Werknemer

De context
- Wat voor werk doe je?

- Hoeveel werk je remote?

- Hoe gaat het bedrijf waar je werkt om met remote werken?
- Ben je hier tevreden over?

Pro's en Con's
- Wat vind jij tot nu toe van het concept remote werken, zonder op de specifieke voor en nadelen in te gaan?

- Wat vind je de voordelen van remote werken?
- Vraag door met waarom
- Wat vind je het grootste voordeel?

- Welk werk vind je makkelijk om van thuis te doen?

- Wat vind je de nadelen van thuis werken? **Wat voor problemen ervaar je?**
- Vraag door met waarom
- Wat vind je het grootste nadeel?

- Wat voor werk vind je het moeilijkste om thuis te doen? Waarom?

- Hoe probeer je deze problemen aan te pakken?

- Zijn er factoren bij jezelf of bij andere collega's die remote werken moeilijker maken? En hoe merk je dat?

[ ]

Toekomst
- Zou je in de toekomst ook thuis willen werken? Zo ja, hoe vaak?

[ ]

- Welke uitdagingen zie je in zo'n combinatie?

[ ]

Extra
- Ken jij nog mensen die ik zou moeten spreken?
- Zou je het interessant vinden om betrokken te blijven bij dit project?

Directie

De context
- Wat voor werk doe je?

```
[                                                        ]
```

- Hoeveel personeel heeft het bedrijf/ het team dat jij managet?

```
[                                                        ]
```

- Hoeveel wordt er remote gewerkt in het bedrijf?

```
[                                                        ]
```

- Hoeveel werk je remote?

```
[                                                        ]
```

- Hoe gaat het bedrijf om met remote werken?
- Ben je daar tevreden over?

```
[                                                        ]
```

Pro's en Con's
- Wat vind jij tot nu toe van het concept remote werken, zonder op de specifieke voor en nadelen in te gaan?

```
[                                                        ]
```

- Wat vind je de voordelen van remote werken?
- Vraag door met waarom
- Wat vind je het grootste voordeel?

```
[                                                        ]
```

- Welk werk vind je makkelijk om van thuis te doen?

```
[                                                        ]
```

- Wat vind je de nadelen van thuis werken?
- Vraag door met waarom
- Wat vind je het grootste nadeel?

```
[                                                        ]
```

- Wat voor werk vind je het moeilijkste om thuis te doen?

```
[                                                        ]
```

- Hoe probeer je deze problemen aan te pakken?
- Hoe verandert jouw rol als teamleider nu er meer op afstand wordt gewerkt?

- Zijn er collega's of teams die thuis werken moeilijk vinden?

- Heeft remote werken negatieve effecten op het bedrijf? Of op het werk van het bedrijf? (Zoals omzet, kwaliteit, tevredenheid van de werknemers, etc.)

Toekomst
- Gaat remote werken een rol blijven spelen in de organisatie? Zo ja, hoe vaak?

- Welke uitdagingen zie je dan bij zo'n combinatie?

Extra
- Ken jij nog mensen die ik zou moeten spreken?
- Zou je het interessant vinden om betrokken te blijven bij dit project?

Appendix 16.2: Remote working newsletter

Tips & Tricks voor remote werken

Oplossingen voor korte interacties.

Er zijn een aantal dingen die je kunt doen om de drempel voor korte interacties te verlagen. Ongepland iemand telefonisch opbellen, zoals dat voor de thuiswerk cultuur vaak ging, blijft effectief. Het klinkt misschien voor de hand liggend, maar het wordt vaak te weinig gedaan.

Een andere goede oplossing is het creëren van een gedecideerd communicatiekanaal voor vragen, feedback of korte besprekingen, zoals Slack (Ook mogelijk in Microsoft Teams of Discord). Deze oplossing komt wel met bepaalde etiketten om het goed te laten verlopen. De belangrijkste zijn:

- **Je bent zelf verantwoordelijk voor je eigen downtime.**
  Neem een aantal momenten om te reageren op berichten en vragen te beantwoorden in de chat. Zorg dat je profiel buiten die momenten om op offline / niet beschikbaar staat en je geen notificaties krijgt. Zo raak je niet de hele dag afgeleid door de chats.

- **Wees zo compleet mogelijk in je communicatie.**
  Zorg dat je in je bericht genoeg context schept en indien nodig bestanden of links bijvoegd. Dit zorgt ervoor dat je collega's direct genoeg informatie hebben om je verder te helpen. Laat eventueel ook weten wat de gewenste reactietijd van je vraag is.

- **Chats bestaan uit tweerichtingsverkeer.**
  Kom niet alleen met vragen naar de chat, probeer ook collega's te helpen met de door hen gestelde vragen.

Voor meer Slack communicatie etiketten klik op "Lees verder"

Bekijk Slack op slack.com

Lees verder

Deel deze nieuwsbrief met je collega's of vrienden! Alleen samen worden we beter in remote werken.

Forward   Share   Share

Bedankt voor het lezen
Tot snel!

Nog niet ingeschreven voor de nieuwsbrief? Dat kan hier!

Appendix 16.3: Remote working pros and cons

Here the full description of all the pros and cons from the 6 categories (productivity, collaboration, connection, innovation, learning and wellbeing) are given. Because there are many pros and cons, the most dominant ones, which are frequently mentioned in interviews or extensively described in literature, are discussed to more extent than others.

Productivity

Pros	Cons
Less distraction	More distractions
Higher productivity	Incomplete home office
	Measuring work

Less distraction
For many people the home office results in less distractions. In the office, especially an open office, the constant presence of people and noise can keep you from optimal concentration. The amount of distractions greatly depend on the age demographic and home situation. Living alone results in significantly less distractions than living with young kids (who were home all of the time when schools were closed because of the virus)

43% of participants talked about this.

More distractions
As discussed above, working from home can also result in more distractions, like temptations from non-work related things or actions by other people in the house.

19% of participants talked about this.

Incomplete home office
Not everyone has a workplace in their home complete with good internet, a good chair and other necessary equipment.

19% of participants talked about this.

Measuring work
Management control, the practice of measuring employees are performing, is traditionally based on the presence and visibility of employees. Remote working makes it hard to monitor what work is being done, and how well it is being performed. This has an impact on managers, but an even bigger one on the employees. Many of them feel like they have to be online and available all the time in order to prove they are working well. Also, employee growth opportunities might be delayed or overlooked since performance assessment is difficult (Hodder, 2020). The value of work should be redefined in a way that gives remote workers equal chances to office workers. An important notion in this is the risk of hyper surveillance in work, where the privacy of remote workers should not be neglected.

Higher productivity
Although dependent on factors such as personality, job and environment research at Stanford has shown remote working leads to higher productivity (Mautz, 2020).

Collaboration

Pros	Cons
Better team collaboration	Incomplete communication
More efficient meetings	Zoom fatigue
Easier to meet	

Better team collaboration
Every company uses some type of software to enable communication and collaboration between the distributed workforce. Where it might be used out of necessity in the first place, it turns out to improve the overall collaboration. Study has shown that 75% of respondents feel like they are collaborating effectively in the forced work from home period, which is 10% higher than the period before COVID-19 (Cushman & Wakefield, 2020). Because teams seem to be collaborating well when they are not in the same location it becomes easier for companies to attract new talent by removing location requirements (Cushman & Wakefield & CREUA, 2020b).

More efficient meetings
An interesting result of online meetings is the increased efficiency. The meeting time is often shorter than face-to-face meetings because of a better meeting agenda and less informal communication during the meeting.

48% of participants talked about this.

Easier to meet
Because geographic distribution does not play a role in virtual meetings it is easier to have a meeting with anyone.

29% of participants talked about this.

Incomplete communication
Communication consists of 7% verbal communication, 38% tone of voice and 55% body language, the last two are greatly oppressed by video conferencing software and hardware. (Lee, 2020)

29% of participants talked about this.

Zoom fatigue
Through the high frequency of Zoom calls during remote work a new term was coined; Zoom fatigue. This describes the feeling of tiredness after doing multiple or long Zoom calls. During the large working from home experiment in 2020 people learned video meetings are more energy draining than face-to-face meetings.

Connection

Pros	Cons
	Building and maintaining relations with coworkers

	Reduced corporate culture

<u>Building and maintaining relations with coworkers</u>
Good relations between co-workers positively impact employee satisfaction, personal and professional development (Cushman & Wakefield, 2020). Strong connections are created on the workfloor and often stem from moments of informal communication. Working from home causes colleagues to not meet face-to-face, and planning meetings to catch up is often skipped because of the already full agenda. This makes it hard to maintain relations, but especially hard for new colleagues to build them up (Interviews, 2020).

76% Of participants talked about this.

<u>Reduced corporate culture</u>
Every company has a culture, which determines aspects like interaction, ambiance, dress code and traditions. It gives managers the ability to promote certain values. Not being in the office creates a distant feeling from this culture. Half the workforce feels less connected to the corporate culture during remote work caused by COVID-19 (Cushman & Wakefield & CREUA, 2020a). This is perceived as a pain because the corporate culture gives you a feeling of connectedness and makes your job fun (Interviews, 2020). It also negatively influences the satisfaction and retention of new employees (Cushman & Wakefield & CREUA, 2020b).

33% of participants talked about this.

Innovation

Pros	Cons
Increased creativity and innovation	Less creativity and innovation

<u>Less creativity and innovation</u>
Remote working can decrease communication between colleagues, which "ultimately can lead to employees missing out on all sorts of important information and sources of inspiration." (Cushman & Wakefield & CREUA, 2020a). New ideas and solutions often come from informal communication and spontaneous conversations. These moments occur when bumping into colleagues at the coffee machine or in the hallway, but can also be planned as brainstorm sessions. Because of the informal nature of this communication it is hard to replicate it online (Interviews, 2020).

48% of participants talked about this.

<u>Increased creativity and innovation</u>
Interestingly remote working can also lead to an increase in creativity and innovation. Research on remote working and product development showed increased product development performance and faster innovations. Being in environments other than the office enabled creativity and innovation to flourish. Important to note is that in this study regular face-to-face contact was possible (Cushman & Wakefield & CREUA, 2020a). Since the answers from the interviews were primarily based on experiences with working from home, where work is done individually, this benefit was barely mentioned.

Learning

Pros	Cons
	Less learning and helping
	Networking

Less learning and helping
According to research by Cushman and Wakefield & CREUA (2020a) 36% of employees do not feel like they are learning because of remote working caused by COVID-19. This problem lies in informal learning. The informal interactions are similar to those for creativity and innovation, but differ because of its content. Where creativity and innovation is mostly about generating ideas, learning and helping is based around knowledge and facts. When you have a question or want some help with a problem you can go talk to a coworker. This interaction is often started with a purpose, you have a question and are looking for an answer, but can also happen spontaneously. These short interactions used to have a low hurdle, since you can just walk up to a coworker, but since all communication moved online people felt it went up. Planning a video meeting just to ask a question often feels like too much of an effort. Learning and helping is especially important for new and/or young employees, who have a need for guidance and observation.

33% of participants talked about this.

Networking
Networking is an important activity that can lead to more opportunities, increased knowledge and faster job advancements. It is especially valuable to young and/or new employees, since they do not yet have a broad network of connections. Working remotely means these connections have to be built through video calls, risking them to be unstable (Hoffower, 2020).

Wellbeing

Pros	Cons
Autonomy	Bad distinction between work and private life
Lower work-life conflict	Higher workload
No commute	Social isolation
	Bad ergonomics of home office
	Privacy & Hyper Surveillance

Autonomy
Being able to decide when and where you work turns out to be satisfactory to employees. It gives a feeling of greater trust and autonomy, which in turn can lead to higher employee satisfaction and productivity.

38% of participants talked about this.

<u>Lower work-life conflict</u>
Working remotely enables people to feel free to go for a walk, do some chores between work tasks or start working earlier so they can spend more time with the kids in the evening. Working remotely up to 2.5 days per week results in higher autonomy and lower work-life conflict (Cushman & Wakefield & CREUA, 2020a)

29% of participants talked about this.

<u>No commute</u>
Not having to travel to work in the morning and back in the evening is perceived as a real advantage of remote working. Where it might seem like a slight convenience at first, it was seen as one of the biggest advantages of remote working by many interviewees. The type of remote working this applies to is obviously working from home, but a workplace that is closer to home than the office will also reduce travel time.

The BCO found that almost half of UK office workers complain that they endure an unpleasant and stressful trip to work. (Harris, 2015)

76% of participants talked about this.

<u>Bad distinction between private and work life</u>
It is hard to keep your work and private life separate when your home environment also becomes your work environment. The sense of physical separation is thereby almost completely gone. Additionally the commute to work is removed from the daily routine, causing the absence of a natural break at the start and end of the working day (Cushman & Wakefield, 2020).
People are also experiencing an increase in the use of their personal mobile phone for work purposes caused by remote working (Hodder, 2020). This causes you to bring your work life into your private life even more. A bad distinction between private and work life can result in a negative impact on mental and physical health (Cushman & Wakefield, 2020).

29% of participants talked about this.

<u>Higher workload</u>
Working from home makes the effort needed to start working lower and to distribute work higher, resulting in more work being done. Data shows work days have elongated 8.2% during the pandemic, which comes down to 49 minutes a day (Cushman & Wakefield & CREUA, 2020b).

The results presented in this report demonstrate that the working hours of T/ICTM workers, and particularly high mobile T/ICTM workers, are typically longer than of those who always work at the employer's premises.(Eurofound & the International Labour Office, 2017)

14% of participants talked about this.

<u>Social Isolation</u>
Not being together with your colleagues can lead to social isolation, which is worsened by the social distancing regulations resulting from the pandemic. A feeling of loneliness can be a real dent in someone's mental health (Hodder, 2020).

<u>Bad ergonomics</u>
Since all face-to-face meetings shifted towards video calls the average screen time for an employee has increased. Looking at a screen for long periods of time can cause computer vision syndrome, resulting in headaches, eye-strain and pain in the neck and shoulders (Randolph, 2017). For many a

home office was not something that was already present in the home environment. Due to the quick need for one often adhoc workstations were created. Without the proper layout and equipment this workplace can cause ergonomic injuries (Shikdar and Al-Kindi, 2007).

Appendix 16.4: Questions hybrid working interviews

De context
- Wat voor werk doe je?

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```

- Hoeveel werk je remote?

```

```

Algemene mening (hier kunnen nieuwe problemen naar boven komen)
- Wat vind je van hybride werken?

```

```

- Zitten er ook nadelen aan? (Laat ze vertellen)

```

```

Management
- kan je me vertellen hoe dit is/was geregeld door het bedrijf?
  - Vaste dagen of zelf bepalen?
  - Waarvoor naar kantoor en waarvoor remote?

```

```

- kan je me vertellen hoe een manager op de hoogte blijft van prestaties?

```

```

- Wat vind je van de manier waarop hybride werken is geregeld?

```

```

Communicatie
- kan je me vertellen hoe je communiceert met collega's?
  - Waar hangt de soort communicatie van af?
    - Horen bepaalde soorten communicatie nog bij bepaalde locaties of bepaalde soorten meetings?

```

```

- Hoe vind je dat de communicatie loopt?

```

```

- Komt het wel eens voor dat er een meeting is met een aantal mensen op kantoor en een aantal mensen remote? Hoe wordt dit geregeld? Wat is jouw ervaring hiermee?

```
┌─────────────────────────────────────────────────────────────────┐
│                                                                 │
└─────────────────────────────────────────────────────────────────┘
```

Inclusion
- kan je me vertellen hoe je op de hoogte blijft van informatie? (van info op kantoor als je remote werkt)
    - en hoe jij anderen op de hoogte houd?

```
┌─────────────────────────────────────────────────────────────────┐
│                                                                 │
└─────────────────────────────────────────────────────────────────┘
```

- Ben je wel eens bang dat je dingen mist? (informatie? kansen?)

```
┌─────────────────────────────────────────────────────────────────┐
│                                                                 │
└─────────────────────────────────────────────────────────────────┘
```

- Hebben mensen die veel op kantoor zijn een voordeel?
- Heb je het gevoel dat als je remote werkt je minder waard bent dan iemand op kantoor?

```
┌─────────────────────────────────────────────────────────────────┐
│                                                                 │
└─────────────────────────────────────────────────────────────────┘
```

- kan je me vertellen of remote werken de band met collega's beïnvloed?

```
┌─────────────────────────────────────────────────────────────────┐
│                                                                 │
└─────────────────────────────────────────────────────────────────┘
```

Appendix 16.5: Hybrid working cons

The cons and challenges experienced with hybrid working identified through literature research and interviews are listed below. The interviews were structured into 3 subjects: management, meetings and inclusion.

Management

Work location management
Incomplete home office
Costs

Work location management
When employees are spread across multiple locations in the office ecosystem good management is essential. This management requires all levels of the organization to communicate clearly and consistently. Everything needs to be managed properly, from work to meetings to availability of workspaces.

The importance of management in hybrid working is illustrated by the fact that two employees, for example a manager and employee, when working remotely 2 days a week, will have a 29% chance of meeting each other in the office (Cushman & Wakefield & CREUA, 2020b). This probability is low and will not be desirable. (See graph).
Another problem caused by the lack of management was mentioned in the conversations with employees from two large multinational companies that had already embraced the remote working culture. They said: "When you show up late to the office, you have to fight for a workplace".
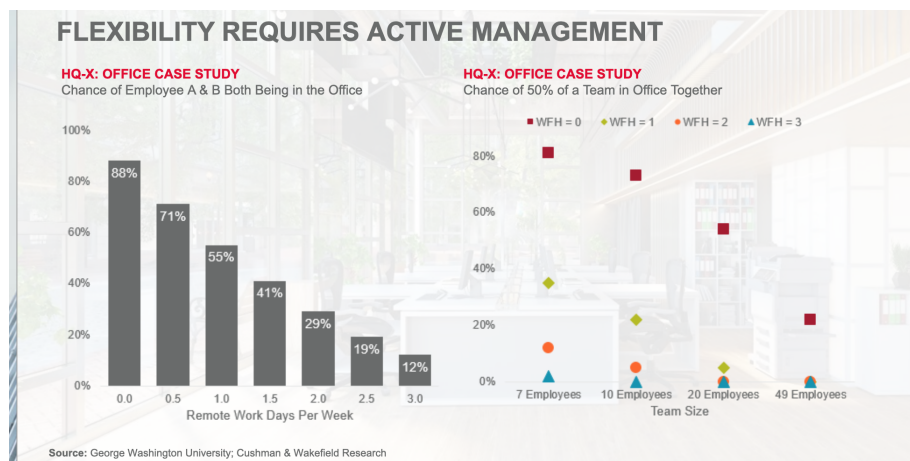
Some companies that participated in the interviews were using a system where you have to reserve a place in the office prior to the day you want to work there. For large companies this system can be a real time consumer if not automated. It also comes with problems like people showing up to the office without a reservation or employees disliking the lack of routine in their workweek. Companies clearly have to find their way in managing the work locations. One participating company in the UK made use of an online automated system that worked satisfactorily.

A frequent worry highlighted in the conversations was figuring out how to optimize the office days. Since office days are reduced to a couple a week, people want to make sure the coworkers they need to talk to or work with are present when they are in the office. It is easy to imagine the upfront alignment required to meet everyone you need to meet at a given day in the office. When you want to meet with 5 people, who each need to meet with 5 others, who then also have to meet with 5 others, it can be a real puzzle to organize optimal meeting schedules in the office.

29% of participants talked about this.

Incomplete home office
In the remote working research the problem of incomplete home offices became clear. Some companies did not take the initiative in improving the home offices of their employees, while others simple did not have the budget to do so. Companies that could not afford the required materials had the option to provide employees with materials from the office as a temporary loan. When hybrid working becomes the new standard these materials have to be returned to the office, leaving the home offices incomplete again.

