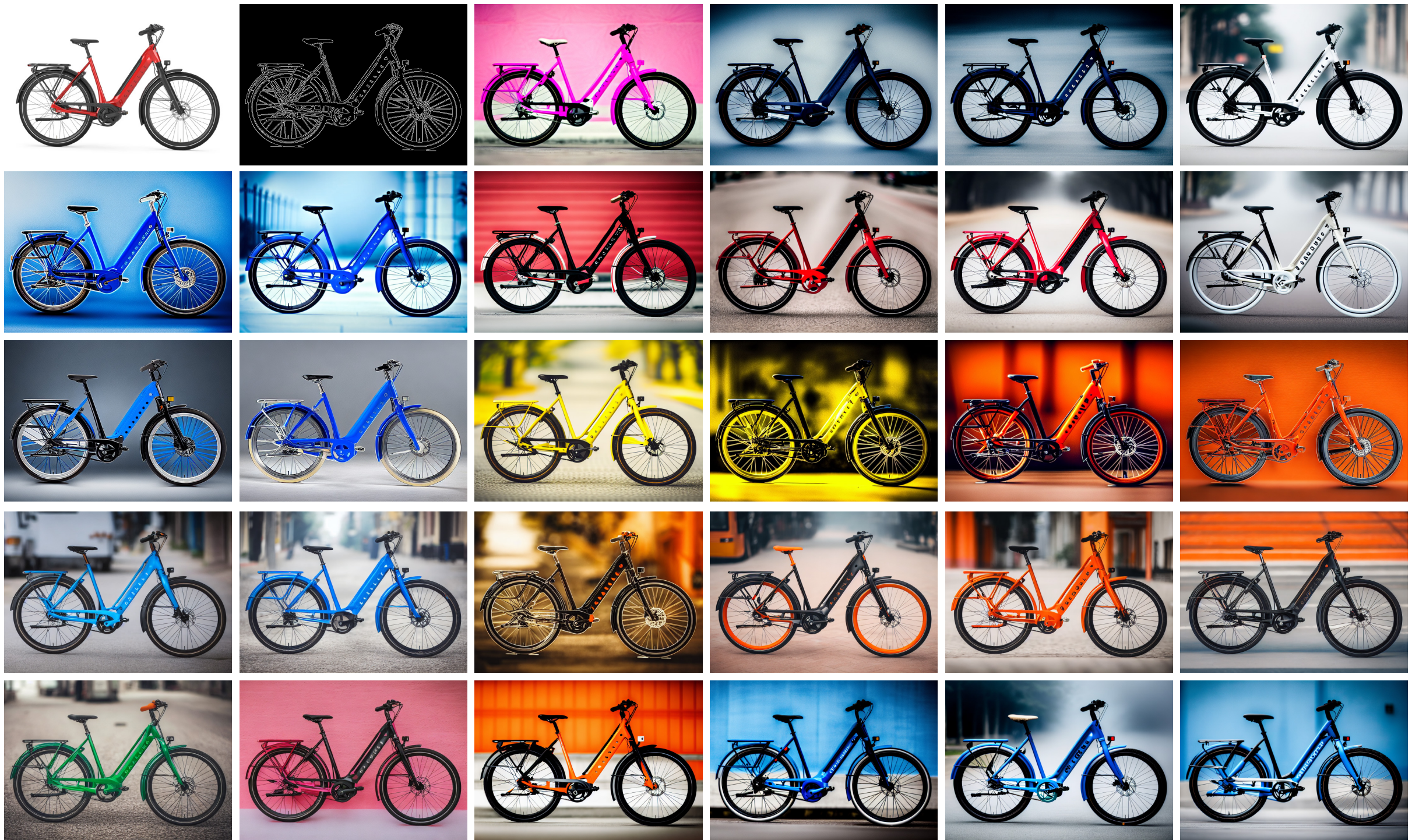
## F. STABLE DIFFUSION - DREAMBOOTH





# G. STABLE DIFFUSION - CONTROLNET

Canny image





Inpainting





## H. PROBLEM FINDING CHOICE

|       | Vision Concepts - concept bikes to drive innovation | Gazelle-specific tuned generative model | Reflection tool - understanding of design style interpretation |
|-------|---|---|--|
| SCORE | Useful for design quality                           | 1                                       | 1  |
|       | Feasibility   | 2                                       | 2  |
|       | Useful for design efficiency                        | -1                                      | 1  |
|       | Useful for PDP efficiency                           | -2                                      | 0  |
|       | Useful for brand recognition                        | 2                                       | 0  |
|       | Relation to AI                                      | -1                                      | 2  |
|       | Personally interested                               | 2                                       | -1   |
|       | Easy to code  | 1                                       | 0  |

| ARGUMENTATION                | Vision Concepts - concept bikes to drive innovation   | Gazelle-specific tuned generative model   | Reflection tool - understanding of design style interpretation  |   |
|------------------------------|---|---|---|---|
| Useful for design quality    | Creating vision concepts will help designers at Gazelle put design first without the limitations of engineering that usually. The process of creating a vision concept also teaches a designers a lot about their own goals and methods. It could, however, create overly ambitious designs later on. Additionally, the conceptual design goal does not necessarily translate to marketable designs, therefore this does not score 2. | Tuning a model on a Gazelle-specific dataset with fitting pictures and labels will give designers more control when generating images. Nevertheless, control remains limited meaning that the designers will likely refrain from using the tool altogether. | Enabling designers and product managers to coherently understand each other and the design style document gives the designers more confidence and guidance to generate concepts within expectations. Additionally, it will help the designers understand their own design process better. | <i>The score in this category resembles the added value towards a high quality design according to Gazelle's design characteristics (comfortable, accessible, and quality) and Dieter Rams' ten principles of good design</i> |
| Feasibility                  | This is very feasible, many companies work with vision concepts or concept products. AI only makes the process quicker in the design and therefore less time intensive.   | Tuning a model can be done, initial testing illustrated that it works, but it also illustrated that the models did not fully grasp the bikes with the visual complexity around the spokes and mechanics.  | The concept of using AI as a reflection tool or an expectation tool has been proven by Van der Burg (2023) and Chung (2023) respectively. However, both of them mentioned that it the current state it illustrated potential more than results.   | <i>The extent to which it expected to be achievable within the timeframe, with the resources available, and with the skillsets involved.</i>  |
| Useful for design efficiency | Creating a vision concept does take time, it will also complicate the design process more because the vision concepts will challenge the designers to come up with more innovative designs.   | Creating a tuned dataset and using a generative model will help the designers save time during both inspiration and the rendering steps of the design process. The amount of time is very debateable and dependable on the designer involved.               | The designer will have a better understanding of their own and the company's design style. Therefore validation steps should speed up, and sparring steps will be more effective because of mutual understanding of the goal.   | <i>The extent to which it expected to speed up the design process. Either to through speeding up tasks of by making the process more linear.</i>  |



