Appendices

A VR based solution
for informing cycling fans

IPD Master
Graduation Thesis
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CONTENTS

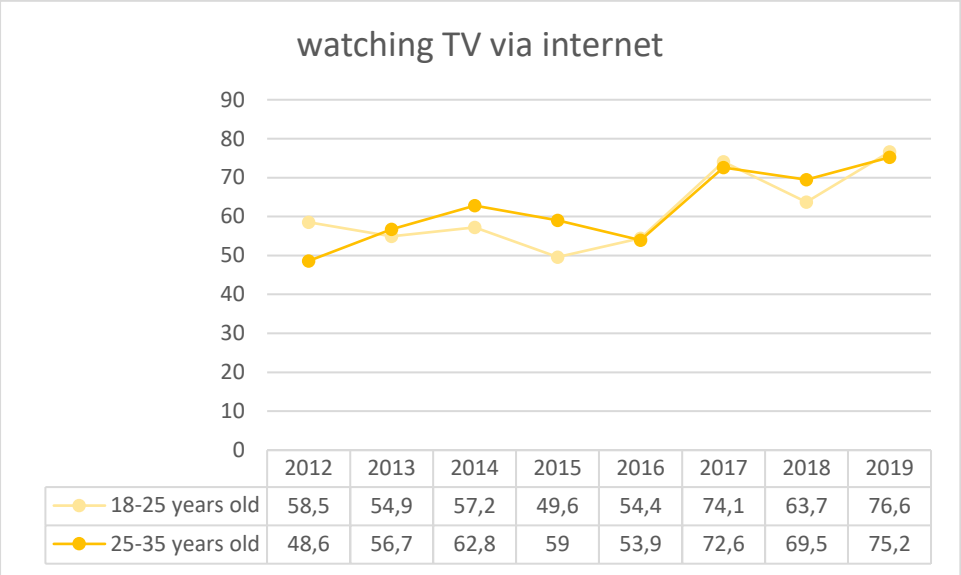
APPENDIX A: LIST OF FIGURES

APPENDIX B: TRENDS

This appendix presents facts and figures that describe the trends which are mentioned in the report.

B.1 Video (live) streaming and video on demand

Figure A-1 shows the amount of people that watch television via internet for the years 2012 until 2019. The data is shown for 18-25 year olds and 25-35 year olds because this it the target group of the project.



	2012	2013	2014	2015	2016	2017	2018	2019
18-25 years old	58,5	54,9	57,2	49,6	54,4	74,1	63,7	76,6
25-35 years old	48,6	56,7	62,8	59	53,9	72,6	69,5	75,2

Figure A-1: the amount of people that watch TV via internet (CBS, 2019)

B.2 VR use for (sports) broadcasts

Figure A-2 shows a prediction of the future of the immersive market. IT can be seen that for VR (see the red bars) the size of 2019 is expected to be double in 2012. Figure A-3 shows the prediction for the usage of VR per segment, where can be seen that the usage for live events is expected to be the second largest segment.

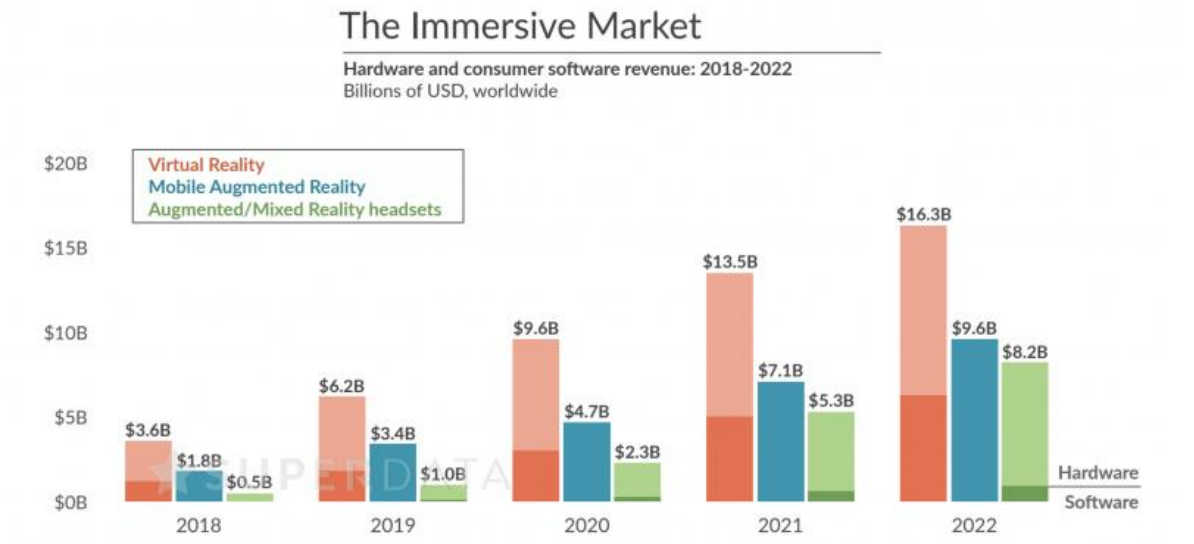


Figure A-2: The future of the immersive market (viar360, 2019)

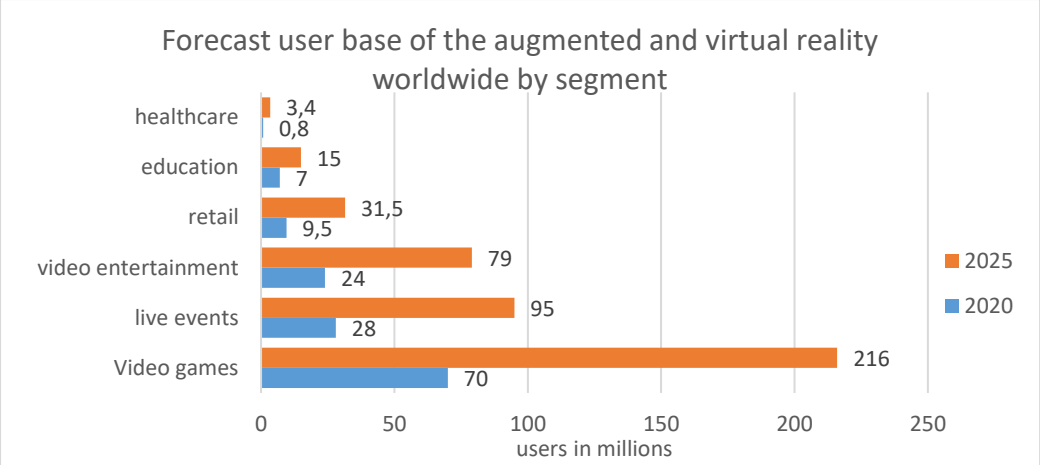


Figure A-3: forecast of the user base of the augmented and virtual reality worldwide by segment (Statista, 2019)

Figure A-4 shows a an overview of the brands and companies that have products or services for the distribution of VR content, to capture 360 videos, are active in VR live (sport) events and that offer VR streaming services.

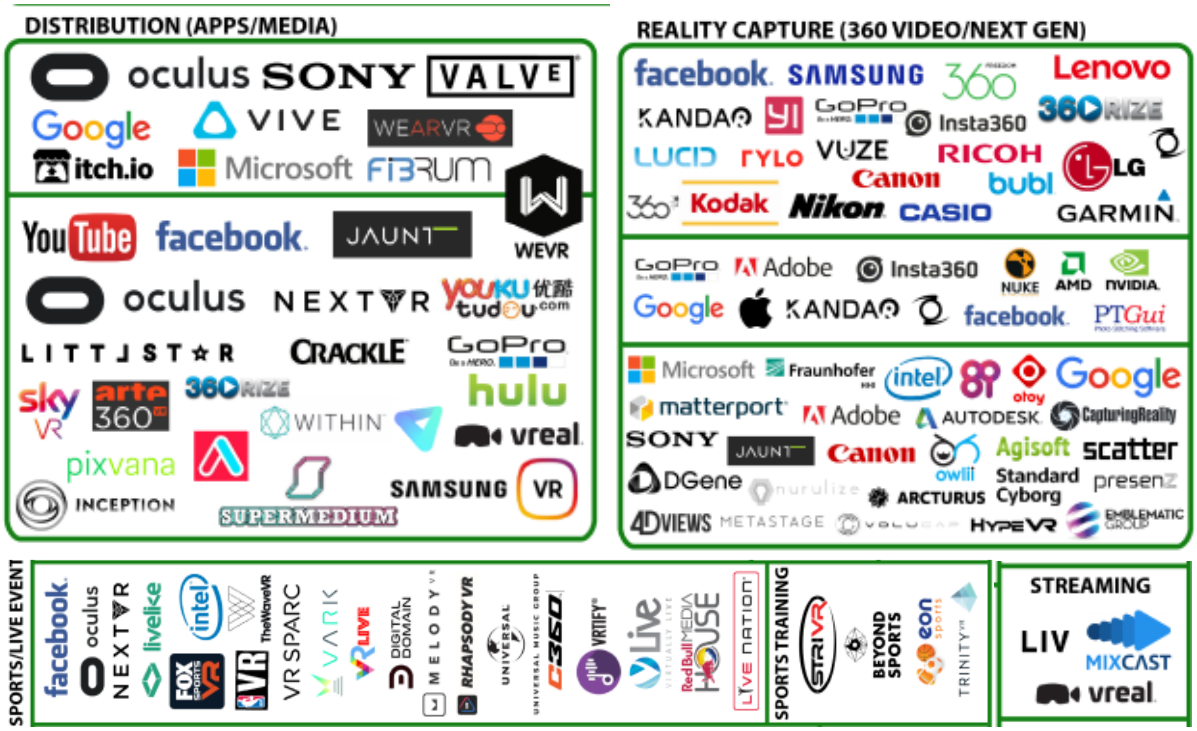


Figure A-4: overview of the VR Industry (section of the original figure from (thevrfund.com, 2019))

B.2.1 Virtual live sports games

Figure A-5 shows images of three examples of Virtual live sport game broadcasts. CVR is a virtual cycling competition where cyclists compete using a trainer bike and cycle in a virtual environment. The second picture shows the NBA basketball competitions that are being broadcast in VR every week. The 'X Games' is an annual extreme sports event, that includes BMX. In 2017 some parts of the event (under which the BMX) could be watched via a 360 degree virtual reality livestream. (Booton, 2017)

VR live games

Figure A-5: virtual live sports events

B.2.2 VR broadcast experience

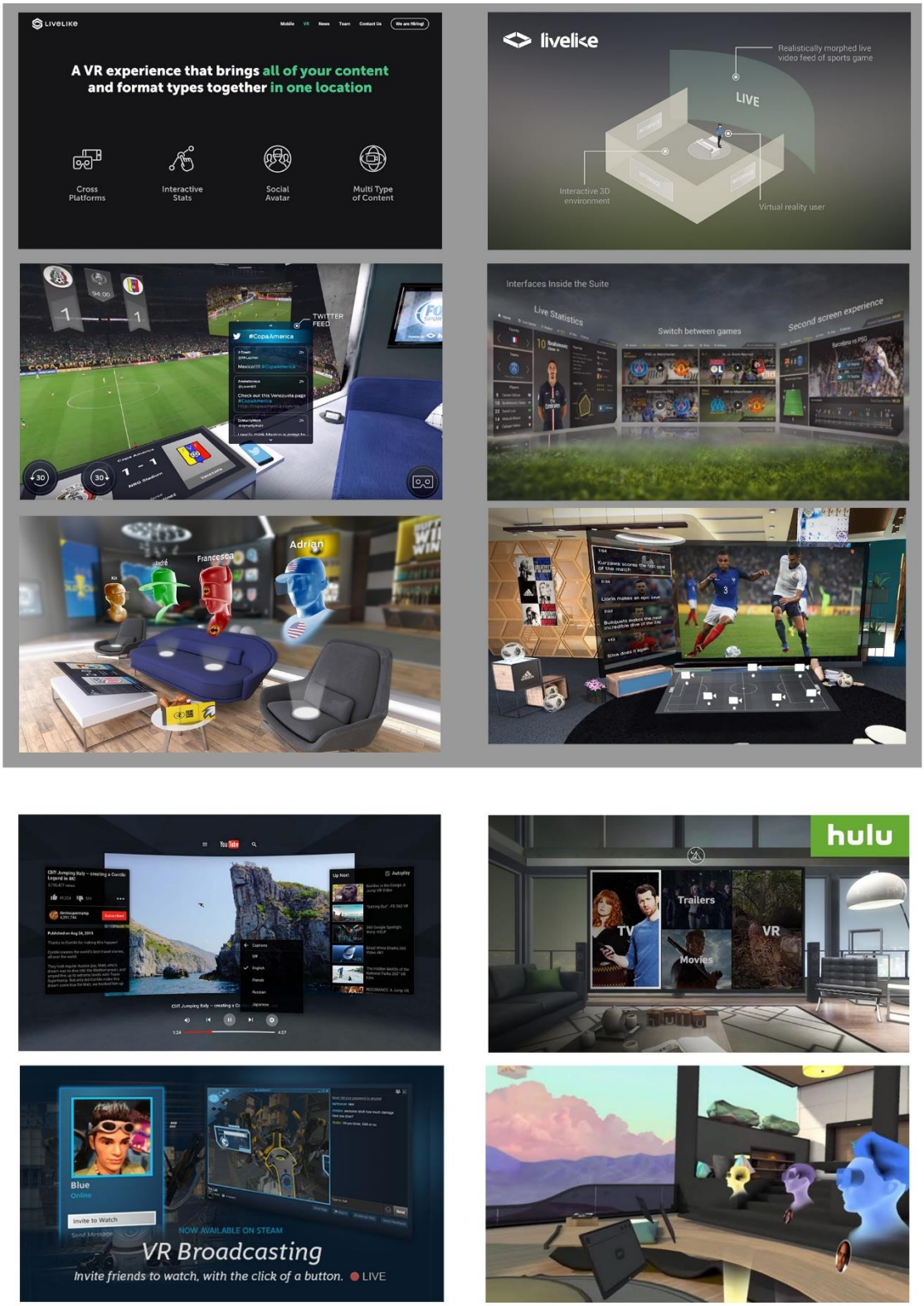


Figure A-6: examples of VR broadcast services, the images in the grey box are al 'Livelike'; the bottom part shows Youtube VR, Hulu, Steam VR broadcasting, and Oculus rooms.

The recent developments in VR standalone HMD devices, with improvements in technology, freedom of usage and even more emerging interaction possibilities, are promising for VR to hit the mainstream VR entertainment market the coming years. (Marr, 2019)

At this moment several options for watching broadcasts or videos (on-demand and even sometimes live) are available. Most of the VR broadcasting applications consist of a virtual room with several interactive screens placed in this scene. This is a bit similar to the use of a second screen, but in this case there are more screens. These screens contain for example information about the competition, the players and the teams, comments on social media, live statistics, live blog, replays, highlights, etc. Also information which would normally be shown on a television broadcast, like rankings and times, are placed in the VR space. Philips predicts that in about 2 years, viewers will be able to control and select what they watch themselves, like what the broadcasting company is doing now. This will help viewers to better understand the sport and games. (Terdiman, 2017) The VR spaces most often look like a Livingroom (see figure at the right, second from the bottom A-6 (Hulu)) or a VIP lounge (like in the top part of figure A-6 (LiveLike)). Most of the VR broadcasting apps use a lot of traditional video footage, most VR sporting events provide a 180- to 210-degree field of view (Nelson Jr., 2017), but nowadays intel and NextVR for example are using 360 video footage for sports broadcasts. LiveLike for example does not use 360 video footage, but they created an interactive room and a huge window where the viewers can look through like if the room they is locates right next to the stadium. In The last image in the grey area in figure A-6 a VR room is shown where the user can pick the preferred viewing angle from the available camera's in the field or sometimes even from body camera's.

Intel has a partnerships for broadcasting sports competitions in VR with NFL, NBA, MLB, PGA, NCAA, and highlights from the Olympics in PyeongChang. In their broadcasts the viewers can select from different types and angles of viewing. To make this possible they use a system of specific cameras. FreeD by Intel uses custom stereoscope camera pods which make it possible to 'pause' a game and look around in the 'paused' scene. This leads to interesting views at key moments.

Figure A-7: A VR broadcast of a NBA game

When using a VR HMD the viewer is separated from the physical environment where they are in. They cannot see where they physically are, who are around them and when using headphones they even won't be able to hear the sounds from the physical surroundings. But on the other side, VR makes it possible to engage with friends while not being physically together. Social viewing is the feature that enables viewers can watch a show 'together' by being at the same time in the same virtual room. They are represented by an avatar and are able to interact and talk with each other while watching for example a sports competition or a movie. Hulu and Oculus Rooms (see A-6) are the main providers for social viewing. Not only sports, or movies are broadcasted in VR, but users can for example also broadcast their gameplay to their friends.

APPENDIX C: TOUR DE FRANCE

This appendix shows the developments of the Tour de France experiences over time, the different types of experiences that are available and how these experiences are created.

C.1 timeline Tour de France broadcasting and viewer engagement

Figure B-1 (the table below) shows the developments of the Tour de France experiences over time.

year	type of experience	what's new	source
2007	game	first PC game, yearly a new game is released	(metacritic.com, 2019)
2009	game	First IOS game, yearly a new game until 2015	(metacritic.com, 2019)
2009	game	First console game, yearly a new game is released	(metacritic.com, 2019)
2010	social integration/ interaction	Tour de France joined Twitter	(letour.fr@Twitter, 2010)
2010	social integration/ interaction	Tour de France joins facebook with an official page	(letour.fr@Facebook, 2010)
2011	digital screen	TV 2 Norway used never.no's Synchronized Companion App Framework to create the world's first Live Broadcast Companion application for the 2011 Tour de France (TdF). The app enabled a completely complementary and immersive two-screen experience for TdF viewers.	(Never.no, 2012)
2012	social integration/ interaction	first post on the official Tour de France Instagram page	(letour.fr@Instagram, 2012)
2015	TV broadcast features	Collaboration with 'Dimension Data' to **collect live data** about all the cyclists during the Tour de France races, which is used to show extra information during live broadcasts	(Dimension Data, 2018)
2015	social integration/ interaction	Dimension data joins twitter with an account about the Tour de france: @letourdata	(letourdata@Twitter, 2015)
2016	TV broadcast viewership	The 2016 Tour de France was the least-watched edition of the sport's premier event since 2009	(Harris & Maxwell, Cycling TV – An Over The Top Revolution, 2016)
2016	data usage	Focus: tell stories with the data. By bringing together skills in journalism, data analysis, and social media, we created a team that could analyse the race in real-time and provide insightful race data and visualisations	(NTT, 2019)
2016	data usage	all-new digital application that gives media commentators at the 2016 Tour de France direct access to live race data for enhanced, in-depth event coverage and analysis.	(NTT, 2019)
2017	data usage	For the Tour de France 2017, 'Le Monde' made an interactive map to show where the routes passed through each year.	(Jacobs, 2017)

2017	TV broadcast viewership	the tour the France ratings on Eurosport increased by 10% with an average viewing number of 785,000.	(Discovery, 2017)
2017	game	Tour de France board game	(cyclingboardgames.net, 2017)
2017	data usage	Last year (2017), we brought machine learning and predictive analytics to the race, enabling us to tell compelling stories every second of the Tour, such as when the peloton will catch the breakaway group, the average rider speed during a crash and the changes in pace as sprinters dash for the finish line. These stories are told via data visualisations, available across broadcast, digital and social. rider profiles are added	(ITU News, 2018)
2017	data usage	Focus: use past data to predict future outcomes using machine learning.	(NTT, 2019)
2018	TV broadcast viewership	In 2018 the Tour had troubles with the TV ratings again. A few reasons for that could be the FIFA World Cup, a doping case, the exceptionally good weather in Europe, etc. --> difficult to find exact figures	(Rogers, 2018)
2018	data usage	'Le Code to France' competition for 'Dimension Data' employees, driving innovative ideas that can be implemented during future Tours.	(ITU News, 2018)
2018	data usage	Focus: Sharing data on emerging technology platforms. Our goal for this year is to continue to enhance the storytelling on all channels – television, digital and social media – which includes making our machine learning models even smarter.	(NTT, 2019)
2019	game	The Tour de France is releasing its Fantasy game for the first time. Fans can now build their own teams, select their riders and score points based on their performance in each stage.	(Tour de France, 2018)
2019	digital screen	The official letour.fr/ website is now responsive on all devices: mobile phones, tablets and computers.	(Tour de France, 2018)
2019	digital screen	Common platform for following the race live with France Télévisions: link to live footage, videos, statistics, updates, rider locations, etc.	(Tour de France, 2018)
2019	TV broadcast features	slow-motion footage from a race motorbike will be broadcasted live.	(Tour de France, 2018)
2019	TV broadcast features	More real-time data: elevation gain, current speed, share of time pulling at the front, virtual general classification, etc.	(Tour de France, 2018)
2019	TV broadcast features	3D race: real-time locations of the riders.	(Tour de France, 2018)
2019	TV broadcast features	Televised ceremony at the start: acclamation of the jersey wearers and heroes of the day.	(Tour de France, 2018)

Figure B-1: Timeline of the different types of user experiences of the Tour de France until 2019

C.2 Tour de France experience

There are different types of motivators for watching mediated sports, these are summarised in figure B-2. Currently the different possible experiences for the Tour de France touch different of these motivators. Examples of additional TdF experiences are shown in figure B-3 (these were also mentioned in the time-line of figure B-1) mapped in a matrix. The two axis are the type of interaction (active or passive) and the type of medium used (analogue or digital). In the passive & analogue quadrant different books about the Tour de France or cyclist biographies are shown. There is also an official TdF package including a magazine. The Quadrant above this, the active & analogue quadrant shows a TdF board game named 'cycling party'. Another experience is watching the Tour de France live at the side-line. The third quadrant is the passive & digital quadrant that includes several second screen options and the TV broadcast. E-books are also placed in this quadrant. The last quadrant is the active & digital quadrant that includes the most experiences. These are the official TdF PC and console games, the Tour de France mobile game (there is a game where the user can 'cycle' a race and there is the cycling fantasy game (that also includes the Tour de France) which is more like gambling game), the activity of @letour on social media accounts and the Zwift (indoor trainer) application that has a route of the Tour de France in their collection.