14% of participants talked about this

Costs
Working from home means you are not making use of certain resources that used to be available in the office. At home you have to take care of your own lunch and coffee, will this be compensated by the company? And who will pay for the increased use of electricity and the need for faster internet? If the company is willing to give financial compensations for these resources, how will employees track the costs they make?

Hybrid meetings

Audio problems
Hard to interrupt
In-office dominance
Internet problems
Visual problems
Asymmetrical communication
Physical materials

Hybrid meetings
Meetings with both physical and online participants are often experienced as frustrating and inefficient. More in depth research on hybrid meetings is done in the next chapter: "Hybrid meetings".

Inclusion

Fomo
Centralized communication
Team contact only
Lack of overview

Fomo

Earlier results have shown that employees want to work remotely a couple of days a week. Research has however shown the expectation of this wish changing over time. The reason for this: Fear Of Missing Out. Remote employees can start worrying about the probability of missing out on important information, opportunities or experiences (Cushman & Wakefield & CREUA, 2020b).

14% of participants talked about this.

Centralized communication

Although communication and collaboration seem to be going well during remote work, hybrid working is a totally different situation. The communication now happens between people in different locations in the office ecosystem. Most online collaboration tools are primarily built for a team in which everyone works remotely. When a team is divided over different locations, and communication starts going through different channels, people are going to miss out on information (Buffer & AngelList, 2020). It will be important to create seamless and centralized communication between employees in different locations in the office ecosystem.

In the office interaction outside of formal meetings can also lead to project advancements or decision making. When a hybrid meeting ends and the online participants have left, the in-office employees often have a conversation about the meeting results or next steps. Since these conversations are not documented it is impossible for remote workers to stay updated on this information. This can create misalignment inside a team, or a feeling of being left out.

It is a challenge for hybrid companies to make sure the remote workers are not left out of important decisions. When most people are in the office and a key discussion takes place, the remote workers are easily left out, making them feel less important (Gascoigne, 2020).

43% of participants talked about this.

Team contact only

In earlier conversations it was often mentioned the goal is to have everyone from a specific team present in the office at the same time, because inside a team is where most communication and collaboration takes place. Some participating companies already realized this strategy, but employees highlighted the negative effect of it. You only have contact with the people in your team, and you have very little to no contact with colleagues from outside your team. This decreases the feeling of being connected to the company you work for. (Interviews, 2020)

29% of participants talked about this.

Lack of overview

When the workforce is divided over the central office and home offices it can be hard for managers and directors to keep an overview of what people are working on and how they are doing. A communication director I talked to marked this problem as the biggest one she experienced with remote and hybrid working.

14% of participants talked about this.

Appendix 16.6: Questions hybrid meeting interviews

Context
- Wanneer vond deze meeting plaats?
- Uit hoeveel mensen bestond deze meeting?
- Wie waren aanwezig?
- Hoeveel fysiek en hoeveel virtueel?
    - Waarom waren de virtuele mensen niet fysiek aanwezig?
- Wat was de doelstelling van deze meeting? (wanneer zou hij succesvol zijn?)
- Wat voor tools en software werden er gebruikt?
- Waar zaten de mensen tov de laptop / microfoon?

Verloop van de meeting
- Kan je me door de stappen lopen van vlak voor de meeting, tot de meeting zelf, en uiteindelijk tot kort na de meeting?
    - Wat is er van tevoren al gecommuniceerd?
    - Hoe wordt het materiaal geïnstalleerd en door wie?
    - Wanneer komen de remote participanten erbij?
    - Begint de meeting dan gelijk of is er nog een babbel.
    - Wat voor gesprekken voeren de mensen op kantoor kort voor en na de meeting?
    - Hoe werd de meeting begeleid? Door wie?

Ervaring
- Wat was jouw ervaring van deze meeting? (Dynamiek, effort, fluency)

- Wat als dit in de lange termijn bekijkt?

Input
- In hoeverre was de input van iedereen gelijk?
    - Wat was het effect geweest als de remote deelnemers niet deel zouden nemen aan de meeting?
    - Wat was het effect geweest als de remote deelnemers fysiek aanwezig zouden zijn geweest?
- Hebben de remote deelnemers altijd minder input? Waarom is dat?

    - Wat is het effect hiervan?
    - Wat als je dit effect op de lange termijn bekijkt?

Behalen doel
- In hoeverre was het doel van de meeting bereikt?
- Was deze uitkomst anders geweest als de meeting niet hybride was?

```
[                                                                    ]
```

- Wat is het lange termijn effect hiervan?

```
[                                                                    ]
```

Efficiëntie
- Wat was de invloed van hybride meeten op de efficiëntie van de meeting?

```
[                                                                    ]
```

- En hoe vertaald zich dat naar de lange termijn?

```
[                                                                    ]
```

Understanding the behavior of online participants in a hybrid meeting.

1. Introduction

The future of work will be hybrid, with employees working from different locations in the office ecosystem. In this way of working hybrid meetings, with both in-office and remote participants, will take place frequently. According to the experiences of people interviewed in this graduation project these types of meetings are hard and frustrating, especially for the online participants. They find it hard to interrupt and to participate actively in the discussion. A hybrid meeting was simulated with students from the TU Delft in order to better understand the interaction taking place and the problems experienced.

2. Research question

- Why is it hard for online participants to actively take part in the discussion?

3. Method

3.1 Participants

The participants are all students from the TU Delft, aged between 23 and 29. This group was chosen because a session with employees in an actual company during a hybrid meeting was not possible with the current Corona restrictions.

In total there were 6 participants, 4 being in the conference room, 2 joining through Zoom. This ratio was chosen because it was learned that online participants are often outnumbered by in-office people in hybrid meetings. Of the participants 5 are male and 1 is female. All participants knew each other well, matching the relations between colleagues in a professional team.

3.2 Stimuli

In order to simulate a hybrid meeting as realistically as possible a conference room setting was built. This includes a long table with chairs, a conference speaker and a large screen at the short end of the table (see figure 1). A laptop with Zoom was connected to the large screen so the online participants could be seen by everyone in the room. A conference speaker from Anker was used to properly record all voices in the room and spread the audio from the online participants.

To create a discussion all participants were given a fictional role in the board of a company. Before the session they were handed out a page with a description of the company, their role, their goal and arguments. These one-pagers can be seen in Appendix 10.7.2.

Figure 1: conference room setup

3.3 Apparatus

Zoom; to record the meeting from an online point of view.
Anker conference speaker; to record clear audio for the Zoom recording.
Nikon D3400; to record the meeting from an in-office point of view.
iPhone XR; to record all audio in the room in case audio from the devices above fail.
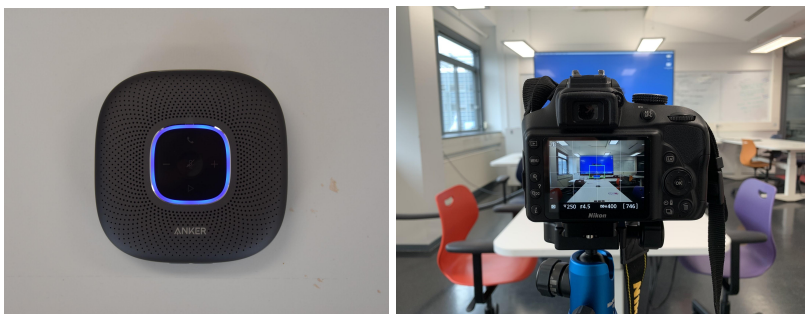Miro; to document the brainstorming session.

Figure 2: conference speaker, camera

3.4 Procedure

Before the session every participant received a one-pager with his role, goal, arguments and the meeting agenda. All participants had arguments unique to their role, supporting their personal goal in the meeting. The meeting had two possible outcomes; pivot or persevere. 3 Participants supported the pivot while the other 3 wanted to persevere. In order to get somewhere they had to use their arguments while listening to those of others, eventually leading to an outcome.

Before the meetings started the in-office participants took place at the table and the Zoom meeting with the online participants was set up. A last central, verbal, explanation was given by the researcher to make sure everyone understood what was expected from them and to take away any possible uncertainties. Then the meeting started according to the meeting agenda.

After the simulated meeting an interview with the group was done to discuss their experiences. From these experiences the biggest pain points were used to start a brainstorming session.

Figure 3: the meeting

3.5 Measures
Through the recordings the number of turns was counted for each participant to see if certain behavior influences turn taking.
The audio recordings were used to process the answers to the questions in the discussion after the simulated meeting.

3.6 Observations
The recordings of Zoom and the camera were used to analyze the behavior of participants during the meeting. Actions that underline existing literature or could lead to new findings were documented.

4. Results
4.1 Observations
Observations made during the session were:

- Eye contact plays a dominant role in turn taking
- Body language is a powerful tool in discussion
- Moments of silence were often used by remote participants to take the turn
- All online participants are one

These findings are explained in the discussion.

4.2 Interview & Group Discussion

Findings from the group discussion after the session are:

- Constant awareness of online participants required
- Online participants as backup participants
- Interrupting instead of contributing
- Hard to find the right moment to speak
- The audio volume of remote participants has a large impact on their turn taking capabilities
- Lack of body language is lack of knowing where someone is at
- Ideas and arguments through Zoom are less convincing

These findings will be explained in the discussion.

4.3 Turn count

The amount of turns per participant was counted to see if there is a difference in input frequency from the remote participants. In the table below the percentage of the total turns per participant is shown.

Participant	Type	Turn percentage (%)
Participant 1	In-office	23
Participant 2	In-office	11
Participant 3	In-office	29
Participant 4	In-office	6
Participant 5	Remote	16
Participant 6	Remote	14

Interestingly enough the amount of turns for remote participants is not as low as expected. They come in 3rd and 4th on the ranking with most turns taken. Even though they did not struggle with giving input, they still explained they felt left out and not taken seriously.

5. Discussion

Eye contact plays a dominant role in turn taking
The observations made the importance of eye contact in communication very clear. The current speaker used it to communicate who he was addressing, while the others used it to confirm their attention. Eye contact was also used to give the next turn to a next speaker, simply by looking someone in the eye at the end of the sentence. The online participants received very little eye contact, resulting in very little turn taking options. Also this eye contact through Zoom was not real eye contact, the in-office people look at the screen where the online participant is displayed, while the camera is on the laptop underneath the big screen. This limits the effect of eye contact for the remote participants.

Body language is a powerful tool in discussion
When new ideas or arguments were presented body language proved to be a powerful tool. Hand gestures and leaning forward made a message more convincing and exciting. This made it hard for online participants to deliver their input as convincingly as the others.

Moments of silence were often used by remote participants to take the turn
When there was no clear next speaker, sometimes a few seconds of silence occured. Most of the time this silence led to an online participant taking the floor, implying they have been looking for a moment to speak for a while and finally have found a very obvious one.

All online participants are one
Because all online participants join through Zoom, being visible on the same screen, using the same camera, they feel less like an individual. During the introduction round in the meeting the turns were passed on clockwise. When the screen was the next in line everyone looked at the screen, but the remote participants did not know who had to start speaking. This feeling was later underlined in the discussion when one of them said he was constantly aware that he was not the only person on the screen. This lack of individuality could possibly influence the experience and interaction.

Constant awareness of online participants required
One participant from the conference room mentioned he found it hard to constantly remind himself of the online participants in the meeting. This became tiring later in the meeting and sometimes withheld him from responding quickly, so the online participants also got a chance to speak.

Online participants as backup participants
An in-office participant realized he was constantly trying to convince the people in the room of his arguments, not actively speaking to the remote participants. He explained this with the feeling that the people on the screen are "a backup".
This feeling was shared by the people joining the meeting through Zoom. One of them said he felt as a helpline, sometimes providing some input that is then used to fuel the discussion between the in-office people.
This shows that the online participants are not experienced as active members in the discussion, from both sides of the meeting.

Interrupting instead of contributing
Adding to the previous point, the online participants felt like they were spectating a discussion between 4 people. Adding to this feeling was the experience of giving input, which felt like interrupting their discussion.

Hard to find the right moment to speak
One of the online participants found it hard to find the right moment to speak, or to understand when it is expected of you to speak.

The audio volume of remote participants has a large impact on their turn taking capabilities
During the meeting the situation where 2 people started talking at the same time happened a couple of times. Some of those situations included an in-office and online participant. Almost every time this resulted in the online participant getting the speaking turn. The reason for this was discussed with the group. The most dominant factor was the audio volume. The speaker was set to maximum volume to make sure everyone could hear the audio well. When the online participant started speaking the loudness of their voice overtook any in-office participant. Another cause identified by the group was the unexpectedness of the interruption. When a person in the room wants to speak, subtle signals make this clear to the others, but these signals are not received from the online participants. Also, the point that was mentioned earlier, that people are consciously trying to give the online people the chance to speak, contributed to the in-office participant giving the floor to the online participant. Lastly, the online participant most often did not know he started speaking at the same time as someone in the room, eliminating his option to stop talking and leaving the turn to someone else.

Lack of body language is lack of knowing where someone is at
Someone's posture can tell a lot about where he is at in the discussion. Is he excited or unhappy? Is he still with us or losing his interest? This information from the online participants is not available to the in-office people. The participant explaining this said he had no idea where the online people were at.

<u>Ideas and arguments through Zoom are less convincing</u>

Through the division of the roles it was planned that a new idea would be brought to the table from both a Zoom and office participant. Both ideas were considered and elaborated on, but when asked afterwards about the participation type, physical or remote, it was noted that ideas from a remote participant are less convincing than from someone in the room, not taking the quality of the idea into account. Eye contact, body language and other communicative tools could make the difference in delivery.

Also when an online participant said he felt like he was not taken seriously, an in-office participant admitted this was actually the case. He said sometimes after the online participant had given an argument he would think to himself "whatever". This is not inappropriate behavior from the in-office participant, it underlines the way remote participants are experienced and valued.

6. Conclusion

The research question was:
- Why is it hard for online participants to actively take part in the discussion?

The lack of involvement of online participants can be explained by two main factors: not feeling like an equal participant and not being able to frequently speak.
For the first one the goal is to give the remote participants the feeling of involvement. This could be achieved by changing the way they are perceived by the in-office participants (output), or by changing the way the in-office discussion is experienced online (input).
For the second factor it will be important to increase the amount of communication tools, mostly non-verbal, for online participants. This way they should be able to take more turns without constantly stopping the conversational flow.

The results show the amount of turns remote participants get is enough to give their input. They however noted that they did not feel included and valued in the discussion. This would mean the problem is not so much in interrupting and turn taking, but in the perception of their input and them as a person. The in-office participants explained the people on the screen felt less important and more like a helpline. Although the batch size of this research is small it should bring up the question if the problem is not so much related to the actual output, but more to the perception of an attendee.

Appendix 16.7.2: One pagers hybrid meeting session

Intro:
The company is the Boring Company, you are drilling a tunnel underneath Los Angeles so Tesla cars can avoid getting stuck in traffic. But because of the pandemic remote work is expected to stay even after the pandemic is under control, causing less traffic to be on the road. Part of the team wants to keep building the tunnel so it's ready when more cars get back on the road, the other part wants to quit the tunnel project and pivot to a situation better suited to the new world.

Meeting agenda:
13:10 - 13:20 Update: What is your role, and what did you work on last week?
13:20 - 13:40 Discussion: Are we going to continue the tunnel project, or pivot?
13:40 - 13:45 Decision: Choose what the final decision and next steps will be.

Your role:
Stakeholder manager
Your job is to keep all the stakeholders in the project happy and invested. If one of the stakeholders gets upset and decides to quit the project this could really harm the continuation of the project, and your reputation as stakeholder manager. Stakeholders in this project are:
- **Municipality** (gemeente). After lots of negotiations they finally gave permission to start digging underneath the city. They hope the Boring Company tunnel can solve the traffic problem and create new jobs for people in LA along the way. If you upset them they can really be a pain in the ass in future projects.
- **Investors**. Digging this tunnel is very expensive. Investors have invested 50 million in total, and in return expect to make a profit when the tunnel becomes a success. Elon Musk himself invested another 100 million.
- **Partner companies.** The Boring Company is drilling the tunnel, but partner companies are building the required tools in the Tesla cars, the tunnel management software, maintenance infrastructure, etc. These companies would all have to stop their work, losing lots of money.

What you've been doing:
Last week you spoke to the stakeholders, and they are currently happy with how the digging is going (they are unaware of the new plans).

Your goal:
Stick to the current idea and keep the stakeholders happy.

Intro:
The company is the Boring Company, you are drilling a tunnel underneath Los Angeles so Tesla cars can avoid getting stuck in traffic. But because of the pandemic remote work is expected to stay even after the pandemic is under control, causing less traffic to be on the road. Part of the team wants to keep building the tunnel so it's ready when more cars get back on the road, the other part wants to quit the tunnel project and pivot to a situation better suited to the new world.

Meeting agenda:
13:10 - 13:20 Update: What is your role, and what did you work on last week?
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13:40 - 13:45 Decision: Choose what the final decision and next steps will be.

Innovator
You are the idea generator for the Boring Company, stimulating innovation and making sure the company stays ahead of the competition. You are trained to notice changes in the world and think about future scenarios. You believe less cars will be on the road because of permanent changes in the way we work after the pandemic, making the tunnel obsolete. You want to prevent the company from failing after years of development and millions spent. You are the brains behind the new vision for the company:

Your idea: The pandemic will increase the demand for flex workspaces where remote teams can come together to collaborate. In LA there is barely any space left to build, and properties are way too expensive to buy. Since we are already digging underground, let's make the first underground flex workplaces!

What you've been doing:
Last week you brainstormed for new directions for the company. Today you want to convince the team of your new big idea.

Your goal:
Pivot the company to your idea.

Intro:
The company is the Boring Company, you are drilling a tunnel underneath Los Angeles so Tesla cars can avoid getting stuck in traffic. But because of the pandemic remote work is expected to stay even after the pandemic is under control, causing less traffic to be on the road. Part of the team wants to keep building the tunnel so it's ready when more cars get back on the road, the other part wants to quit the tunnel project and pivot to a situation better suited to the new world.

Meeting agenda:
13:10 - 13:20 Update: What is your role, and what did you work on last week?
13:20 - 13:40 Discussion: Are we going to continue the tunnel project, or pivot?
13:40 - 13:45 Decision: Choose what the final decision and next steps will be.

R&D Manager
As manager of the R&D team you are the experienced product development guy. You know what it takes to develop a successful product. The tunnel is going to be another flawless one, but because of your experience with innovation you have doubts about the need for a tunnel underneath LA after the pandemic. You and your team have been brainstorming for new, and potentially more successful, products for the Boring Company.

Your idea: Digging the tunnel came with lots of challenges. In order to solve them you and your team have developed innovative boring machines. These autonomous boring machines are the best ones out there. The Boring Company could start focussing on further developing them and selling them to other companies. Companies that are interested are Metro/Train tunnel diggers, and the Hyperloop companies.

What you've been doing:
Last week you and your R&D team brainstormed ideas for pivoting the company.

Your goal:
Pivot the company to your idea.

Intro:
The company is the Boring Company, you are drilling a tunnel underneath Los Angeles so Tesla cars can avoid getting stuck in traffic. But because of the pandemic remote work is expected to stay even after the pandemic is under control, causing less traffic to be on the road. Part of the team wants to keep building the tunnel so it's ready when more cars get back on the road, the other part wants to quit the tunnel project and pivot to a situation better suited to the new world.

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13:40 - 13:45 Decision: Choose what the final decision and next steps will be.

Chief Operating Officer
As COO you are responsible for the company's operations. You oversee all operations in the company and make sure everything is finished in time. The project is going according to plan, but since the pandemic there is some discussion going on in the company about whether to stick to the tunnel idea, or pivot. You are convinced there will still be enough cars on the road after the pandemic and that you can't predict what the future will look like. Sticking to the current plan is saver, let's not take any risks in such unstable times.