|                                     |   |   |   |  |
|-------------------------------------|---|---|---|--|
| <b>Useful for PDP efficiency</b>    | The vision concepts will challenge the designers to make more innovative designs which complicate the goals of the engineers. Therefore there would have to be many more meetings and finetuning sessions to solve realise the envisioned innovation.   | The only minimal benefit would be that a generative AI trained on a Gazelle-specific dataset will suggest things that look like Gazelle and should therefore be producible. Realistically, this will not be the case most of the time.  | If the designers understand each other and the product manager better, the entire process will have fewer moments of disagreement and should become more linear and straight forwards, i.e. less time would be wasted.  | <i>The extent to which it helps speeding up the entire product development process. Perhaps through integration of engineering considerations or creating a more linear process.</i> |
| <b>Useful for brand recognition</b> | Vision concepts would challenge the innovation team at Gazelle to make more unique bikes and recognizable compared to competitors.  | Tuning the model would mainly help during inspiration and ideation, it probably will not have significant effect on the recognizeability of the bikes.  | Creating a better and mutual understanding of the Gazelle design-style boosts the ability of the design team to create a cohesive product portfolio and product family.   | <i>The extent to which it helps Gazelle make their product more recognizable to customers</i>  |
| <b>Relation to AI</b>               | While AI could be the key to make vision products a more affordable innovation driver, I would first need to understand the intricacies of designing vision products and would therefore be barely touch AI within the span of this project.  | I would have to train or tune a model to make this work, very AI centred.   | I would have to train or create a model to illustrate the mindset and interpretation of different people. Therefore, it would be very AI centred.   | <i>The extent to which AI will play a role in the direction</i>  |
| <b>Personally interested</b>        | I am super curious to dive into the world of vision concepts. They are very popular drivers of innovation, however, most companies cannot afford them due to the time and material costs. I would be interested to see how AI could make the process more affordable while still teaching the designers enough to set clear directions. | I have experimented with this option the most. I quickly noticed that the problems with its feasibility lay in the visual complexity of the bike. It can be helped, nevertheless, I also noticed that the designers at Gazelle were not really interested in this tool because it does not speed things up significantly. They lack control, which I understand. Additionally, loads of companies are working on this feature and will undoubtedly think of some way to fix it. | I am very intersted in the mental processes linking inspiration to output. It is also an issue that more companies face, motivating me to adress the topic to more people. It might also be useful during testing because of the limited time I have available from the designers to train a model. | <i>The extent to which I am motivated and interested to pursue this direction</i>  |
| <b>Easy to code</b>                 | I would dive mainly into the vision concept design process and then look how off-the-shelf AI could be used to make it quicker and more affordable.   | I would mainly need to label and tune, and then see how the designers respond to the model. The models are already present online, would need to learn some code but in first glance it seems quite difficult.  | I need to find a model that can be trained on the patterns that I want, perhaps, there are some off-the-shelf models present that recognize the   | <i>The difficulty I expect in the coding part. Perhaps because it is easy to code, or I can use off-the-shelf models to reach my goals.</i>  |



# I. MOOD BOARDS

*Throughout a project, members need to be aligned and work towards the same goal as much as possible. Engineers work towards numeric goals and designers work towards aesthetic goals. The aesthetics of their design should fit the project proposition. Designers can use several tools to communicate aesthetic direction, the most popular are mood boards.*

*Apart from the project-specific aesthetic direction, the designer incorporated the Gazelle design style, which is currently summarised in a mood board. The designers interpret this mood board in different ways.*

## MOOD BOARDS

To communicate aesthetic expectations, most designers use mood boards. Mood boards communicate an aesthetic direction without any sketches from the designer required. That is why mood boards are an effective way to share design direction without sketches. Some argue that mood boards have to be explained to be effective communication tools, however, just the pictures themselves will always be interpreted.

Traditionally, mood boards were made by cutting out magazines (Lucero, 2012). Nowadays, most designers make mood boards digitally because more images are readily available (ADDSOURCE). The change from analogue to digital has sped up the process but left some communicative gaps and confusion. For example, digital mood boards do not hold tangible products or artefacts.

Additionally, it is more difficult to cut away parts of images irrelevant to the mood board. That leads to images showing more than the designer might want to present, which leads to more interpretations of the mood board than the designer wants to allow.

## MODELS OF MOOD BOARDING USE

Nevertheless, mood boards have been the most popular method to communicate aesthetic direction for decades. How could such a tool better communicate aesthetic direction with minimal variability due to interpretation? Below are some models to better explain.

*Proposition to Mood board*

[proposition] \* [mental process] \* [research findings] → [moodboard]

When the designer receives the proposition, he has no design direction. He collects his aesthetic findings in a mood board to set a design direction. That is the blurry image described in the metaphor.

*Mood board to Product*

[proposition] \* [mental process] \* [moodboard] → [design]

When the designer has set the mood board - the blurry image - he slowly works towards the final design - the in-focus image. He translates the mood board and the proposition into a design.