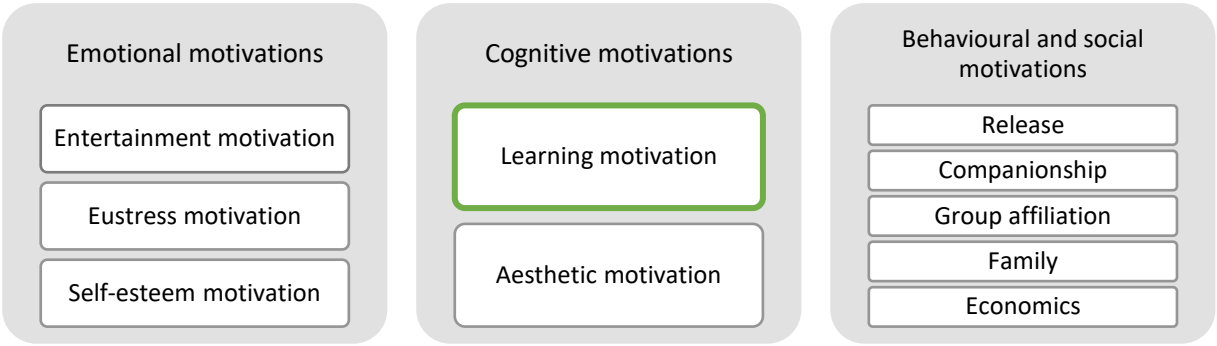


Figure B-2: motivators for watching mediated sports (Raney, 2009)

Figure B-3: Tour de France experience portfolio

C.3 Appendix FIXME: Examples of Tour de France broadcast data visualisations.

This page (figure B-4) includes several screenshots of the information that is shown during a Tour de France broadcast on Eurosport.

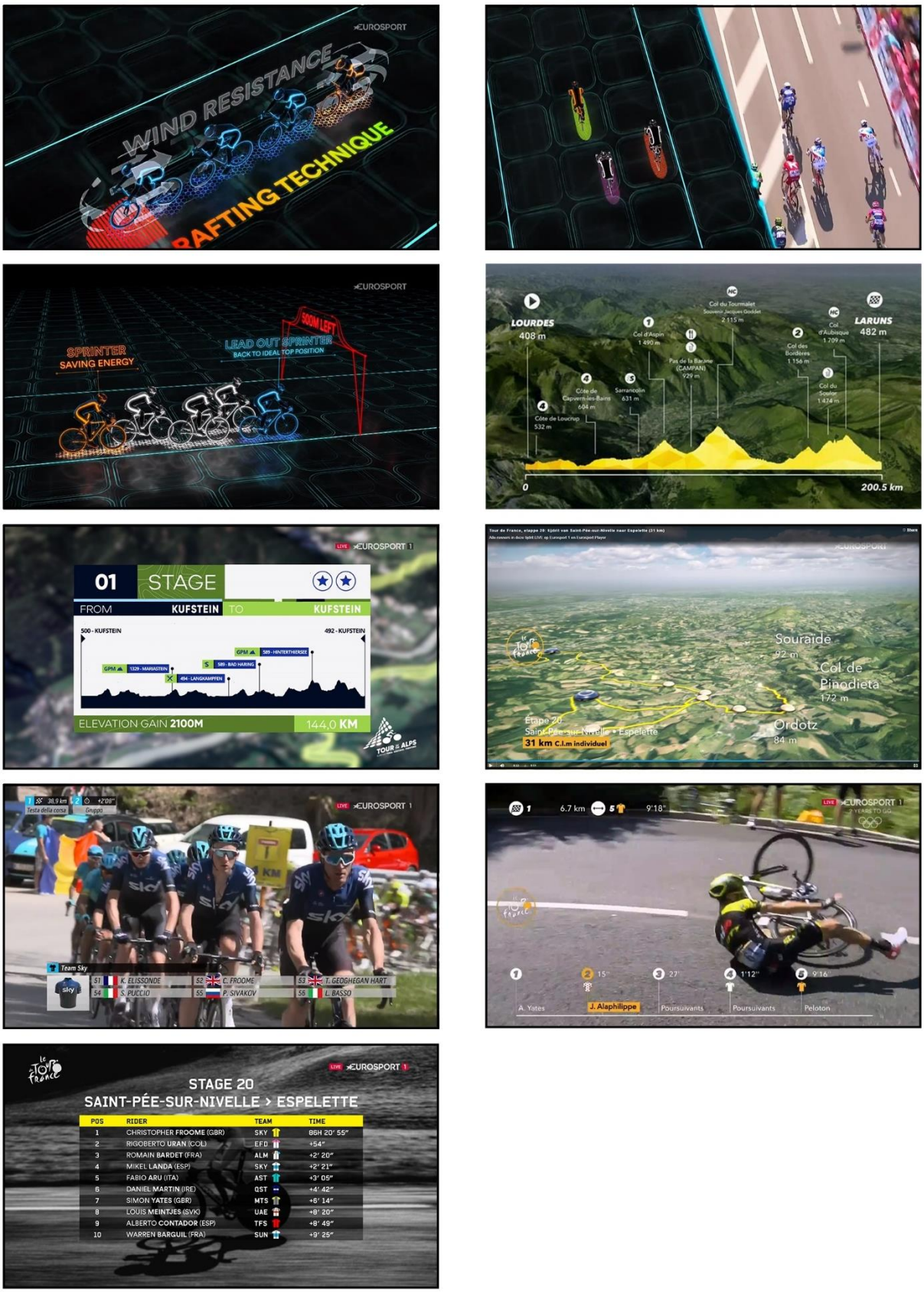


Figure B-4: screenshots od a Tour de France broadcast at Euro

C.4 Technologies

Figure B-5 shows the architecture of Dimension Data's solution at the Tour de France (Based on the white paper about the technology solution by Dimension Data (Wade, 2018)). The data analysis as two sections: the traditional analysis and the machine learning. The four elements that are produces using machine learning are visualised and shared with the viewers. Figure FIXME shows examples of these four types of visuals using machine learning generated data.

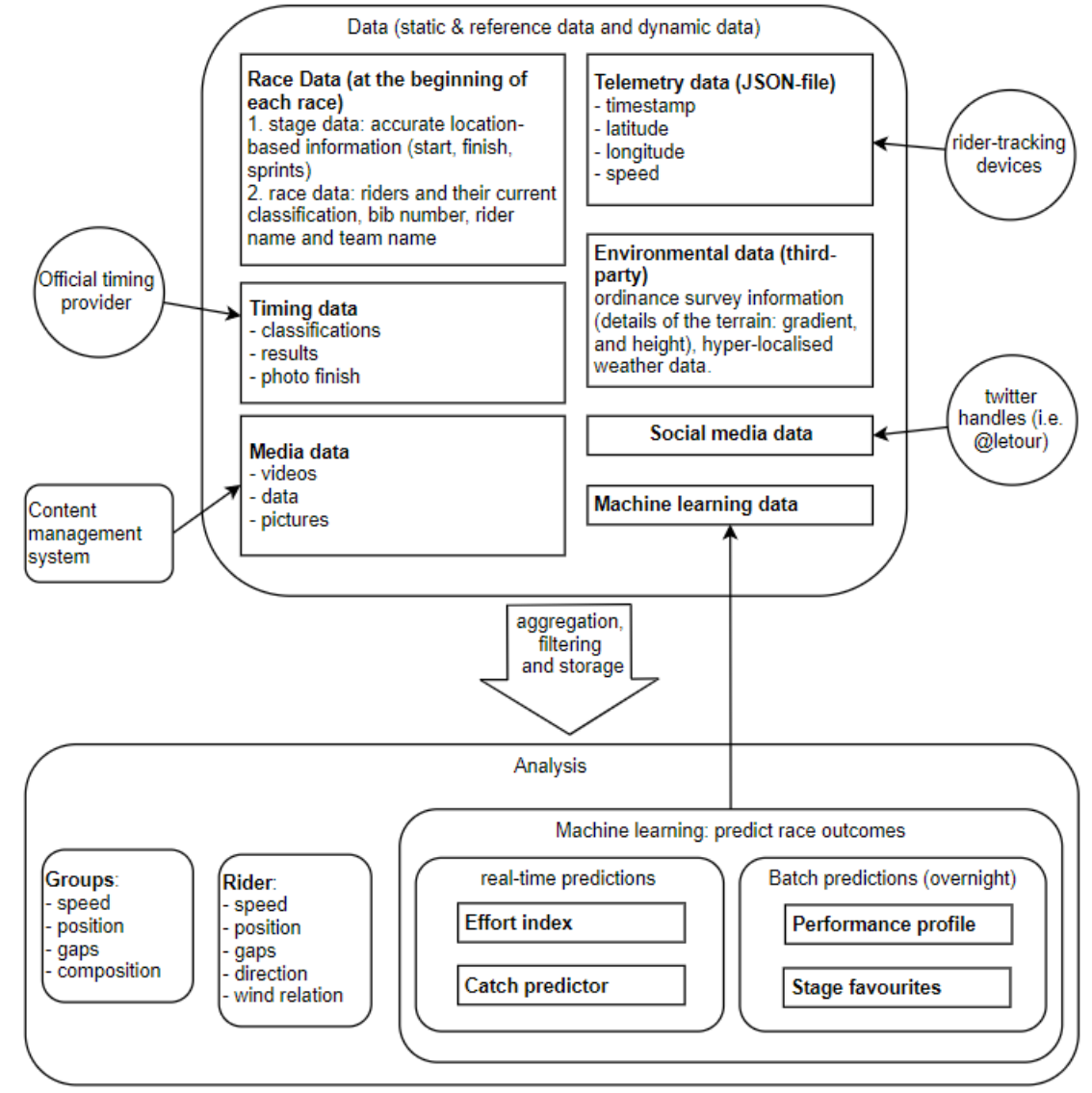


Figure B-5: schematic overview of the architecture of Dimension Data's solution

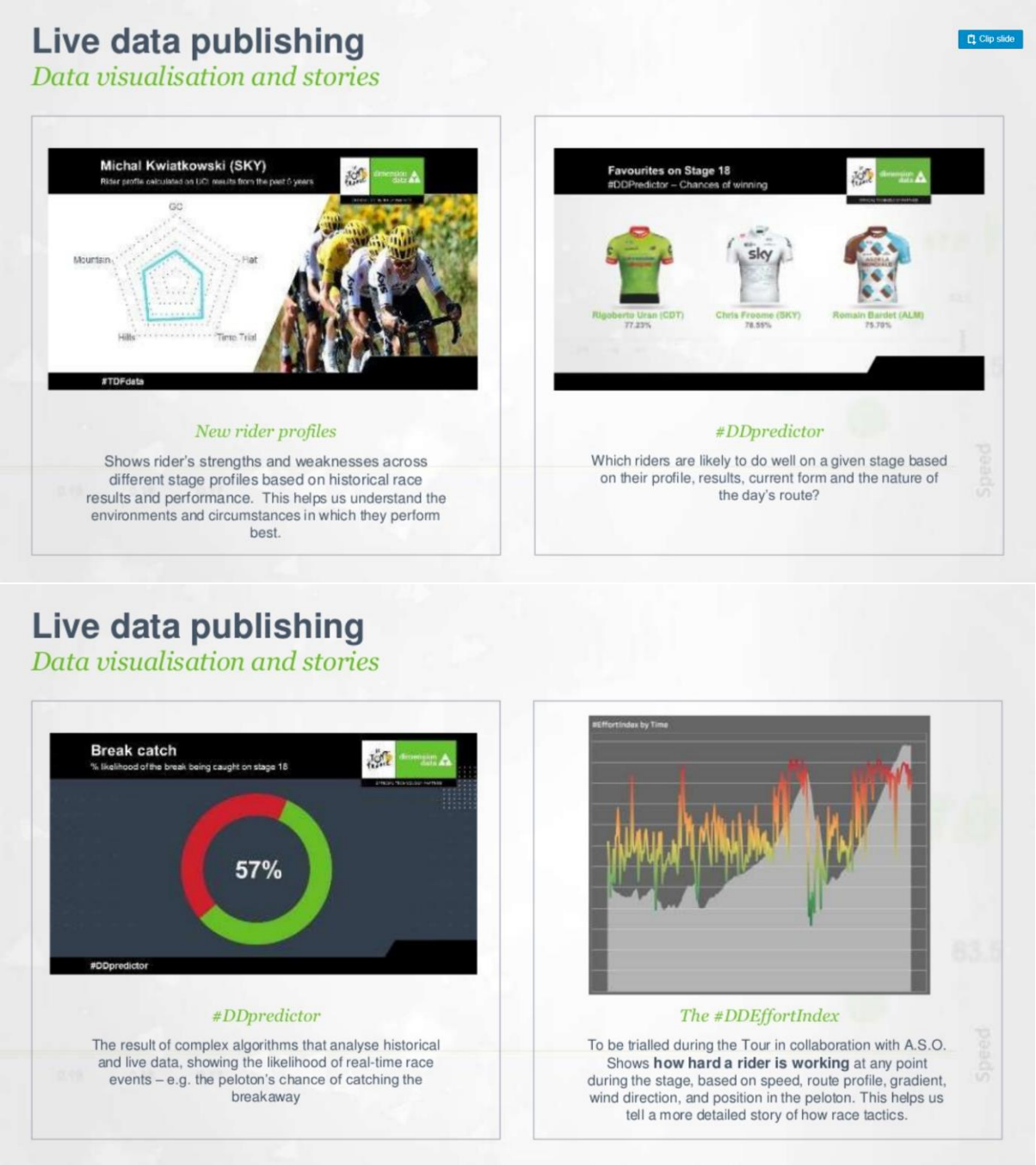


Figure B-6: examples of the four types of visuals using machine learning generated data (Grey, 2018)

APPENDIX E: PROCESS

At the start of every chapter in the report a schematic illustration of the process of that phase is presented. This appendix shows all these visualisations of each phase and the links between them together.