What you've been doing:
Last week you've been overviewing operations in the tunnel to see if everything is going as planned.

Your goal:
Stick to the current idea and don't take any unnecessary risks.

Intro:
The company is the Boring Company, you are drilling a tunnel underneath Los Angeles so Tesla cars can avoid getting stuck in traffic. But because of the pandemic remote work is expected to stay even after the pandemic is under control, causing less traffic to be on the road. Part of the team wants to keep building the tunnel so it's ready when more cars get back on the road, the other part wants to quit the tunnel project and pivot to a situation better suited to the new world.

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13:40 - 13:45 Decision: Choose what the final decision and next steps will be.

Chief Financial Officer
Drilling a tunnel underneath LA is everything but cheap. Investors have put 50 million in the project, and Elon Musk himself another 100 million. It is your job the project can be realized with the money that the company has; 150 million. So far the development of the tunnel has cost 120 million, the remaining 30 million should be enough to finish the project. If everything stays on track you have nailed your job, maybe you can land a promotion because of it?
You know the tunnel is going to make enough money, even if the amount of cars in it is a bit less than expected before the pandemic. Stopping the tunnel project would mean you, as CFO, have poured 120 million down the drain, ouch.

What you've been doing:
Last week you made a projection for spending the last part of the budget.

Your goal:
Stick to the current idea and execute your financial plan.

Intro:
The company is the Boring Company, you are drilling a tunnel underneath Los Angeles so Tesla cars can avoid getting stuck in traffic. But because of the pandemic remote work is expected to stay even after the pandemic is under control, causing less traffic to be on the road. Part of the team wants to keep building the tunnel so it's ready when more cars get back on the road, the other part wants to quit the tunnel project and pivot to a situation better suited to the new world.

Meeting agenda:
13:10 - 13:20 Update: What is your role, and what did you work on last week?
13:20 - 13:40 Discussion: Are we going to continue the tunnel project, or pivot?
13:40 - 13:45 Decision: Choose what the final decision and next steps will be.

Strategy Expert
You are the strategic mastermind of the company. When the company started you have turned Elon Musk's crazy ideas into a realistic strategic plan: creating buzz around the idea of digging under a tunnel of LA, resulting in millions of people loving the idea, eventually winning over the municipality to give a permit to start digging. Also starting to dig the first part of the tunnel on the company's own property to prove the feasibility of the project was your idea.
But the pandemic has made you doubt the importance of the Boring Company tunnel. If there is a good idea to pivot to you could make it work with your effective strategies. You can't come up with the entire strategy in today's meeting, but you have to convince them you are capable of doing it.

What you've been doing:
Last week you worked on the marketing strategy for when the tunnel is opened to the public.

Your goal:
Pivot and create a new strategic plan.

Appendix 16.8: Effect eye contact frequency & quality on feeling of involvement

Experiment card:

Experiment	Eye contact is key
I believe that	More and better eye contact in a multi-person conversation leads to a higher feeling of involvement.
In order to test I will	Show people 4 videos, with different amounts of eye contact towards the camera, and ask how involved they felt (involvement on a scale of 6).
And measure	The average score of involvement for each video.
I'm right when	The score for the video with the most amount of eye contact is at least 2 points higher than the one with the lowest amount.

Method

In this quick experiment the effect of eye contact on the feeling of involvement in a conversation is tested. The participants are presented with 4 different video's; each showing 2 people sitting at a table. One of them is giving a pitch about a specific idea. In the first video no eye contact with the online participants is made. In the second a few small moments of eye contact were made, by shortly looking into the camera. In the third video the speaker made frequent eye contact with the online participants, but by looking above the camera. This resembles the behavior in a traditional conference setup, where the camera is located underneath the tv screen, resulting in indirect eye contact (see figure 1). In the fourth video frequent and direct eye contact is made. At the end of each video the participants are asked to score their feeling of involvement in the meeting on a scale of 1 to 6.

Figure 1: camera location in conference rooms

Total amount of eye contact video 1: 0 seconds
Total amount of eye contact video 2: 5 seconds (direct)
Total amount of eye contact video 3: 15 seconds (indirect)
Total amount of eye contact video 4: 15 seconds (direct)

Results

Number of participants: 31
Average score video 1: 2.6
Average score video 2: 4.1
Average score video 3: 3.5

Average score video 4: 4.8

This study shows the more eye contact is made with online participants, the higher the perceived feeling of inclusion. The difference between the score for the video without any eye contact and the one with a high amount is 2.2. This is a significant difference.

What is also interesting is that a low amount of direct eye contact results in a higher inclusion than with a large amount of indirect eye contact. The difference in score is not that big (0.6), but it does show the impact of quality eye contact.

Interesting notes
The participants had the option to elaborate on their given score, which resulted in some interesting insights on the experience of online participants in a hybrid meeting.

- One participant noted that the video with indirect eye contact was "pissing him off". Humans want to make eye contact when communicating, when this can not be established it can apparently be frustrating. Interestingly this seems to be less of a problem in full-online meetings, where eye contact can also not be completed. Two possible explanations for this are 1) the distance between the camera and eyes on the screen is larger in a conference room than on a laptop, or 2) seeing that other participants are receiving real eye contact while you are not can shine light on what you are missing.
- While the goal was to increase the amount of eye contact moments in the different videos this unconsciously led to longer periods of eye contact as well. This was noticed by a participant, who wrote "I was looked at longer, which made me feel involved". This teaches us that both the frequency and the duration of eye contact influence the feeling of involvement.
- Multiple participants (3) noted something about the confirmation of their participation in the meeting. In video 3 the speaker says "I can see you on the screen", which turned out to positively affect the feeling of involvement". In the scores for the other videos it was mentioned that you, as a participant, do not know if the people in the room can see you. Confirmation of attendance can be an interesting factor to keep in mind.
    - Having learned that "being seen" is important information for an online participant brings me back to an earlier thought of giving every online participant an individual place at the conference table. This way, if you are being looked at, you know it is you who they are looking at, and not one of the other people on the screen.
- Including a participant in the meeting can also be done verbally. The question at the end of video 3 was towards all participants, one participant wrote this down as a positive contributor to the feeling of involvement. He also gave this video, with indirect eye contact, a higher score than the one with a high amount of direct eye contact. Another participant gave the video with little eye contact a higher score than the one with high eye contact for the same reason; the first started with a welcoming message while the latter started the pitch immediately.

- One participant wrote the first video, without eye contact, gave him the feeling of being a spectator in the meeting. This feeling was also noted by participants in

previous conversations about hybrid meetings. This experiment confirms that eye contact is indeed one of the main contributors in this problem.

Limitations
- In this study every video presented a different meeting. This was done to prevent participants from getting bored by hearing the same pitch 4 times, possibly leading to lower involvement scores at the end. The content of the different stories can however influence the feeling of involvement. A pitch that is more appealing to a specific participant can cause him to feel more involved.

Design opportunities
- Confirming that the user has joined the meeting and is visible can positively contribute to the feeling of involvement.
- Giving every online participant an individual place at the conference table confirms the information of being looked at when you receive eye contact from an in-office participant.

Appendix 16.9: Effect camera position on perceived eye contact

Research question
What is the effect of different camera positions in the conference room on the perceived eye contact by online participants?

Method
A picture that represents a person in a Zoom call was put on a tv screen. A phone and a flexible mount were used to try out different webcam positions. The phone recorded some video footage in every position to allow for analysis. In the analysis the effect of the camera position on perceived eye contact was evaluated. Because of the quick nature of this experiment it was chosen not to quantify the results with a group of participants. The judgement of me as designer was sufficient to understand the effect of the different camera positions. The goal is to explore different camera positions and find the most effective one.

The first six positions were conventional conference cam placements. The next six were experimental.
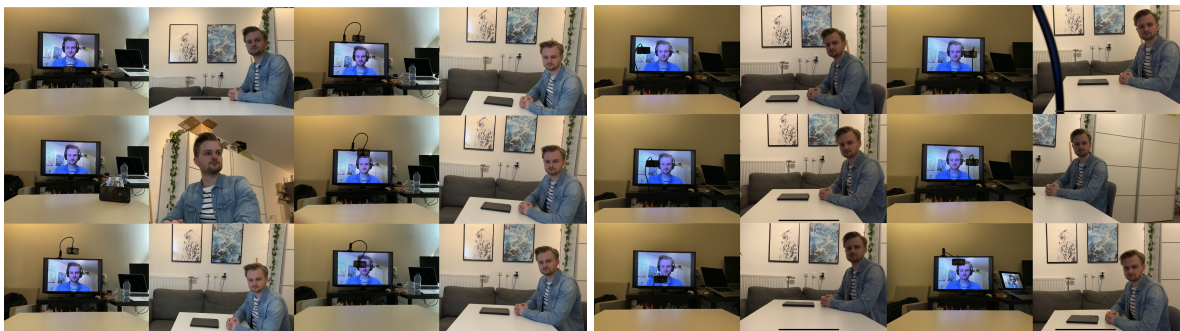

Figure 1: Different camera positions

Results
It seems like there is a strict classification: eye contact or no eye contact

Getting the camera close to the eyes on the screen has a small impact
while realizing this is technologically complex.

Putting the camera on top, as close to the screen as possible is the best option.

We are less sensitive to eye contact when people look below our eyes than when they look to the left, right or above our eyes (Chen, 2002)
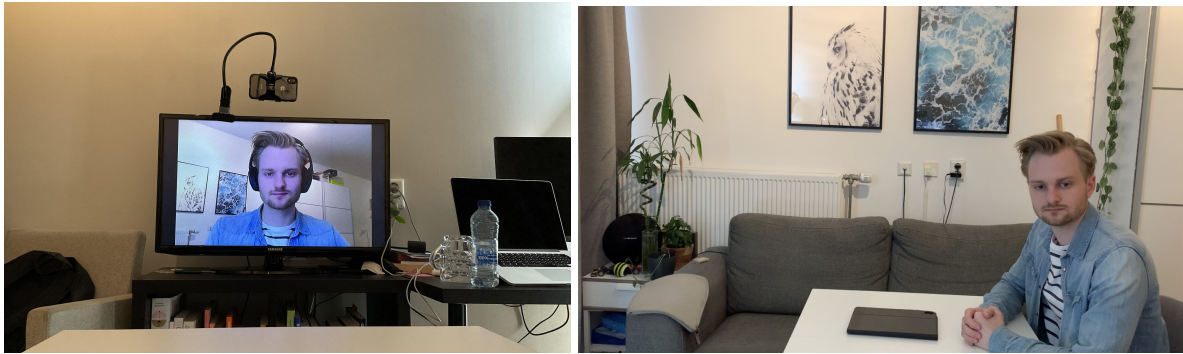
Figure 2: Example of camera position and the resulting view.

Learnings:
- Putting the camera as close to the eyes of the person on the screen has very little effect on the perceived quality of eye contact. Only if you come really close there is a slight improvement. There seems to be a simple classification: eye contact or no eye contact.
- It is not worth it developing solutions that come closer to the real thing. It will most likely be expensive.
    - It might be cheaper to fix with software, but I do not have the expertise for that.
- AR and under-display cameras seem to be the right solution for this problem.
- Research papers already found that humans are very good at understanding gaze direction. If the direction is slightly off they will know.
    - Why did it seem more effective when you sit further away from your laptop? That created the illusion of eye contact, while in this experiment all positions were clearly no eye contact.

Appendix 16.10: Body language screen in hybrid interaction.

Research questions
- What is it like to communicate remotely through the telepresence screen?
- How connected do you feel?
- How often do the others look at you?
- Does it feel like they are looking at you?
- Is it easy to say something?

Method
This was just a casual hangout with the telepresence screen. The screen setup was built and a total of 4 people were having an informal conversation. The goal was to test the interaction and hear people's opinions. The main goal was for me to experience what it is like to be the remote participant in a hybrid communication setting. To get complete feedback the different roles, remote and in-office, were switched a couple of times.
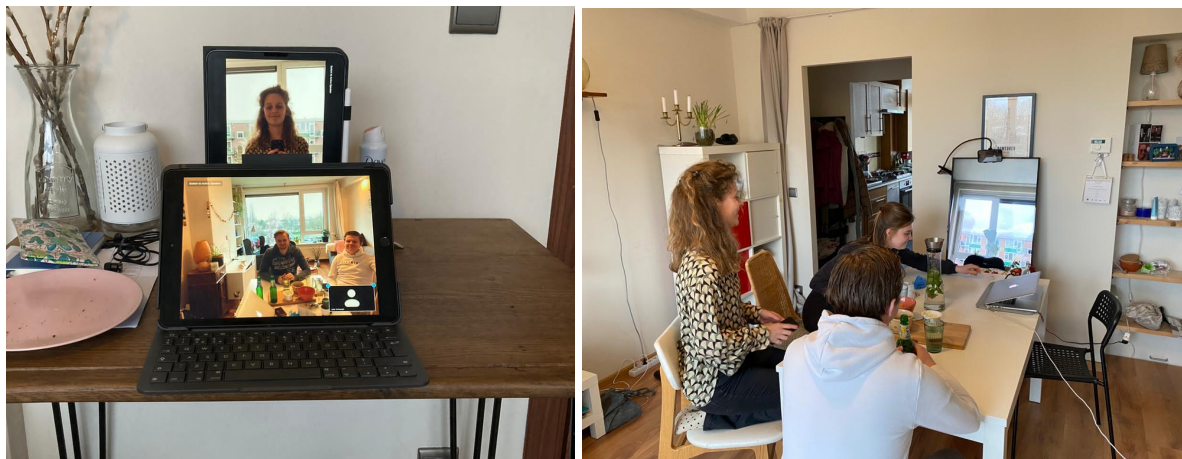

Figure 1: Telepresence screen setup

Result
- The overall interaction between all participants was good.
- I did not always hear what was being said, but we did not use a conference mic.
- I could not see the dices on the table when playing a game
- When they looked at me it did not really feel like a connection, because they looked at my eyes on the screen, and the webcam was at a higher point of view. It felt more like an overview shot than my actual eyes.
- The people in the room liked the experience of me sitting at the table.
- It is a real struggle to build this setup, with all the devices, pinning the right views, muting the right devices, turning the device for a vertical view, etc. It takes around 20-30 minutes building this setup.

Limitations
- Because this was done in a group of friends the chances of me not being included were not that big.
- This small talk is not representative for the formal interaction and discussion in meetings.

Learnings

- The telepresence screen should be a really easy plug and play device.
- The only purpose of the tv is displaying the call, so it does not have to be an actual tv, just a monitor with a small computing device receiving and sending the signals (audio, video, wifi/bluetooth)
- When someone in the room looks at the screen it should feel more like eye contact, this can greatly increase the feeling of connectedness.

Appendix 16.11: Telepresence screen and non verbal communication

Research question
How well does a screen with life sized participant representation & body language view get non verbal communication across?

Method
During this experiment the card game "the Mind" was played (See figure 1). During this game every player gets cards with numbers on them (1-100). The goal is to place all cards on the table in the right order, without speaking. You have to communicate non-verbally (also no hand gestures or codes).
Since this game requires really good non verbal communication it is the ultimate test for the product in development, that has to improve the delivery of non verbal communication. The first game was played face-to-face so there is something to compare the results to. The second game was played with one of the players sitting in the bathroom, joining the game through the telepresence screen (See figure 2).

Figure 1: The Mind   Figure 2: Virtual participant at the table

Results
The first game (face to face) got us to complete level 12, which is the highest level in the game. Also no mistakes were made and no lives were lost. It was not the first time playing this game for the participants.

The second game, with the screen, got us to level 6. One life was lost in level 5, and the remaining two in level 6. It was significantly harder to play the game this way, the reasons why are discussed below.

Learnings
- It was harder to play the Mind with the telepresence screen.
- It costed more energy to receive all signals, compared to face-to-face
- The contact felt less intense, making the connection more flat and less informative
- For the remote person the other's face was displayed really small (smaller screen, in-person not very close to the camera, remote person sitting further away from the screen).

- Receiving signals from such a small head made it intensive.
- The game is about mutual understanding, but the telepresence screen is focussed on improving the situation in the office (because this can lead to a higher involvement of the remote participants). Because the connection is not better for the remote person, the overall mutual connection does not really improve.
- When Julia laughed after I played a card, I had no idea whether I messed up or made the right choice. This confusion did not happen face-to-face.
- Soft breathing signals, like a deep breath or a sight, are not coming across anymore.
- When remote you don't see what happens in the corner of your eye. When you are looking at your cards you can't see what the other person is doing. (This cost us one life, because J did not see K was also grabbing a card.) This was no problem for the in-office person with the large screen. (You still see things happening in the corner of your eye).
- For the remote person there does not really change anything when using this telepresence screen. The only change is that you have to sit further away from the screen, only making the interaction harder. (So maybe the only change is a negative one).
    - This is true for 1on1 interaction. When there are more people in the office the screen should result in a higher natural involvement of the remote person, improving the meeting experience for that person. But it is still interesting to keep this side of the experience in mind. Can we improve it?
- For the remote person it was hard to keep an eye on the eyes and the card activities at the same time, which is weird since these are very close to each other on the screen.
- Overall it was harder to get an idea of whether the other has higher or lower cards than you do.
- You are not making real eye contact, because of the camera-screen eyes distance. This results in a less deep connection and understanding.
- Every time the right call was made the other nodded. This did not happen that obvious when face-to-face, it was more subtle then.
- When playing with the laptop camera in front of the in-office person (so a larger face for the remote person to see) it became slightly better, because the signals were displayed bigger. (In this game it was hard because you then couldn't see the other holding the cards anymore).
- When J was looking away or yawning I really felt a disconnect (as remote p), giving me the feeling "Am I still there? Does she feel connected or bored?

Limitations
- The game requires very intense non verbal contact, which is not needed to such extent in meetings. (But it's a nice way to test the product).
- The result is also influenced by the cards you are handed. If you get numbers really close to each other the changes to failure are larger.

Design opportunities

- The screen really improves the in-office connection to the remote person, but not really the other way around.
    - Maybe this can be where you can add most value
    - And create the competitive advantage. The screen is easy to copy, but maybe I can create tech and software that really makes it feel like you are there, or makes it really easy to pick up a lot of information from the people in the room.
- The experience for the remote person should be better because of higher involvement in the conversation, but this is already the case in 1-on-1 interaction. So now there was only a reduced experience, because you had to sit further away from the laptop screen.

Appendix 16.12: Effect of directional audio and gaze

Research questions:
-   What is the effect of directional audio in video conferencing?
-   What is the effect of directional gaze in video conferencing?
-   Is the effect similar to that of eye contact?

Method

A video recording of a person talking about a random subject was made and played on a tv screen. This simulated the presence of an online participant. A speaker on an office chair was used to manually control the direction of gaze and audio. First the effect of directional audio was tested, with a normal speaker and with a speaker in a cone, secondly visual cues for gaze direction were tried out, with an eye on a post-it and with an AirPods box. Two participants switched roles as the person being spoken to, and the person controlling the simulated gaze direction.