## REFLECTION AND SIMPLIFICATION OF INSPIRATIONAL IMAGES

The last section contains many complex tasks. All tasks can be simplified to the model below.

[tasks] \* [mental process] \* [input] → [output]

As mentioned, a complex proposition leads to a complex mental process. A complex task - the proposition in this case - or input - the research insights or mood board - require a complex mental model to generate an output successfully. Complex mental models require large datasets to find the pattern. That dataset does not exist. Therefore, it is difficult to train an AI to predict the output of complex propositions.

Designers and product managers would benefit from understanding designers' mental design processes to manage expectations. A simpler task could give insight into the mental process of designers and product managers. For example, both parties could be asked to rate images on different axes and a model would learn their individual mental model of how they rank images.

[rate image] \* [mental model] \* [images to be ranked] → [image rating]

The model would predict how different members rate images, which indicates their interpretation. That is a form of reflection and a tool to share interpretations. The problem here would be that some images contain too many aspects to be interpreted similarly by multiple people. In other words, if the "images to be ranked" are too complex, the mental model becomes overly complex. That illustrates the ambiguity of mood boards. If the pictures on a mood board contain multiple objects or features, they quickly become ambiguous and open to interpretation.











## L. EXCEL REFLECTION QUESTIONNAIRE

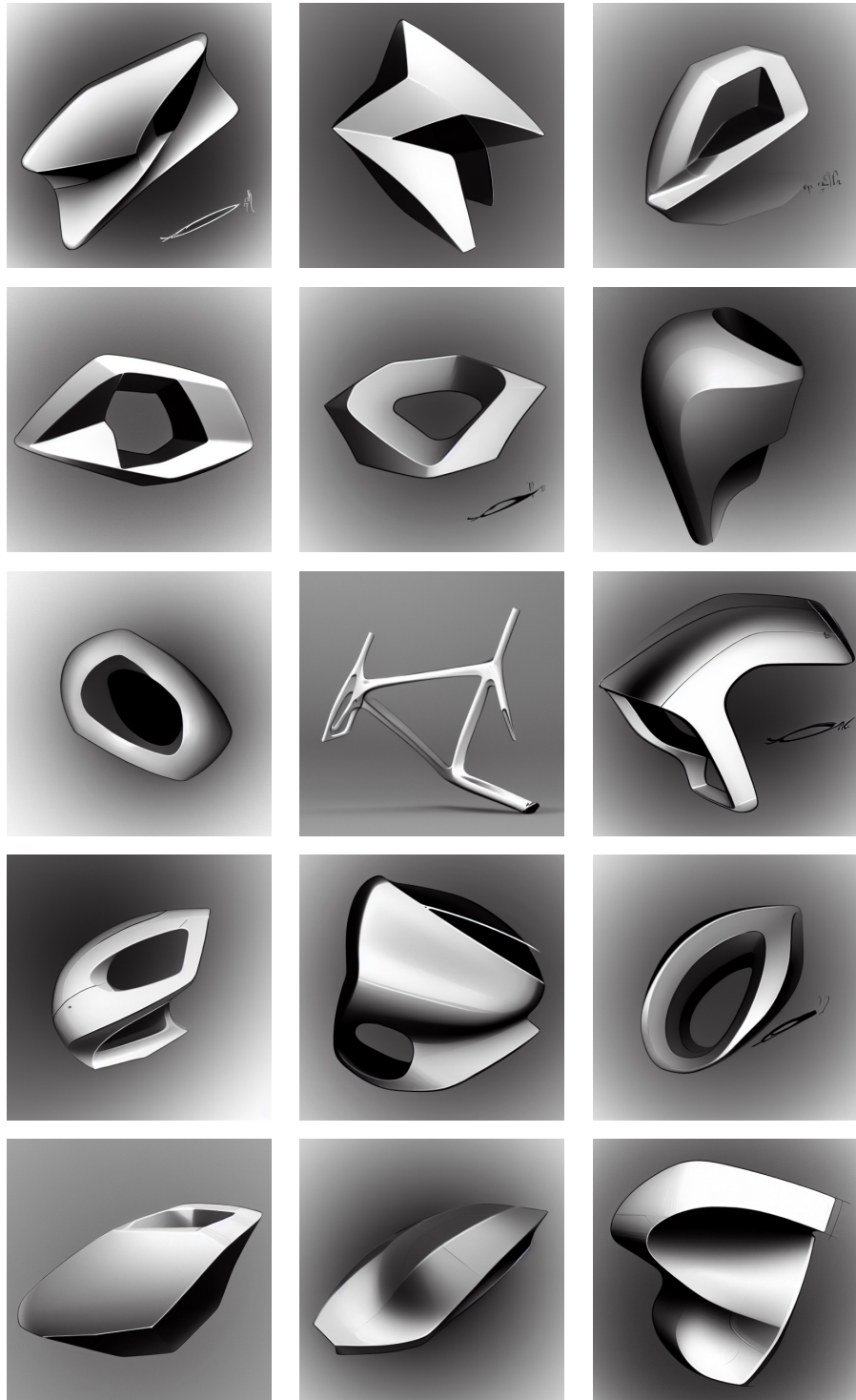
The excel sheet can be found in the appendices folder.