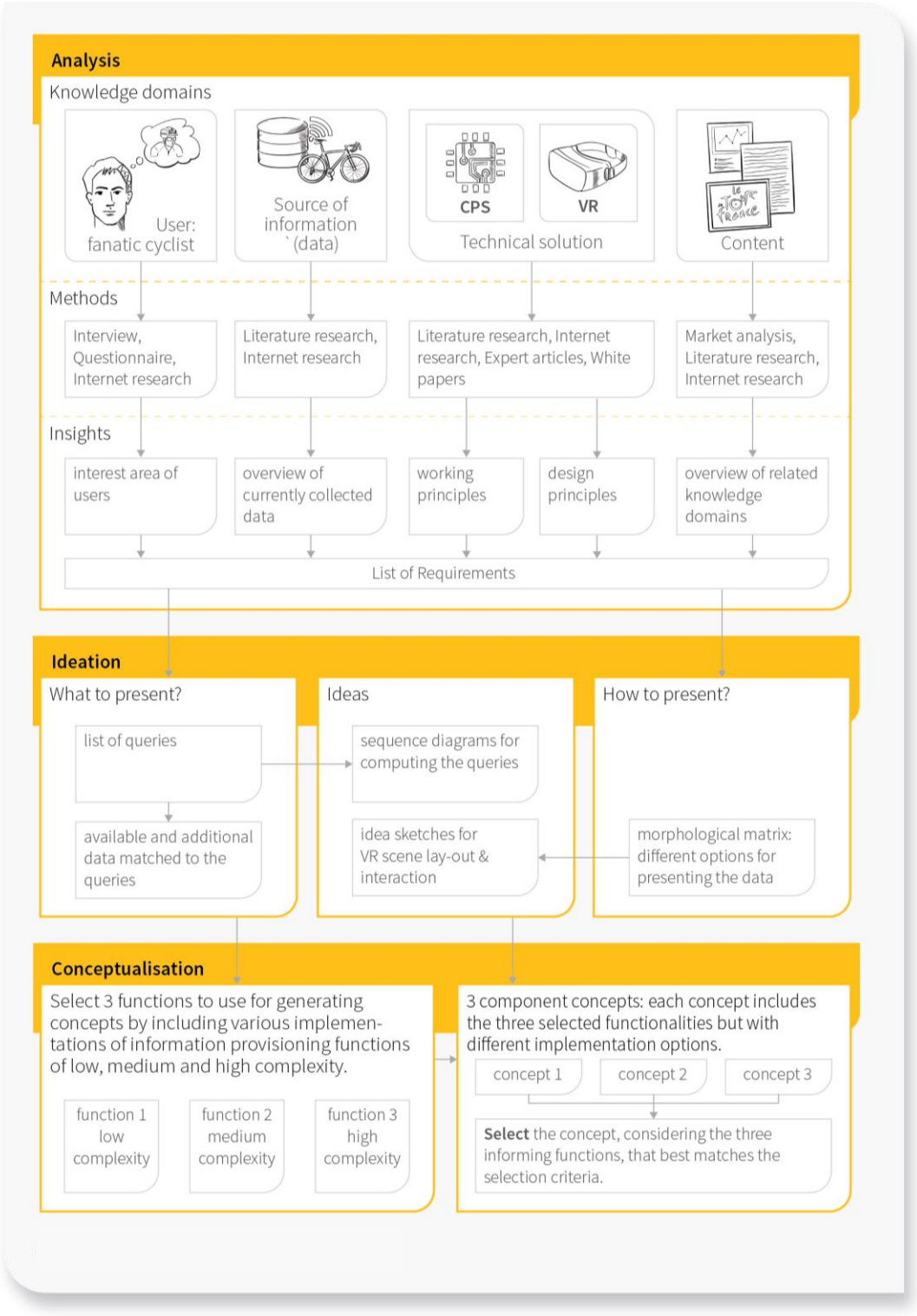


Figure D-1: an overview of the project process part 1

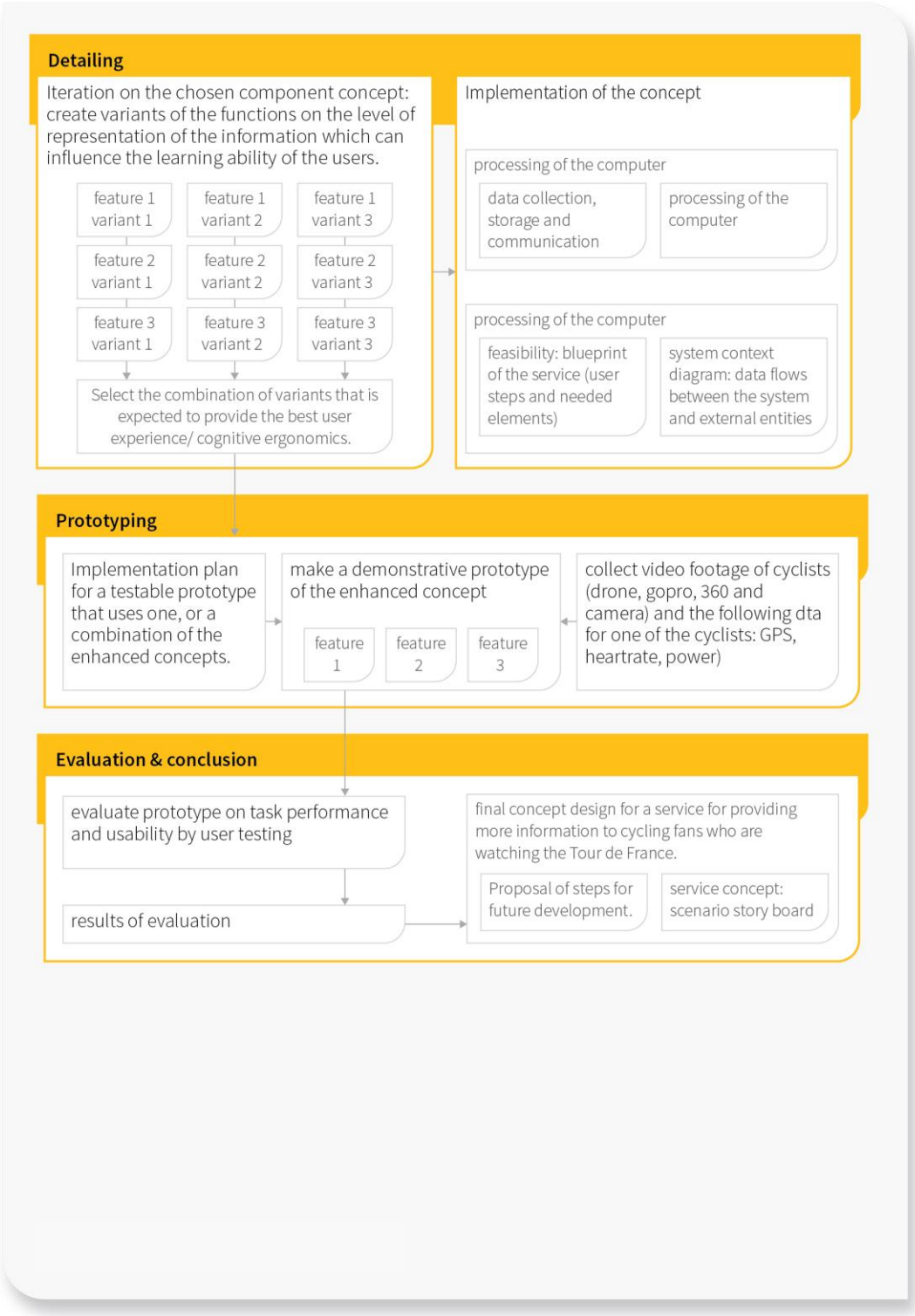


Figure D-2: an overview of the project process part 2

APPENDIX F: USER RESEARCH

F.1 A visit to a cycling association

Below a summary of the two interviews, translated into English, is shown. The interviews were short and open interviews with the goal to find out how they participate in cycling and how they watch the Tour de France. These conversations were used to understand the target group better and to use that to create a questionnaire that fits to their experience. Figure E-1 presents two personas based on conversations with cyclists when visiting the cycling association.

F.1.1 Interview 1: cyclist of the competition

Cycling is a social sport, after cycling we often drink a beer together. With my cycling buddy's I also compare my data to them, using the Strava App. We are competitive and motivate each other. Every week there is a club-competition for 10 weeks long. There are two groups and the time per round of every cyclist is measured. For this I already need some tactics, e.g. the position in the group and the shape of the route.

Everyone is using a cycling computer, when your heartbeat gets too high you know that you have to take it easy.

There are different types of cyclists:

- 'lazy cyclists' who like to cycle in the back of the peloton
- Cyclists who sprint the whole race and make it challenging for the rest of the group

It is like a game but then real.

About watching the 'Tour de France': I love it to lay down in a hammock after cycling to watch a cycling race. It is a complete experience, you try to check in advance what the stage looks like and who have a chance to win the race. Because I am cycling myself, I can see which challenges there are and what tactics are used or could be used while watching a race.

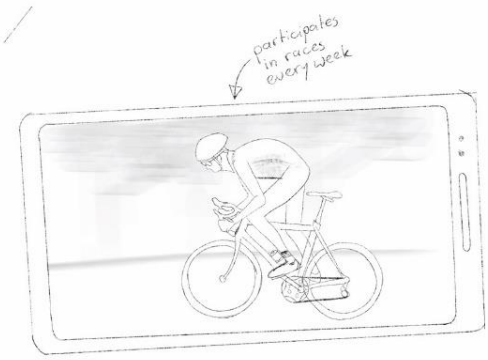
A nice thing about cycling is that you can easily get quite far in comparison to running. You quickly leave the town.

F.1.2 Interview 2: board member

Most people who practise the cycling sport themselves also watch races.
Most cyclists who are training at the association are competitive. That is needed to improve yourself.
I did cycling myself as well, but quit because of an injury. Now I am still active as a board member. The association is very large, so I do not know everyone by name. Often I can recognize people by their bikes.

F.1.3 Observations

It is a large association with members of a large variety of ages. They all come together at these races. The atmosphere is quite cosy, friendly and fun. People get along in groups of people that are of similar age. During the race there was even a group of elderly sitting at a table in the clubhouse.



Persona 1: Tim

Age: 20
Occupation: TU Delft student
Housing: lives in a student house with 3 other cycling fans.

Cycling

- Is member of a cycling association.
- Participates in a cycling race every week.

Watching the Tour de France

Tim's watching behaviour depends on the amount of work he has to do for his study.
1. While studying TIm watches the TdF online and uses a second screen application.
2. Watching it live on TV at home together with his room-mates.

Persona 2: Bas

Age: 30
Occupation: young professional
Housing: lives together with his girlfriend

Cycling

- Likes to do cycling tours with friends to relax after work or on the weekends.
- Commutes to work on a race-bike.

Watching the Tour de France

After doing a cycling tour with friends Tim watches the TdF at home or at a sports café with his friends.
1. Laying in a hammock with a tablet.
2. Together with friends in a sport café on a large screen.

Brands

Tim

Both

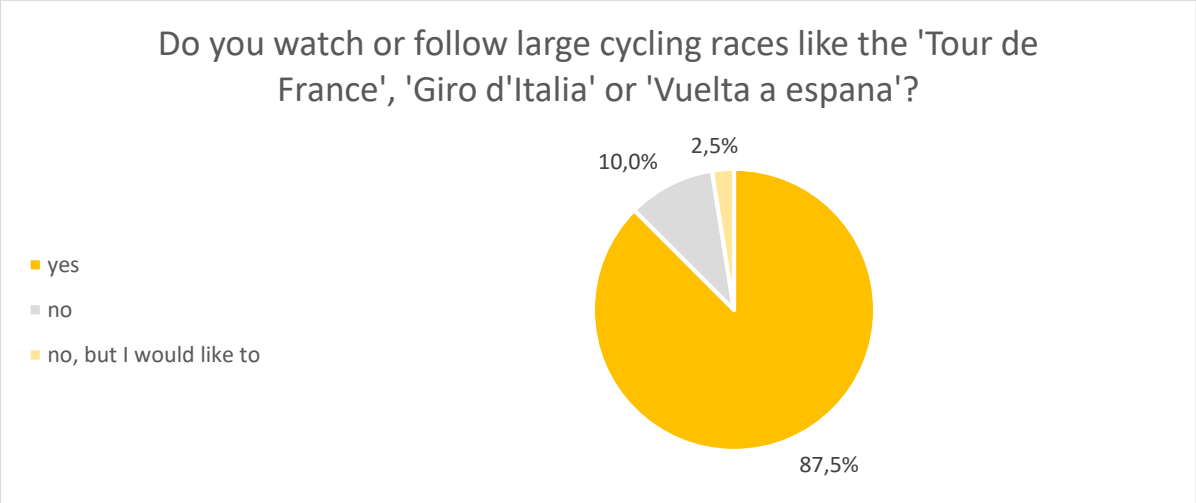
Bas

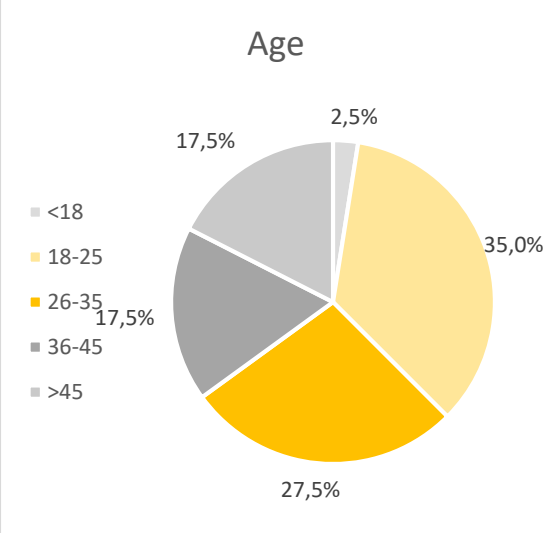
Figure E-1: two personas

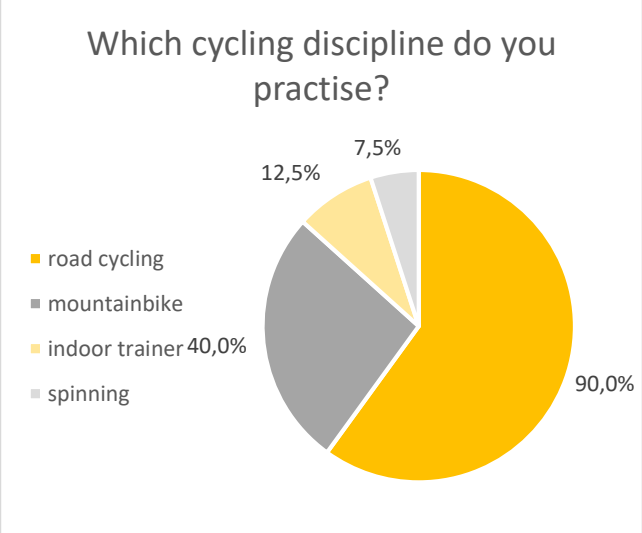
F.2 questionnaire under cyclists

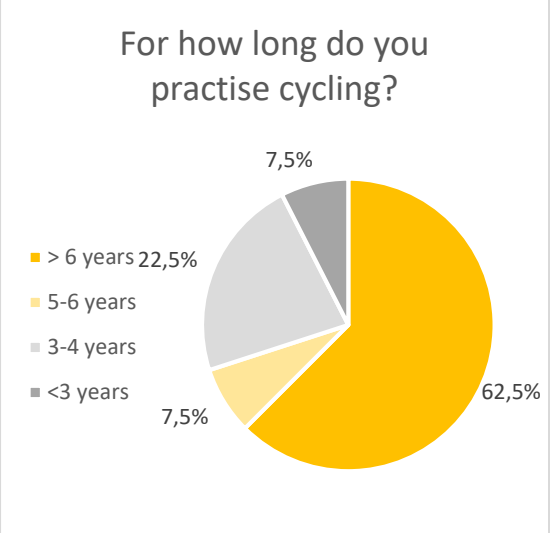
This section presents the results of the questionnaire that is conducted under 40 cyclists. The questionnaire was conducted in Dutch and the results are translated into English.

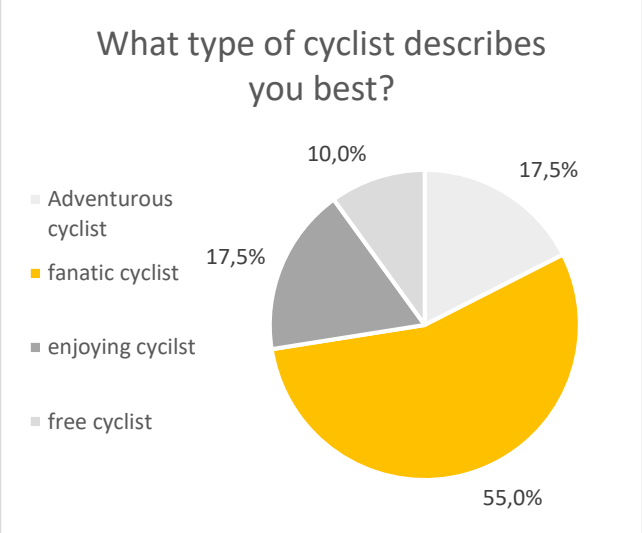
F.2.1 Respondent information, n=40



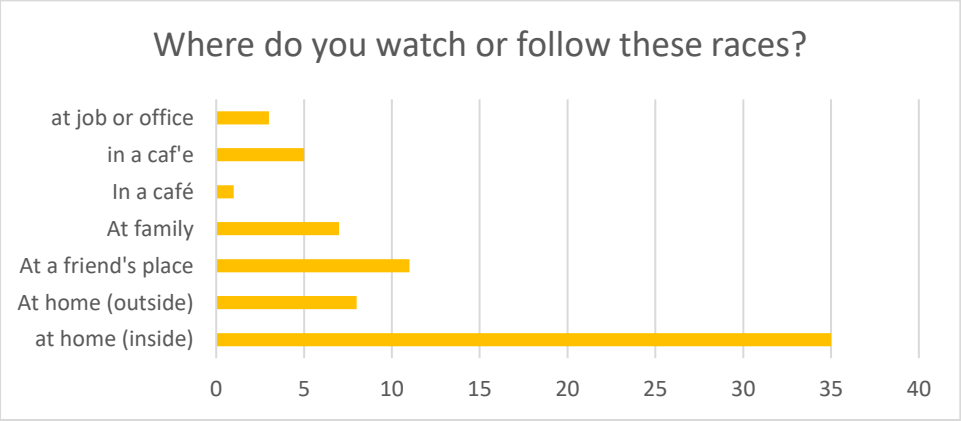


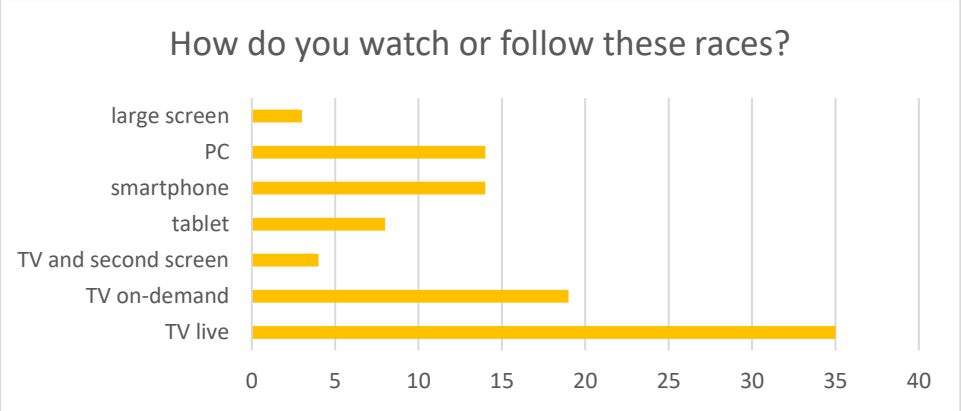


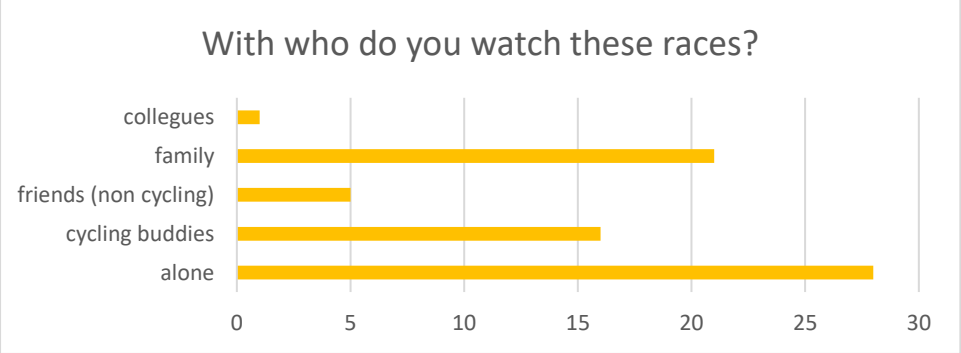


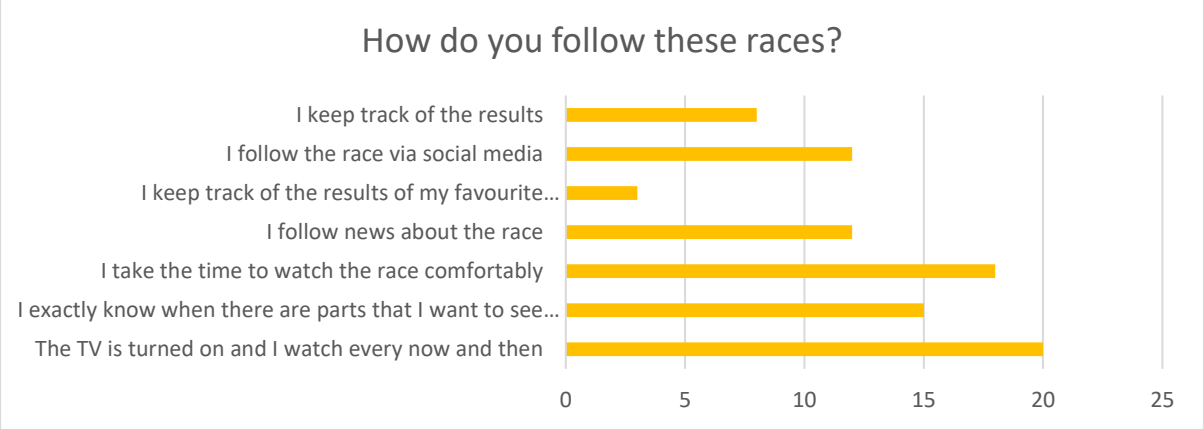


F.2.2 Het volgen van grote races zoals de Tour de France, Giro d'Italia en Vuelta a España n=36