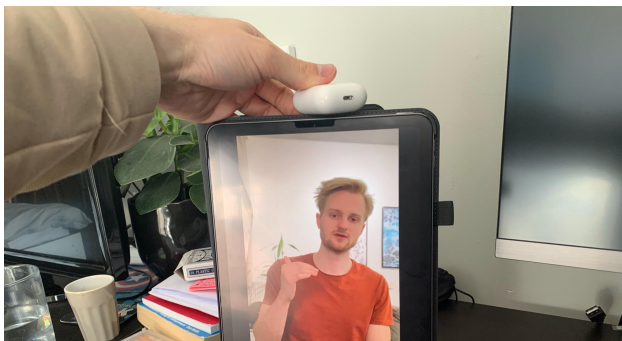Figure 1: Directional elements under the screen

Figure 2: Directional element on top of the screen

Result
- The speaker did not give quite a directional experience, because the speaker is built to fill a room with music
- The phone in a tube resulted in a better directional audio experience. You could still hear the audio from any direction but the increase in volume when it was pointed at you gave some feeling of personal adressment.
- The directional gaze element was quite effective. When pointed at you a feeling of awareness was evoked "oh he's looking at me now". It is effective in involving someone and grabbing his attention.
    - This effect was later confirmed by the research of Jarrett (2017), who said: "As adults, locking eyes with another person immediately triggers in us a state of increased self-consciousness".

Limitations
- The direction of the audio or gaze was random and the person simulating it was in the field of view, making it less believable.
- The amount of gaze direction switches was done intuitively. It will be interesting to test with an eye tracker how much eye movement takes place when looking at a meeting on your laptop. If the eye activity is high the device in the office could be really distracting with its quick and constant motion.
    - If this is the case a threshold of 2 seconds could for example be installed in the software, preventing quick and distracting gaze direction movement.
- The video recording was used in every test done in this experiment. Because of this the focus on the screen and the story being told declined over time, increasing the focus on the gaze direction prototype. This could have influenced the effectiveness of the prototype.

Learnings
- The visual cue for gaze direction has to have the right balance. If it is very subtle (now it was a lighting port on an AirPods box) you have to look at the device very often, to check if he's looking at you. On the other side if the visual cue is too dominant it can be distracting, drawing your eyes to it constantly and keeping your eyes away from the other person's eyes on the screen.
- Using LEDs as a visual indicator will probably be better than a mechanical rotation, being more subtle and cheaper.
- The top of the screen is the best location for the gaze direction indicator, since it is close to the face of the person on the screen. (The eye on the speaker underneath the screen was out of the field of view, making it ineffective).
- The gaze direction indicator might be a good combination with the directional audio. (gaze is more effective, but audio might complement the experience)

Appendix 16.13: Projected selective gaze

Research questions
- Is projecting a participant on a curved surface feasible?
- How is the projected selective gaze experienced?
    - Is the projected selective gaze effective?
    - Is the projected selective gaze natural?

Method

A large piece of paper was used to create a curved surface. A beamer was placed on an office chair so it was able to rotate. A youtube video where a speaker had a black background was used, because black does not get projected. This would result in only the participant being projected onto the surface.

Figure 1: beamer setup

Figure 2: person projected on the curved surface

Results
- The looking around behavior created by the curved surface was pleasant. It did not require extra attention for or translation of the information. It did not perfectly simulate the way a person looks around the room, but this is not a problem.
- The projection is less effective in creating the special one-on-one connection like eye contact does. This is because, as found out earlier in the project, if the online participant looks into the camera, everyone in the room will have the feeling of being looked at. With the projection you would know you are being looked at when the body of the participant was aiming in your direction.

- Because the online participant is basically making eye contact with everyone in the room and the direction of his body is what makes it directional, the total effect is less accurate. It would be hard for two people sitting next to each other to understand who is being spoken to.
- The projection system is feasible as long as one projector per screen is used. If one projector needs to project on multiple curved surfaces you would get significant distortions in the faces and bodies.
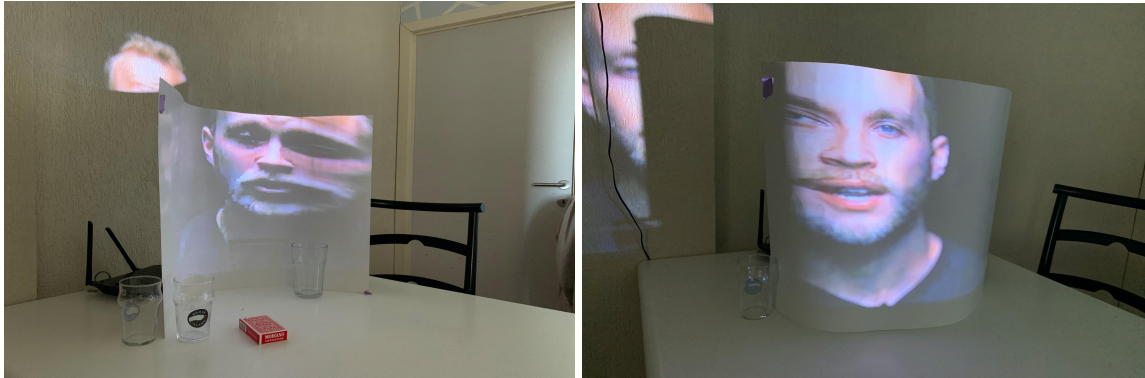

Figure 3: Distortions caused by small projection angles

Limitations
- Because no semi transparent material was available the projecting was done from the front of the screen, instead of from the back as was intended in the concept.
- There was no short throw beamer used in this experiment, possibly influencing the way the face is projected on the curved surface.
- The selective gaze effect was not used in an actual conversation or meeting, leaving the effects on group dynamics unknown.

Learnings
- You need a projector with a short throw
    - Otherwise the distance to the projection surface needs to be large
- You need a projector with high nits, so it is bright in daylight.
- You need a silent projector, the fan in this one made quite some noise, which can be distracting in a meeting.
- The brighter the beamer, the more the fans have to blow to compensate for the heat. This could make the combination of a bright and silent beamer difficult.

Appendix 16.14: Concept criteria scores

The scores given to each concept are explained here.

Concept 1 scores
Startup potential
Competitive advantage
Concept 1 offers low startup potential because of the low newness factor. A conference room setup with screens like these is new, but the product itself only exists out of a rotated monitor and a mobile screen stand. This product would not be patentable and result in a low competitive advantage. Also producing monitors requires too many resources and expertise, which are not present in a startup.

The full user experience around the product, including the placement, software, connecting hardware etc. would offer some opportunity to set yourself apart from the competition.

Resources
The core of concept 1 is the monitor. Manufacturing monitors yourself requires many resources and expertise, and the low batch size in the beginning will result in a high cost price. Buying monitors and leasing them would mean the startup is a service company and does not create its own products.

Competition
With the monitor as the core of the product's value all monitor manufacturers can be seen as competitors. Microsoft, Samsung, LG would all be able to bring a similar product to the market, especially the ones that offer video conferencing software next to their hardware products (including screens), such as Microsoft, Google and Cisco. Their access to resources and users would make this market hard to compete in.

Future plans
While the monitor itself does not offer great possibilities for innovation, the system and interaction around it does. The camera that allows the remote participants to see their in-office colleagues, the speakers that spread their input, the automatic participant distribution over the screens in the room all offer chances for improvement. The experience supported by this technology can also expand beyond the office context. The monitor allows for natural remote interaction in all industries, for example in e-health.
"The healthcare sector is also going to see a rising trend in video conferencing usage, with the term 'telemedicine' becoming more widely used in the healthcare market." (Keegan, 2020)

Scalable
The product is relatively easy to scale. The necessary components are the monitor, stand, camera and system connector. Scaling the company would only mean scaling up the amount of components. Because the total product is quite large, scaling the distribution could be challenging.

Natural
The product allows for natural interaction because the remote participant has a life-sized, seamingly full-body representation. Almost all non verbal communication can easily be recognized by the people in the office. This effect has been validated through some quick experimentation, where the screen was used in an informal group conversation. The full description can be found in Appendix 16.10.

Effective
The earlier experiment with the game "The Mind" showed the effectiveness of the non verbal information transfer. The full description of the experiment can be found in Appendix 16.11. Since the

goal is empowering the online participant this is achieved by the concept. The biggest limitation is the 2D nature of the interaction, leaving out some crucial dimensions in communication.

Affordable

The consumer price indication for concept 1 is €1000 - €2000. This price is derived from the price of a tv screen, a movable tv stand and webcam. The range depends on the quality of the screen, and what type of webcam is used (standard or 180 degree panoramic). The product is aimed at meetings with 4-10 participants. If half of the participants join remotely this would come down to an investment of €5000. This is similar to the price range of other products with the same Job To Be Done, such as tv screens, beamers and collaboration screens as seen in Appendix 16.25. And the goal of offering a more affordable and rich communication as concluded from that same Appendix is also met. The affordability score given is 3.

Concept 2 scores

Startup potential

Competitive advantage

The technology used in concept 2 is new and most likely patentable. Companies and researchers have been developing methods to achieve eye contact through video conferencing, without significant successes (often complex technology, large setups or high costs). This technology is based on artificial eye contact, which has not yet been tried or commercialized. A patent is one of the strongest ways to achieve competitive advantage.

Resources

The development of the product requires some basic hardware, combined with eye tracking software and a small embodiment. Such a product is doable to develop and manufacture with startup resources.

Competition

Because no companies have been successful yet in conveying eye contact in a simple and affordable way there are no direct competitors yet. This would result in a first mover advantage. If the product is successful other competitors in the video conferencing hardware could start developing similar products.

Future plans

If the technology is effective, its compact size would make it easy to combine with other video conferencing equipment, such as conference cameras and speakers. This offers the opportunity to grow into more video conferencing equipment categories. Another option would be an acquisition of a large equipment manufacturer, allowing them to integrate the technology in their products and bringing its value to the masses.

Scalable

The product is small and cheap to manufacture, making it easy to scale up production and distribution. Hardware products are less scalable than software, but since all concepts are hardware products concept 2 is most scalable.

Natural

The product creates artificial eye contact and gaze, making it less natural than face-to-face interaction. The first experiments show that the product does not draw much attention and energy, but is effective in conveying the feeling of being looked at. This shows the product itself is not human-like, but the effect is.

Effective

As described above the simulated gaze is effective, it evokes a similar effect to real eye contact. The earlier experiment in which this was tested is described in Appendix 16.12. The effect does not create a remote presence equal to that of in-office participants, but it does add a new dimension to the hybrid interaction.

Affordable

The estimated consumer price for this product is €100. This is derived from the price of a Ring doorbell, a product with similar tech components.

Concept 3 scores

Startup potential

Competitive advantage

The system with a rotating projector steered by eye tracking data can probably be patented. This allows for a solid competitive advantage as a startup.

Resources

The development and manufacturing of a projector system requires specific knowledge and resources, which are hard to aquire for a startup. The product also requires a custom curved projection screen, but this will be easier to manufacture.

Competition

The core principles of the product are the eye tracking software, and the projector. Companies that manufacture projectors, such as Optoma, Epson and Benq can thus be seen as competitors.

Future plans

This concept offers a complete package of tools to empower online participants in a hybrid meeting. Their visual presence increases, but their group dynamics capabilities do too. The completeness of this product allows it to make a large impact on the market of hybrid video conferencing. Like concept 1 this product could also grow into other markets like e-health.

Scalable

Scaling up the product means scaling up the amount of components, such as the projector and the screen. The curved screen is a custom component, meaning the manufacturing has to be increased. The curved screen is a large component, but in the design of the part it can be made sure it can be distributed as a small part (projection screen can be rolled up, frame can be disassembled).

Natural

The natural interaction created by a life sized and body language view is already validated with experimentation for concept 1. The visualization of the gaze direction is however more natural, because it does not require any artificial representations. This effect has been tested and was found to be pleasant. The full experiment can be found in Appendix 16.13.

Effective

The effectiveness of the gaze direction is proven by the experiment from Appendix 16.13 too. When the projector was rotated towards you as a participant it did give you the feeling of being addressed.

Affordable

The product has an estimated retail price of €2000 - €4000. The projector needs to have a short throw, meaning it can be close to the projection screen, and a high brightness, because most meeting rooms are bright environments. Projectors with these kinds of properties have a price range of €500 - €5000. Additionally a motorized rotating mount for the beamer makes for an expensive component.

Appendix 16.15: Selective gaze experiment

Research question
- How do people experience a gaze direction indicator during a speech?

Method
To test the effects of communicating the gaze direction of the person on the screen a simple prototype was built. The prototype consisted of three LEDs, each representing a direction (left, right, center). The LEDs were connected to an Arduino Uno, running a program that turned each LED on individually in a random order, and for a random duration. This way the flexible and unpredictable expression of gaze was simulated. This prototype was placed on a laptop screen, where a video of a person talking to the camera was played. Three participants sat down around the table and watched the video. They received a short verbal explanation from the researcher explaining that the LEDs show who the speaker is looking at. At the end of the video the participants were asked to explain their experiences.
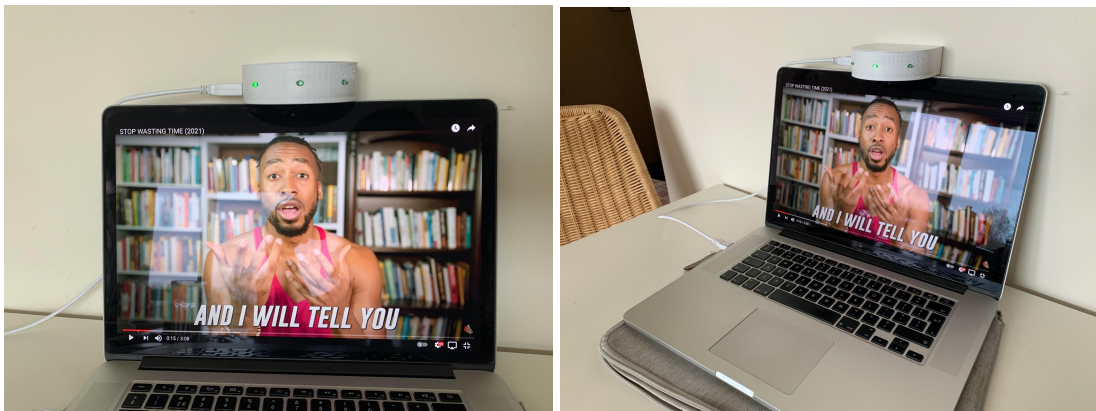

Figure 1: The prototype

Figure 2: The setup

Results
It gives you the feeling of being spoken to, especially when it is combined with verbal cues such as "you".

Learnings
- The indicator triggers a feeling of being addressed, and increased self awareness.
- The led is small, so sometimes you miss that you were being looked at
  - It should be a bit more visual, so you can receive the information while looking at the person on the screen.
- Selective gaze has its added value in group dynamics and turn taking, so you need a responsive version of this prototype in order to test that. Use 3 press buttons to trigger the three directions and test in a meeting setting.

Limitations
- The experiment used a one-way interaction, it does not reveal the value of the product in group dynamics.
- The speaker looks straight into the camera, which does not give you the impression he is looking at multiple people on his screen.

The participants were aware that the direction on the indicator was not real, which influences the intensity of the triggered effects.

Testing the impact of the gaze direction indicator in a group discussion

1. Introduction
Eye contact is the most important factor in communication, contributing to information such as attention and emotion and the turn taking dynamics in multi person conversation. With online attendees joining the conversation through video calling software, the directional properties of eye contact and gaze disappear. With the gaze direction indicator this 3 dimensional effect is brought back to the information flow. Does this improve aspects such as attention and turn taking in a hybrid meeting? This will be tested in this research.

2. Research question
- What is the effect of the gaze direction indicator on turn taking?
- What is the effect of the gaze direction indicator on attention and inclusion?
- How do users experience the product?

3. Method
3.1 Participants
The participants are all students from the TU Delft, aged between 23 and 29. This group was chosen because of the accessibility of the participants. If the results of the research are positive the next group of participants will be employees in a real company.

For this research there were 8 participants in total, divided over 2 sessions with 3 in the in-office group, 1 online. In the first session the remote participant role was performed by a random attendee. It was later decided to let the researcher himself take this role, which was done in the second session, because it turned out the task of constantly updating your gaze direction with the controller was challenging and thus often forgotten. The researcher made sure the gaze direction communicated to the in-office group was accurate at all times.

3.2 Stimuli
Since the prototype of the product is not connected to the internet yet the online participant was present in the same room as the rest, but separated with a large screen to prevent any type of direct communication. (See figure 1). A zoom meeting was set up between the two groups with two laptops, one for each side of the meeting. The Zoom meeting was used for the video communication, not for audio. The microphones and speakers were turned off to prevent acoustic feedback. The two groups could hear each other well because they were in the same room.

Figure 1. The two separated sides

To stimulate a conversation between the participant a discussion topic was shortly presented. In the week of this test news about NeuraLink, a company from Elon Musk, hit the news. A monkey, implanted with the brain chip, was playing the famous game 'pong' with just his brain as a controller. The conversation was about what market or users could benefit most from this technology.

The gaze direction indicator was mounted on top of the laptop screen on the office side. The online participant received the controller for the indicator. Turning the knob to the left would result in the left led turning on, and the same goes for the other 2 directions (straight and right). (See figure 2).
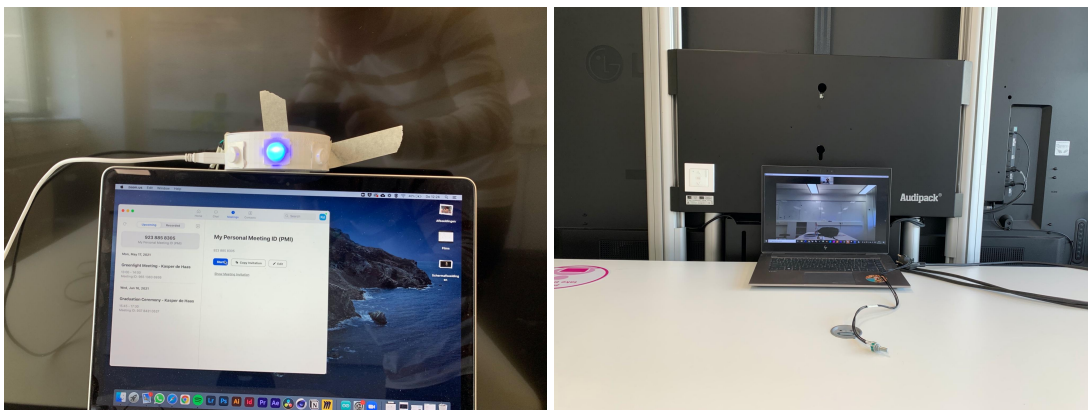

Figure 2. Gaze direction indicator

In the first session the remote participant was displayed on the laptop screen, and in the second on the large tv screen. (See figure 3).
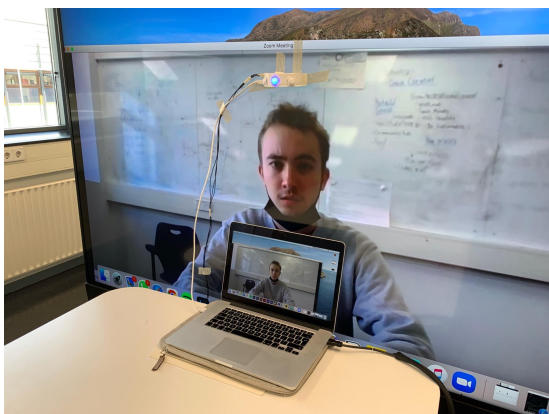
Figure 3. Remote participant representation (session 1: laptop only, session 2: big screen)

3.3 Apparatus
Laptop: to display the remote participant (first session)
Large TV screen: to display the remote participant life sized (second session)
Zoom: to record the meeting from an online point of view.
iPhone: to film the meeting on the in-office side, and to record audio from the discussion at the end.

3.4 Procedure
At the beginning of the session the discussion topic was verbally explained by the researcher. The controller for the prototype was explained to the participant with the remote role.

The discussion would go on for about 15 minutes. This would create enough time for the participants to get some experience with the prototype. After the conversation all participants were asked to express their experience and thoughts about the product in a group discussion. This way they could both express their own opinions, and build on that of others. Because eye contact mainly triggers unconscious processes and feelings the remarks of one participant frequently triggered new feedback from the others.