| Submission Date | Hi, what is your name? (first name suffices) | I voluntarily consent to my questions being used for research purposes | How long have you been working in this design team? (years, months) | What is your function in this design team? (manager, designer, junior/senior) | How often do you use image-generating AI? | I experienced the session as fun | I experienced the session as interesting | I experienced the session as insightful | The session helped me better understand how I interpret form studies | The session helped me better understand how other participants interpret form studies | The session helped me better understand how the group interprets form studies | The session helped me better communicate how I interpret images | Throughout the session, the group discussions got more effective | Throughout the session, the group started using a more and more similar vocabulary | After the session, I felt that the group was more aligned on the descriptions of form studies | After the session, I felt that the group had a better collective understanding of how to describe form studies |   |
|-----------------|--|--|---|---|---|----------------------------------|--|---|--|---|---|---|--|--|---|--|---|
| Mar 12, 2024    |  | 3 Yes  | 11 months   | Designer  |   | 3                                | 5  | 5                                       | 5  | 6   | 6   | 6   | 5  | 6  | 7   | 6  | 6 |
| Mar 7, 2024     |  | 1 Yes  | 8 years   | manager   |   | 1                                | 4  | 7                                       | 7  | 7   | 7   | 7   | 7  | 7  | 7   | 7  | 7 |
| Mar 6, 2024     |  | 2 Yes  | 4,2   | Designer  |   | 4                                | 5  | 6                                       | 6  | 6   | 7   | 6   | 5  | 7  | 7   | 7  | 7 |
|                 |  |  |   |   | 2.666666667                               | 4.666666667                      | 6  | 6                                       | 6.333333333  | 6.666666667   | 6.333333333   | 5.666666667   | 6.666666667  | 7  | 6.666666667   | 6.666666667  |   |