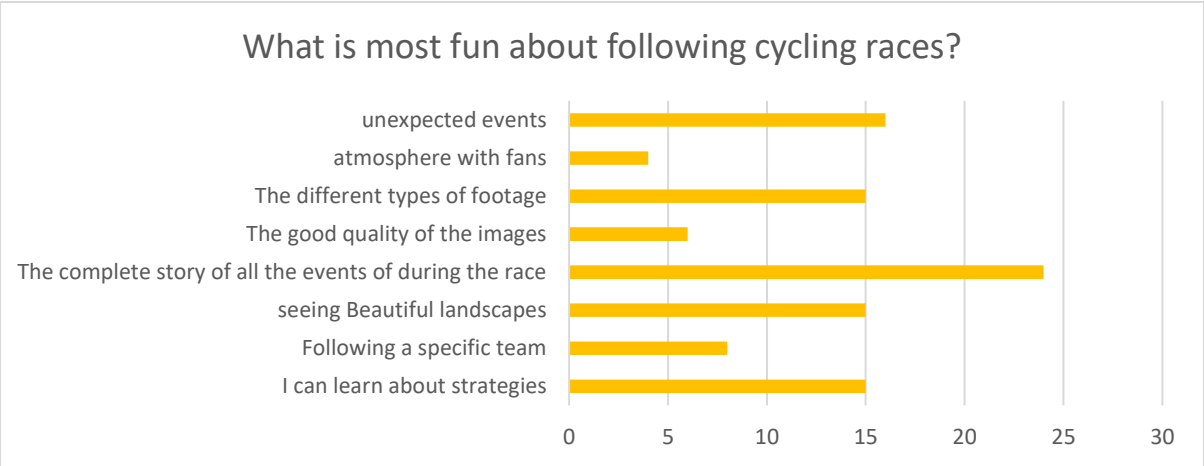


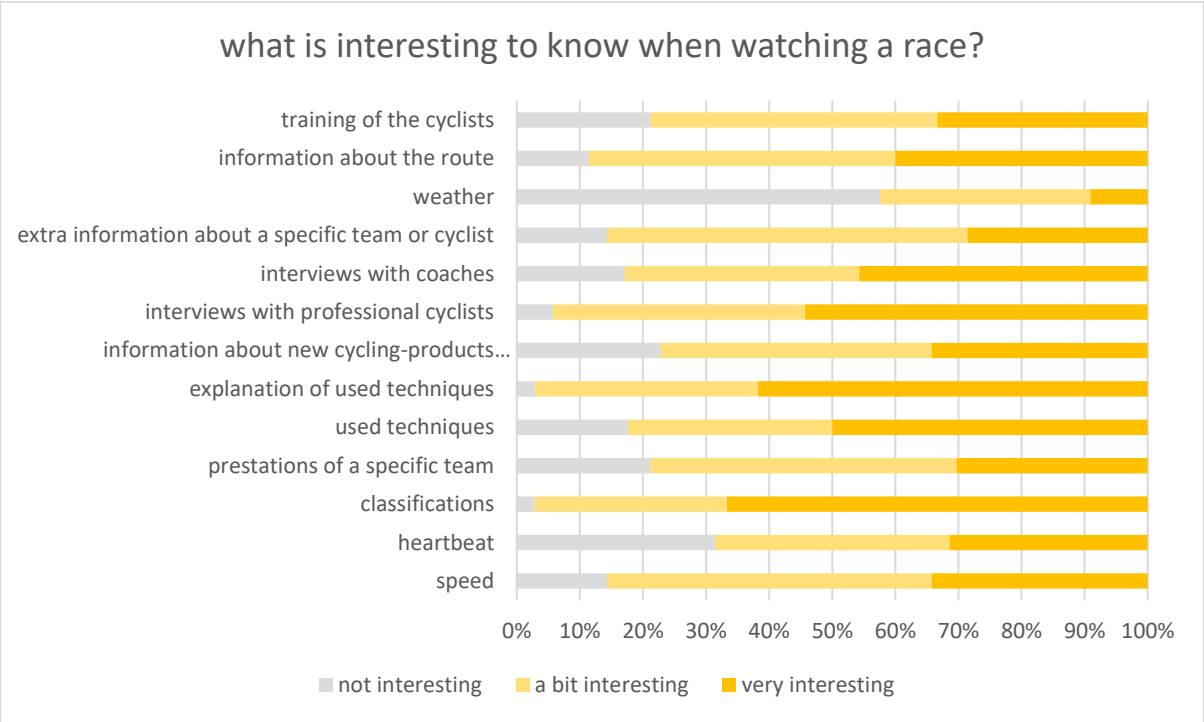




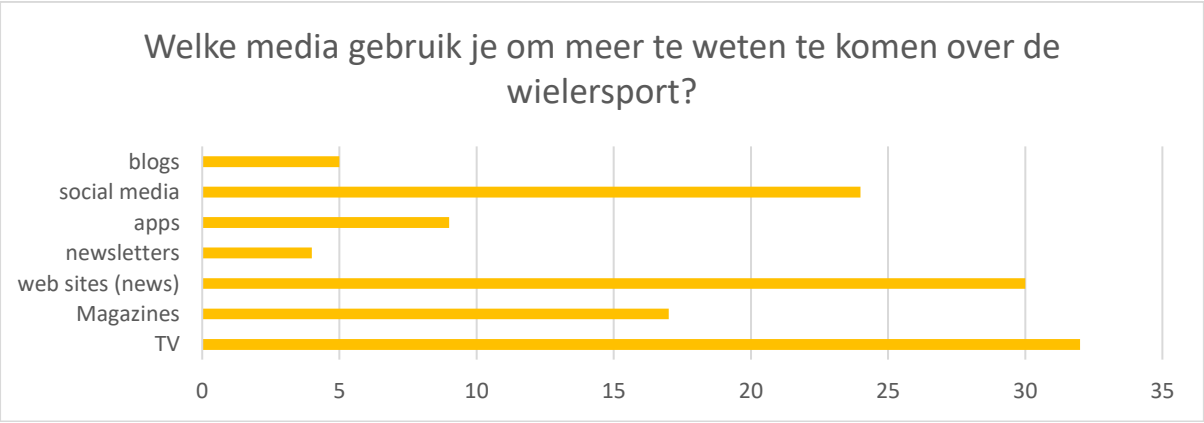


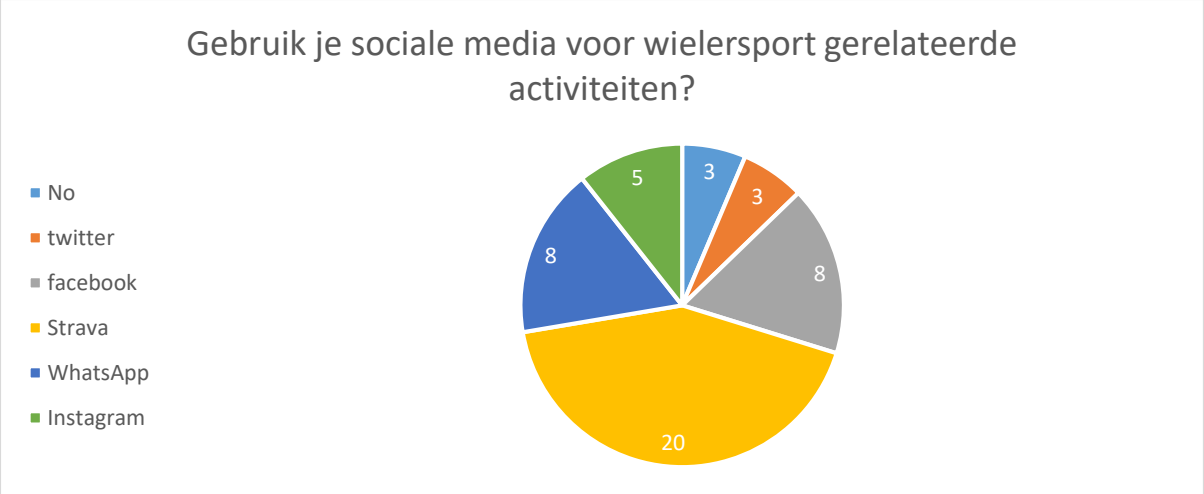
F.2.3 Kijkbeleving van grote races zoals de Tour de France, Giro d'Italia en Vuelta a España n=36

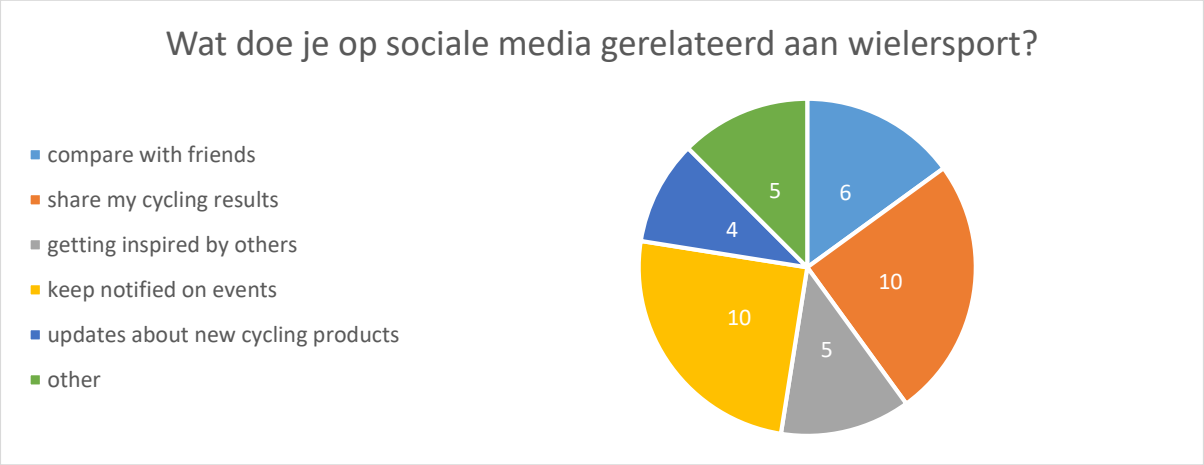


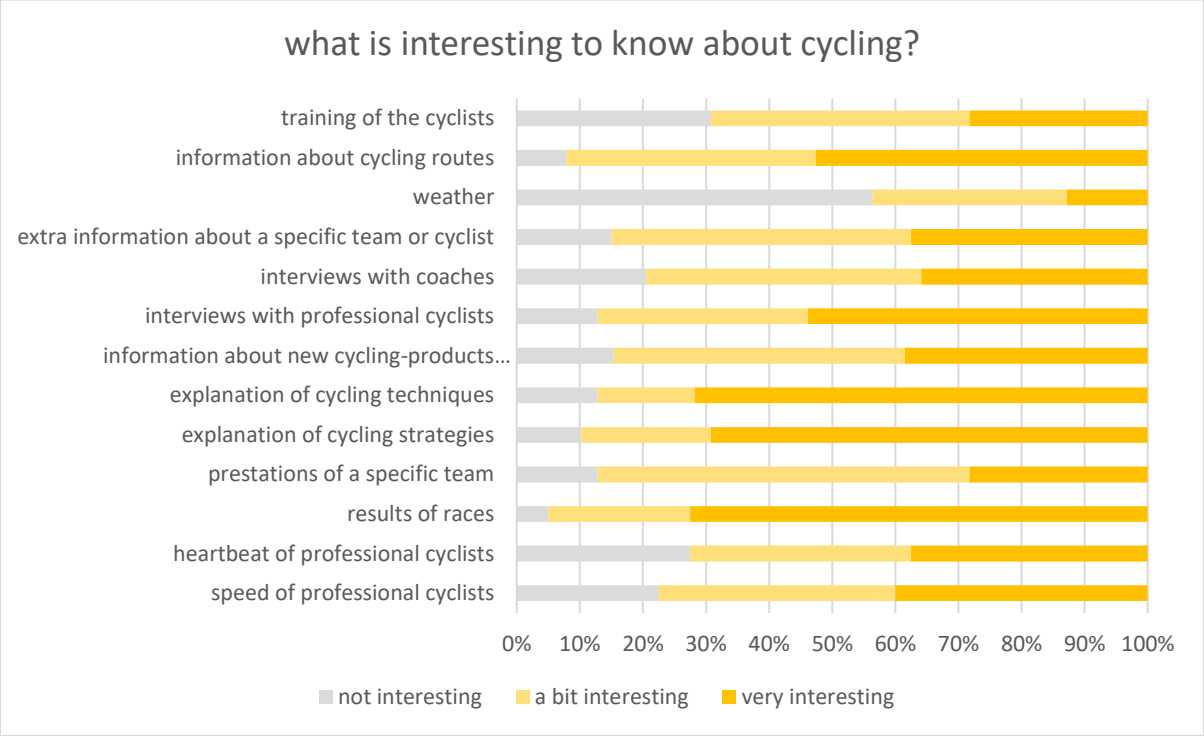


F.2.4 wielersport gerelateerde activiteiten n=40

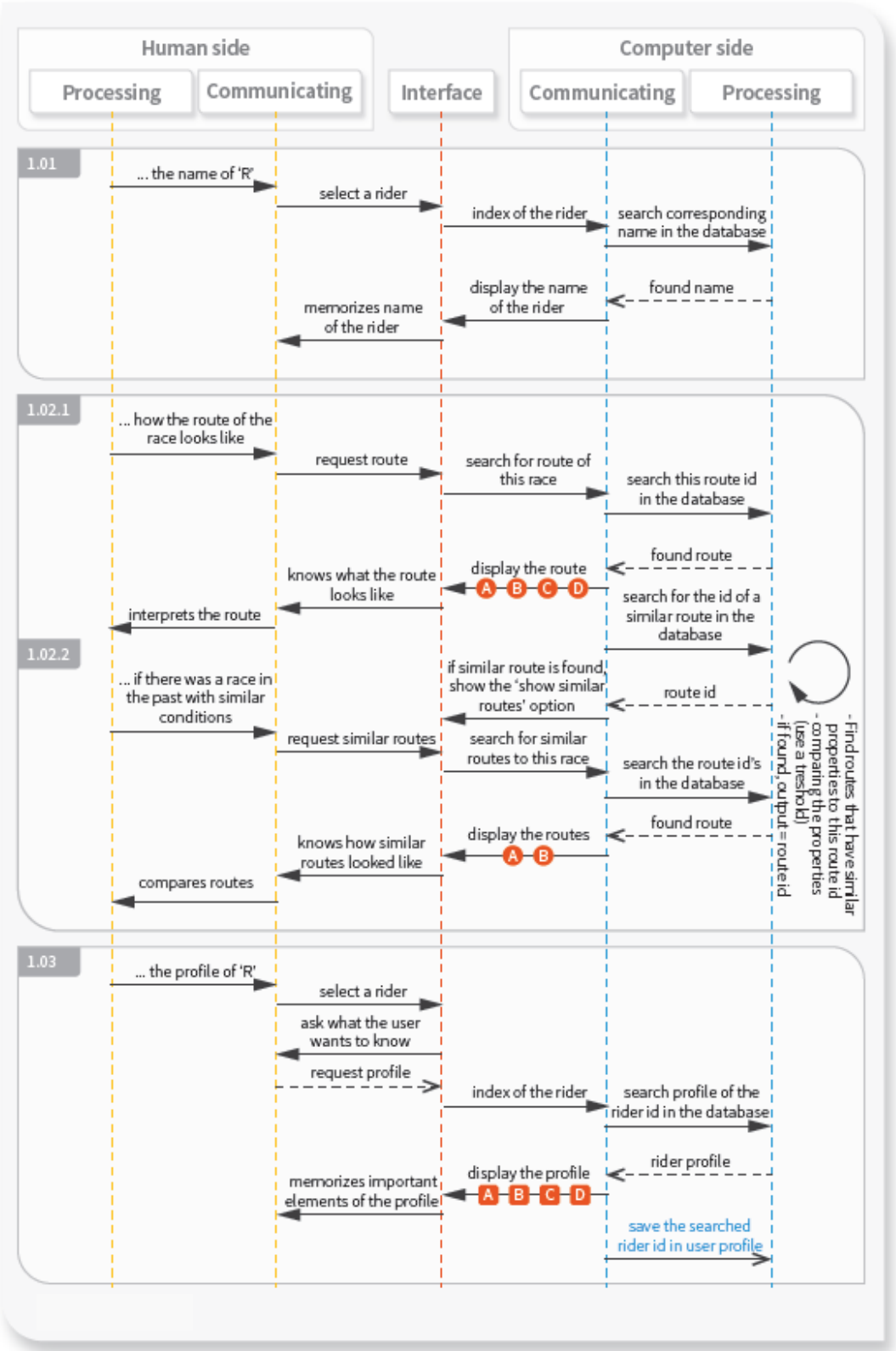


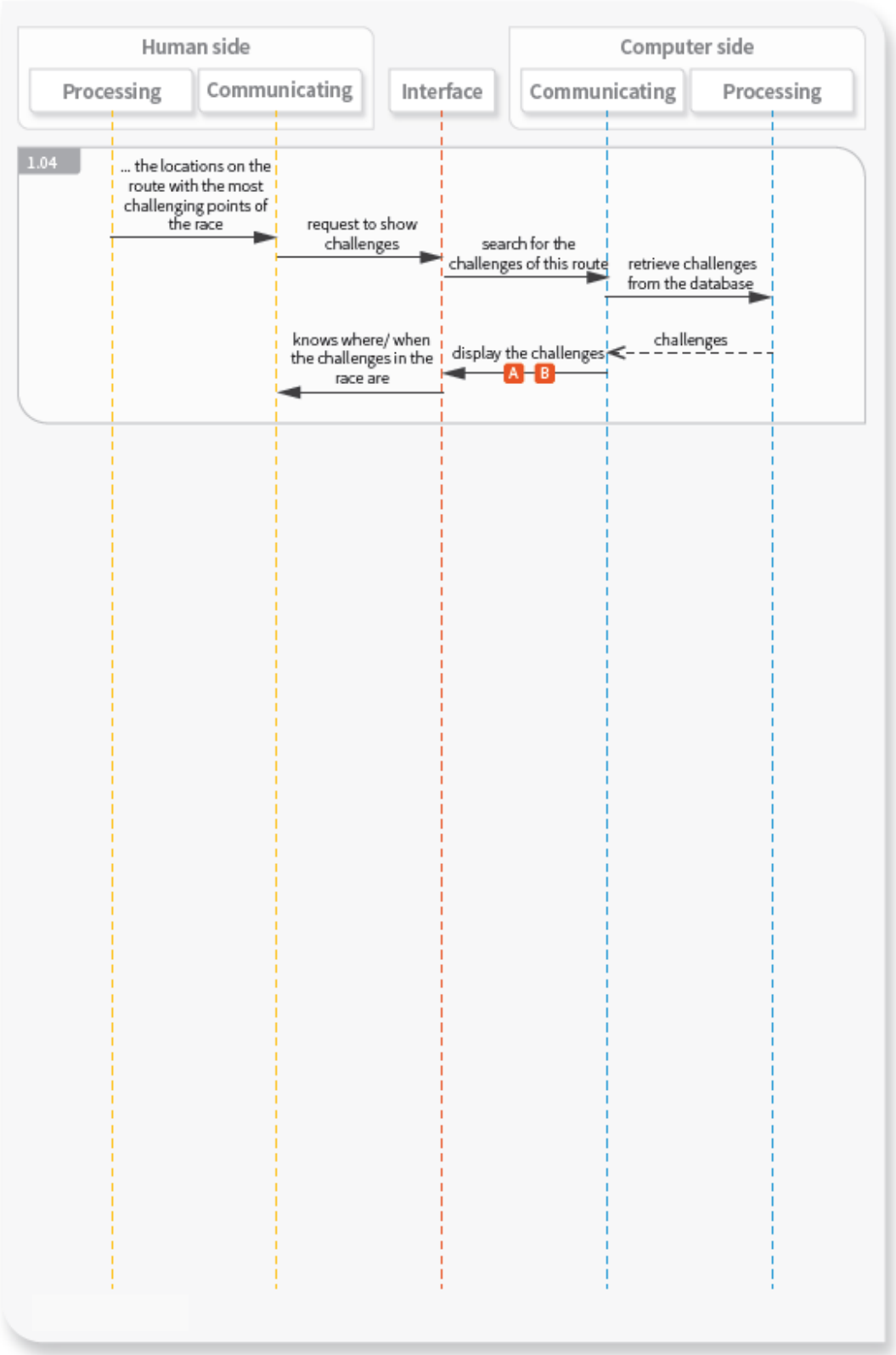

Gebruik je sociale media voor wielersport gerelateerde activiteiten?
No
twitter
facebook
Strava
WhatsApp
Instagram
3
3
8
20
8
5

