

# Cycling amongst automated vehicles

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Thank you for opening this questionnaire. It is about cycling amongst automated vehicles, more concretely some design concepts which can be helpful in this context. It will take approximately 10 minutes.



\* Vereist

## Consent

Participation in this study is voluntary and can be ended at any time. No personal identifiable data (except age) will be collected, therefore your answers will be anonymous and cannot be traced back to you. This study is conducted by Jochem Verstegen, a bachelor student of Industrial Design at TU/e currently doing his final bachelor project. If you have any questions, you can always contact the researcher via [j.r.p.verstegen@student.tue.nl](mailto:j.r.p.verstegen@student.tue.nl). The questionnaire consists of multiple choice questions and a few optional open ended questions. Since it will not be about any sensitive subjects, there are no risks involved with participating in this study.

I acknowledge that I am sufficiently informed about the research project and have had the opportunity to ask questions. Furthermore, I acknowledge that I take part in this research project voluntarily and can end participation at any moment, without giving any reason. I consent to my answers being used for quotes in research publications and to the anonymous research data being made available for any future research. \*

- Yes, I consent and want to continue to the questionnaire.
- No, I do not consent and do not want to answer the questionnaire.

## Introduction

Every major car company is working on developing automated vehicles (AVs). In the future, the use of these automated vehicles could lead to some major advantages, like increased road safety, faster travel times and less energy usage. To reach these advantages, it is very likely that the automated vehicles on the roads will form a network together to communicate all kinds of information like position, speed, route, road conditions, and more.

A current challenge with AVs is dealing with vulnerable road users like pedestrians or cyclists. Since these are human beings, it is difficult to predict their behaviour. A human could always make a sudden movement, like a turn, without indicating it in advance. Or, if a cyclist would indicate their turn by holding up their arm, it is possible for AVs to not properly recognize this for various potential reasons. Perhaps the cyclist does not hold up their arm long or high enough, or sunlight is causing glare in the AV's camera resulting in it missing out on the cyclist's indicated intention.

This problem could be solved by adding an interaction ability to the bicycle, either as a separate device or by embedding electronics into the bicycle. In this questionnaire, you will be shown 4 different design concepts that can be used to properly communicate your intention to make a turn to automated vehicles around you, without having to depend solely on their sensors or cameras. For each concept, you will be asked to answer a couple of questions, after which you can compare them to each other. It will take approximately 10 minutes. Please note that there are no correct answers.<sup>1</sup>

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First of all: Do you have any thoughts about cycling with automated vehicles around you?

Feel free to share any thoughts, opinions, questions, concerns or ideas you may have.

## Cycling experience

The following questions are meant to understand your cycling experience, which could have an influence on your views about the topic of cycling amongst automated

3

Which of the following statements applies to you? \*

- I cycle regularly, once a week or more.
- I cycle occasionally, approximately once or a couple times a month.
- I cycle rarely, only a couple times a year.
- I don't cycle anymore, but I used to cycle regularly or occasionally (once a month or more).
- I never cycled, or I only cycled rarely in the past but not any more.

4

How would you rate the cycling infrastructure at the location you currently live? \*

0	1	2	3	4	5	6	7	8	9	10
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Awful

Excellent

5

How would you describe the cycling infrastructure at the location you currently live? \*

Please choose the answer which matches closest with your opinion.

- Very good, everything I need is safely accessible by bicycle.
- Pretty good, most places are accessible by bicycle and it is safe enough.
- Mediocre, I can reach places by bicycle but it is not always safe or comfortable.
- Pretty bad, I mainly use roads meant for cars and it does not feel very safe.
- Terrible, there is no infrastructure for bicycles at all and riding a bicycle is dangerous.

6

Did you use a bicycle when you were growing up? \*

For example biking to primary school or for fun at young age.

- Yes, at the same location as where I live now.
- Yes, but at a different location as where I live now.
- No, I started riding a bicycle at an older age.

7

How would you rate the cycling infrastructure at the location you grew up?

\*

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

Awful

Excellent

8

How would you describe the cycling infrastructure at the location you grew up? \*

Please choose the answer which matches closest with your opinion.