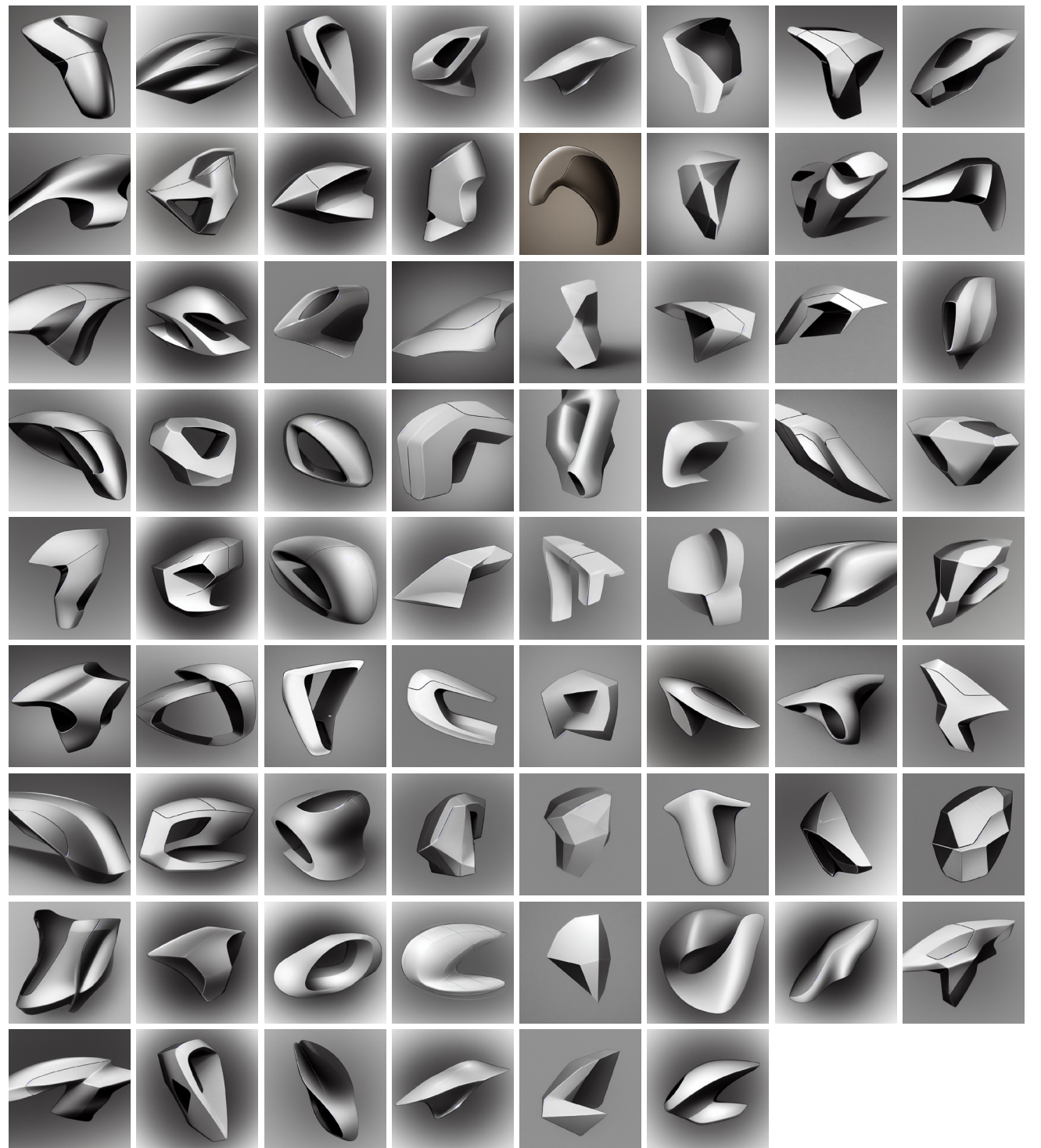


# M. LORA OUTPUT INITIAL TESTS

1st training



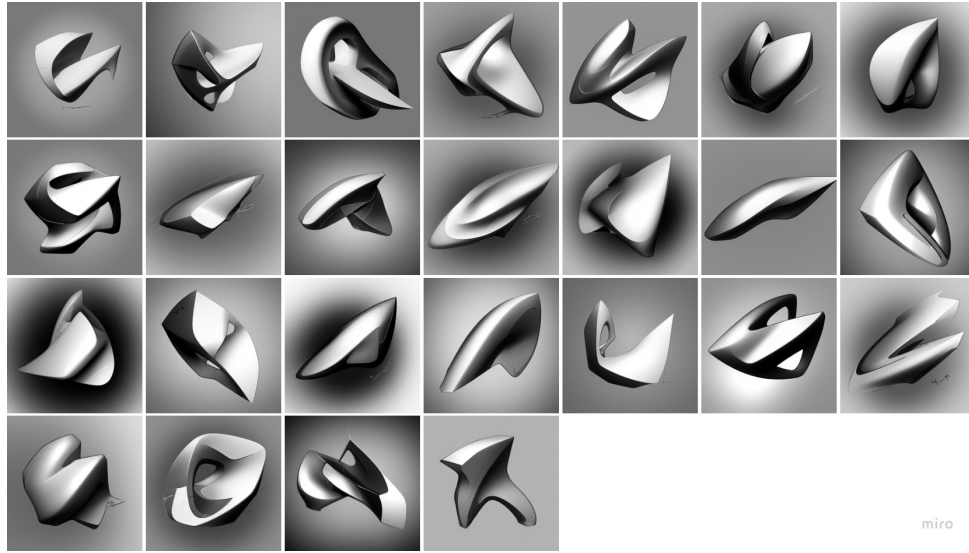
2nd training



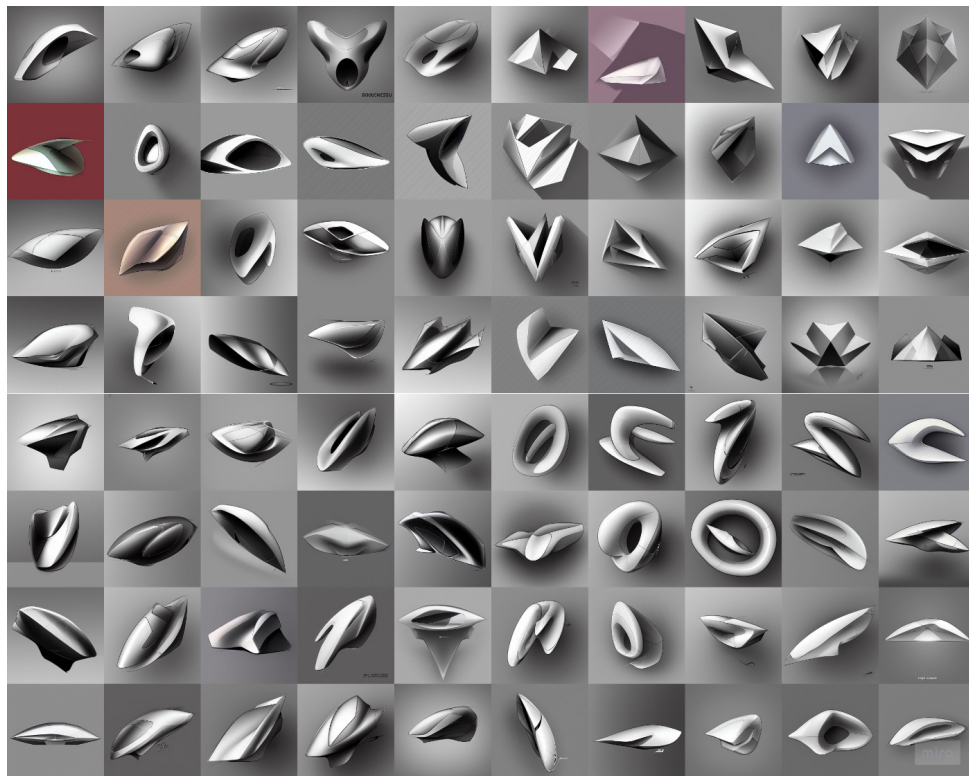