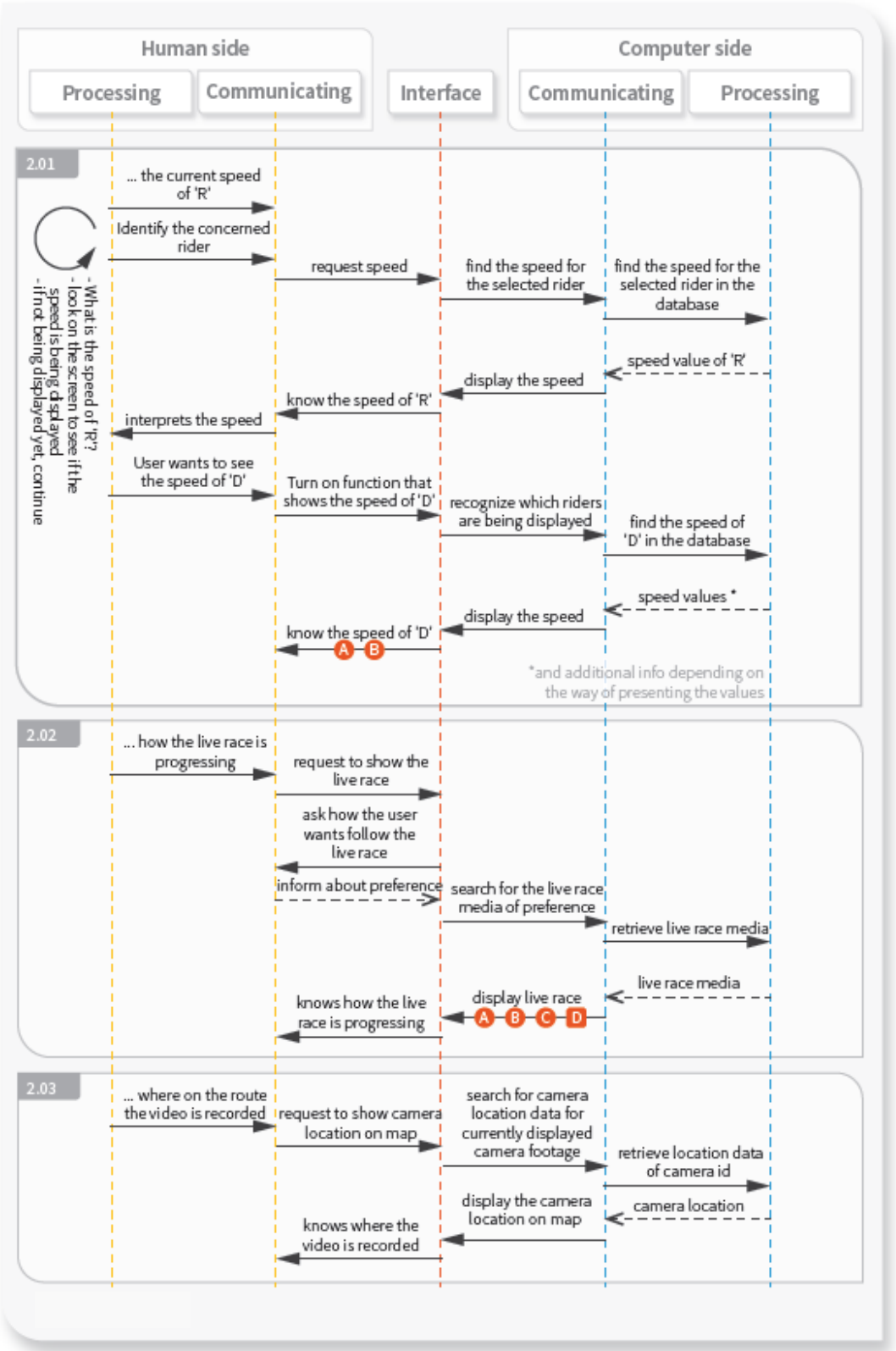

Wat doe je op sociale media gerelateerd aan wielersport?
compare with friends
share my cycling results
getting inspired by others
keep notified on events
updates about new cycling products
other
6
10
5
10
4
5

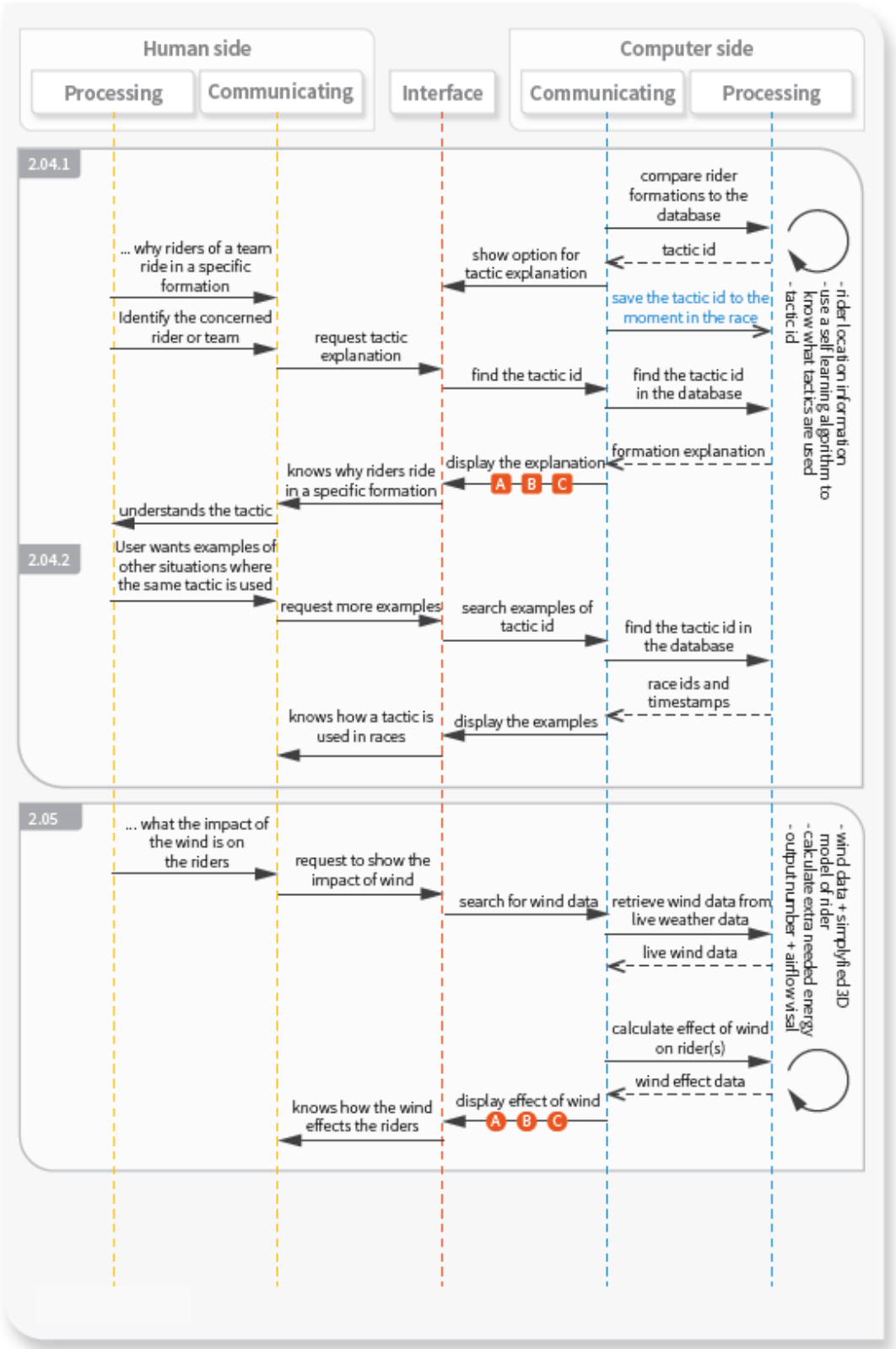

what is interesting to know about cycling?
training of the cyclists
information about cycling routes
weather
extra information about a specific team or cyclist
interviews with coaches
interviews with professional cyclists
information about new cycling-products...
explanation of cycling techniques
explanation of cycling strategies
prestations of a specific team
results of races
heartbeat of professional cyclists
speed of professional cyclists
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
not interesting
a bit interesting
very interesting

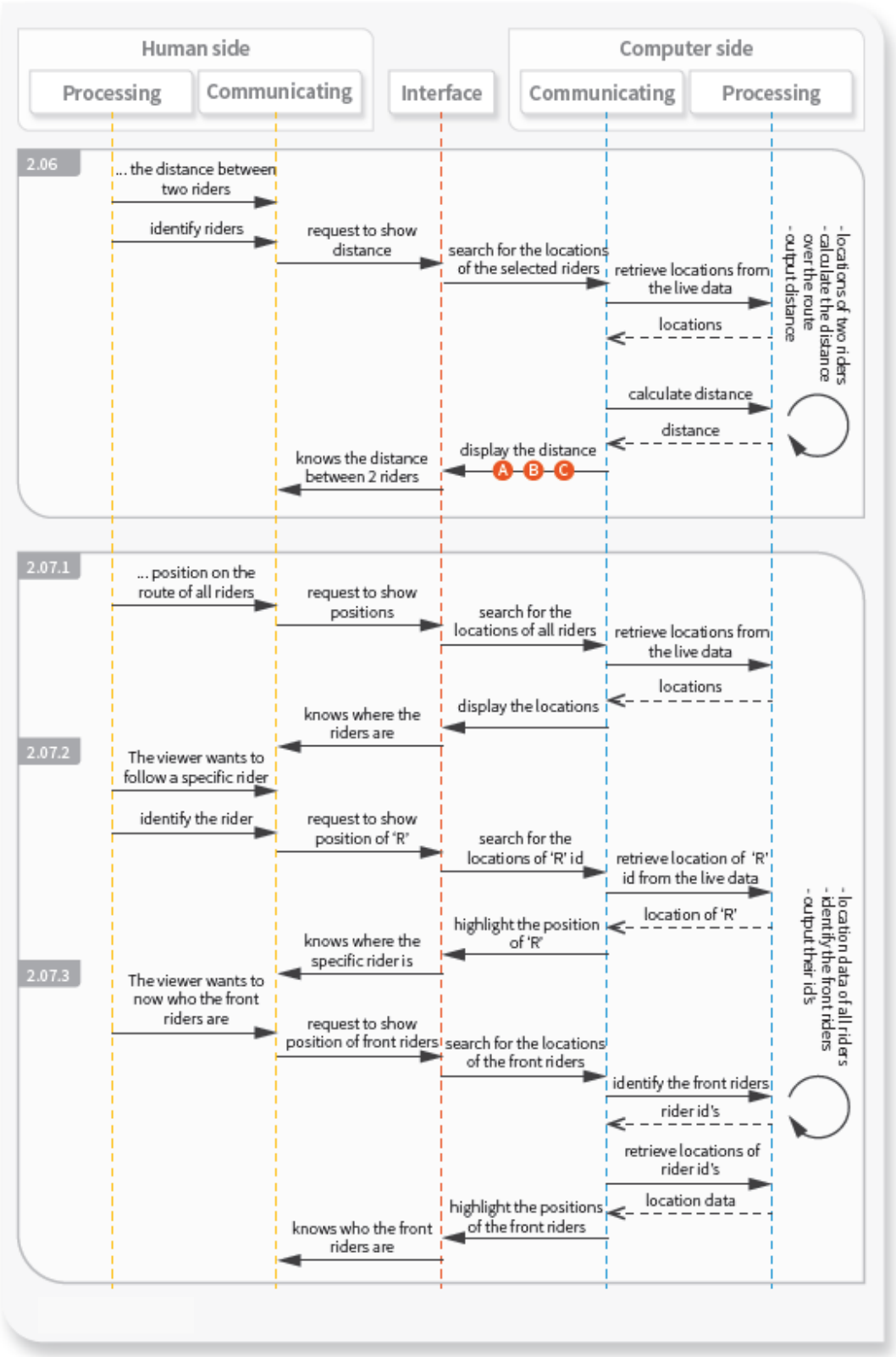
APPENDIX G: SEQUENCE DIAGRAMS

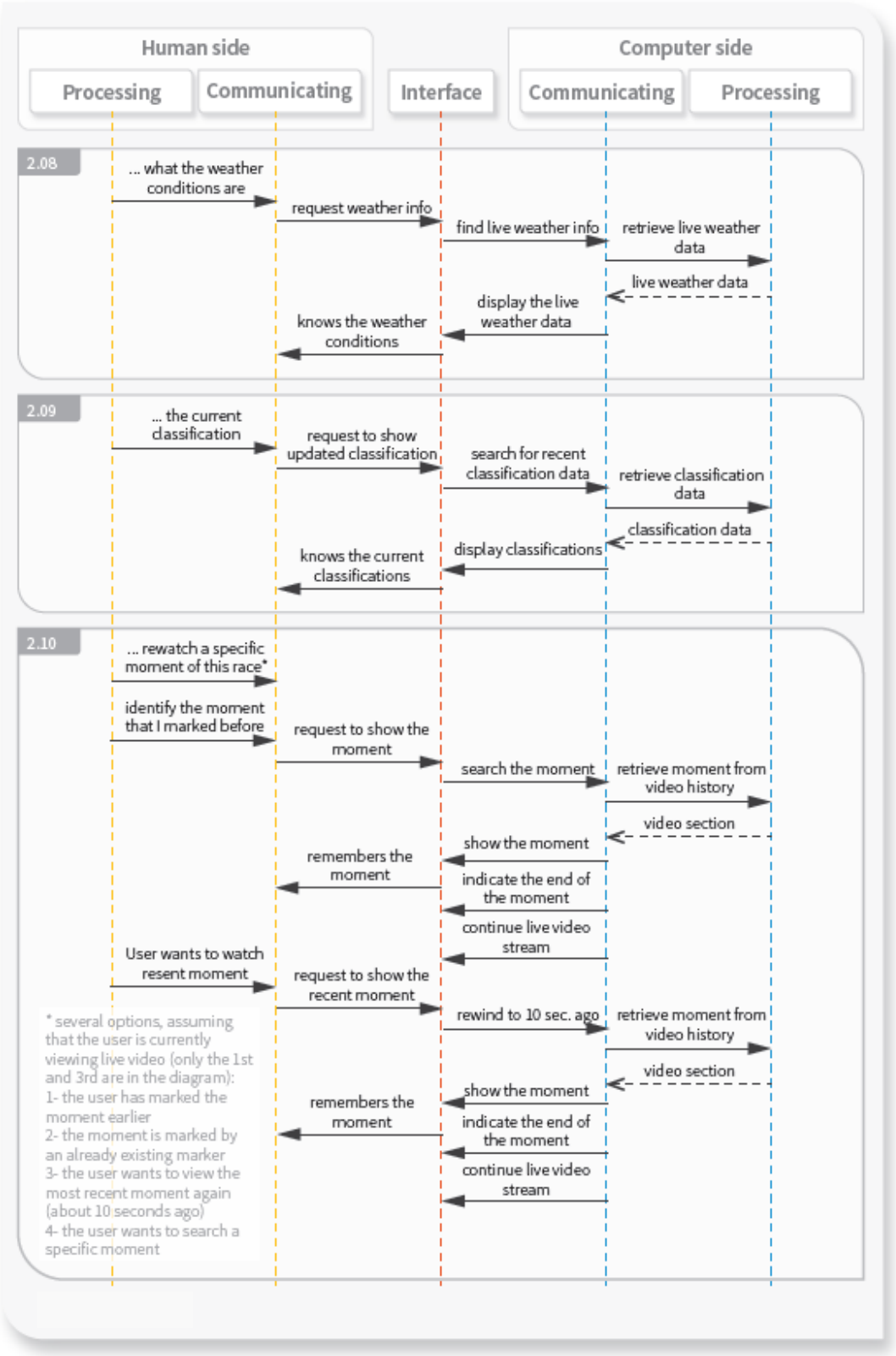



Human side
Processing
Communicating
Interface
Computer side
Communicating
Processing
1.04
... the locations on the route with the most challenging points of the race
request to show challenges
search for the challenges of this route
retrieve challenges from the database
challenges
display the challenges
A
B
knows where/ when the challenges in the race are


Human side
Processing
Communicating
Interface
Computer side
Communicating
Processing
2.01
... the current speed of 'R'
Identify the concerned rider
- What is the speed of 'R'?
- look on the screen to see if the speed is being displayed
- if not being displayed yet, continue
request speed
find the speed for the selected rider
find the speed for the selected rider in the database
speed value of 'R'
display the speed
know the speed of 'R'
interprets the speed
User wants to see the speed of 'D'
Turn on function that shows the speed of 'D'
recognize which riders are being displayed
find the speed of 'D' in the database
speed values *
display the speed
know the speed of 'D'
A B
*and additional info depending on the way of presenting the values
2.02
... how the live race is progressing
request to show the live race
ask how the user wants follow the live race
inform about preference
search for the live race media of preference
retrieve live race media
live race media
display live race
A B C D
knows how the live race is progressing
2.03
... where on the route the video is recorded
request to show camera location on map
search for camera location data for currently displayed camera footage
retrieve location data of camera id
camera location
display the camera location on map
knows where the video is recorded


Human side
Processing
Communicating
Interface
Computer side
Communicating
Processing
2.04.1
compare rider formations to the database
tactic id
... why riders of a team ride in a specific formation
show option for tactic explanation
save the tactic id to the moment in the race
- rider location information
- use a self learning algorithm to know what tactics are used
- tactic id
Identify the concerned rider or team
request tactic explanation
find the tactic id
find the tactic id in the database
formation explanation
display the explanation
A B C
knows why riders ride in a specific formation
understands the tactic
2.04.2
User wants examples of other situations where the same tactic is used
request more examples
search examples of tactic id
find the tactic id in the database
race ids and timestamps
knows how a tactic is used in races
display the examples
2.05
... what the impact of the wind is on the riders
request to show the impact of wind
search for wind data
retrieve wind data from live weather data
live wind data
- wind data + simplyfied 3D model of rider
- calculate extra needed energy
- output number + airflow visal
calculate effect of wind on rider(s)
wind effect data
knows how the wind effects the riders
display effect of wind
A B C


Human side
Processing
Communicating
Interface
Computer side
Communicating
Processing
2.06
... the distance between two riders
identify riders
request to show distance
search for the locations of the selected riders
retrieve locations from the live data
locations
- locations of two riders
- calculate the distance over the route
- output distance
calculate distance
distance
display the distance
A
B
C
knows the distance between 2 riders
2.07.1
... position on the route of all riders
request to show positions
search for the locations of all riders
retrieve locations from the live data
locations
display the locations
knows where the riders are
2.07.2
The viewer wants to follow a specific rider
identify the rider
request to show position of 'R'
search for the locations of 'R' id
retrieve location of 'R' id from the live data
location of 'R'
highlight the position of 'R'
knows where the specific rider is
2.07.3
The viewer wants to now who the front riders are
request to show position of front riders
search for the locations of the front riders
identify the front riders
rider id's
retrieve locations of rider id's
location data
highlight the positions of the front riders
knows who the front riders are
- location data of all riders
- identify the front riders
- output their id's


Human side
Processing
Communicating
Interface
Computer side
Communicating
Processing
2.08
... what the weather conditions are
request weather info
find live weather info
retrieve live weather data
live weather data
display the live weather data
knows the weather conditions
2.09
... the current classification
request to show updated classification
search for recent classification data
retrieve classification data
classification data
display classifications
knows the current classifications
2.10
... rewatch a specific moment of this race*
identify the moment that I marked before
request to show the moment
search the moment
retrieve moment from video history
video section
show the moment
remembers the moment
indicate the end of the moment
continue live video stream
User wants to watch resent moment
request to show the recent moment
rewind to 10 sec. ago
retrieve moment from video history
video section
show the moment
remembers the moment
indicate the end of the moment
continue live video stream
* several options, assuming that the user is currently viewing live video (only the 1st and 3rd are in the diagram):
1- the user has marked the moment earlier
2- the moment is marked by an already existing marker
3- the user wants to view the most recent moment again (about 10 seconds ago)
4- the user wants to search a specific moment

Options for implementation

1.02.1

- A display the route as a elevation graph
- B display the route as a top-view map
- C display the route as a semi-3D map
- D display the route as a 3D map (3D model)

1.02.2

- A display the routes as in multiple visualisations next to eachother
- B display the routes in one visualisation

1.03

display in the rider profile:

- A type of rider based on performance level (like DimensionData does, using a radar chart)
- B previous prestations
- C personal/ team info (name, age, etc)
- D online activity (i.e. riders official twitter/ strava account)

1.04

- A display the challenges as a list with indication of kilometers
- B display the challenges on a map

2.01

- A display the speed at the location of the rider
- B display the speed for each rider next to the name

2.02

display the live race via:

- A traditional video
- B 180 - 360 video footage
- C voice-over (sports commentator
- D live data (speed, distance, location, rankings, etc...)