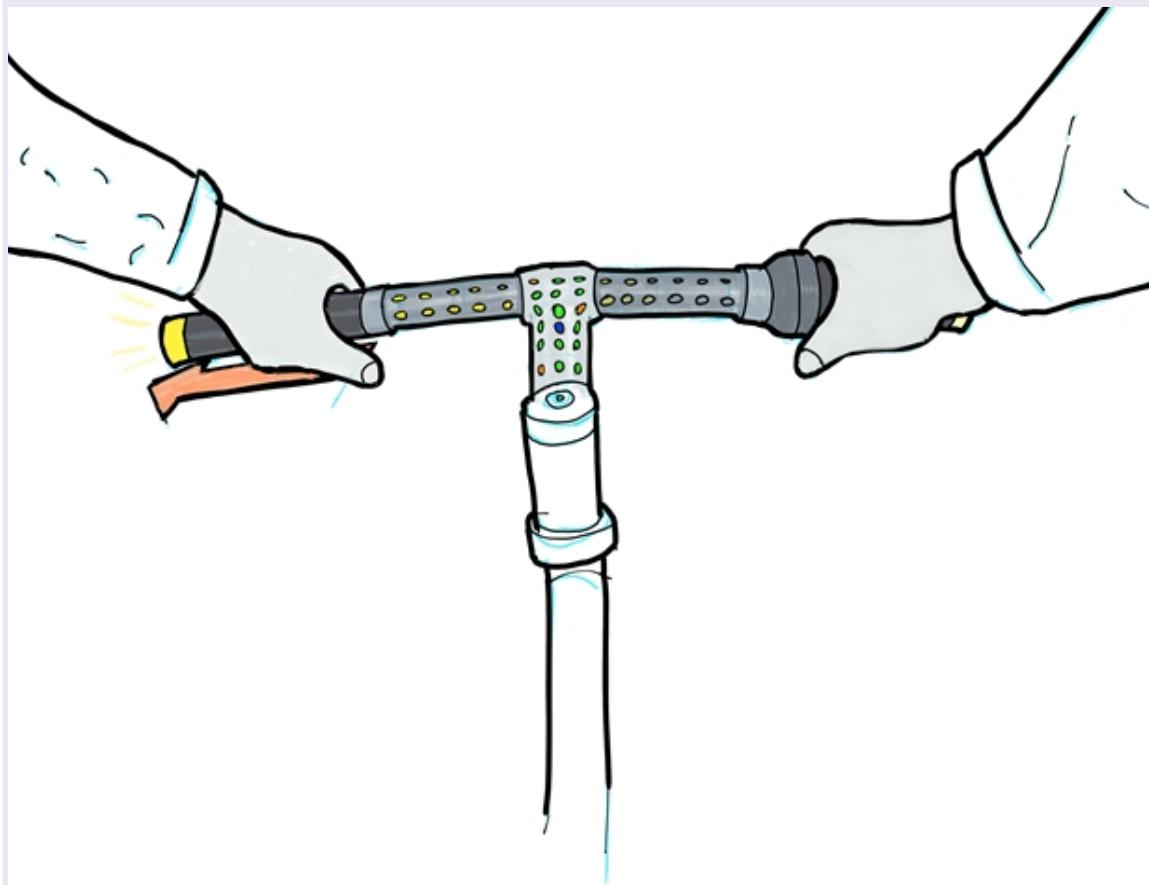
- Very good, everything I needed was safely accessible by bicycle.
- Pretty good, most places were accessible by bicycle and it was safe enough.
- Mediocre, I could reach places by bicycle but it was not always safe or comfortable.
- Pretty bad, I mainly used roads meant for cars and it did not feel very safe.
- Terrible, there was no infrastructure for bicycles at all and riding a bicycle was dangerous.

## Concept 1/4: Sliding handles (hands)

Now you will be given a short explanation of the four design concepts along with a sketch, and asked to answer a few questions about each concept. Please note that all the motions that would be required to use the concept do not interfere with someone's cycling ability.

The first design concept is about using hands to indicate the intended upcoming turn. As the cyclist, you can still keep both your hands on the handlebar. Both handles can slide sideways a small amount, towards the direction you will turn. So, as can be seen in the picture, if you want to go left you slide the left handle towards the left.

It is possible to add blinkers to the handle as well, to show you that your turning intention has been registered. Additionally, LEDs can be added into the handlebar frame, for example to show whether the automated vehicles nearby are aware of your intention and giving you room to complete the turn. Furthermore, it is a possibility to give you feedback in the form of sounds or vibrations in the handles.