3.5 Measures
The audio recording from the discussion at the end was used to document all experiences and feedback.

3.6 Observations
The video recording of the office side was analyzed to gain insights on the effect of the gaze direction indicator on group dynamics and turn taking.

4. Results
4.1 Observations
- When the gaze direction indicator was aimed at the participant at the left side, she would nod and smile, possibly because she was aware she was being looked at.

4.2 Group discussion

Session 1
- Participants did not pay a lot of attention to the leds.
- The operator of the prototype frequently forgot to update the gaze direction.
- There was a mismatch between the gaze direction on the product and the gaze direction of the eyes on the screen.
- The online participant found it hard to interrupt and felt disconnected.
- The online participant does not experience any changes.
- Attention demanding LEDs

Session 2
- The participants found it nice to know who the remote participant was speaking to.
- Product as a tool for handing out turns.
- Simulated presenter behavior by the product.
- High awareness of gaze direction for the user of the product.
- Attention demanding LEDs.
- Better virtual attendance.
- Slightly larger than life-sized attendance is intimidating.
- No clear preference for one of the solutions

5. Discussion

Session 1
- Participants did not pay a lot of attention to the leds.
    - This could be because the information of the gaze direction is mainly processed unconsciously, or because the information was not very valuable in the interaction.
- The operator of the prototype frequently forgot to update the gaze direction.
    - Afterwards he noted that he would just change the direction to whoever was speaking, and leave it there disregarding where he was actually looking. It turned out to be hard to participate in the conversation and stay aware of what you are looking at simultaneously. This does however significantly impact the outcome of this session. The in-office participants said it was confusing when the gaze direction on the product did not match the direction of who was speaking.
    - One participant said "Sometimes I was speaking and the light would not point in my direction, which made me think he either forgot to change the direction or is in fact not paying attention to what I was saying."
        - This shows the information of where the online participant is looking at does in fact affect the in-office participants. The direction was often not accurate, but it did create doubts about whether the remote participant was paying attention. The information transfer is proven to be successful.
    - As mentioned before because of this a second session was done where the researcher would control the prototype, making sure the gaze direction on the product is accurate and frequently updated.
- There was a mismatch between the gaze direction on the product and the gaze direction of the eyes on the screen.
    - The left led would turn on, but his eyes were still centered, causing confusion with the in-office participants. This is because the participants are close to each other on

the screen, causing the different gaze directions of the actual eyes to differ only slightly.

- The online participant found it hard to interrupt and felt disconnected.
    - Even though the online person was in the same room and there was no delay in the communication, he found it hard to interrupt and felt disconnected.
    - It was hard to interrupt because of 'stage fright'. Normally when you make eye contact with someone when you speak, you don't see where the others are looking. But when you start speaking as a remote participant, you see all the heads turning your way, and all the eyes looking at you.
        - Filtering some information might make it easier to interrupt.
    - When the remote participant spoke, to him it felt like he was interrupting the conversation on the other side.
- The online participant does not experience any changes.
    - The online participant said this product did not change anything for him. He did not feel like he could do more, like responding to a specific person, and he could not see the effect of the product in the office. Because there was no direct feedback from the product to him he did not experience any benefits.
- Attention demanding LEDs
    - One participant said when the person on the screen would say something she would look at the led first, before looking at his face on the screen. If the camera is incorporated in the product this would cause pure eye contact at the beginning of the turn of the online participant. Based on the research that showed better eye contact increases the feeling of involvement this would mean the leds could create the same effect.

Session 2
- The participants found it nice to know who the remote participant was speaking to.
    - If a question was asked to one person, the others would know it was not expected from them to say something. This gave them a feeling of relaxation and confirmation (no confusion about who has to answer).
    - One participant said she has had hybrid meetings before where it was unclear who the online participant was speaking to. This product would solve that problem for her.
- Product as a tool for handing out turns.
    - Because the researcher played the remote role the in-office participants felt a bit like he was the leader of the conversation. The gaze direction turned out to be a powerful tool in handing out turns.
    - This proves the effectiveness of simulating eye contact and its functions in multi person conversation. As discussed in the report eye contact plays a large role in turn taking, which can thus successfully be done with this technology.
- Simulated presenter behavior by the product.
    - When the online participant was talking to all in-office participants at once, and shortly looked at every one of them, this simulated the behavior of someone who is giving a presentation to an audience according to the participants. A speaker who wants to include the whole audience usually shows similar gaze behavior. The fact that the product creates the same experience for the audience proves the correct simulation of human gaze direction.

- High awareness of gaze direction for the user of the product.
    - One in-office participant said if she was a remote attendee using the product she would probably become very aware of where she is looking, knowing everyone in the room can see it. She would prefer to switch the product off when she is just listening, and back on when she wants to speak.
- Attention demanding LEDs.
    - One participant said she was paying a lot of attention to the led's, so maybe they have to be more subtle.
- Better virtual attendance.
    - The life sized screen gave the in-office participants the impression of the online participant sitting at the table.
- Slightly larger than life-sized attendance is intimidating.
    - The view turned out to be slightly larger than life-sized, which gave one participant an intimidating feeling. This was also caused by the large black screen around the representation of the participant. The screen was a dominant object sitting at the table.
- No clear preference for one of the solutions
    - If they had to choose between the two solutions (screen and gaze direction) one participant would prefer the life sized view and another would prefer the gaze direction.

Appendix 16.17: Existing indicator research

When designing the indicator and deciding the components, existing indicators were analyzed to understand how this is frequently done. Insights such as components, configurations, materials and placement can be gathered from this.

Google Home

Google home is known for the three white dots shining through the mesh material. Teardown videos of the product reveal that three LEDs with small diffuser caps are used.

Figure 1: Google home teardown (DD ElectroTech, 2018)

Apple Homepod

Another smart speaker, the Apple Homepod, uses an indicator that is similar to the desired gaze direction indicator. Product teardowns show small LEDs placed in a circle are at the core of this, what some thought was an LCD screen. A plastic diffuser placed over the LEDs blends the light and colors, and finally plastic covers up these components to create an aesthetic whole.

Figure 2: Apple homepod teardown (iFixit, 2021)

Audi Matrix LED headlights

In the latest cars of Audi and Mercedes a new headlight technology is included, called Matrix LED headlights. With this certain animations can be projected on a wall or on the road, and allows the car to shine light on specific parts of the road. It does this by using a "small chip with around one million micromirrors".

Figure 3: Audi Matrix LED headlights (Audi, 2021)

Car door logo projector

In many modern day cars the car's logo is projected on the ground when opening the door. The component at the bottom of the door creating this image exists of a LED with a combination of small lenses. The beam created by the lenses goes through a small foil with the logo printed on it, making this visible on the projected surface.
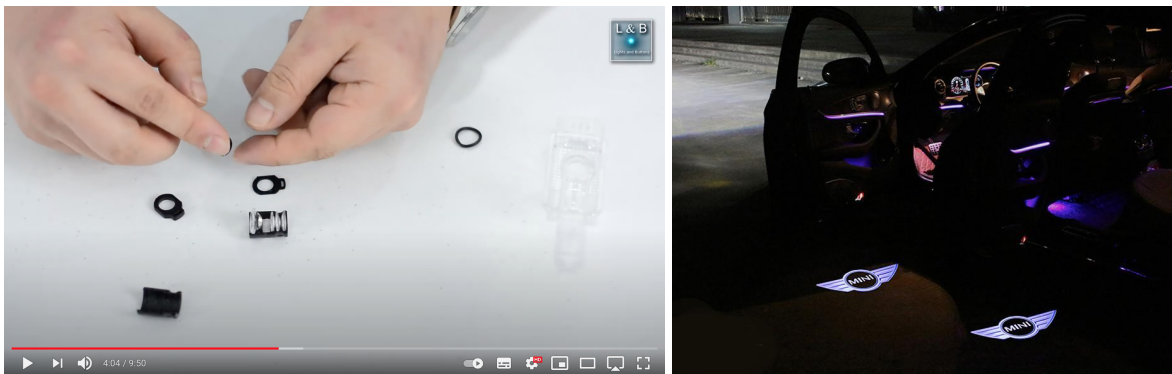

Figure 4: Components inside a car door projector (Lights and Buttons, 2019)

Appendix 16.18: Indicator component research

Mechanical
Some mechanical options are:

Indicator to motor
The indicator can be directly connected to a stepper motor. This creates a centralized lightsource. A stepper motor can accurately control its rotation, namely in steps of just 1.8 degrees ("Stepper Motor", 2021).

Figure 1: Stepper motor

Gear configurations
Different gear configurations offer different possibilities for the range of motion of the indicator. The gear ratios influence the speed the indicator can be moved with.
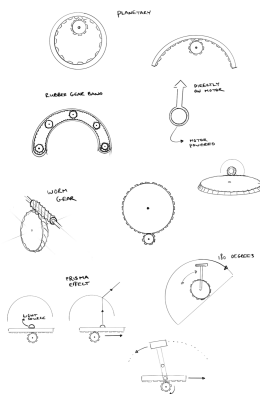

Figure 2: Gear configurations

Mirror to motor
By connecting a small mirror to the motor the light source itself does not have to move. By rotating the mirror the light beam can be reflected into different directions. This principle, called Galvo mirrors, is used in light shows and SLA 3D printers.

Figure 3: Galvo mirror

Optical

Some optical system options are:

Single LED

A single LED is available in different types, colors and brightness. Some can only emit white light, while others can do a RGB spectrum.

LED strip

A LED strip is a collection of LEDs connected to each other to form one, often flexible, component. The strips can have one or multiple rows. There are two main types of strips: SMD5050 and WS2812B. The first is the simple version, the second enables all LEDs to be individually controlled (MUO, 2020).
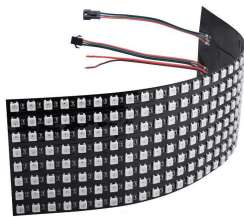

Figure 4: LED strip

LED jewel

A small collection of LEDs in a circular configuration is what Adafruit calls LED jewels. This configuration gives the shape that is ideal for the eye representative, and a similar configuration is also used in the Apple Homepod.
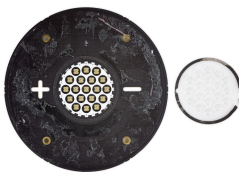

Figure 5: Apple Homepod LEDs

Laser

A laser, which is short for "light amplification by stimulated emission of radiation" ("Laser", 2021) is a system that uses optical amplification to create a narrow and powerful light beam. Such a narrow light beam can be advantageous for an indicator but since a laser can damage the eyes, and the indicator in this product is made to point at faces, it cannot be used.

Figure 6: Laser

Beam control

The LED itself can be used in different ways, standalone or with tools. Tools such as reflectors and lenses create different effects on the light being emitted. Some of these tools are shortly discussed below.

Reflectors

Reflectors are a cheap method for controlling the light from an LED. The different shapes and finishes create different lighting effects. The reflectors are made of plastic with a metal coating. They are more affordable than lenses, but offer less control over the beam (RS Components, 2021).
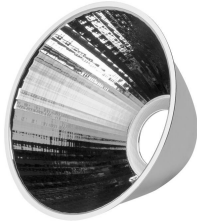

Figure 7: Reflector

Lenses

Lenses are solid shapes made from plastic, silicone or glass manipulating the behavior of light. A convex lens enables a lightsource to be transformed into a converged beam, while a concave lens does the exact opposite (RS Components, 2021). Combinations of lenses can be made to create the ideal beam. A Fresnel lens, often found in lighthouses, is a lens type where the amount of material used is minimised by getting rid of the excess material while maintaining the curve of the lens ("Fresnel Lens", 2021).

Figure 8: Fresnel lens

Diffuser

A diffuser is a semi transparent material that diffuses the light that is coming through. This turns the concentrated brightness of an LED and spreads it out over a larger surface. This effect can be seen on the Apple Homepod mentioned before.

Appendix 16.19: Indicator system prototypes

System 1:
This system needs a powerful and narrow beam of light that is created in the center of the product. By rotating this light source with a stepper motor the light beam can be aimed in different directions. To test the effect of a LED convex lens a quick prototype was built. A LED 18 degree spot lens was used in the prototype. As seen in figure 1 the lens does create a spot light, but this is not narrow enough to create a defined dot on the outside of the housing.

Figure1: LED through convex lens in light and dark environment

In figure 2 the dot on the outside of the housing can be seen for three different distances: 10mm, 20mm and 30mm, through PLA with a 0.7mm thickness. This showed that the light source needs to be close to the embodiment to create a sufficient indicator.
A brighter LED can be used when the distance to the wall is increased, but higher brightness comes with more generated heat. To distribute this heat a heat sink is needed, which adds extra costs and complexity.

Figure 2: 0.7 mm PLA with different distances to the led (left to right: 10mm, 20mm, 30mm)

Figure 3: The 18 degree spot lens for LEDs

System 2:
The second system uses a WS2812B LED strip, which has LEDs that can be individually addressed and can show different RGB colors. The LED animation of going from left to right was effective in communicating directions, and the brightness was sufficient for creating a dot on the other side of the material. In figure 5 different PLA material thicknesses were tested (0.7mm, 1mm, 2mm, 3mm) with the LED being placed directly behind it. A thickness of 0.7mm is advised when light needs to go through (Shapeways, 2016) and shows the brightest and most defined dot in the test. A thickness of 1mm is also acceptable, but higher thicknesses absorb too much light.
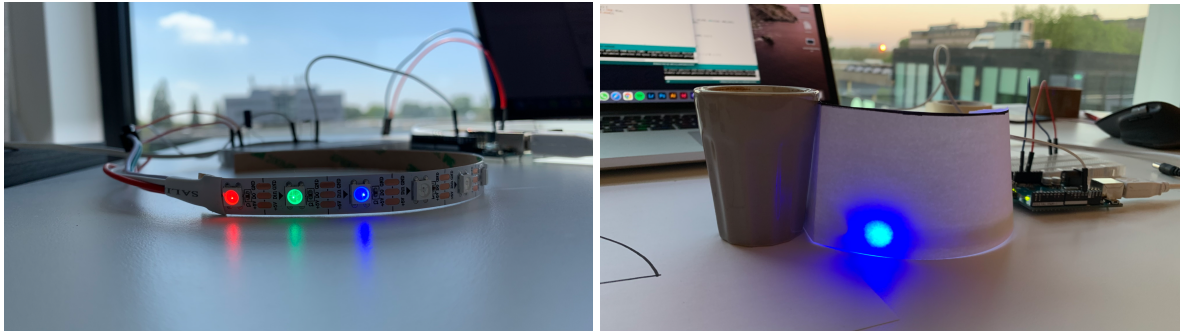

Figure 4: LED strip animation through paper

Figure 5: LED through different PLA thicknesses (left to right: 0.7mm, 1mm, 2mm, 3mm)
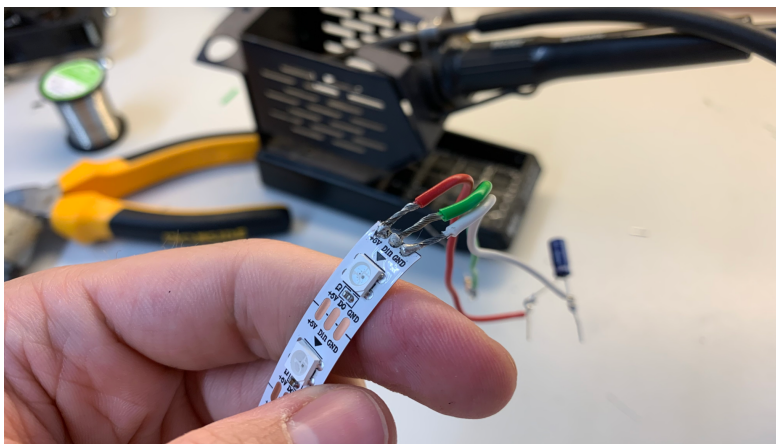
Figure 6: Soldering the LED strip

System 3:
System 3 uses a rotating indicator with a LED jewel (circle configuration) directly behind it. Different LED types were used for this prototype so they could be placed in a circle formation. Eventually they should also be WS2812B LEDs.
Rotating the indicator around its center was able to communicate a direction, but was experienced as less dynamic.

Figure 7: LED jewel with 1mm PLA (left: directly behind it. right: 10mm distance)

Figure 8: Rotating indicator disk

Appendix 16.20: Moodboard embodiment design

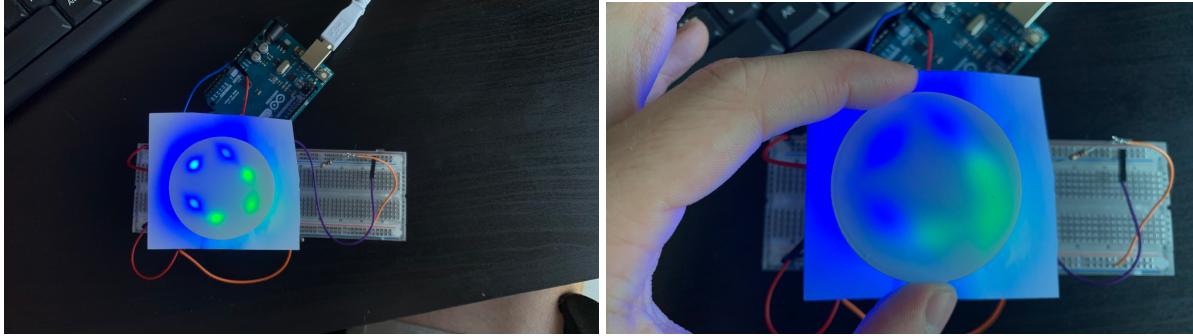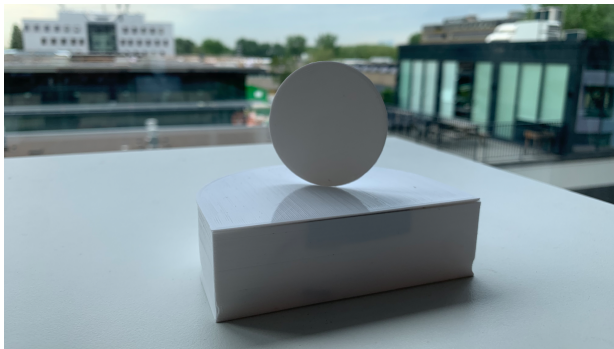## Appendix 16.21: Followup research

Is the indicator accurate enough?
Since the indicator is one of the most crucial parts of the product it has to work flawlessly. The eye contact simulation should be able to create a one-on-one connection with someone in the room. The accuracy of the indicator in different conference rooms and different configurations of people around the table should be tested. When does someone feel like establishing eye contact, and when does it become clear the person next to you is being looked at?

What do different visual indicators do with the perception of the remote participant?
Different colors, speeds of movement and micro animations can have an effect on the visual perception of the indicator. Different indicator behaviors and color combinations could be tested with groups of users to see what they think about them.

How to nudge attention to online participants?
In the research from Appendix 16.16 it was found that the test person playing the role of remote participant in the meeting, while physically being present in the room, still felt excluded and found it hard to interrupt. Since eye contact has been proven to play a large role in the feeling of involvement (research from Appendix 16.8) and turn taking (chapter 6) it could be effective when the product uses the theory of nudging to increase the amount of eye contact towards the online attendee.

Can we create more nuance in turn taking?
In the research from Appendix 16.7.1 the participants talked about the lack of nuance in the interruptions of online participants. Every time they started speaking it was experienced as a hard transition, breaking the conversational flow. Since the indicator on the product only turns on when an online user is speaking, turning it on right before the interruption starts could function as an interruption indicator. Chapter 6 already revealed that an interruption starts before the current speaker is finished talking, so showing an online person is about to start talking while someone in the office is still speaking would match face-to-face conversational behaviors.