2.04.1

explain tactic using:

- A an animation
- B video example of a race
- C a voice over

2.05

- A display the effect of the wind in a visual (3D)
- B display the effect of the wind by a number (amount of
- C extra energy needed by cyclists

2.06

- A Show a number for the distance
- B Use indications on the road (virtual) to make distance more clearly visible (like mile markers at the highway)
- C Draw a few circles (like a radius map) around the rider (virtually) you are focussing on with a fixed measurement

APPENDIX H: CONCEPTS

H.1 Sketches

This section shows the idea sketches (see figure G-1) that show different ideas that were explored for the lay-out of the elements in the VE and possibilities for interactions.

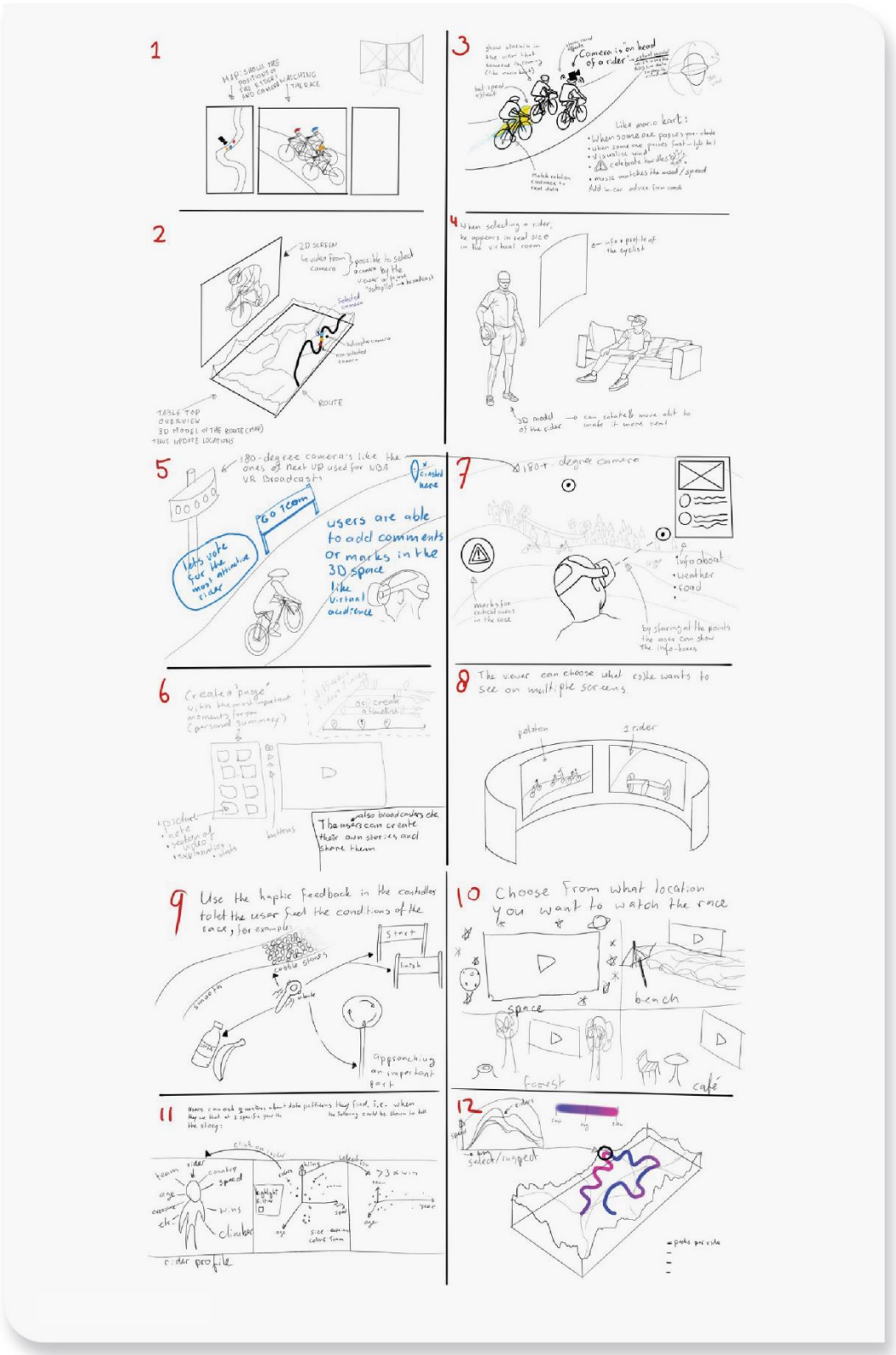


Figure G-1: idea sketches

H.2 Concept combinations from the morphological matrix

Figure G-2 shows the morphological matrix with the combination of the three concepts indicated.

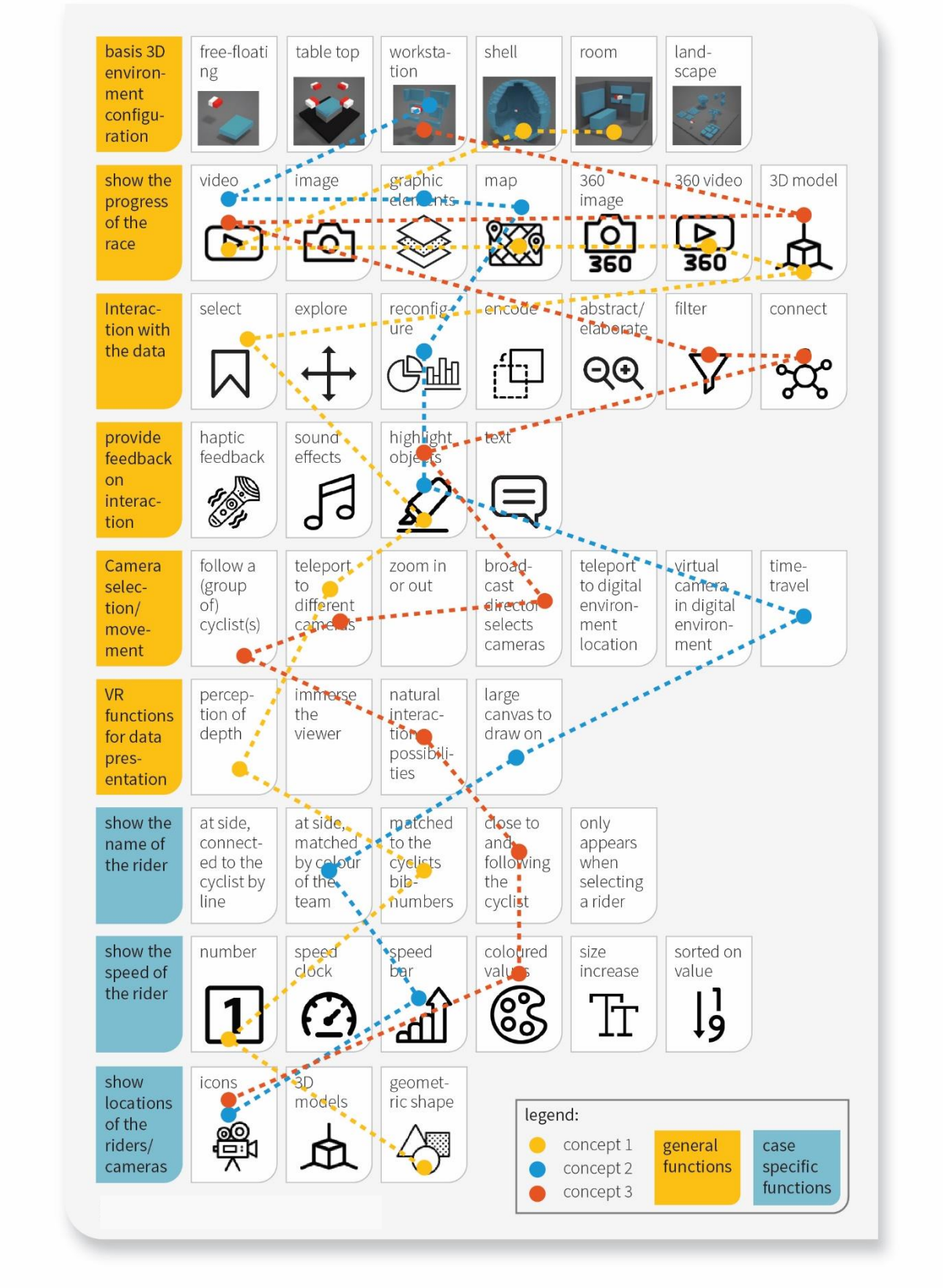


Figure G-2: Morphological matrix

APPENDIX I: TECHNOLOGY ROADMAP

Figure H-1 shows a technology roadmap for from the last 2 years and a prediction for the future about where the VR industry and market could move towards. The roadmap has three layers: market (VR applications), product (VR devices), and technology.
Some of the elements in the map have a reference to one of the notes below:
[1] the HTC Vive was the first commercial release of a headset with sensor-based tracking
[2] Oculus rooms makes VR more social by letting users be virtually together in a virtual room.
[3] Hands are used as controllers in the Hololens, an AR device.
[4] https://files.ably.io/research/whitepapers/the-future-of-sports-data.pdf
[5] Intel announced that they have plans to "unveil a range new technology products at the upcoming Tokyo 2020 Olympic Games, including AI-driven 3D tracking of athletes to enhance the broadcasts of events" (Singh, 2019).
[6] Foveated rendering is available in the HTC Vive Pro Eye, but only with supported apps and it is mainly targeted on the business sector (Engadget, 2019).
[7] The ultra-thin concept sketch is a prediction from Oculus on the future of VR headsets (Fingas, 2018).

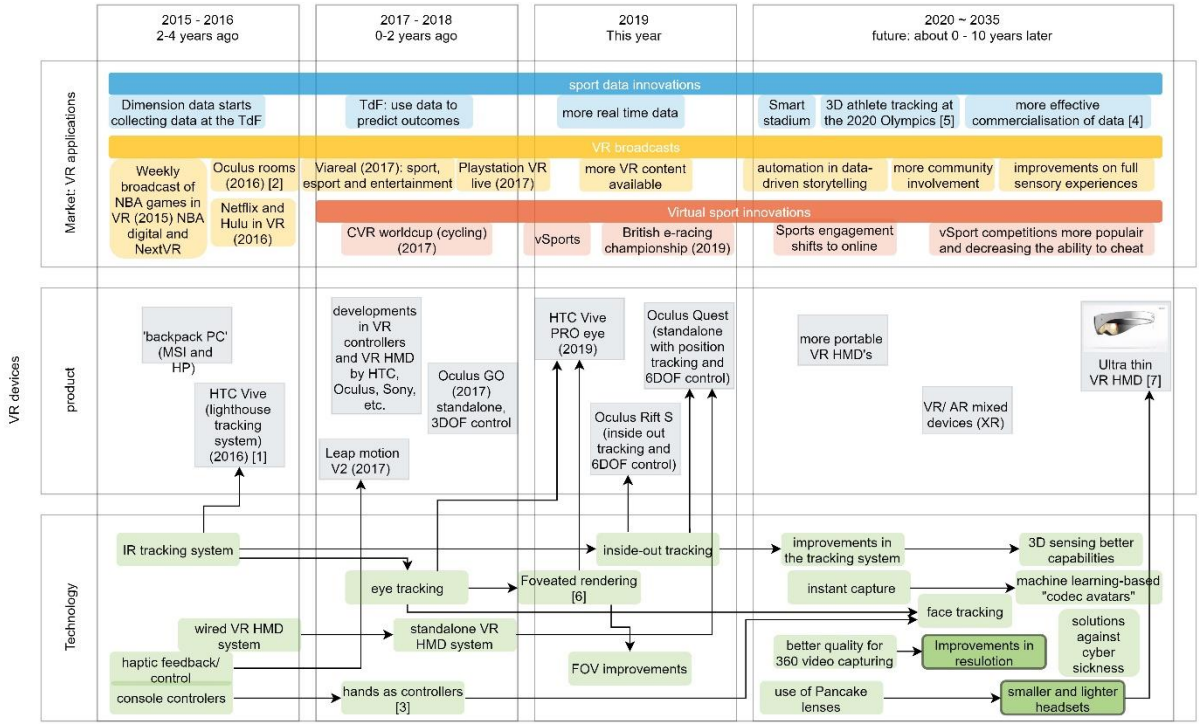


Figure H-1: Technology roadmap

APPENDIX J: PROTOTYPING

J.1 Recording video and data

For the recording of the data, a group of six cyclists performed a fictional short race of three minutes in a flat meadow area in the Netherlands (on a street named 'Spookverlaat'). Figure I-1 shows a image from google earth of this street. This image is used as a reference to create the 3D map that is used in the prototype.

Figure I-1: Google Earth image of the street 'Spookverlaat' in the Netherlands.

J.2 Set up unity with the VRTK (VR Toolkit)

The following steps were taken to get the VRTK asset in combination with the HTC Vive and SteamVR working:

1) Open a new project in unity version 2017.3 (Do not use another version or open the created project in another version of 'Unity'!)
2) Install VRTK from the asset store: https://assetstore.unity.com/packages/tools/integration/vrtk-virtual-reality-toolkit-vr-toolkit-64131
3) Download the older version of the SteamVR plugin here: https://github.com/ValveSoftware/steamvr_unity_plugin/releases/tag/1.2.3 and import it in the project (Asset > Import Package > Custom Package > locate the downloaded file.
4) Check the SDK's

Using the straight pointer of the VRTK:

1) Try the example "simple pointer" from VRTK (should work)
2) Copy and paste in your own project
3) Go to [VRTK_SDKManager] and paste the "LeftcontrollerScriptAlias" from [VRTK_Scripts] in the box Script Aliases > Left Controller. Do the same for right.

APPENDIX K: TESTING

K.1 Test plan

This appendix is an additional explanation to what is already mentioned in the report. The objective, research question, test setup and description of the participants are already written in the report and not mentioned again.

Methods

Quantitative data is collected using a quiz (to evaluate the learning effect) and the UEQ (to evaluate the experience). The quiz questions will, in both test versions, be shown on the screen. The questions will be shown on the screen, so that the participant cannot review the questions. The time to answer will be limited: the question will first be read aloud (pre-recorded) and then a timer of 5 seconds starts. The participants will fill in their answers on a paper form. Between every question there is a blank screen for 1 second. The following are included in the quiz:

1. How many cyclists did participate in this race?
2. When did the group split into two groups?
3. What was the average speed of the cyclists in the first half of the race
4. What was the speed of the winning cyclist when crossing the finish line?
5. Who had a camera on the bike?
6. Where on the scooter were the cameras located?
7. What is the name of the cyclist who was in front of the peloton for most of the time?
8. Who won the race?
9. What was the highest speed of the winning cyclist?
10. What was the shape of the route of this race?

The UEQ is a standardized questionnaire that asks the participant to evaluate the service on the following items using a 7 point Likert scale:

	1	2	3	4	5	6	7		
annoying	○	○	○	○	○	○	○	enjoyable	1
not understandable	○	○	○	○	○	○	○	understandable	2
creative	○	○	○	○	○	○	○	dull	3
easy to learn	○	○	○	○	○	○	○	difficult to learn	4
valuable	○	○	○	○	○	○	○	inferior	5
boring	○	○	○	○	○	○	○	exciting	6
not interesting	○	○	○	○	○	○	○	interesting	7
unpredictable	○	○	○	○	○	○	○	predictable	8
fast	○	○	○	○	○	○	○	slow	9
inventive	○	○	○	○	○	○	○	conventional	10
obstructive	○	○	○	○	○	○	○	supportive	11
good	○	○	○	○	○	○	○	bad	12
complicated	○	○	○	○	○	○	○	easy	13
unlikable	○	○	○	○	○	○	○	pleasing	14
usual	○	○	○	○	○	○	○	leading edge	15
unpleasant	○	○	○	○	○	○	○	pleasant	16
secure	○	○	○	○	○	○	○	not secure	17
motivating	○	○	○	○	○	○	○	demotivating	18
meets expectations	○	○	○	○	○	○	○	does not meet expectations	19
inefficient	○	○	○	○	○	○	○	efficient	20
clear	○	○	○	○	○	○	○	confusing	21
impractical	○	○	○	○	○	○	○	practical	22
organized	○	○	○	○	○	○	○	cluttered	23
attractive	○	○	○	○	○	○	○	unattractive	24
friendly	○	○	○	○	○	○	○	unfriendly	25
conservative	○	○	○	○	○	○	○	innovative	26

Figure J-1: UEQ questionnaire in English

Measures:
While G2 is testing the prototype, their interaction with it will be recorded using Unity. In other words, we will know when they are watching from which camera view and in which state the 3D map is.

Test procedure:
The tests are performed according to the following steps:

1. Introduction to the research
    a. Consent form
    b. Preliminary questionnaire
2. Introduction to the prototype
    a. Let the user get familiar with the system
3. View prototype (1 race from start to finish: 3 minutes)
4. Quiz
5. Questionnaire

The introduction to the research will be written on the first page of the consent form.

The introduction to the prototype is different for S1 and S2. For S1 there will be a short preview of the footage to check if the participants can clearly see the screen and that they know what to expect.
The participants of S2 will get an explanation of how the VR system works. Then the participants will try to select a camera a few times in a mock-up virtual scene.