9

Please indicate how much you agree with the following statements:

- 1 = Fully disagree
- 2 = Disagree
- 3 = Neither agree nor disagree (neutral)
- 4 = Agree
- 5 = Fully agree

10

I think the sliding handles will be very intuitive to use. \*

1

2

3

4

5

Fully disagree

Fully agree

11

I think the sliding handles will help me feel safer on my bicycle amongst automated vehicles. \*

1

2

3

4

5

Fully disagree

Fully agree

12

I would trust the sliding handles to properly register my intention and communicate it to the automated vehicles around me. \*

1

2

3

4

5

Fully disagree

Fully agree

13

I expect the feedback of the sliding handles to clearly tell me how the automated vehicles around me will react (and if I can safely cross the street).

\*

1

2

3

4

5

Fully disagree

Fully agree

14

I would use the sliding handles to indicate my intentions while cycling. \*

1

2

3

4

5

Fully disagree

Fully agree

15

What do you like about the sliding handles?

16

How would you improve the sliding handles?

17

Is there anything more you would like to say about the sliding handles?

Share anything you like, for instance types of feedback you can think of or criticism about this idea.

## Concept 2/4: Rotating pedals (feet / heels)

The second design concept is about using feet to indicate the intended upcoming turn. As the cyclist, you can still keep both your hands on the handlebar. Both pedals can rotate a slight amount, allowing you to push your heel towards the direction you will turn. So, as can be seen in the picture, if you want to go left you push your left heel towards the left, causing the pedal to rotate together with your foot.

It is possible to use this concept together with a kind of feedback positioned elsewhere on the bike, like LEDs in the handlebar, vibrations or sounds. Additionally, it can be used to activate a set of blinkers somewhere on the bike as well.



18

Please indicate how much you agree with the following statements:

- 1 = Fully disagree
- 2 = Disagree
- 3 = Neither agree nor disagree (neutral)
- 4 = Agree
- 5 = Fully agree

19

I think the rotating pedals will be very intuitive to use. \*

1

2

3

4

5

Fully disagree

Fully agree

20

I think the rotating pedals will help me feel safer on my bicycle amongst automated vehicles. \*

1

2

3

4

5

Fully disagree

Fully agree

21

I would trust the rotating pedals to properly register my intention and communicate it to the automated vehicles around me. \*

1

2

3

4

5

Fully disagree

Fully agree

22

I expect the feedback of the rotating pedals to clearly tell me how the automated vehicles around me will react (and if I can safely cross the street).

\*

1

2

3

4

5

Fully disagree

Fully agree

23

I would use the rotating pedals to indicate my intentions while cycling. \*

1

2

3

4

5

Fully disagree

Fully agree

24

What do you like about the rotating pedals?

25

How would you improve the rotating pedals?

Is there anything more you would like to say about the rotating pedals?

Share anything you like, for instance types of feedback you can think of or criticism about this idea.

### Concept 3/4: Twisting seat (hips)



The third design concept is about using hips to indicate the intended upcoming turn. As the cyclist, you can still keep both your hands on the handlebar. The seat can twist a slight amount, allowing you to turn your hips towards the direction you will turn. So, if you want to go left you turn your hips towards the left, causing the seat to twist together with your upper body.

It is possible to use this concept to activate a set of blinkers at the back of the seat. Additionally, it can be used together with a kind of feedback positioned elsewhere on the bike, like LEDs in the handlebar, vibrations or sounds. It is also possible to make the seat vibrate as a kind of feedback, for instance to tell you that your turning intention is detected.

27

Please indicate how much you agree with the following statements:

- 1 = Fully disagree
- 2 = Disagree
- 3 = Neither agree nor disagree (neutral)
- 4 = Agree
- 5 = Fully agree

28

I think the twisting seat will be very intuitive to use. \*

1

2

3

4

5

Fully disagree

Fully agree

29

I think the twisting seat will help me feel safer on my bicycle amongst automated vehicles. \*

1

2

3

4

5

Fully disagree

Fully agree

30

I would trust the twisting seat to properly register my intention and communicate it to the automated vehicles around me. \*

1

2

3

4

5

Fully disagree

Fully agree

31

I expect the feedback of the twisting seat to clearly tell me how the automated vehicles around me will react (and if I can safely cross the street).