Should the technology be implemented in a conference camera?
If the product has an integrated webcam this could result in a better experience for the remote users. In the research from Appendix 16.16 it was found that in-office participants often looked at the indicator first, before looking at the eyes on the screen, when an online attendee started speaking. Earlier research, from Appendix 16.8, showed that the quality of eye contact is crucial in the feeling of involvement. Quality eye contact means looking directly into the camera. If the product also functions as the webcam, and in-office people tend to frequently look at the indicator, this could mean the quality of eye contact towards the remote people increases, together with their feeling of involvement.

Appendix 16.22: Cost price calculation sheets

Opbouw van de fabricagekostprijs van een compleet product (vgl. Kals)

Product	Gaze indicator					prijs per product			
In-huis te vervaardi	prijs/stuk	stuks/product	ijs per product						
Product	€ 71,84	1	€ 71,84						
			€ 71,84	totaal vervaardiging		€ 71,84		Source	
Inkopen	prijs/eenheid	eenheid	nheid/product	ijs per product					
Wifi chip	€ 1,000		1	€ 1,00				https://www.alibaba.com/pro	
Microcontroller	€ 1,000		1	€ 1,00				https://www.alibaba.com/pro	
WS2812B LED	€ 0,050	eur/m^2	81	€ 4,05				https://www.alibaba.com/pro	
Power cable	€ 1,000		1	€ 1,00				https://www.alibaba.com/pro	
Printplaat	€ 40,000	eur/m^2	0,0008	€ 0,03					
Schroefjes	€ 0,050		3	€ 0,15					
			1	€ 0,00					
Eye tracking dev	€ 26.010,000	in totaal	0,0001333333	€ 3,47					
				€ 0,00					
			1	€ 0,00					
				€ 10,70	totaal inkoop	€ 10,70			
Assemblagekosten		assemblageserie	7.500						
	capaciteit	machineuren	uurtarief						
montagestation	80	93,75	€ 43,33	€ 4.062,19					
ellen montagestation	nvt	10,00	€ 43,33	€ 433,30					
handmontageplek	200	37,50	€ 2,50	€ 93,75					
verpakken	360	20,83	€ 2,00	€ 41,67					
			totaal machinekosten	€ 4.630,90					
machines als	mens/machin	arbeidsuren	uurtarief	arbeidskoste					
montagestation	1	93,75	€ 25,00	€ 2.343,75					
ellen montagestation	1	10,00	€ 30,00	€ 300,00					
handmontageplek	2	75,00	€ 19,30	€ 1.447,50					
verpakken	1	20,83	€ 19,30	€ 402,08					
			totaal arbeidskosten	€ 4.493,33					

				totaal assemblagekosten	€ 9.124,24	€ 1,22			
Kft Productiekostprijs geassembleerd product voor interne calculatie				**Productiekostprijs Gaze indicator**	**€ 83,75**				

Opbouw van de fabricagekostprijs van een compleet product (vgl. Kals opgave 15.3)

Benaming	Gaze indicator		Productieserie	7.500	stuks	per onderdeel

Materiaalkosten	bruto hoeveelheid/product		eenheid	prijs/eenheid	bedrag	
halffabrikaat	ABS	0,0933	kg	€ 1.00	€ 0.09	
					€ 0.00	
			totaal materiaalkosten		€ 0.09	€ 0.0933

Bewerkingskosten	capaciteit [stuks/u]	machineuren	machine-uurtarief	machine-kosten		
IMD spuitgieten	380	19,74	€ 20.0000	€ 394.74		
IMD spuitgieten	400	2500,00	€ 20.0000	€ 50.000.00		
IMD spuitgieten	360		€ 20.0000	€ 0.00		
Compact Spuitgieten	2160		€ 15.0000	€ 0.00		
			totaal machinekosten	€ 50.394.74	€ 6.72	

machines als bovenstaand	mens/machine-bezetting	arbeidsuren	mensuurtarief	arbeidskosten		
IMD spuitgieten	0,25	4,93	€ 19.3000	€ 95.23		
IMD spuitgieten	0,25	625,00	€ 19.3000	€ 12.062.50		
IMD spuitgieten	0,25	0,00	€ 19.3000	€ 0.00		
Compact Spuitgieten	0,1666666667	0,00	€ 19.3000	€ 0.00		
			totaal arbeidskosten	€ 12.157.73		
			totaal bewerkingskosten	€ 62.552.47	€ 8.34	

Instelkosten serie	insteltijd [u]	uurtarief insteller	mach.	kosten	per	
IMD spuitgieten	10	€ 19.3000	€ 20.0000	€ 393.00	€ 0.0524	
IMD spuitgieten	10	€ 19,3000	€ 20,0000	€ 393,00	€ 0,0524	
IMD spuitgieten		€ 19,3000	€ 20,0000	€ 0,00	€ 0,0000	
Compact Spuitgieten		€ 19,3000	€ 15,0000	€ 0,00	€ 0,0000	
					€ 0.10	

Gereedschapskosten	aanschafprijs	standtijd [stuks]	restwaarde	prijs/eenheid		
matrijs behuizing onder	€ 45.000	1.300.000	€ 0.00	€ 6.00		
matrijs behuizing boven	€ 45.000	1.300.000	€ 0.00	€ 6.00		
matrijs behuizing voorkant	€ 45.000	1.300.000	€ 0.00	€ 6.00		
		1.300.000		€ 0,00		
subtotalen	€ 135.000		€ 0.00			
gemiddelde waarde	€ 67.500					
kapitaalrente	0,0%	rentekosten	€ 0.00	€ 0.00		

			totaal gereedschapskosten	€ 18.00	€ 18.00		
Algemene toeslagen							
uitval-factor*	1,0%	*afgekeurde producten, zie Kals voor percentage	**subtotaal**		€ 33.26		
overheadfactor**	15,0%	** algemene toeslag voor productiefaciliteiten					
totaal	**16,0%**				€ 5.32		
		KFi voor interne calculatie:	**Productiekostprijs Gaze indicator**		**€ 71,84**		

Opbouw van de investeringen benodigd voor een compleet product (Thomassen)			
NB Deze investeringen zitten al in de prijs van het product verwerkt, maar moeten toch apart benoemd worden.			
Uitwerken ontwerp / verpakking / …	uren	tarief euro/u	bedrag
	766,5	60,00	€ 45.990
Ontwikkelen gereedschappen	uren	tarief euro/u	bedrag
	16	40,00	€ 640
Aanschaf gereedschappen (per onderdeel, ui	Onderdeel	gereedschap	prijs
	Behuizing boven	matrijs	€ 45.000
	Behuizing onder	matrijs	€ 45.000
			€ 45.000
Aanschaf speciale machine			€ 0
			€ 0
Aanpassingen in productieinrichting / assem	instellen montagestation	arbeid	€ 300
	instellen montagestation	machine	€ 433
Werkvoorraad inkopen			
	Totaal investeringen	Gaze indicator	€ 182.364

	Voorbeeldberekening voor de winkelprijs op basis van de fabricagekostprijs (bron: Erik Thomassen).						
KFt	Productiekostprijs geassembleerd product voor interne calculatie:	Gaze indica	€ 83,75				
FOB	Overheadfactor voor algemene bedrijfskosten* (ontwerpkosten: €45.990, totaal	15%	€ 8,00				
FOV	Overhead factor voor verkoopkosten	5%					
FW	Winstfactor (onvoorziene kosten worden a.h.w. uit de winst betaald)	50%		Winst in €		€ 41,88	
	Totaalfactor = product van (elk van deze factoren+1) min 1	81,1%	€ 67,94				
KV	Verkoopprijs af-fabriek (moet je betalen als je product bij de fabriek zelf ophaalt)		€ 159,70				
	Marge tussenhandel (bijvoorbeeld: importeur, groothandel, leverancier, distribut	30,0%	€ 47,91				
	Groothandelsverkoopprijs		€ 207,61				
	Marge detailhandel (winkel) is zeer branche- en aanbiedingsafhankelijk, ligt tussen 25% voor een webshop en 300% voor een servicegerichte detaillist in een mooi pand op een A-locatie. Strategie met oog op concurrentie bepaalt de marge.	25,0%	€ 51,90				
	Netto verkoopprijs (exclusief BTW)		€ 259,51				
	BTW (= Belasting op de toegevoegde waarde, = omzetbelasting)**	21,0%	€ 54,50				
	Verkoopadviesprijs, normale winkelprijs		**€ 314,01**				
	*) Voordat iets geproduceerd wordt, moet er doorgaans van alles gedaan zijn: niet alleen het ontwerpproces, maar ook bijvoorbeeld prototyping in meerder stadia, gebruiksonderzoek, marktontwikkeling, certificering, octrooiaanvragen en dergelijke. Als dit allemaal in de productprijs verdisconteerd moet worden, kan deze aardig oplopen.						
	**) hoog tarief = 21%, laag tarief =6% (voeding, boeken), soms ook nog heffingen zoals bijvoorbeeld de wettelijke verwijderingsbijdrage.						

Appendix 16.23: List of Requirements

The list of requirements states all requirements that the product should meet. Now that the product has been developed into a conceptual state (not production ready), it can be scored on some of the criteria matching this stage.

Because the product is in an early development phase most requirements are not numerical and have not been validated yet. As noted in the Delft Design Guide (2014) not all requirements have to be numerical, especially when the product is in an early phase. Since the list of requirements is a living document this is the version containing all findings and information collected until now. Further development of the product will result in additional, and more concrete, requirements and wishes.

1. **Performance**
   1.1. The product has to connect people from different locations in the office ecosystem.
   1.2. The product has to communicate the gaze direction of an online participant to the in-office participants.
   1.3. The product should improve the turn taking process.
   1.4. (Wish) The product should increase the involvement of the online participants in a hybrid meeting.
   1.5. (Wish) The product should enable in-office and remote participants to make more eye contact.
   1.6. (Wish) The product has to improve the quality of eye contact between people in the office and people from remote locations.
   1.7. (Wish) The product should enable a natural interaction.
   1.8. (Wish) The product should let online participants take turns in the meeting without interrupting the conversational flow.
   1.9. (Wish) The product should not limit the communicative behavior of in-office participants.

2. **In-office product use**
   2.1. The product has to be used in the conference room.
   2.2. The product should support hybrid interaction in meetings with 2 - 8 people, with a maximum of 4 online participants.
   2.3. (Wish) The product should also support different meeting sizes and configurations.
   2.4. The product has to be compatible with existing video conferencing software.
   2.5. The product should be a USB video conferencing equipment system.
   2.6. The product should not be bigger than 300 x 150 x 150 mm.
   2.7. The product should take up as little space as possible when not in use.
   2.8. The product has to exist out of one physical unit with all required components integrated in it.
   2.9. The product should not create tripping risks in the conference room because of power cords.
   2.10. The product should be easy to connect to a power source in all conference rooms.
   2.11. The product should take less than 10 seconds to prepare for a hybrid meeting, when it is already installed in the conference room.

3. **Rules & Regulations**
   3.1. The product should use a secure server.
   3.2. The product should have a CE marking.
   3.3. The product should pass a PIA test.

4.   Remote product use

4.1.   The product requires no physical components in remote locations (for example the home office) other than the preexisting tools.

4.2.   The remote participant should be aware he/she is using the product.

4.3.   Setting up the software component for a hybrid meeting should take less than 30 seconds, when it is already installed on the computer.

4.4.   (Wish) The remote user should have the software installed and product understood before the meeting starts, to prevent him from being late.

4.5.   The gaze direction indicator should not cause confusion in the office when the eyes of the remote user cannot be properly tracked.

5.   Product Lifetime

5.1.   The product should have a product lifetime of at least 3 years, when being used 3 times a day for an hour each.

5.2.   (Wish) The product should be able to do software updates through WiFi.

5.3.   The product should be designed for disassembly.

6.   Business

6.1.   The product should be sold to the company, and used by its employees.

7.   Production & Costs

7.1.   The product should have a retail price of 500 euros at most.

7.2.   The retail price should have a margin of at least 50%.

7.3.   The product should be mass produced.

7.4.   At least 10.000 units should be produced.

7.5.   The hardware components should be off-the-shelf components.

7.5.1.   Except for the PCB, which should be custom manufactured.

7.6.   The manufacturing of the housing should be outsourced.

7.7.   The development of the software should be done in-house.

Testing the effects of the Be There One on involvement and dynamics in a hybrid meeting

1. Introduction
The Be There One is developed to improve the involvement of online attendees in hybrid meetings, while also increasing the overall group dynamics. At this point in the product development it is tested in simulated environments and mostly backed by research papers. By letting the product be used in a real meeting, by a company from the intended target group, the effects of the product can be validated.

2. Research question
-   What effect does the Be There One have on the involvement of an online attendee in a hybrid meeting?
-   What effect does the Be There One have on the group dynamics in a hybrid meeting?
-   What is the market potential of the product based on the experience of this pilot company?

3. Method
3.1 Participants
The participants in the pilot are 4 employees from Delta Capita, a technology consultancy located in Amsterdam. The company has around 300 employees and is one of Europe's 1000 fastest growing companies in 2020 and 2021.

3 Participants will form the in-office group of the meeting, while the 4th participant will join the meeting through Zoom. All 4 pilot participants are present in the office since the current version of the prototype works on WiFi. The "remote" participant will sit in a separate room.

3.2 Stimuli

The meeting during the pilot was an actual meeting that was already planned by the employees. The meeting agenda and slides prepared by them were used to guide the meeting.

The prototype of the Be There One was used to test the effects of the product. The product consists of 2 components: hardware and software. The hardware component was placed on the top of the monitor in the conference room, as seen in figure 1.

The remote meeting attendee used the provided laptop, equipped with the software that informs the product in the conference room what to do.
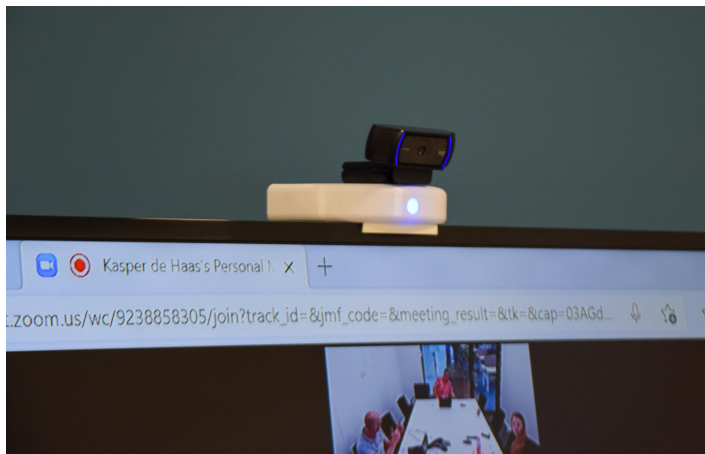
Figure 1: Prototype placed on monitor

3.3 Apparatus

iPad; to take notes during the pilot meeting and record the discussion at the end.
Nikon D3400; to take pictures during the pilot.

3.4 Procedure

Before the pilot started all participants signed an NDA, since the innovation has not been patented yet. After that the product and pilot were verbally explained to all participants.

When the participant with the remote role was seated in a different room the meeting could start. During the meeting the participants were responsible for what they did and talked about.

After the meeting was done the remote participant rejoined the group and a 30 minute discussion was held in order to learn how the product was experienced by the group.

Figure 2: The pilot meeting

3.5 Observations

During the pilot the researcher was present in the conference room. Notes were taken on notable events relating to the hybrid meeting and product.

4. Results

4.1 Observations

The observations made during the meeting are listed below. All results are further discussed in the Discussion.

- The product is hard to use in a meeting with slides
- Indicator turning off is associated with the user closing his eyes
- The volume threshold should be custom to each user
- The current version of the eye tracking is not accurate enough
- Eye tracking should be able to cope with head movement
- The remote participant was sometimes excluded

4.2 Group Discussion

After the pilot the experience with the product was discussed. These are the things they mentioned.

- Improved feeling of connection with the online participant
- Higher involvement for the online participant
- The online participant and his input is perceived the same
- Maintaining eye contact was hard
- Leaving the indicator on when not speaking was beneficial
- The remote participant was sometimes excluded
- No improved eye contact towards the online participant
- Expressed commitment towards purchase

5. Discussion

Observations

<u>The product is hard to use in a meeting with slides</u>
Because slides were shared on the screen the online participant got a full screen view of the presentation. For this product to work the office view has to be full-screen (because of the eye tracking software). In Zoom there is a function that lets you choose which window you want to see full screen, in MS Teams (where this meeting was hosted) this feature is absent. We eventually had to switch to a Zoom meeting because of this. Also, making the office view large, and the slides small, made it impossible for the online user to read the slides.

The meeting was mainly one person walking through certain topics, supported by presentation slides. The presentation slides were shared on the large screen in the conference room. Because of this the online participant was not visible for the larger part of the meeting.

<u>Indicator turning off is associated with the user closing his eyes</u>
When the indicator was off for a while one of the in-office participants said "Can you open your eyes again?". This showed that it felt like the online participant was tuning out when the indicator turned off.

After a while a participant from the office group asked the online participant if he is still with them, and if he can open up his eyes. This was because the online participant had spoken a couple of times without the indicator turning on. When checking it turned out the software had returned an error and had stopped. After relaunching the software this was fixed.

<u>The volume threshold should be custom to each user</u>
The indicator has a volume level threshold to make sure it only turns on when the online user is talking. During the pilot the indicator was on for most of the time, even when the online participant was not speaking. The threshold, as determined and tested during development, turned out to be too low for the noises that this user and his environment made during the meeting.

<u>The current version of the eye tracking is not accurate enough</u>
The indicator was aiming straight forward for the larger part of the meeting. Slight adjustments of the eyes were not registered by the eye tracking software. What this did with the in-office experience is explained in the next part.

When the indicator was moving it was going in the wrong direction most of the time. Sometimes the online participant was speaking and the direction went in the direction of the person he was talking to. So there were enough moments the product worked well that can be used to discuss the experience.

Near the end one in-office participant asked whether the light on his side of the product was working or not, because that direction had barely turned on during the meeting. This might be because the eye tracking had a hard time registering that direction, which can depend on aspects such as lighting, (asymmetric) shape of the face, or position of the head (of the online user).

The indicator kept pointing straight forward while the online participant was clearly looking to the right and left. It turned out the software was loading, after a relaunch the problem was fixed.

Eye tracking should be able to cope with head movement
The online participant moved his head quite a bit when talking, this made it hard for the eye tracking to stay accurate.

Group Discussion

Improved feeling of connection with the online participant
The product added something to the meeting, is the first thing they mentioned after being asked how they experienced it. The in-office participants agreed on feeling more connected to the online participant.

"The fact that you see his "eyes" moving around really adds something"
"You really feel something when he looks at you".

"You associate the product with having a connection with someone", because the participant at the head of the table started feeling uncomfortable when the indicator would point in his direction for a long period of time. (The prototype did this often when the online participant was not speaking.) He said it felt like staring.

Higher involvement for the online participant
The group in the conference room felt more connected and felt like they involved the remote participant more because of that.

The participants realized they would look to the screen more because of the product, to see where the online participant was looking. Looking to the screen more often makes it easier for the online attendee to give input and feel involved.

The online participant and his input is perceived the same
The group did not feel like they experienced the remote participant and his input differently. They just felt more connected to him.

Maintaining eye contact was hard
It was hard to keep making eye contact for a while through the product because it would often move to a different direction soon afterwards.

The 3 possible reasons for this are 1) consciously making short eye contact with multiple people to address them all 2) looking away from the screen when thinking while talking and 3) inaccuracy in the eye tracking software.

The product should not be a replacement of video

The indicator was a very abstract representation of an online meeting attendee, because when the slides were shared on the screen it was the only visible aspect of that person.