# N. LORA OUTPUT LABELLING SESSION

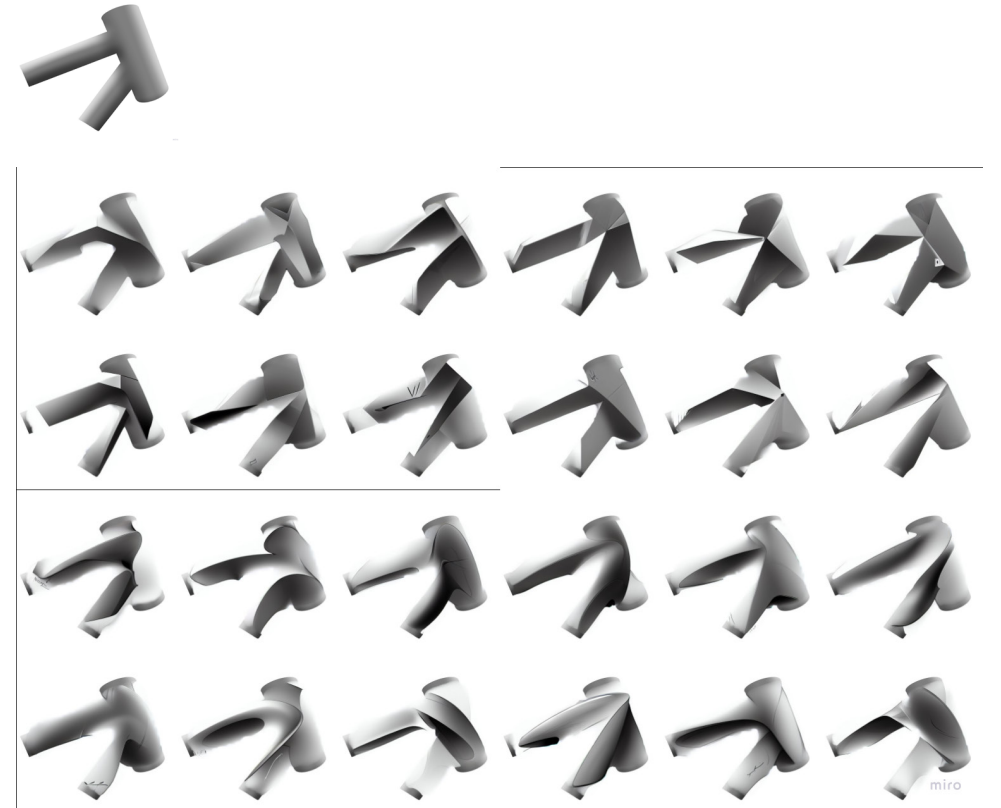
No regularisation images



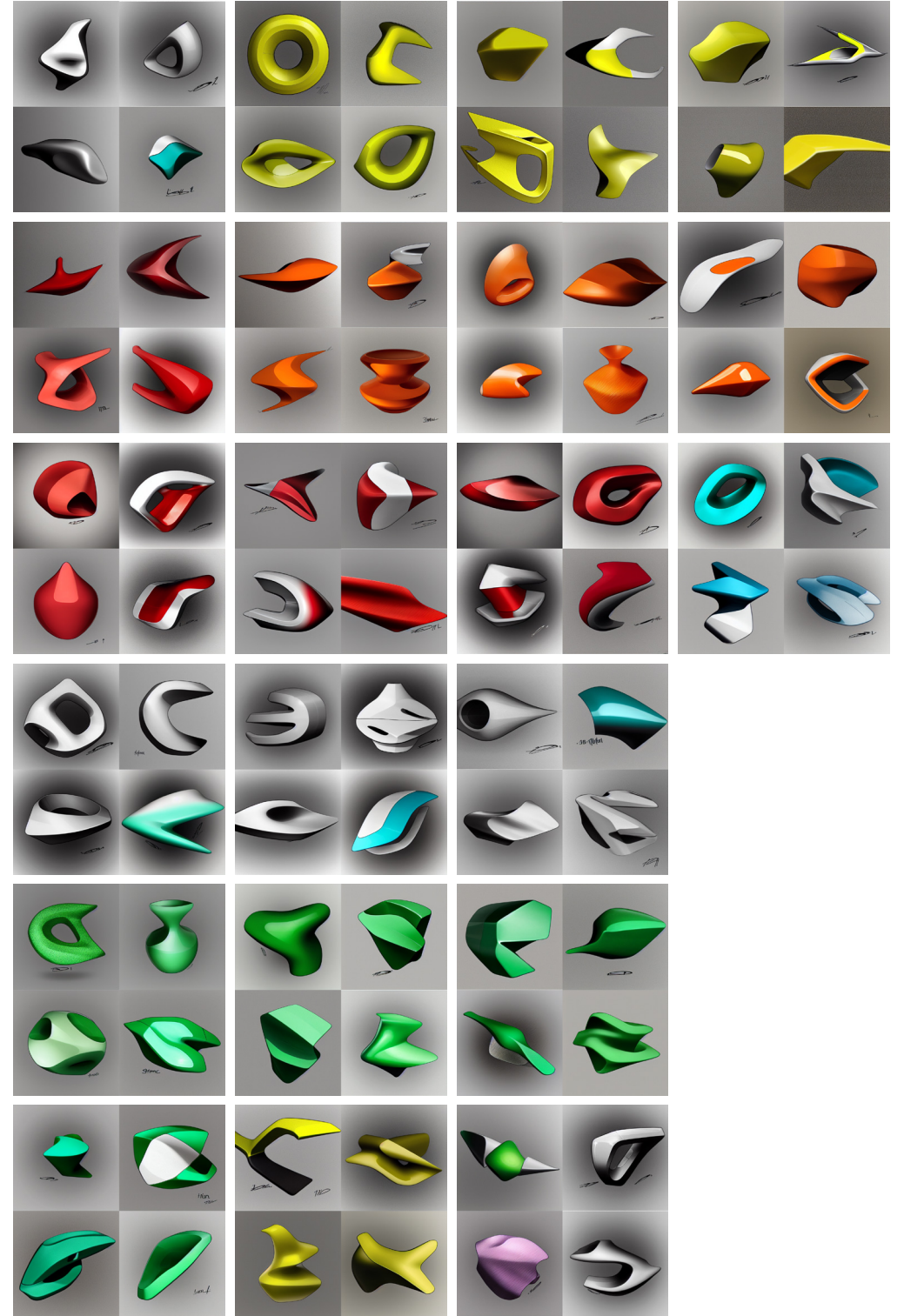
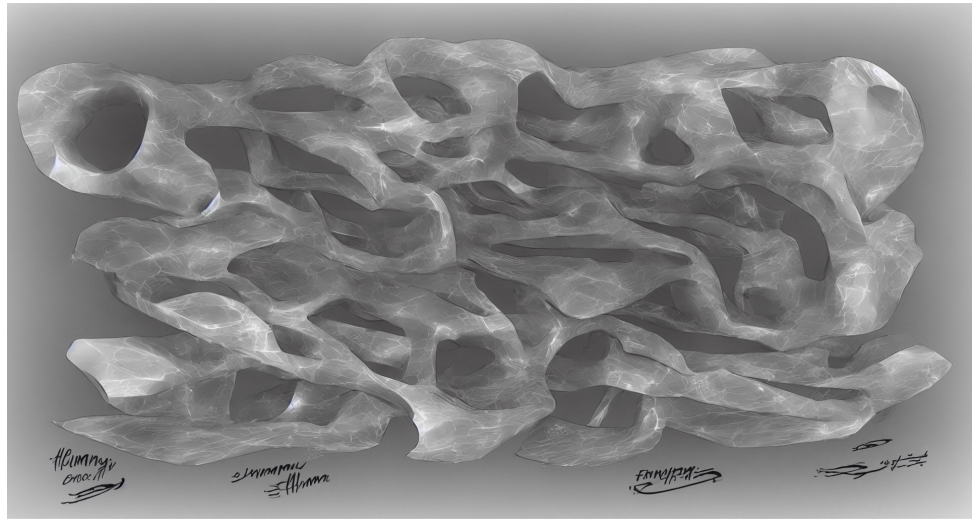
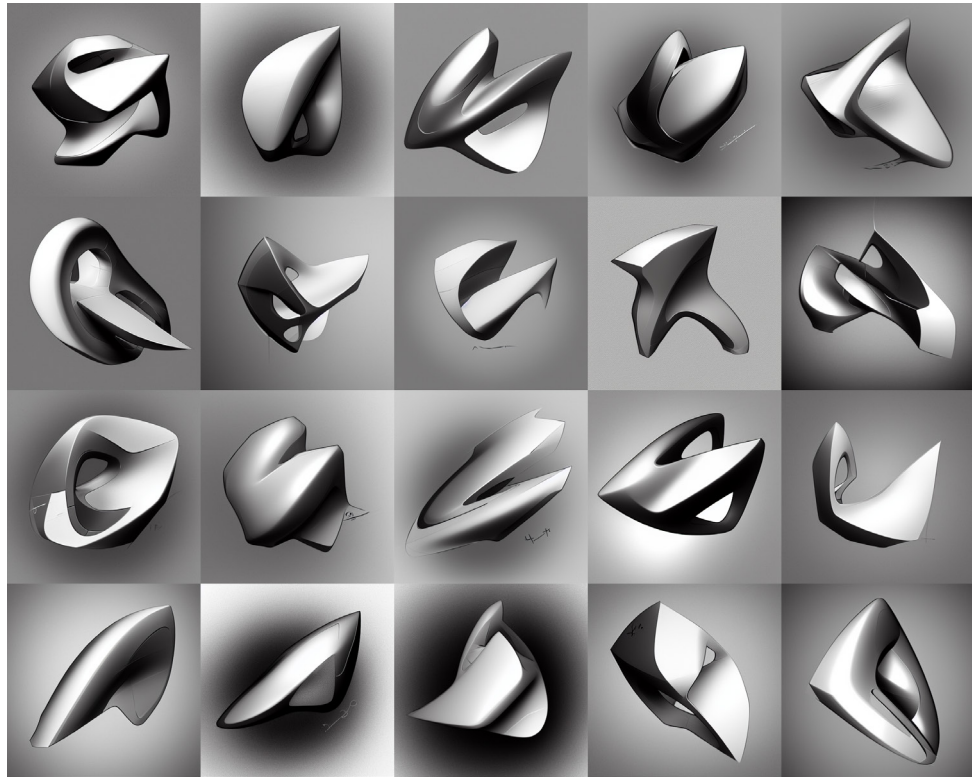
With regularisation images