\*

1

2

3

4

5

Fully disagree

Fully agree

32

I would use the twisting seat to indicate my intentions while cycling. \*

1

2

3

4

5

Fully disagree

Fully agree

33

What do you like about the twisting seat?

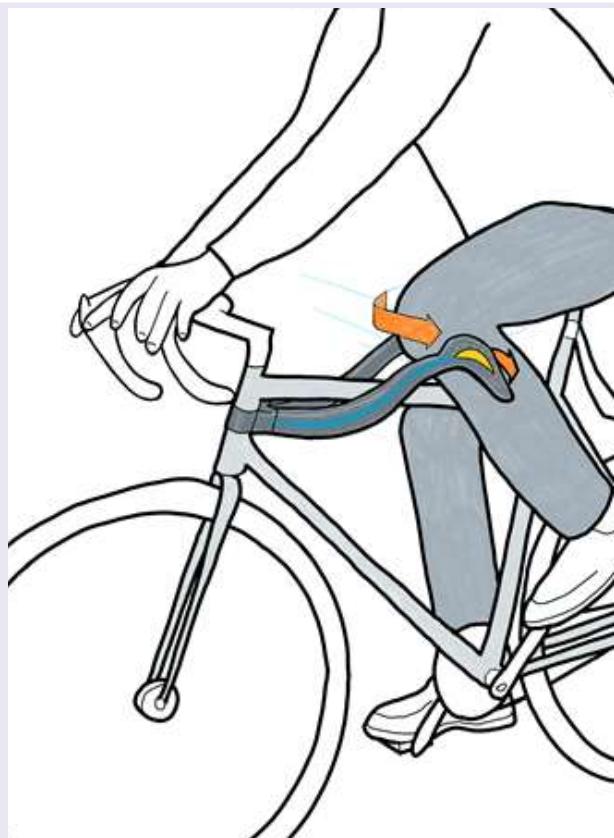
34

How would you improve the twisting seat?

Is there anything more you would like to say about the twisting seat?

Share anything you like, for instance types of feedback you can think of or criticism about this idea.

## Concept 4/4: Knee rods (knees)



The fourth and final design concept is about using knees to indicate the intended upcoming turn. As the cyclist, you can still keep both your hands on the handlebar. There are rods positioned next to your knees which can be pushed sideways a slight amount, allowing you to push your knee towards the direction you will turn. So, as can be seen in the picture, if you want to go left you push your left knee towards the left, pushing the rod towards the left.

Blinkers can be implemented into the design. Additionally, the concept can be used together with a kind of feedback positioned on the rods themselves or elsewhere on the bike like LEDs, vibrations or sounds. Furthermore, this design could be made as a

36

Please indicate how much you agree with the following statements:

- 1 = Fully disagree
- 2 = Disagree
- 3 = Neither agree nor disagree (neutral)
- 4 = Agree
- 5 = Fully agree

37

I think the knee rods will be very intuitive to use. \*

1

2

3

4

5

Fully disagree

Fully agree

38

I think the knee rods will help me feel safer on my bicycle amongst automated vehicles. \*

1

2

3

4

5

Fully disagree

Fully agree

39

I would trust the knee rods to properly register my intention and communicate it to the automated vehicles around me. \*

1

2

3

4

5

Fully disagree

Fully agree

40

I expect the feedback of the knee rods to clearly tell me how the automated vehicles around me will react (and if I can safely cross the street). \*

1

2

3

4

5

Fully disagree

Fully agree

41

I would use the knee rods to indicate my intentions while cycling. \*

1

2

3

4

5

Fully disagree

Fully agree

42

What do you like about the knee rods?

43

How would you improve the knee rods?

44

Is there anything more you would like to say about the knee rods?

Share anything you like, for instance types of feedback you can think of or criticism about this idea.

## Comparing

In this section, you will be asked a few questions, for which you can choose one or more answers.

45

Which concept(s) would be the easiest to trigger / activate? \*

So which do you think will take the least effort to use?

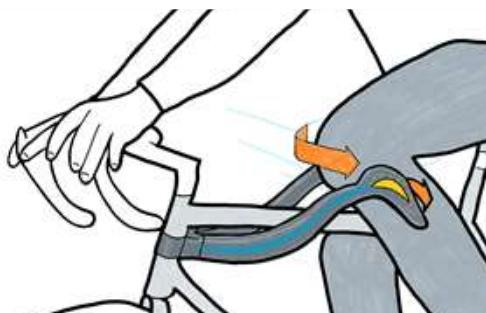
Selecteer maximaal 3 opties.