It was however an improvement on the standard setup, because even when the slides were shown there was still a visible connection with the online participant. "It prevents you from forgetting that there is another person in the conversation".

The product is also meant to be an addition to the view of a person on the screen, it should not be used as a replacement.

Leaving the indicator on when not speaking was beneficial

The product should not show the indicator when the online user is not speaking, but the prototype sometimes did (unexpectedly). This did give the people in the room the feeling the remote person was listening and paying attention.

One participant even found it unfortunate that the indicator turned off when people in the room were talking. She did not know what the remote attendee was doing at that point. This effect was of course strengthened by the fact that you could not see this person on the screen.

The remote participant was sometimes excluded

After a while the conversation was mainly in the conference room. The product does create more connection with the remote attendee, but still this exclusion of that person happened at some points during the meeting. They admitted that this was also because the online participant was not visible on the screen for the majority of the meeting.

One participant was aware that he turned his back to the screen when a discussion was mainly between the in-office employees. This completely removes all visual attendance of the online person.

With face-to-face-only meetings this also happens, but you move back to a position that is open to everyone sooner. It could be interesting to include and test a subtle reminder in the product that triggers re-involvement of the online attendees.

No improved eye contact towards the online participant

The participant with the remote role noted that the product helped strengthen eye contact and connection in the office, but he himself did not experience more eye contact (because people would still look at the screen instead of the camera).

<u>Expressed commitment towards purchase</u>
The group guessed the price at 250 euros, which is close to the calculated retail price of 300 euros. Since they are convinced of the added value of the product, and agree with the price, the company is willing to sign a letter of content, stating that they are seriously committed to buying the product when it is officially launched.

"For 300 euros this is a logical addition to any conference room".

6. Conclusion
The research questions were:
- What effect does the Be There One have on the involvement of an online attendee in a hybrid meeting?

The product resulted in an improved feeling of connection with the online participant for the in-office group. This led to them trying to involve that person more.

- What effect does the Be There One have on the group dynamics in a hybrid meeting?

The group dynamics was not notably improved during this pilot. The meeting was mainly led by the meeting facilitator, which largely determined the dynamics of the meeting. Possible effects of the product on the group dynamics should be further investigated in future research.

- What is the market potential of the product based on the experience of this pilot company?

The market potential was validated by testing the commitment of the pilot company to purchasing the product. The company signed a letter of intent, indicating that they are seriously committed to purchasing the product after its launch.

Appendix 16.25: Market research

Introduction
For the solution for the identified problems to be realized and successful a market gap needs to be identified. As a startup the big competitors should be avoided and opportunities should be leveraged. The market size will reveal if the company can be profitable in this market.

Method
Research questions
1. **What is the market size? (Market) (Main RQ)**
2. What key players are in the market? (Competing organizations)
3. **What competing products are out there?(Competing solutions) (Main RQ)**
4. **What market gaps can be identified? (Main RQ)**

Approach
To learn more about the market different market analysis reports were studied. Statistics on events and sales in this market were used to form an overview of what the market looks like today, and what it will look like in the future. Lastly competing products were identified to understand what considerations potential customers will go through.

Methods
TAM SAM SOM
The theory used for splitting the market into different layers is the TAM SAM SOM method. The market size can be divided in three categories: Total Addressable Market (TAM), Serviceable Addressable Market (SAM), Serviceable Obtainable Market (SOM).

JTBD
Identifying competing solutions was done with the use of Job To Be Dones (JTBD). According to this theory a consumer "hires" a product to do a specific task: the JTBD. There are two types of JTBD's; do goals and be goals. Do goals represent what someone wants to do, while be goals refer to the emotional end goal of these tasks and activities (Klement, 2018).

Market Size
TAM: Global video conferencing market
In 2019 the global video conferencing market has exceeded 14 billion dollars.

The market is expected to grow with a Compound Annual Growth Rate (CAGR) of 19% from 2020 to 2026, finally reaching a market size of 50 billion dollars (Wadhwani & Gankar, 2020). This growth is the result of the increasing SaaS market, which grew with 64% in the second quarter in 2020. The pandemic plays a major role in this with a growing demand for services such as Zoom (InfotechLead, 2020).

SAM: Hardware segment
The hardware segment of this market is good for 2.24 billion dollars (Wadhwani & Gankar, 2020).

The hardware products in the video conferencing market can be divided into two sub-categories; codec and USB systems. Codec systems, also known as end point systems, create a direct connection between two locations. This eliminates the need for the use of a third party server provider, increasing the secureness of the connection. These systems are more expensive than USB systems. USB systems are plug and play, meaning they can be set up by simply plugging them in. They make use of a server, for example when using Zoom or Microsoft Teams (AVer Information Inc.,

2018). This type of product is gaining popularity throughout the years. The USB subsegment is growing 34% each year, compared to the 3% in codec systems (InfotechLead, 2020).
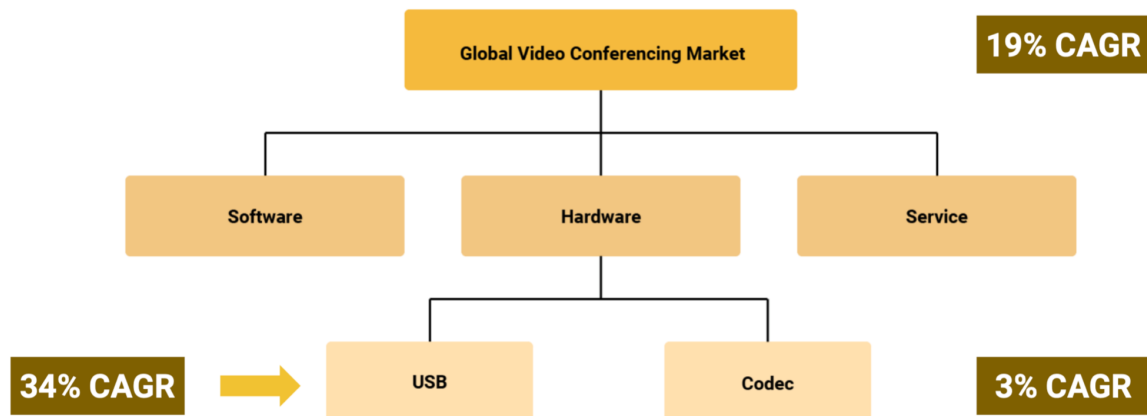
Figure 12: Market segmentation

SOM: Market share
If 1% of this market could be obtained this would leave a SOM of 22.4 million dollars.

This number is purely an indication of what would be. There are no sales conversion rates derived from large batched experiments that can give an accurate estimation. What is used as a reference is the company Owl Labs, who also developed an innovation in the video conferencing industry, being a 360 degree webcam. The company is built around this product and in that way is similar to this project. Owl Labs started in 2014 and currently has a yearly revenue of 41 million dollars (Growjo, z.d.).

Figure 13: Owl Labs 360 degree meeting camera

Competing organizations
Key players in the video conferencing market are Cisco, Logitech, Poly, Microsoft and Huawei.

Cisco
Cisco is the current market leader in the hardware segment, with a 47% market share (InfotechLead, 2020). The company had a total revenue of 49.3 billion dollars in 2020 (Cisco, 2020).

Logitech
Logitech is the second largest company in the hardware segment, with a 17% market share (Statista, 2021), and leader in the USB video conferencing system market segment (InfotechLead, 2020). Logitech's annual revenue in 2020 was 2.98 billion dollars (Logitech, 2020).

Microsoft

Microsoft is active in the video conferencing market with both software and hardware, being most known for its Microsoft Teams. The company has a 10% market share in the video conferencing market (Wadhwani & Gankar, 2020). Because the company is a large player in many markets the total revenue comes down to 143 billion dollars (Microsoft, 2020).

Poly (Plantronics & Polycom)

Poly is a manufacturing company for conferencing tools with a revenue of 1.7 billion dollars in 2020 (Poly, 2020).

Huawei

Huawei is one of the largest tech manufacturers in the world, offering various conferencing solutions. Its total revenue in 2020 was 136.7 billion dollars (Global Times, 2021).

There are many more companies offering solutions in this market. Some others worth mentioning are Google, Facebook, Zoom, Panasonic, Lifesize, Adobe, BlueJeans and Citrix.

Competing solutions

Identifying competing solutions was done with the use of Job To Be Dones (JTBD). Since the design goal of this project is to add more non verbal communicative tools to a hybrid meeting this will most likely require a screen. The new product will thus compete with the screen that is currently in most conference rooms. The function of that screen is showing the online participants, in particular for adding non-verbal communication to the conversation.

Do goal:
- Receive non verbal communication from the online participants.

Be goal:
- Create a more equal and natural communication between the people in the office and the people at remote locations.
- Give the online participants a feeling of involvement.

All products that help achieve these goals should be considered a competitor. The products that achieve the do goal are categorized and shown in figure 14. The competitors in achieving the be goals can be found in figure 17.
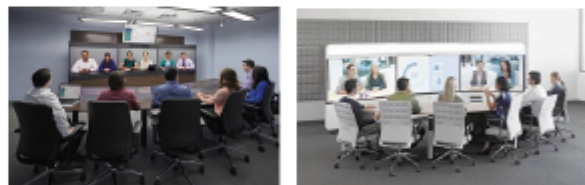
Figure 14: Competing solutions

TV screens
TV screens are present in almost every conference room. They are used to show presentation slides, videos, or other supporting materials. In hybrid meetings the screen can be used to view all remote participants.

Key players: Samsung, LG, Sony
Price range: 150 - 10.000 euros.

Beamers
Beamers are also a frequently seen piece of equipment in conference and presentation rooms. They are a great alternative to tv screens when the size of the displayed content needs to be large.

Key players: Optoma, Epson, Benq
Price range: 150 - 7.000 euros (adding projection screen: 150 - 700 euros)

Laptops
Laptops are products owned by every individual in the company. It is often a laptop that runs the meeting in a conference room, projecting the screen into a tv or beamer. When none of these viewing devices are present in the environment of the meeting the laptop itself can be used.

Key players: Lenovo, HP, Dell, Apple
Price range: 250 - 4.000 euros

Immersive video conferencing rooms
Complete video conferencing rooms are built to deliver immersive experiences in meetings. The rooms often exist out of an end point system, camera's, lighting and screens. Because the people at the other side of the connection have the same equipment the whole system gives the impression they are sitting at the same table.

Key players: Cisco, Array Telepresence, Poly, Huawei
Price range: 50.000 - 400.000 euros

Collaboration screens
A different type of screen that is often found in meeting and huddle rooms is the collaboration screen. It separates itself from tv screens with its touch screen, allowing people in the room and from other locations to work on the same whiteboard.

Key players: Cisco, Microsoft, Samsung
Price range: 2.000 - 80.000 euros

Robotic telepresence devices
Robots offer the opportunity for people to join a location remotely and move around. Some devices offer the ability to look around, while others take it a step further and allow you to move freely throughout the building. The purpose of these solutions go beyond just meetings, since you can allow all interaction in the office to be experienced.

Key players: Kubi, Double Robotics, Beam
Price range: 600 - 15.000 euros

High end technology
The subject of remote and hybrid working is currently a hot topic, this makes it no surprise that new products and technologies have been released during this project. Two solutions worth mentioning are Microsoft Mesh (video published March 2021) and Google's Project Starline (video published May 2021).

Microsoft Mesh
Microsoft has been working on augmented reality glasses for a long time now. The Hololens is their first product bringing this technology to companies. The Hololens 2 was released in 2019. Microsoft Mesh is the application that allows people to see each other as if they were standing in the same room, through the Hololens 2. The Hololens costs €3.500,- (Microsoft, 2019).
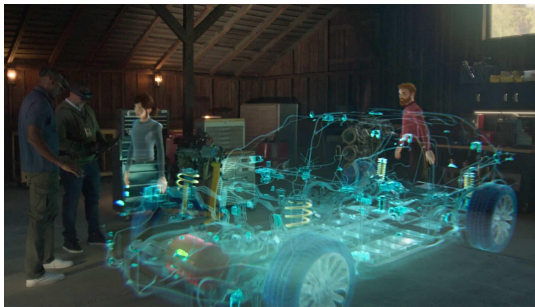
Figure 15: Microsoft Mesh

Google's Project Starline
Google has introduced the world to Project Startline, a booth that creates a video call which is experienced as if the other person is really sitting in front of you. It makes a 3D model of the person sitting in the booth and maps the video onto it. This is projected in the other person's Starline booth, on the 3D screen. This way both people experience the other as 3 dimensional and real. This product is not commercially available yet.

Figure 16: Google's Project Starline

Meeting facilitator

Spread out

Figure 17: Be goal competitors

Meeting facilitator
The current way companies try to involve the online participants is through the meeting facilitator. He or she should include the remote attendees by asking them questions or handing them turns. This is a solution that does not create extra costs, but it does not create the equal and natural communication that companies want.

Spread out
A current method for creating equal participation for all meeting attendees, as named by multiple companies spoken to during the research phase, is spreading out through the office and joining the meeting individually. Every participant, whether in the office or at home, uses a laptop to join in. This creates an equal playing field during the meeting, but eliminates all potential benefits a hybrid meeting can bring. These benefits have been discussed before in chapter 5.

Market gaps
Having analyzed competing products and companies allows market gaps to be identified. These gaps are visualized with the use of a market gap matrix. The most promising market gap was found by combining the two axisses: Immersiveness and Amount of locations joining.

Figure 18: Market gap high immersion, join as individuals

The immersion axis defines the degree to which remote participants are visually present and equal to the people in the room. Companies like Cisco and Array Telepresence offer complete conference rooms for high immersion. These rooms are however end points in a codec system, which means there is a single connection between two set locations. This allows people to join the meeting only as a group from one of the two end points. There is no solution on the market offering people to join the meeting in the office from various locations in the office ecosystem.

As discussed before these existing, high immersive, codec systems are expensive ($10.000+). There is no similar solution available for a lower price point. This brings us to the second market gap.

Figure 19: Market gap high immersion low price

Offering these immersive video conferencing experiences as USB systems instead of codec can already greatly reduce the costs.

Another promising market gap was found when focussing on products that support rich communication. In the context of this project the meaning of rich communication is communication where more information is transmitted and received than just verbal and facial (as supported by current equipment). Recently some technologies supporting rich communication were published by Google and Microsoft. These technologies offer great potential, but come with a price tag. Because companies of all shapes and sizes are currently transforming into a hybrid form there will be a demand for more affordable products.

Figure 20: Market gap rich communication affordable

These three market gaps should be considered as tools. They offer opportunities that can be leveraged, but should not limit the ideation process. In the ideation chapter it will become clear if one of these market gaps can be profited from.

Innovation adoption

Throughout the years innovations have changed the way we collaborate remotely. Analyzing the biggest innovations and drivers for change helps increase the chances of a successful optiontion of the product to be developed.

In the book Diffusion of Innovations (2003) five characteristics of innovations are defined, which all influence the adoption of the innovation.

1. **Relative advantage**

The relative advantage refers to the way the innovation is perceived compared to the existing solutions. If this is significantly better the new product will be adopted faster.

2. **Compatibility**

The more compatible the new product is with existing factors such as values, experiences and needs, the better its adoption will be.

3. **Complexity**

If a product is difficult to understand it can be a hurdle in the adoption of it. It is important to be aware of how complex your product is perceived by the users, and how this can be minimized.

4. **Trialability**

Trying out a product can be a positive contributor to the decision whether to buy it or not. If something is new people may want to try it out first.

5. **Observability**

If the effects of an innovation are visible to others this helps understand the added value of the product at a faster pace.

These five factors can be used to score the final concept. This is done in chapter 14.

Company vision

With all this information about the market, products and competitors a direction for the product to be developed and the company that will bring it to market can be formulated. The first version of the company's vision and mission are:

Vison: A world where flexibility and autonomy form the basis for increasing company performance and employee satisfaction.

Mission: Company X wants to enable natural and equal communication between participants from different locations in the office ecosystem.

Conclusion

The main research questions were:

1. What is the market size?
TAM: Global video conferencing market: 14 billion dollars.
SAM: Hardware segment: 2.24 billion dollars.
SOM: Obtainable market: 22.4 million dollars.

3. What competing products are out there?
Products that can complete the Job To Be Done are tv screens, beamers, laptops, immersive video conferencing rooms, collaboration screens, robotic telepresence devices.

4. What market gaps can be identified

Three markt gaps were identified:
- High telepresence x Join individually
- High immersiveness x USB
- Rich communication x Affordable

The company's vision and mission are:

Vison: A world where flexibility and autonomy form the basis for increasing company performance and employee satisfaction.

Mission: Company X wants to enable natural and equal communication between participants from different locations in the office ecosystem.

Design goals

11. The product has to offer an immersive experience through a USB product.
12. The product has to meet as many of the five characteristics of innovations as possible (Rogers & Marshall, 2003).

Appendix 16.26: Target group research

Introduction
The challenges in hybrid meetings cannot be solved for everyone at the same time. It is important to develop a solution aimed at a specific target group. As a startup it is also crucial to focus on your early adopter. From these early adopters the product can be scaled into a larger customer base. In this chapter the target group for the product is defined.

Method
Research questions
1. **What is the target group for the product? (Main RQ)**
2. **Who are the early adopters? (Main RQ)**

Approach
Defining the target group and early adopters is an ongoing process in which iterating and learning is crucial. Based on the information and learnings gathered until this point definitions were made. The goal is to create concrete definitions that give a complete view of which companies are included and which are not.

Crossing the chasm
A well known theory for categorizing your users over time is the model by Geoffrey Moore (2014). Here the categories are the innovators, early adopters, early majority, late majority and laggards. As a startup you have to understand who your innovators and early adopters are. These are the people that experience the problem the most, and are willing to try out new solutions. They do not care if the product has some flaws and if others are not using it yet. These users are able to significantly increase your customer base, by convincing the early majority to start using the product. This bridge between the early adopters and the early majority is called "crossing the chasm". Doing this can be seen as the biggest challenge for any innovation. The rule is that in order to cross the chasm, people from the early majority need at least 5 friends who recommend the product (Starting Greatness, 2019). This gives them enough trust and encouragement to become a new user. This shows how important it is to create positive experiences for the early adopters.
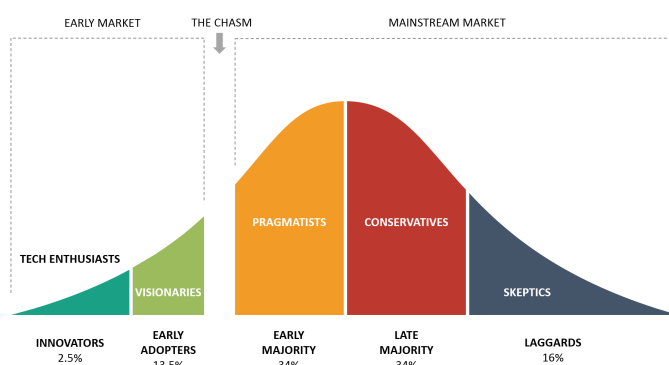
Figure 21: Crossing the chasm

The target group definition is a dynamic description, it can change overtime. As you learn and iterate your definition gets better and better. With this the conversion rates should also get better and better, as you start filtering out the wrong potential customers (Lean Startup Co., 2020). With the current learnings the following target group definition has been made:

Medium and large hybrid companies with high employee autonomy who frequently have interactive meetings with mid sized teams (4-10 people).

The most important characteristics for the target group are listed below.

- Office work in the knowledge industry
    - The knowledge industry has the highest remote working rate (Eurofound & the International Labour Office, 2017).
        - Knowledge companies: "enterprises where knowledge and knowledge-based products are offered to the market. The products and services can vary from plans to prototypes or mass-produced products where R&D costs are a large part. The work in knowledge enterprises is based on employees' intellectual skills and the tasks are not routine. (Knowledge enterprise, 2021).
    - Work in the labour industry is not suitable for remote working.
    - Work with low autonomy and use of ICT have minimal use of remote working. So does work where physical presence is required (Eurofound & the International Labour Office, 2017).