Generation based on a front tube joint sketch



# O. LORA OUTPUT SINGLE DESIGNER SESSION





## P. GRADUATION PROPOSAL

Project proposal on the next page



# IDE Master Graduation Project

## Project team, procedural checks and Personal Project Brief

In this document the agreements made between student and supervisory team about the student's IDE Master Graduation Project are set out. This document may also include involvement of an external client, however does not cover any legal matters student and client (might) agree upon. Next to that, this document facilitates the required procedural checks:

- Student defines the team, what the student is going to do/deliver and how that will come about
- Chair of the supervisory team signs, to formally approve the project's setup / Project brief
- SSC E&SA (Shared Service Centre, Education & Student Affairs) report on the student's registration and study progress
- IDE's Board of Examiners confirms the proposed supervisory team on their eligibility, and whether the student is allowed to start the Graduation Project

### STUDENT DATA & MASTER PROGRAMME

Complete all fields and indicate which master(s) you are in

|                |                      |  |                      |     |     |
|----------------|----------------------|--|----------------------|-----|-----|
| Family name    | <input type="text"/> | IDE master(s)                              | IPD                  | Dfl | SPD |
| Initials       | <input type="text"/> | 2 <sup>nd</sup> non-IDE master             | <input type="text"/> |     |     |
| Given name     | <input type="text"/> | Individual programme<br>(date of approval) | <input type="text"/> |     |     |
| Student number | <input type="text"/> | Medesign                                   |                      |     |     |
|                |                      | HPM  |                      |     |     |

### SUPERVISORY TEAM

Fill in the required information of supervisory team members. If applicable, company mentor is added as 2<sup>nd</sup> mentor

|                        |                      |               |                      |  |
|------------------------|----------------------|---------------|----------------------|--|
| Chair                  | <input type="text"/> | dept./section | <input type="text"/> | <p>! Ensure a heterogeneous team. In case you wish to include team members from the same section, explain why.</p> <p>! Chair should request the IDE Board of Examiners for approval when a non-IDE mentor is proposed. Include CV and motivation letter.</p> <p>! 2<sup>nd</sup> mentor only applies when a client is involved.</p> |
| mentor                 | <input type="text"/> | dept./section | <input type="text"/> |  |
| 2 <sup>nd</sup> mentor | <input type="text"/> |               |                      |  |
| client:                | <input type="text"/> |               |                      |  |
| city:                  | <input type="text"/> | country:      | <input type="text"/> |  |
| optional comments      | <input type="text"/> |               |                      |  |

### APPROVAL OF CHAIR on PROJECT PROPOSAL / PROJECT BRIEF -> to be filled in by the Chair of the supervisory team

Sign for approval (Chair)

Name \_\_\_\_\_ Date \_\_\_\_\_ Signature \_\_\_\_\_



## CHECK ON STUDY PROGRESS

To be filled in by **SSC E&SA** (Shared Service Centre, Education & Student Affairs), after approval of the project brief by the chair. The study progress will be checked for a 2<sup>nd</sup> time just before the green light meeting.