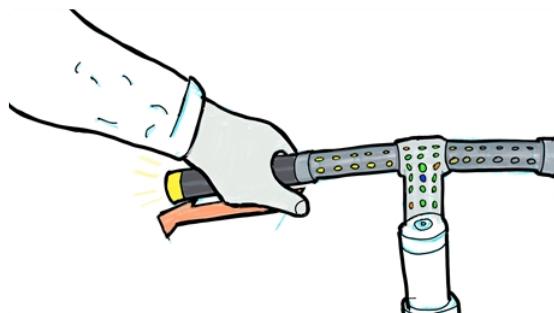
The rotating pedals



The twisting seat



The knee rods

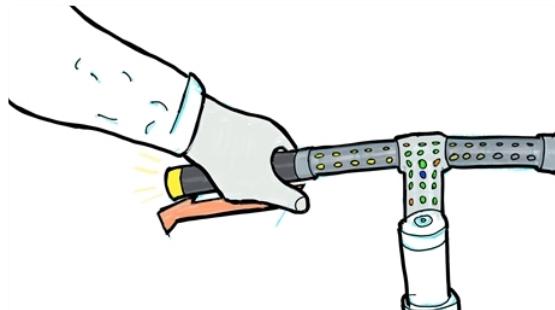


The sliding handles

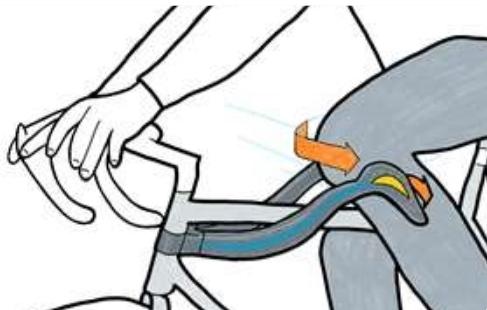
Which concept(s) would be the most likely to "misfire"? \*

So which do you think will trigger accidentally, when it should not?

Selecteer maximaal 3 opties.



The sliding handles



The knee rods



The twisting seat

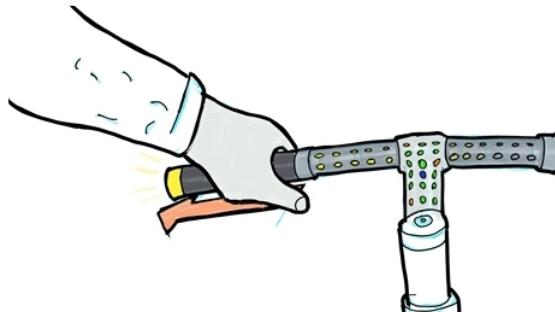


The rotating pedals

Which concept(s) would allow for the best feedback about how the automated vehicles around you will react? \*

So which do you think will keep you aware about what the automated vehicles around you will do?

Selecteer maximaal 3 opties.



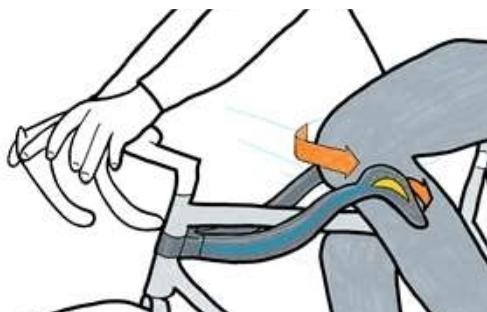
The sliding handles



The twisting seat



The rotating pedals

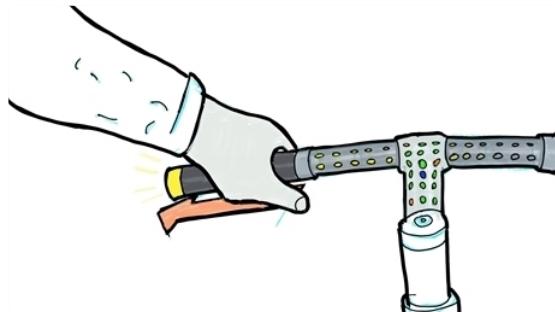


The knee rods

Which concept(s) would make you feel the right amount of safety in traffic?  
\*

Not too much, not too little.