- Medium and large companies
    - The company needs to have a budget to solve the problem.
    - Medium companies = 40 - 250 employees
    - Large companies = 250+ employees ("Small and Medium-Sized Enterprises", 2021)

- Companies with high employee autonomy
    - With high freedom of choice when to work and from where.

- Companies that work in teams and collaborate frequently. (1+ times a week)
    - Jobs that are mostly individual (sales for example) cause little problems in communication and collaboration. (Interviews)

- Companies / Teams that do frequent generative meetings
    - One-way, routine and update meetings are easy to do remotely and hybridly. (Interviews)
    - Generative meetings, ones with back-and-forth communication and a dynamic conversational flow, are harder to do with online attendees joining in. (Interviews)

As the last bullet point suggests, the type of meeting being done also influences whether the problems are experienced or not. To zoom in a bit more on what meeting properties cause the problems to be more significant some are listed below.

Target meetings:
- Meetings with participants in- and outside of the office.
    - The product is aimed at supporting hybrid interaction.
- Meetings with a high interaction and interruption rate (Generative meetings).
- Meetings with no right or wrong conclusion
    - Garau et al. (2001) found that the users of his visual video conferencing system experienced most value in meetings that require discussion and have no correct conclusion.
- Meetings with 4-10 participants.
    - In a meeting with 2-3 participants it is relatively easy to keep everyone involved.
    - Meetings with more than 10 participants are even harder to do hybridly, but require solutions specifically developed for this scale of group interaction.

9.5 Early adopters

Within this target group there are companies and employees that struggle more with the challenges in hybrid meetings than others. These people are described in the following early adopter definition:

Medium sized Dutch companies in the target group that are inexperienced with hybrid working.

This definition will soon be iterated on when the product is pitched and piloted with the first customers. The most important characteristics for the early adopters are listed below.

- Young professionals
    - Young employees care more about their impression and added value. They want to build their career, get promoted and build a network. Older employees often have higher functions and have already proven their worth (Hoffower, 2020).
- Companies in the Netherlands
    - Companies with relatively high shares of employees using remote working are Finland, Japan, the Netherlands, Sweden and the US (Eurofound & the International Labour Office, 2017).
    - It is easier to start a company in your own country.
- Jobs that are inexperienced with hybrid working
    - Jobs that have always been hybrid (sales, software) experience less problems with hybrid working. (Interviews). If they recently started doing so, or only did it sporadic in the past, they are experiencing the problems more intensely.
    - Remote working is frequently used in sectors such as IT, financial services, general services and public administration (Eurofound & the International Labour Office, 2017).
- Medium sized companies
    - Using a product that has no existing customer base yet, and that is not from a well known and trusted company, can be considered as a risk by the first users. In large companies there are strict protocols for new products, and the decision makers are hard to contact. With medium sized companies trust can be built with the decision makers and the risk taken is smaller.

9.6 Conclusion

The main research questions were:
1. What is the target group for the product?
Medium and large hybrid companies with high employee autonomy who frequently have interactive meetings with mid sized teams (4-10 people).

2. Who are the early adopters?
Medium sized Dutch companies in the target group that are inexperienced with hybrid working.

9.7 Design goals

13. The product needs to be aimed at medium and large hybrid companies with high employee autonomy who frequently have interactive meetings with mid sized teams (4-10 people).
14. The product has to be introduced at medium sized Dutch companies in the target group that are inexperienced with hybrid working.

Appendix 16.27: Business Model Canvas

BMI●Business model canvas

● Key partners

Who are your most important partners?
Which key resources do you acquire from partners?
Which key activities do your partners perform?

Manufacturing partners for the manufacturing and/or supply of components of the hardware product (embodiment, PCB, etc).

Shipping partners such as PostNL, DHL, UPS and FedEX which deliver the product to the customer.

● Key activities

What are the activities you perform every day to create & deliver your value proposition?

Increasing the awareness of the product through marketing & testimonials.

R&D to improve the product's core functionalities while adding new and valuable features (or new products to the product portfolio)

● Key resources

What are the resources you need to create & deliver your value proposition?

Financial
€200.000 to manufacture the product with manufacturing partners.

Human
Strong R&D department. Software developers to build the software component. Product engineers to develop the hardware component.

Intellectual
A patent on the technology.

● Value propositions

What is the value you delivery to your customer?
Which of your customer's problems are you helping to solve?
What is the customer need that your value proposition addresses?
What is your promise to your customers?
What are the products and services you create for your customers?

One liner: An artificial eye contact device in hybrid meetings for better involvement and dynamics.

Handshake statement: The Be There One is an artificial eye contact device for hybrid companies. Remote meeting participants are no longer excluded and invaluable because of the valuable connection that can be made with them.

● Customer relationships

What relationship does each customer segment expect you to establish and maintain?

Online & phone communication channels for support

● Channels

How does your value proposition reach your customer? Where can your customer buy or use your products or services?

1) Awareness
Three different marketing strategies for each of the decision makers (For example through LinkedIn Marketing). Word of mouth will also be important.

2) Evaluation
The lighthouse customers do a pilot where they can evaluate the value proposition. Recommendations of these companies will be important in convincing new customers.

3) Purchase
The product can be ordered from the company's own webshop, or through third party webshops.

4) Delivery
Global distribution channels with key partners. First NL only, later the rest of EU and USA.

5) After sales
Customer support through social media channels and a call centre.

● Customer segments

For whom are you creating value?
What are the customer segments that either pay, receive or decide on your value proposition?

The product is created for the target group:

Medium and large hybrid companies with high employee autonomy who frequently have interactive meetings with mid sized teams (4-10 people).

The employee is the user of the product. The product is purchased by the decision makers in the company, which consists of the Team leader, HR professional and management.

- **Employee** (wants to be be included in the hybrid meeting)
- **Team leader** (wants his team to perform well)
- **HR professional** (wants high employee satisfaction)
- **Management** (wants to make or save money)

● Cost structure

What are the important costs you make to create & delivery your value proposition?

The cost structure is more of a **value driven** model. The focus is on creating as much value for companies and their employees as possible.

Primary costs are R&D, to improve & innovate, and manufacturing costs, to produce the product components.

Secondary costs are from marketing and customer support.

● Revenue streams

How do customers reward you for the value you provide to them?
What are the different revenue models?

The revenue stream comes from the sale of the hardware product.

Retail price of €300,- with a profit margin of 50%, resulting in **€42,- profit per unit**

Appendix 16.28: Design Brief

IDE Master Graduation
Project team, Procedural checks and personal Project brief

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

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT
Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME
Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name	de Haas
initials	K.K. given name Kasper
student number	4443454
street & no.	
zipcode & city	
country	
phone	
email	

Your master programme (only select the options that apply to you):

IDE master(s): ★ IPD   ◯ Dfl   ◯ SPD

2nd non-IDE master: _____

individual programme: ___ - ___ - ___ (give date of approval)

honours programme: ◯ Honours Programme Master

specialisation / annotation: ◯ Medisign
◯ Tech. in Sustainable Design
◯ Entrepeneurship

SUPERVISORY TEAM **
Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair	Ruud van Heur	dept. / section: HCD / AED
** mentor	Gert Hans Berghuis	dept. / section: DOS / MCR
2nd mentor		
	organisation:	
	city: _____	country: _____

comments (optional)

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

Procedural Checks - IDE Master Graduation

APPROVAL PROJECT BRIEF
To be filled in by the chair of the supervisory team.

chair ___Ruud van Heur_____   date ____-____-_____   signature _____

CHECK STUDY PROGRESS
To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: _____ EC

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

List of electives obtained before the third
semester without approval of the BoE

◯ **YES**   all 1st year master courses passed

◯ **NO**   missing 1st year master courses are:

name _____   date ____-____-_____   signature _____

FORMAL APPROVAL GRADUATION PROJECT
To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **.
Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: ◯ APPROVED   ◯ NOT APPROVED

Procedure: ◯ APPROVED   ◯ NOT APPROVED

comments

name _____   date ____-____-_____   signature _____

Initials & Name ___K.K._____de Haas_____   Student number __4443454____

Title of Project ___Improving hybrid working in the office ecosystem of the future_____

Improving hybrid working in the office ecosystem of the future

project title

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

start date   18 - 01 - 2021   07 - 06 - 2021   end date

Since the beginning of 2020 our lives have been turned upside down by the outbreak of COVID-19. Our current new lifestyles will open our eyes to new possibilities and opportunities we previously ignored or neglected. One of these new opportunities is remote working.

Although remote working is not at all a new phenomenon, the amount of companies allowing their employees to work remotely permanently is expected to increase because of the recent events (see figure 1). A large driver in this change is the employee demand. Remote work, which means working from outside the office, results in higher employee satisfaction caused by higher autonomy and lower work life conflict. [3]

My vision on the future of work is based around the concept of hybrid working. Since remote working comes with both pros and cons, hybrid working is expected to increase in popularity. This future of work requires an office ecosystem; no longer will the office be the sole location for a company's operations. Companies will create a network of different locations and experiences, supporting convenience, functionality and wellbeing, while optimizing connection, innovation, collaboration and learning. [4]

Products aimed at supporting hybrid working styles will need to take into account the needs and wishes from the company and the employee. With this it is important to take into account factors like role, personality, company size and industry. A one-size-fits-all solution will most likely not be possible, choices have to be made in what target group to focus on.

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TUDelft

introduction (continued): space for images
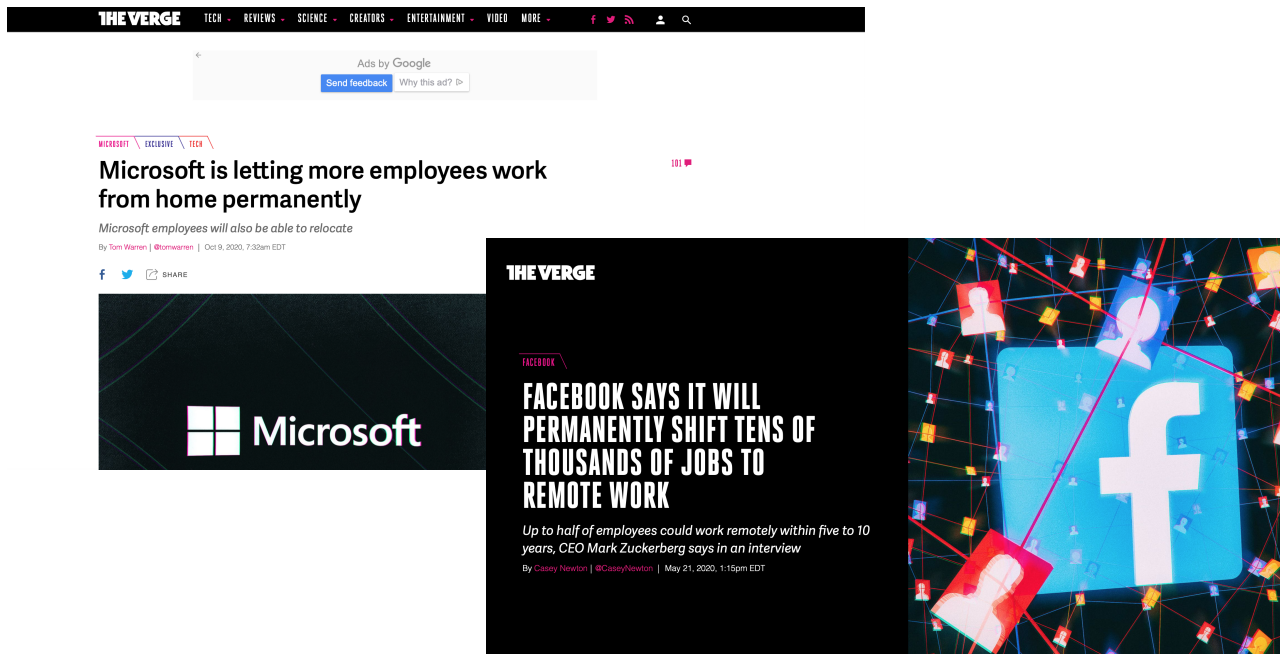
image / figure 1: Companies adpoting remote work permanently
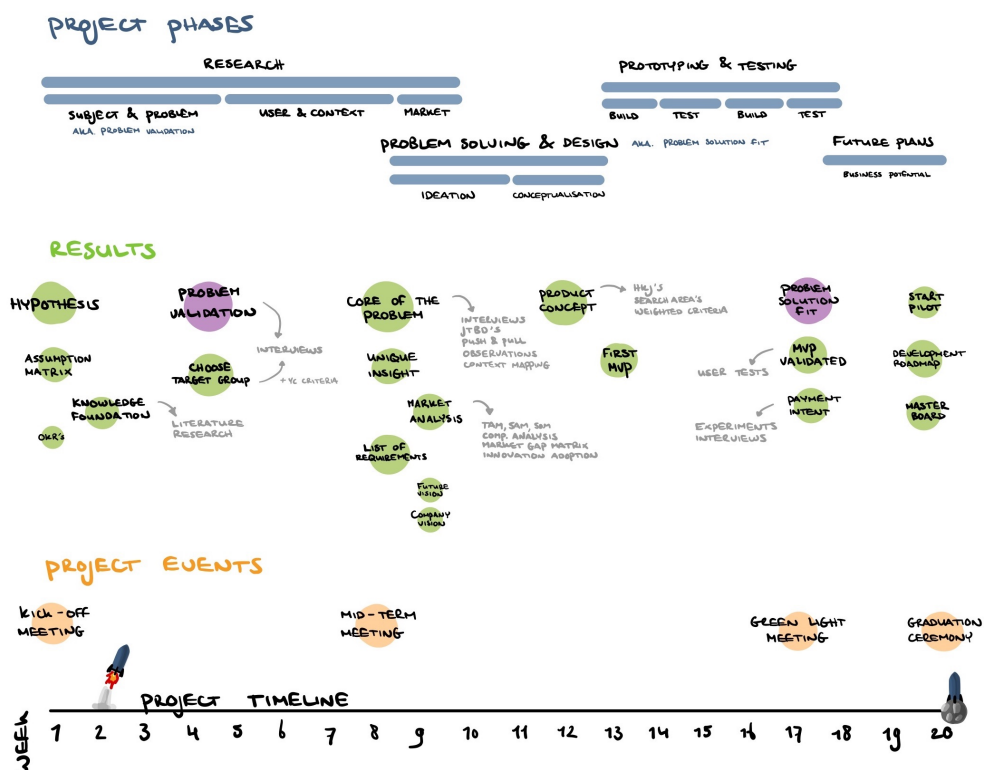
image / figure 2: Project planning visual (in addition to Gantt Chart)

Initials & Name   K.K.   de Haas   Student number   4443454

Title of Project   Improving hybrid working in the office ecosystem of the future

PROBLEM DEFINITION **
Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

Current research shows the biggest problems experienced with remote work are: 1) losing out on personal connections, 2) mental disadvantages, 3) no clear distinction between work & private live and 4) less innovation & creativity. [1, 2, 3, 6]

This information serves as input for the, mainly, future scenario: hybrid working. More research has to be done to test problem hypotesis 1 (Research Question: What problem is caused by hybrid working?): Hybrid working reduces the quality of hybrid communication* between coworkers in the office ecosystem. *Hybrid communication happens when part of the participants are remote and part in the office.

This will reduce employee satisfaction, retention and engagement [4] and negatively impact creativity and innovation, and learning and development. [3] These effects concern not only the employee, who is the end user of the product, but also the management, who is the paying customer.

If problem hypothesis 1 is true, problem hypothesis 2 will be tested:
Bad quality in hybrid communication is caused by a low social presence of remote participants.

If problem hypothesis 2 is true, the solution hypothesis will be tested (see Assignment). If a hypothesis turns out false, the research results will be used to define a different answer to the research question.

For the solution the target group is corporates who frequently meet, have 100+ employees and plan on working hybrid in the future.

ASSIGNMENT **
State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

The research phase will be focussed on finding a problem and its cause in hybrid working (hypothesis: bad quality of hybrid communication, caused by low social presence), the design phase will be focussed on finding an effective solution through prototyping and testing. The purpose of the hypotheses defined in this brief is to give initial focus in the project phases, if another direction proves more promising it will be chosen.

Solution hypothesis: A higher social presence* for remote participants in hybrid communication will increase the quality of communication.
*Social presence is "the degree to which a person is perceived as 'real' in mediated communication".[5]

If the solution hypothesis is untrue, other solutions will be explored through ideation and testing.

The research will be focussed on the future of work, hybrid working and social connection.

The solution
- has to improve the quality of hybrid communication;
- can be a product or service;
- has to suit the future of work;
- will be focussed on in-office work;
- has to be functional in different company sizes;
- will be offered in a subscription model (to match company budget)

The goal is to end the project with a problem solution fit and MVP.

Initials & Name   K.K.   de Haas   Student number   4443454

Title of Project   Improving hybrid working in the office ecosystem of the future

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and 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 activities.

start date   18 - 1 - 2021   7 - 6 - 2021   end date

In this project the Lean Startup will be used as the main methodology. This means all unvalidated knowledge is defined as a hypothesis, and is not perceived as true until experimentation proves it is. Some of the experiments are already defined and given place in the Gantt Chart, others will result from learnings and choices during the project. The experiment cards for the experiments planned under 3. Prototyping & Testing are shown on the right.

In order to get a first overview of what phases are needed in the project, and what results are needed along the way, a visual representation of the planning was made. This drawn-out visual overview can be seen in figure 2 on page 4.

During the final year of my Bachelor I started developing an interest in Startups and entrepreneurship. I find the journey of starting and growing a company very fascinating and exciting. I used my Masters to further develop my knowledge and experience in this area; I did an internship at a YesDelft! Startup and had a go at building my own company during the elective Build Your Startup. In my free time I started reading articles, buying books and watching videos on the topic of entrepreneurship. With the graduation project as final project in my Master education I want to grab the opportunity to build an innovative product with the potential of starting a new company. This means the product has to be feasible, desirable and viable. There should also be an identified market gap, together with proven purchase intent by the target group.

Since my focus has been on tech Startups, I have been looking for an opportunity for a technological solution to a new problem. With the COVID-19 pandemic stirring up every industry I saw my options decline, until I realized new unsolved problems were reaching the surface in many areas. When learning about Startups many workflows and methods caught my interest. Now, in the context we are currently living in, and the context we will be living in in the future, new and adapted workflows are required; the perfect opportunity for new products.

My learning goals are:
- User research: Learning how to develop a deep understanding of the user and its context.
- Business potential: Developing a business model around the product, and assessing whether the business can be profitable.
- Payment intent: Testing whether the target group would actually pay for the solution being developed.

Sources:
1) Buffer & AngelList. (2020, februari). State of Remote Work 2020. Buffer. https://lp.buffer.com/state-of-remote-work-2020
2) Cushman & Wakefield. (2020, maart). The Future of Workplace.
3) Cushman & Wakefield & Center for Real Estate and Urban Analysis. (2020a, oktober). Purpose of place; history and future of the office. Cushman & Wakefield.
4) Cushman & Wakefield & Center for Real Estate and Urban Analysis. (2020b, december). Workplace ecosystems of the future. Cushman & Wakefield.
5) Cobb, S. (2009). Social Presence and Online Learning: A Current View from a Research Perspective. Journal of Interactive Online Learning, 241–254. https://www.ncolr.org/jiol/issues/pdf/8.3.4.pdf
6) Hodder, A. (2020). New Technology, Work and Employment in the era of COVID-19: reflecting on legacies of research. New Technology, Work and Employment, 35(3), 262–275. https://doi.org/10.1111/ntwe.1217

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