Content for the prototypes for both setups
For both S1 and S2 the same video footage will be used, but in S1 the footage will be edited into a broadcast-like video. The table J-1 shows how this video will be edited. It also indicated where the information to answer each question can be found. In S2 the participants can select themselves from which camera they watch the race. In this setup, the information shown on the virtual screen differs per type of camera, but information is always shown on the map. Table J-2 shows what information is shown for which camera view in S2. In this way, for both setups, the information needed to answer the quiz question is provided (see table 3 for an overview where the answers on the quiz questions can be found). All tables are shown on the next page.

Table J-1: The storyboard of the video (used in S1): the red text shows where the answers on the questions can be found

Cut	Camera view	Content of footage	Information shown	Answer to question nr.
1	B: scooter Go Pro	Start of the race	-	6
2	A: drone	(long) view of the start of the race show the split in 2 groups	Show for 20 seconds the speed of the cyclists	6, 7, 1, 3
3	C: Scooter 360 high	(short)	Show the names of the cyclists in the first peloton (first group)	6, 2, 3
4	D: bike 360	(short) view of the cyclists in front of the camera bike.	Show the names	5
5	A: drone	Overview of the race and the route	-	1, 10
6	B: scooter Go Pro	Switching between the scooter camera's	Show the names	6
7	C: Scooter 360 high		Show name and speed	6
8	B: scooter Go Pro		Show name and speed	6
9	D: bike 360	view of the cyclist's face and then rotate to his view forward.	Show the speed of this cyclist only	4, 5, 9
10	E: finish line	Finish of the race	Show the names of the 3 first finishing cyclists in a ranking.	4, 8

Table J-2: The shown information per camera view in S2

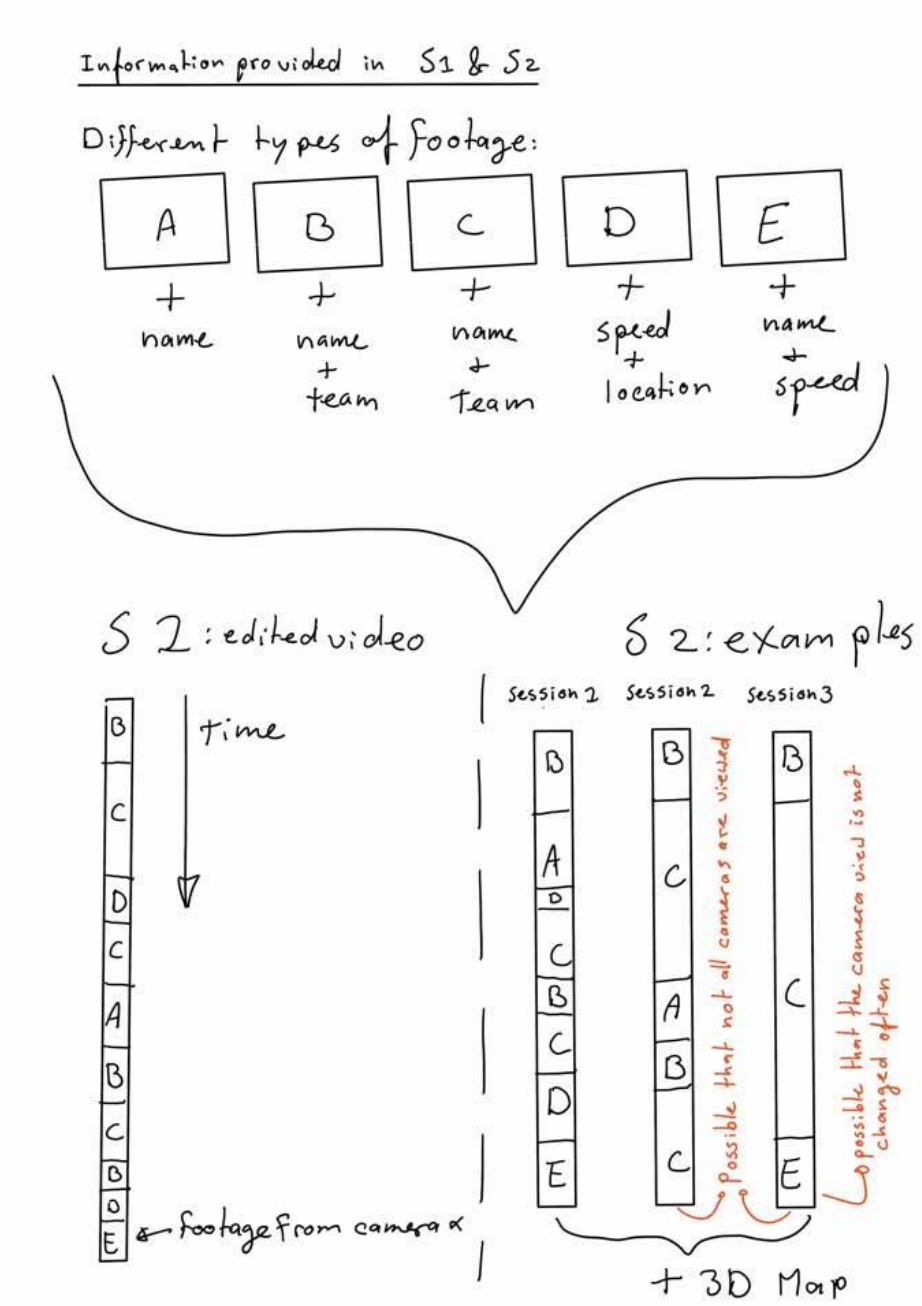
	Stationary camera at finish-line (3D)	Camera on bike (360)	Camera on motorbike (2D and 360)	Drone camera (2D)
Name of cyclist	x		x	
Speed of cyclist	x	x		
location of cyclists		x		x (is already in the video)

Table J-3: overview where the answers on the quiz questions can be found

Question	S1: screen setup		S2: VR setup			Information asked
	video	info	video	info	map	
1	x		x		x	Number
2	x		x		x	Moment (map)
3		x		x	x	Speed
4	x	x	x	x	x	Speed
5	x		x		x	Camera location
6	x		x		x	Camera location
7		x		x	x	Name
8	x	x	x	x	x	Name
9		x		x	x	Speed
10	x		x		x	Shape (map)

Information equity

The same video footage is used for both S1 and S2. The information overlays on this footage will be the same for the used footage, but in S1 the footage is edited into one video and in S2 the users can select which footage to watch by themselves. This results in viewing different information for a different amount of time (since the information for the different types of footage is not the same, see image below). For S2 the information will always be visible on the 3D map, but in a different representation than on the video.
So for S1 the shown information is fixed, and for S2 the shown information differs per session. Because of the 3D map in S2 the information is always available. It can happen that in S2 the information is shown on the screen and the map at the same time. The shown information in S1 and S2 is similar, but the 3D map has a different representation which results in a higher chance that the viewer can pick up the information (because of the different representations), but also in a higher chance of missing out on information (when only focusing on the screen).



Answer options for the questions

1. How many cyclists did participate in this race?
   a. 5
   b. 6
   c. 8
2. When did the group split into two groups?
   a. Before or during the first corner
   b. After the first corner, but before the second corner
   c. During or after the second corner
3. What was the average speed of the cyclists during the race
   a. 35 km/h
   b. 40 km/h
   c. 45 km/h
4. What was the speed of the winning cyclist when crossing the finish line?
   a. 50 km/h
   b. 48 km/h
   c. 45 km/h
5. Who had a camera on the bike?
   a. ~~Bart~~ → Tom
   b. Lucas
   c. Daan
6. Where on the scooter were the cameras located?
   a. Front and back
   b. Back and above
   c. Only at the back
7. What is the name of the cyclist who was in front of the peloton for most of the time?
   a. Jan
   b. Bart
   c. Daan
8. Who won the race?
   a. Bart
   b. Jan
   c. Tom
9. What was the highest speed of the winning cyclist?
   a. 48 km/h
   b. 50 km/h
   c. 53 km/h
10. What was the shape of the route of this race?

a. 

b. 

c. 

Correct answers

1. B
2. A
3. B
4. C
5. ~~C~~ →A
6. B
7. B
8. C
9. C
10. A

Tour de France broadcast user test

Dear participant,

Welcome to the user test for a Tour de France broadcasting service. During this user test you will watch a recreated broadcast of a cycling race. Afterwards you will be asked to do a quiz and to fill in a questionnaire. Please follow the instructions

The test is about the performance of the designed product, NOT about your personal capabilities.

To keep the results anonymous you will be given a participant number.

Participant nr: …….

Group: O S1 O S2

Consent form

1. I volunteer to participate in a product evaluation experiment conducted for a student's graduation project at the University of Technology Delft, Faculty of Industrial Design Engineering.
2. I understand that the product evaluation experiment is designed to gather information to the evaluate the designed product.
3. My participation in this product evaluation experiment is voluntary. I understand that I will not be paid for my participation, except for the free gift. I may withdraw and discontinue participation at any time without penalty.
4. Participation involves answering personal background questions, using a Virtual Reality device or watching a large screen, doing a quiz and filling in a questionnaire. This process will take around 20 minutes.
5. I understand that the experiment doesn't want to measure my performance, but the performance of the designed product. No specific participant related performance measurement is transferred to any external source.
6. I have read and understand the explanation provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.
7. I have been given a copy of this consent form.

Name:

…….
Sign:

…….
Date:

…….

For further information you can contact me via d.h.vantol@student.tudelft.nl

Preliminary questionnaire

What is your age?

……

What is your nationality?

……

Did you ever use a virtual reality device before?

O a high-end virtual reality headset

O virtual reality goggles in which you place a phone

O no, I have not used a virtual reality device before

Have you watched large cycling races like the Tour de France?

O yes

O no

Do you do cycling as a sport?

O yes

O no

Quiz answer sheet

The questions will be presented on the screen. After each question is read aloud, a timer of 5 seconds will start. Please draw a circle around the answer on this sheet after each question is read. You will first see an example question.

Example Question	Answer		
0	A	B	C

Please ask the researcher if you have any questions.

Now the quiz will start.

Question	Answer		
1	A	B	C
2	A	B	C
3	A	B	C
4	A	B	C
5	A	B	C
6	A	B	C
7	A	B	C
8	A	B	C
9	A	B	C
10	A	B	C

Please make your evaluation now.

For the assessment of the product, please fill out the following questionnaire. The questionnaire consists of pairs of contrasting attributes that may apply to the product. The circles between the attributes represent gradations between the opposites. You can express your agreement with the attributes by ticking the circle that most closely reflects your impression.

Example:

attractive	○	⊗	○	○	○	○	○	unattractive

This response would mean that you rate the application as more attractive than unattractive.

Please decide spontaneously. Don't think too long about your decision to make sure that you convey your original impression.

Sometimes you may not be completely sure about your agreement with a particular attribute or you may find that the attribute does not apply completely to the particular product. Nevertheless, please tick a circle in every line.

It is your personal opinion that counts. Please remember: there is no wrong or right answer!

Please assess the product now by ticking one circle per line.

	1	2	3	4	5	6	7		
annoying	○	○	○	○	○	○	○	enjoyable	1
not understandable	○	○	○	○	○	○	○	understandable	2
creative	○	○	○	○	○	○	○	dull	3
easy to learn	○	○	○	○	○	○	○	difficult to learn	4
valuable	○	○	○	○	○	○	○	inferior	5
boring	○	○	○	○	○	○	○	exciting	6
not interesting	○	○	○	○	○	○	○	interesting	7
unpredictable	○	○	○	○	○	○	○	predictable	8
fast	○	○	○	○	○	○	○	slow	9
inventive	○	○	○	○	○	○	○	conventional	10
obstructive	○	○	○	○	○	○	○	supportive	11
good	○	○	○	○	○	○	○	bad	12
complicated	○	○	○	○	○	○	○	easy	13
unlikable	○	○	○	○	○	○	○	pleasing	14
usual	○	○	○	○	○	○	○	leading edge	15
unpleasant	○	○	○	○	○	○	○	pleasant	16
secure	○	○	○	○	○	○	○	not secure	17
motivating	○	○	○	○	○	○	○	demotivating	18
meets expectations	○	○	○	○	○	○	○	does not meet expectations	19
inefficient	○	○	○	○	○	○	○	efficient	20
clear	○	○	○	○	○	○	○	confusing	21
impractical	○	○	○	○	○	○	○	practical	22
organized	○	○	○	○	○	○	○	cluttered	23
attractive	○	○	○	○	○	○	○	unattractive	24
friendly	○	○	○	○	○	○	○	unfriendly	25
conservative	○	○	○	○	○	○	○	innovative	26

K.2 Test results

K.2.1 Results quiz

Table K-4 shows the information about the participants, and table K-5 shows their scores on the quiz questions, the amount of correct answers per participant and the amount or correct answers per question. The answers on question 5 are shown in the last column, they are left out of the evaluation because there is no data for all participants of S1.

participant	test no	age	nationality	did you use VR before?			watching cycing	Do you do cycling as a sport? 5 = no; 1 yes, but no competition; 2: yes, also competition	gender
				yes high end	yes low end	no			
1	S1	32	D	0	0	1	yes	2	F
2	S1	21	D	1	0	0	yes	1	M
3	S1	24	D	1	1	0	no	5	M
4	S1	23	D	1	1	0	yes	5	F
5	S1	23	D	1	0	0	yes	5	F
6	S1	23	D	0	0	1	no	5	M
7	S1	23	D	1	0	0	yes	5	M
8	S1	25	D	0	1	0	no	5	M
9	S1	24	D	1	0	0	no	1	M
10	S1	30	D	1	1	0	yes	5	M
11	S2	27	D	1	1	0	yes	5	M
12	S2	26	D	1	1	0	yes	5	F
13	S2	24	D	0	0	1	yes	5	M
14	S2	24	D	1	0	0	yes	1	M
15	S2	26	D	0	0	1	yes	5	M
16	S2	23	D	1	0	0	yes	1	M
17	S2	23	D	0	0	1	yes	5	F
18	S2	53	D	1	0	0	yes	1	F
19	S2	55	D	0	1	0	yes	1	M
20	S2	52	D	1	0	0	yes	1	F

Table K-4: Detailed information about the participants

participant	test no	Quiz (1 is right answer, 0 is wrong answer)										amount of right answers	gem right	question 5
		1	2	3	4	5	6	7	8	9	10		5,6	
1	S1	1	1	0	0		1	1	1	0	1	6		
2	S1	1	1	1	0		1	1	1	1	1	8		
3	S1	1	0	0	0		0	1	0	1	0	3		
4	S1	1	0	0	0		1	1	1	1	0	5		
5	S1	0	0	1	0		0	1	1	1	0	4		
6	S1	1	0	1	1		1	1	0	1	1	7		
7	S1	1	0	1	0		0	1	1	1	1	6		
8	S1	1	1	1	0		1	1	1	1	1	8		0
9	S1	0	0	1	0		0	1	0	1	1	4		0
10	S1	1	1	0	1		0	1	0	1	0	5		1
		8	4	6	2		5	10	6	9	6			
11	S2	1	0	1	0		1	0	0	1	1	5	5,5	0
12	S2	1	0	1	1		0	1	1	0	1	6		0
13	S2	1	1	1	0		0	1	1	1	1	7		1
14	S2	1	0	0	0		1	1	1	1	0	5		1
15	S2	1	1	1	1		0	0	1	1	1	7		1
16	S2	0	0	0	0		1	1	1	1	1	5		1
17	S2	1	1	1	0		0	1	1	0	1	6		1
18	S2	1	1	0	0		0	1	1	1	0	5		1
19	S2	1	0	0	0		0	0	0	0	1	2		0
20	S2	1	0	1	1		1	0	1	1	1	7		1
		9	4	6	3		4	6	8	7	8			7

Table K-5: Answers on each question per participant

K.2.2 Results UEQ

Explanation from the UEQ document:

"The values for the single items are listed to allow you to detect outliers in the evaluations. If an item shows big deviations to the evaluations of the other items of the same scale this can be a hint that the item is misinterpreted (for example, because of a special context in your evaluation) by a higher number of participants.

Values between -0.8and 0.8 represent a more or less neural evaluation of the corresponding scale, values > 0,8 represent a positive evaluation and values < -0,8 represent a negative evaluation.

The range of the scales is between -3 (horribly bad) and +3 (extremely good). But in real applications, in general, only values in a restricted range will be observed. It is due to the calculation of means over a range of different persons with different opinions and answer tendencies (for example the avoidance of extreme answer categories) extremely unlikely to observe values above +2 or below -2.

Thus, even a quite good value of +1.5 for a scale looks from the purely visual standpoint on a scale range of -3 to +3 not as positive as it really is. For this reason this sheet contains two variants for the figure that depicts the scale means. Use the figure with the reduced scale -2 to +2 if you communicate the results to persons that have not much knowledge on the interpretation of this type of data and in situations where you don't want to explain in detail how building mean values and answer tendencies influence the observed data."

T-test:

FIXME figure numbers

Group Statistics

item		situation	N	Mean	Std. Deviation	Std. Error Mean
Attractiveness	scale means per person	S1: screen	10	,75000	,923794	,292129
		S2: VR	10	,99133	,699037	,221055
Perspicuity	scale means per person	S1: screen	10	1,10000	,951607	,300925
		S2: VR	10	1,55000	1,289918	,407908
Efficiency	scale means per person	S1: screen	10	,55000	,888194	,280872
		S2: VR	10	,87500	,810093	,256174
Dependability	scale means per person	S1: screen	10	,70000	,752773	,238048
		S2: VR	10	,45000	,839974	,265623
Stimulation	scale means per person	S1: screen	10	,60000	1,074968	,339935
		S2: VR	10	1,15000	,859586	,271825
Novelty	scale means per person	S1: screen	10	,45000	,823273	,260342
		S2: VR	10	1,57500	,486627	,153885

Independent Samples Test

item			Levene's Test for Equality of Variances: F	Levene's Test for Equality of Variances: Sig.	t-test for Equality of Means: t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference: Lower	95% Confidence Interval of the Difference: Upper
Attractiveness	scale means per person	Equal variances assumed	,894	,357	-,659	18	,518	-,241333	,366340	-1,010984	,528318
		Equal variances not assumed			-,659	16,762	,519	-,241333	,366340	-1,015080	,532413
Perspicuity	scale means per person	Equal variances assumed	1,154	,297	-,888	18	,386	-,450000	,506897	-1,514951	,614951
		Equal variances not assumed			-,888	16,558	,387	-,450000	,506897	-1,521639	,621639
Efficiency	scale means per person	Equal variances assumed	,088	,771	-,855	18	,404	-,325000	,380150	-1,123665	,473665
		Equal variances not assumed			-,855	17,850	,404	-,325000	,380150	-1,124148	,474148
Dependability	scale means per person	Equal variances assumed	,335	,570	,701	18	,492	,250000	,356682	-,499362	,999362
		Equal variances not assumed			,701	17,788	,492	,250000	,356682	-,500002	1,000002
Stimulation	scale means per person	Equal variances assumed	,107	,747	-1,264	18	,222	-,550000	,435252	-1,464431	,364431
		Equal variances not assumed			-1,264	17,169	,223	-,550000	,435252	-1,467612	,367612
Novelty	scale means per person	Equal variances assumed	5,367	,033	-3,720	18	,002	-1,125000	,302421	-1,760363	-,489637
		Equal variances not assumed			-3,720	14,605	,002	-1,125000	,302421	-1,771117	-,478883