Master electives no. of EC accumulated in total \_\_\_\_\_ EC

Of which, taking conditional requirements into account, can be part of the exam programme \_\_\_\_\_ EC

|                          |            |  |
|--------------------------|------------|--|
| <input type="checkbox"/> | <b>YES</b> | all 1 <sup>st</sup> year master courses passed |
| <input type="checkbox"/> | <b>NO</b>  | missing 1 <sup>st</sup> year courses           |

Comments: \_\_\_\_\_

Sign for approval (SSC E&SA)

Name \_\_\_\_\_ Date \_\_\_\_\_ Signature \_\_\_\_\_

## APPROVAL OF BOARD OF EXAMINERS IDE on SUPERVISORY TEAM -> to be checked and filled in by IDE's Board of Examiners

Does the composition of the Supervisory Team comply with regulations?

|                          |            |                               |
|--------------------------|------------|-------------------------------|
| <input type="checkbox"/> | <b>YES</b> | Supervisory Team approved     |
| <input type="checkbox"/> | <b>NO</b>  | Supervisory Team not approved |

Comments: \_\_\_\_\_

Based on study progress, students is ...

|                          |  |
|--------------------------|--|
| <input type="checkbox"/> | <b>ALLOWED</b> to start the graduation project     |
| <input type="checkbox"/> | <b>NOT</b> allowed to start the graduation project |

Comments: \_\_\_\_\_

Sign for approval (BoEx)

Name \_\_\_\_\_ Date \_\_\_\_\_ Signature \_\_\_\_\_



# Personal Project Brief – IDE Master Graduation Project

Name student \_\_\_\_\_ Student number \_\_\_\_\_

## PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT

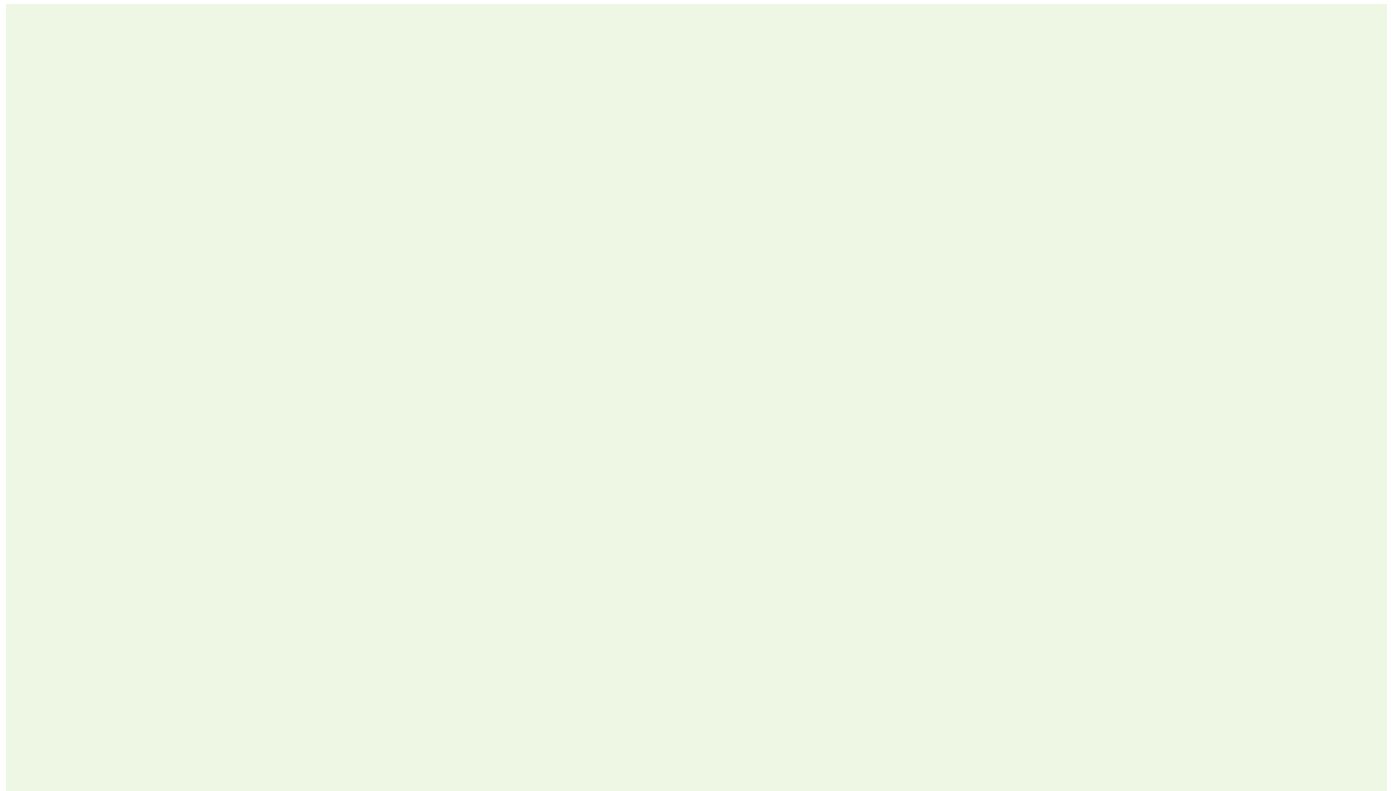
Complete all fields, keep information clear, specific and concise

**Project title** \_\_\_\_\_

*Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.*

### Introduction

*Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)*



→ space available for images / figures on next page



have a huge impact on  
t al., 2023; Lawton et al.,  
rs to “generate, explore, and  
friction through its  
te the speed at which AI can  
/ is contradictory to the  
, 2023).  
o create friction during the  
0). In such a workflow, the AI  
n. Most media present

image / figure 1

image / figure 2

## Personal Project Brief – IDE Master Graduation Project

### Problem Definition

*What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice.  
(max 200 words)*

### Assignment

*This is the most important part of the project brief because it will give a clear direction of what you are heading for. Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence) As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:*

*Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)*



## Project planning and key moments

To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a **kick-off meeting, mid-term evaluation meeting, green light meeting and graduation ceremony**. Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities).

Make sure to attach the full plan to this project brief.  
The four key moment dates must be filled in below

|                                  |
|----------------------------------|
| <b>Kick off meeting</b> _____    |
| <b>Mid-term evaluation</b> _____ |
| <b>Green light meeting</b> _____ |
| <b>Graduation ceremony</b> _____ |

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

|                                     |  |
|-------------------------------------|--|
| Part of project scheduled part-time |  |
| For how many project weeks          |  |
| Number of project days per week     |  |

Comments:

## Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.

(200 words max)