Selecteer maximaal 3 opties.



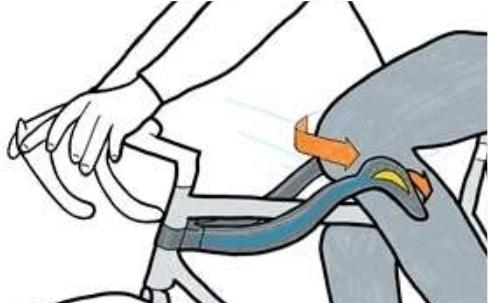
The sliding handles



The rotating pedals



The twisting seat



The knee rods

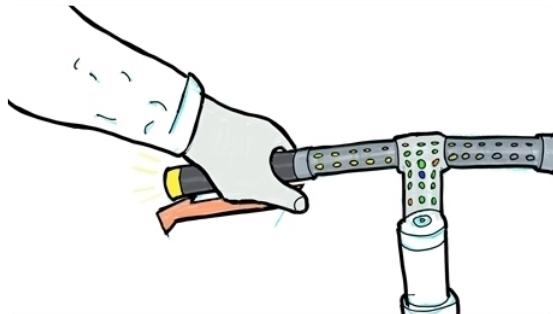
Which concept(s) would you be most likely to use? \*

So which do you think you will probably use?

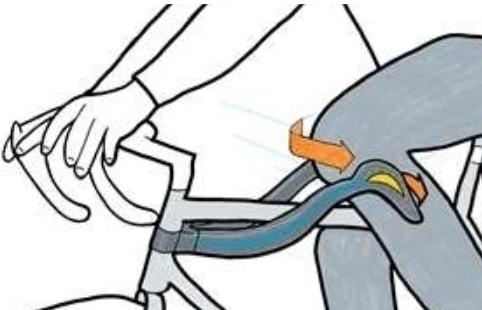
Selecteer maximaal 3 opties.



The twisting seat



The sliding handles



The knee rods



The rotating pedals

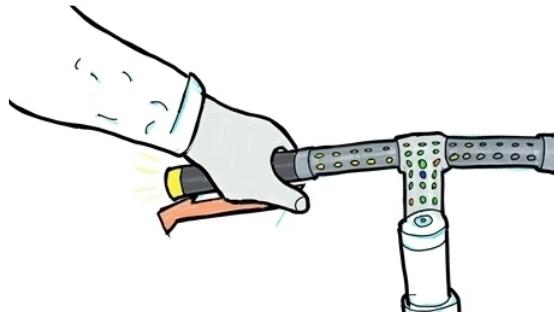
Which concept(s) would you be least likely to use? \*

So which do you think you will certainly not use?

Selecteer maximaal 3 opties.



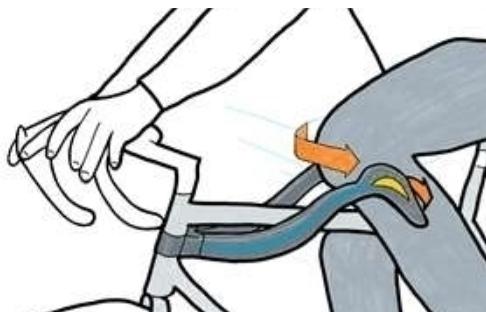
The twisting seat



The sliding handles



The rotating pedals



The knee rods

## Final questions

Almost done! I'd like to know some general things about you, because these things can influence your thoughts and opinions about the topic in general and the

51

What is your age?

De waarde moet een getal zijn

52

For which reason(s) do you use your bicycle most often? \*

If there are multipole equally frequent reasons, please select both.

Traveling to work / school

Recreational

As a sport

Andere

53

Which statement regarding technology applies to you most? \*

Please select the one which most accurately describes your situation.

- I am not interested in technology and don't know how to use most of it.
- I don't mind using technological products when I need to.
- I think technology is useful and I regularly use it.
- I like using technological products and enjoy trying out new ones.

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Do you have any thoughts about cycling with automated vehicles around you, while using a concept like these to communicate your intentions?

Feel free to share any thoughts, opinions, questions, concerns or ideas you may have.