Scenario 1: screen

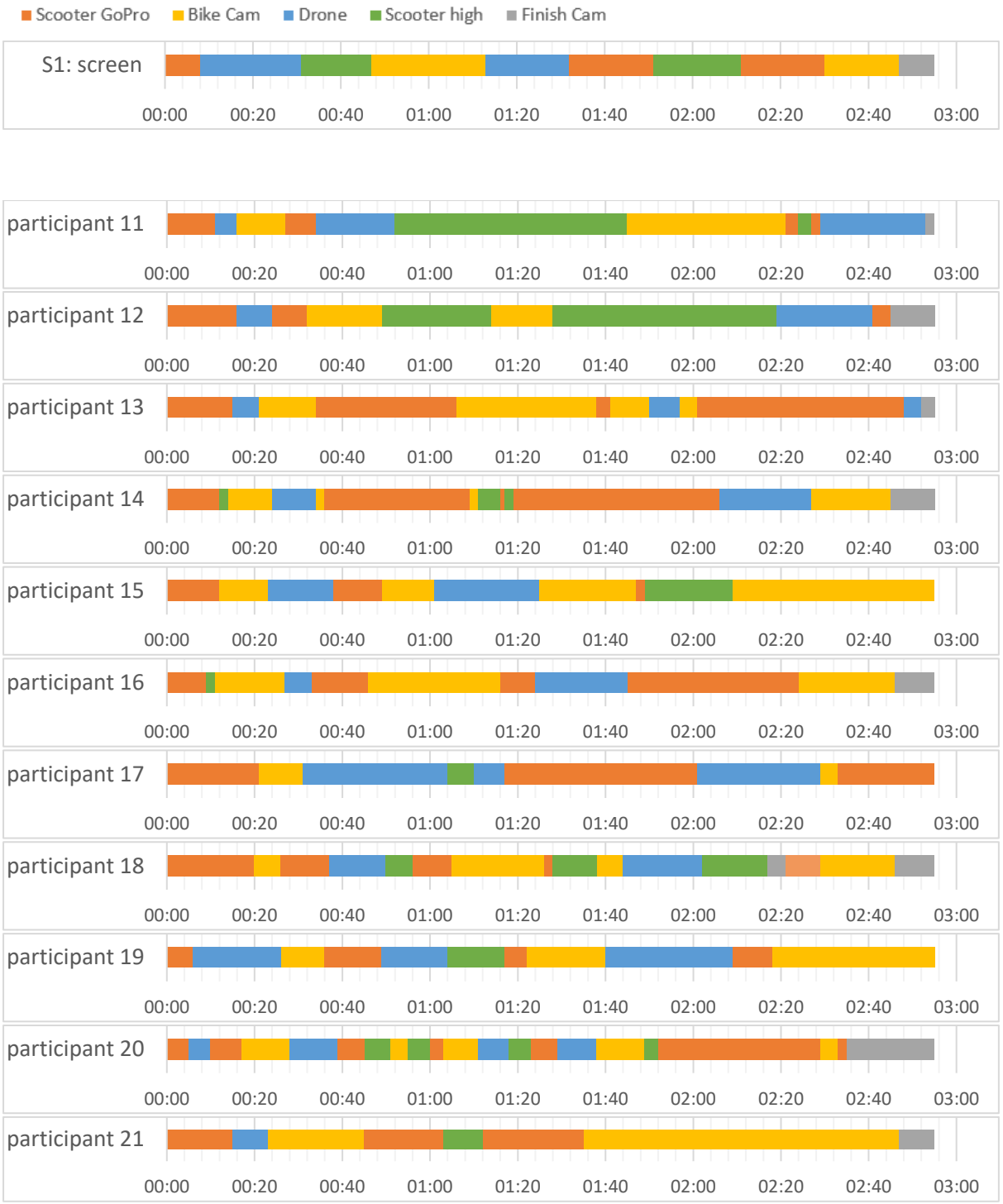
Item	Mean	Variance	Std. Dev.	No.	Left	Right	Scale	
1	0,8	2,0	1,4	10	annoying	enjoyable	Attractiveness	
2	1,6	1,2	1,1	10	not understandable	understandable	Perspicuity	
3	0,5	0,9	1,0	10	creative	dull	Novelty	
4	1,5	1,6	1,3	10	easy to learn	difficult to learn	Perspicuity	
5	0,9	1,9	1,4	10	valuable	inferior	Stimulation	
6	0,5	0,9	1,0	10	boring	exciting	Stimulation	
7	0,8	2,0	1,4	10	not interesting	interesting	Stimulation	
8	1,1	1,2	1,1	10	unpredictable	predictable	Dependability	
9	0,5	1,4	1,2	10	fast	slow	Efficiency	
10	0,1	1,2	1,1	10	inventive	conventional	Novelty	
11	0,8	1,3	1,1	10	obstructive	supportive	Dependability	
12	0,8	0,8	0,9	10	good	bad	Attractiveness	
13	0,7	2,9	1,7	10	complicated	easy	Perspicuity	
14	0,9	1,4	1,2	10	unlikable	pleasing	Attractiveness	
15	0,3	2,7	1,6	10	usual	leading edge	Novelty	
16	0,8	1,3	1,1	10	unpleasant	pleasant	Attractiveness	
17	0,5	1,6	1,3	10	secure	not secure	Dependability	
18	0,2	1,1	1,0	10	motivating	demotivating	Stimulation	
19	0,4	2,5	1,6	10	meets expectations	does not meet expectations	Dependability	
20	0,9	2,1	1,4	10	inefficient	efficient	Efficiency	
21	0,6	1,6	1,3	10	clear	confusing	Perspicuity	
22	0,8	1,5	1,2	10	impractical	practical	Efficiency	
23	0,0	2,7	1,6	10	organized	cluttered	Efficiency	
24	0,6	1,2	1,1	10	attractive	unattractive	Attractiveness	
25	0,6	0,3	0,5	10	friendly	unfriendly	Attractiveness	
26	0,9	1,0	1,0	10	conservative	innovative	Novelty	

Scenario 2: VR

Item	Mean	Variance	Std. Dev.	No.	Left	Right	Scale	
1	0,8	1,7	1,3	10	annoying	enjoyable	Attractiveness	
2	1,6	1,8	1,3	10	not understandable	understandable	Perspicuity	
3	1,2	2,0	1,4	10	creative	dull	Novelty	
4	2,0	1,1	1,1	10	easy to learn	difficult to learn	Perspicuity	
5	1,4	1,4	1,2	10	valuable	inferior	Stimulation	
6	1,4	1,4	1,2	10	boring	exciting	Stimulation	
7	1,6	1,6	1,3	10	not interesting	interesting	Stimulation	
8	0,0	1,3	1,2	10	unpredictable	predictable	Dependability	
9	1,2	2,0	1,4	10	fast	slow	Efficiency	
10	1,8	0,4	0,6	10	inventive	conventional	Novelty	
11	1,4	1,8	1,3	10	obstructive	supportive	Dependability	
12	1,4	0,9	1,0	10	good	bad	Attractiveness	
13	0,4	4,3	2,1	10	complicated	easy	Perspicuity	
14	1,0	1,1	1,1	10	unlikable	pleasing	Attractiveness	
15	1,8	0,2	0,4	10	usual	leading edge	Novelty	
16	0,9	1,9	1,4	10	unpleasant	pleasant	Attractiveness	
17	0,2	2,8	1,7	10	secure	not secure	Dependability	
18	0,8	1,1	1,0	10	motivating	demotivating	Stimulation	
19	0,6	2,3	1,5	10	meets expectations	does not meet expectations	Dependability	
20	0,8	1,3	1,1	10	inefficient	efficient	Efficiency	
21	1,5	4,3	2,1	10	clear	confusing	Perspicuity	
22	1,0	2,0	1,4	10	impractical	practical	Efficiency	
23	1,2	1,5	1,2	10	organized	cluttered	Efficiency	
24	0,9	1,2	1,1	10	attractive	unattractive	Attractiveness	
25	1,3	0,7	0,8	10	friendly	unfriendly	Attractiveness	
26	1,7	0,5	0,7	10	conservative	innovative	Novelty	

K.2.3 observations

The graphs on this page show the order of selected cameras: the top graph shows the pre-edited video used for S1 and the others are the graphs for every participant of S2 who selected the cameras themselves.



K.2.4 Results open questions

Marking of interesting comments:

- Comments on technical aspects
- Comments on conceptual aspects
- VR design details

K.2.4.1 S1: screen

Question 1: Wat vond je goed aan dit product?

#1. Goed aan het product vond ik de afwisseling van beelden van de kopgroep en de drone beelden bovenaf.
#2. duidelijk overzicht over het verloop van de race, weet welke renners aanvallen.
#3. De camera in de race, dat je racen was was cool, zeker met de snelheid.
#4. Handig voor beginnende wielrenliefhebbers, die geen idee heeft wie wie is & hoe alles werkt tijdens zo'n wedstrijd.
#5. Normaal gesproken vind ik wielrennen niet erg spannend, omdat ik vergeet wie wie is. Nu kon ik ze wel onderscheiden dus snapte ik ook wat er gebeurde toen er ingehaald werd.
#6. Betere tools voor overzicht
#7. Snelheid omdat het je helpt om te realiseren hoe snel het wel niet gaat.
#8. Eh.. niets?
#9. Duidelijker wie de personen zijn. Ondersteunende info zoals snelheid
#10. Overzicht over wie wie is, spannende beelden vanaf de fiets, overzicht van waar op de trip ze zijn

Question 2: Wat vond je minder goed aan het product?

#1. De ontsnapping van Tom heb ik niet gezien, behalve op het einde.
#2. je ziet echt alles, de renners kunnen makkelijk draften achter de motor.
#3. Kon eigenlijk niet zo goed tussen de races differentiëren, vooral omdat de camera niet zei vanaf wie die filmde. Film kwaliteit, lage resolutie.
#4. Dingen verspringen omdat de wielrenners natuurlijk niet op 1 plek blijven, ook t.o.v. elkaar. Dus kan informatie nogal gaan verspringen tijdens 1 shot.
#5. Geluid erbij was leuk geweest, het was een beetje stil, maar ik zou ook weer niet het standaard commentaar erbij willen hebben.
#6. Te weinig rust
#7. Ik vond de namen beetje storend. Heb dit liever zoals gewoonlijk, zeker omdat de commentator deze ook vaak noemt.
#8. Geen geluid, gekke camera hoeken, missende info
#9. Misschien achternamen, namen bewogen niet allemaal vloeiend mee, namen iets te groot → afleidend
#10. Ziet er niet heel gelikt uit. Namen wellicht niet boven iemand zijn hoofd. Dat ik niet weet welke informatie wanneer komt.

Question 3: Miste je informatie?

#1. Had het leuk gevonden wat meer weetjes over de renners te zien: leeftijd, lengte, gewicht, wattage (per kilo), belangrijkste overwinning.
#2. afstand tussen de groepen, tijdsverschil.
#3. Individuele racen informatie, snelheid, hartslag, etc. Een overzicht van wie op welke plaats was, wist niet wie aan het winnen was.
#4. Tour de France → wat die truien betekenen, hoe ze gekwalificeerd staan & welke plaats ze moeten halen om op hun plek te blijven in het klassement. & stuk van de route (hoever de groepen uit elkaar liggen).
#5. Ik had het leuk gevonden om bijvoorbeeld te weten wat voor weer het was, temperatuur en windracht enzo. En omdat ik niet zoveel van wielrennen weet wat het ook wel leuk geweest om bijvoorbeeld te zien of ze snel gaan/ niet snel, of ze goed presteren zegmaar.
#6. Onvolledig gedurende kijkervaring.
#7. Overige afstand, allicht een hoogte profiel
#8. Ja, zo'n paneel links met de nummers en posities en tijden enzo
#9. Ranking van de andere racers, kaartje van de baan en posities meer permanent.
#10. Wat leuk zou zijn; u van parcours, berg op/ af, plek in de ranking 1^e/ 2^e/ 3^e … positie in de race

Question 4: Wat viel je op aan dit product?

#1. positief: je zag mooi de omgeving, negatief: je zag de kopgroep (Bart & Jan) in het begin maar half.
#2. Dat ze ook zonder kennis van de renners kunt ziet wat er gebeurt.
#3. De fps camera met route aanduiding in de lucht was top.
#4. Dat het groten deels dezelfde info bevat als op tv, zoals namen en snelheid die gereden word, maar nu per persoon en tegelijkertijd per shot.
#5. Was goed te volgen ☺
#6. Weinig innovatie in huidige uitzending
#7. Goed geïntegreerd in de kijkervaring.
#8. Het is niet te volgen
#9. Camera's op het stuur lijkt nieuw, meebewegende namen.
#10. Soms 1 naam, soms meerdere. Wisseling van info

K.2.4.2 S1: VR

Question 1: Wat vond je goed aan dit product?

#11. Als iemand iets me de sport kan uitleggen vind ik de sport altijd leuker. Interessant voor broadcasting. Overzicht.
#12. Dit product was heel goed structureel geordend. Je wist meteen wat je zag en het was makkelijk te begrijpen.
#13. Jij bepaalt welke view belangrijk is en daardoor altijd de informatie krijgt die jij wilt.
#14. VR zorgt in dit geval voor een goed overzicht van de race waarbij je zelf kunt kiezen wat je wilt zien.
#15. Door controle te hebben over de camera's wordt het interactief waardoor je meer betrokken bent in de race. Alle info is continue zichtbaar, waardoor je goed overzicht hebt over de race.
#16. Het overzichtelijk maken van een wielrenwedstrijd kan met zo veel renners nog wel eens chaotisch zijn. Zelf de regie in handen krijgen.
#17. Ik vond de plattegrond een goede toevoeging. Ik vond het leuk dat je tussen camera's kon switchen.
#18. Verfrissend nieuw en ik kon zelf bepalen
#19. Door de plattegrond wel overzichtelijk hoe de race zou lopen.
#20. Doordat je zelf de controle hebt over wat je wanneer wilt zien (welke camera positie) heb je een gevoel van controle over de race die je (gaat) zien/ ziet.
#21.

Question 2: Wat vond je minder goed aan het product?

#11. Afgesloten VR omgeving. Niet met meerdere mensen VR headset kan ongemakkelijk zijn of leiden tot misselijkheid.
#12. De VR headset was een beetje zwaar en ik had pas na een paar keer drukken door hoe de controller werkte. Maar voor de rest een goed product!
#13. Ik miste feedback (een trilling) zodra de laser een camera selecteert.
#14. Kiezen tussen camera's die dicht bij elkaar staan.
#15. Er is soms zoveel te zien dat je niet weet waar je moet kijken. Je kan spannende minuten missen zoals Tom die iedereen inhaalt als je even niet oplet en bij de verkeerde camera kijkt. → missen van een moment
#16. Met name het comfort van de VR headset en de lage resolutie, deze gaf mij het gevoel dat ik mijn bril niet op had.
#17. Soms een beetje te veel. Bij een inhaalmoment wil je switchen van camera's maar gaat het iets te snel om de actie goed te volgen. → missen van een moment
#18. Ik was zelf als regisseur te laat met de beelden. → missen van een moment
#19. Doordat je zelf het camerastandpunt kunt kiezen, kies je niet altijd voor het beste beeld/ standpunt. → missen van een moment
#20. Er war wat veel info in de kantlijn waar ik niet op lette tijdens de race, waardoor ik informatie miste.
#21.

Question 3: Miste je informatie?

#11. Uiteindelijk voice commentaar. Zelf camera
#12. Tijd van start/ finish op het einde
#13. Misschien de snelheid geplot tegen de tijd een (v,f) diagram
#14. In de echte tour misschien hoogte
#15. Wellicht fijn als er eerst nummers staan van de ranking. Ik moest eerst zoeken of de volgorde van de lijst ook de ranking was. Dit omdat er niet werd ingehaald en de lijst dus niet veranderde.
#16. Het zou fijn zijn als in de kaart namen boven de renners te zien zijn. Ook zorgde de lage resolutie ervoor dat ik de renners niet goed kon onderscheiden.
#17. Afstand tot finish aangeven op de kaart.
#18. Ja, bijvoorbeeld dat er een signaal komt dat er iets spannends gebeurd.
#19. Nee, eerder teveel aan informatie. → anders dan de andere antwoorden
#20. Zie hierboven
#21.

Question 4: Wat viel je op aan dit product?

#11. Meer overzicht van de situatie. Fietsers misschien abstraheren.
#12. Verschillende camera's die ik op kon klikken om de wielrenners te zien in verschillende perspectieven.
#13. Het zelf in staat zijn on van beeld te wisselen.
#14. Dat het heel makkelijk aan te leren is.
#15. Het maakt de race extra spannend omdat je zo betrokken raakt.
#16. Hoe simpel het te leren is.
#17. De kaart vond ik echt tof gemaakt, geeft een duidelijk overzicht.
#18. Leuke interactie, nieuw om zo naar een wedstrijd te kijken.
#19. Leek veel op computerspel en minder op een beeldverslag van een wielrenwedstrijd.
#20. De lay-out was van goed kwaliteit. Door het VR principe ben ik "echt" bij de race, dat doet iets met mijn lijf en dat maakt zo'n race echt spannender.
#21.

APPENDIX L: RECOMMENDATIONS

L.1 Processing by the computer

The sequence diagrams that are presented in the report have ITO (processing) loops and blue arrows that indicate that the system saves data (about the usage). Beside the user interactions described in the sequence diagrams, the system is also computing on the background to find out what the data can explain about the cycling races. The table below shows an overview of examples of how the Sense-Reason-Learn-Adapt cycles of the I-CPS principles can possibly be used. The table addresses five points that are used for teaching the viewers about cycling races. These are underlined in the learn-column: User, cycling tactics, Tour de France races, cyclists' stories and story of the race (specific stage of the Tour de France). The last column describes how these cycles can be used in the designed conceptual 'Tour de France' VR application. For the reason-column, some of the points are already calculated by 'Dimension Data', these points are indicated using blue.

Sense (data)	**reason**	**Learn**	**adapt**	**Penetration into real life process: 'Tour de France' VR application**
• What the user selects • Gaze direction • User information (entered when creating a profile)	• User preferences • What the user looks at	<u>User</u> • Users usage • User profile	• What information is shown (tactics explanation, progress of the race, additional information about e.g. the cyclists, the area/ route, etc.)	Adapt the information shown to the user preferences, e.g. show more information about the favourite cyclist of the user, or show more information about the environment when that fits the users' interests
• Relative positions • Teams • Ranking • Relative position over time of the winners • Tactics explanation database	• What tactics are used when? • Analysis: what might have been better? • Compare race data (route, weather (wind), challenges, positions and speed) to predict/ recognize the tactics used and find patterns	<u>Cycling tactics</u> • If the predictions were correct • What tactics the top 3 cyclists of this race used	• Update database with learnings: when a tactic is used, conditions of the race at that moment	A tactics explanation can be selected from the tactics-explanation-videos/ animations database and added at the right moment during the race.
• Routes (GPS) • Type of route/ race • Weather • Height profile • Rankings • Incidents • Challenges • Length and Duration	• Stage favourites: who will win this race	<u>Tour the France races</u> • If the predictions were correct	• Update database with the information about the prediction and who really won.	This information will be used to tell a story about who was expected to win and why, and how this did or did not happen
• Name • Age • Team • Speed • Prestation (ranking) • location • History of the above	• Effort index • performance profile • Compare the two points above • Compare to the race predictions	<u>Cyclists' stories</u> • How the cyclist develops over time	• Update cyclist profile	This information can be used to elaborate more on a winning cyclist that was for example unexpected, or to analyse the users' favourite cyclist.
• All data of the 3 rows above • Sports commentator (speech recognition) • Sports broadcast (order of videos, selected information to show)	• Important moments predictions • Recognize names of cyclists, teams, places etc. to show additional information • Catch predictions • "Le Buzz"*	<u>Story of the race</u> • What is most important to show in a summary of the race	• Update the race progress database	Using the most important moment indications, a summary of the race can be assembled.

* "Le Buzz" is a machine-learning that analyses the movements within the peloton to predict potential key moments such as the increased likelihood of a crash, a split in the peloton, or a change in the race dynamics. (NTT Limited, 2019)

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