Appendix I

In this appendix, designs and models made during the graduation project are attached. Other issues of the whole procedure are also included.

The list of files:

1. Design and build of the measurement stool
2. Design and build of the experiment setup
3. Design and use of questionnaires
4. Step by step experiment protocol
5. Ethical issues approvement

Measurement stool

Introduction

To measure the anthropometric data of participants in an efficient way, a special measurement stool was built. It could measure hip width, popliteal height and popliteal-buttock depth following the method described in DINED.

Design

The stool was shown in figure 1. It was made of aluminum cuboid frame with a dimension of 600*500*630mm (depth, width, height, respectively). The anthropometric data of P95 of Dutch population was considered in deciding the dimensions of the stool.

To make the measurement easier and more accurate, removable backrest, pedal and two wooden strips were attached to the stool as well. Measuring tapes were sticked to the surface of the stool for easy reading the value.

Usage

Default setting: The removable back is put on the back edge of the stool.

The pedal is put on the lowest position.

Two wooden trips are put on each side of the stool.

The subject sits on the stool as shown in figure 2. Keep the back straight, with legs drooping naturally. The knees close together with the knees' fossa touching the edge of the seat.

For hip width measurement [1], the researcher moves the two wooden strips to the left and right side of the subject's hip. Read the values on the measuring tape respectively. The difference between the two figure is the hip width.

For popliteal-buttock measurement [2], the researcher moves the removable wooden backrest to the subject's back and read the value on the tape.

For popliteal height measurement [3], the researcher lifts the pedal up until the subject's feet is parallel to the floor and provide no support force, then read the value.

Figure 1 measurement stool

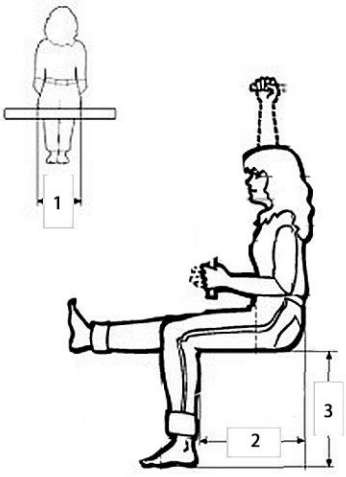


Figure 2 measurement method

Experiment setup

Introduction

To simulate the scenario in a realistic context, an experiment setup was built inside the Boeing 737 cabin. The setup could simulate the 3 different inclination angles (known as angle of attack) of the plane in this experiment. Cameras and pressure mats were also emerged into the setup and were used to measure physical data and recorded the whole procedure.

Design

The setup consisted of an adjustable platform and various measuring devices. 2 20-25mm wooden boards were mounted together as the main platform. 2 rows of economic aircraft seats were mounted to the platform. The width of the seats was 17 inches and the pitch between 2 rows was 30 inches. Floor mat was put on the wooden platform, like in real cabin.

Scissor jacks under the boards were used to lift the platform in order to adjust the inclination angle. To prevent the platform from bending, files of books and self-made wooden support were put under the platform. Participants sat on the second row of the seat during the experiment. Figure 1 showed the setup.

2 GoPro cameras were used. One was installed to the celling of the cabin in front of the participant. It was to record the facial expression and shoulder movements during the whole procedure. The other was installed to a tripod next to the platform, which was used to recording leg movements.

2 pressure mats were sticked to the backrest and the cushion of the seat. (See figure 2) The buckles of the safe belts were wrapped with soft cloth, to prevent the pressure mats from being scratched by sharp corners.

Figure 1 experiment setup

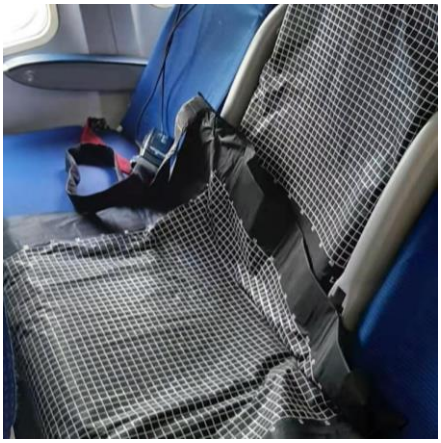


Figure 2 pressure mats

Questionnaires

Introduction

For measuring the subjective feelings of comfort and discomfort, a set of questionnaires were designed and used in the experiment. The questionnaire set consists of a 10-point likert scale overall comfort and discomfort questionnaire and a local postural discomfort (LPD) questionnaire with personalized body map.

Design

There are four pages in the questionnaire set. The first page starts with an example of how to mark the scale. It follows by a 10-scale question on their overall comfort feeling.

The next two pages of the set are the LPD questionnaire. Page 2 shows the back side of the body while page 3 shows the front side. The division of body parts is based on the figure made by Slapsinskaite et al, 2015. Some body parts are merged together to reduce fill-in time. Body maps of two genders are designed. (See figure 1) Participants will be given different questionnaires according to their gender.

The last page of the set asks a question on overall discomfort feeling.

To avoid the confusion of the word comfort and discomfort in different languages and cultures, overall comfort and discomfort questions were split to the beginning and the end of the set. The male set of questionnaires is shown in the end.

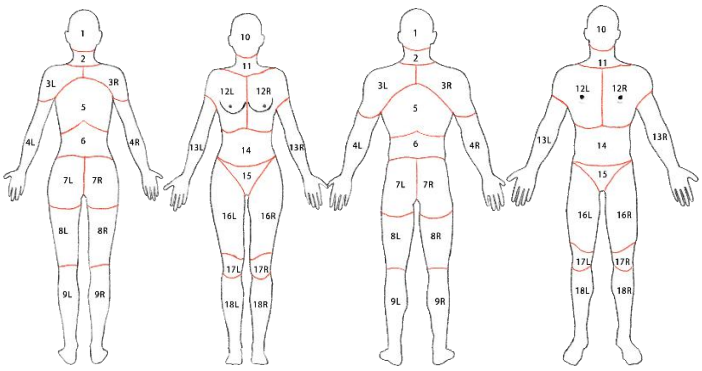


Figure 1 female and male body maps used in LPD questionnaire

Usage

For each condition of angle of attack (AOA), participants are asked to fill in the questionnaire set three times at 0 minute, 10 minute and 20 minute, respectively. Three different AOAs are tested in the experiment, therefore participants will finish 9 sets of questionnaire in total. Participants should finish the questionnaire while sitting on the seat, because the questions are based on their current feeling. Usually, it takes 1.5-2 minutes to finish one set.

After experiencing all the conditions, participants are also asked to rank the three AOAs regarding comfort levels based on their memories. It should be done at least two minutes after participants leave the seats.

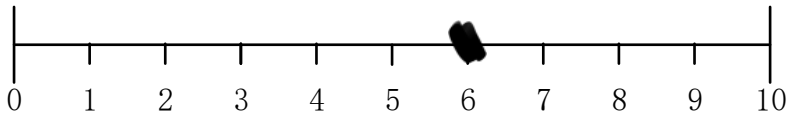
Reference

Slapsinskaite, A., Razon, S., Balagué Serre, N., Hristovski, R., & Tenenbaum, G.. (2015). *Body map.* (Version 1). PLOS ONE. https://doi.org/10.1371/journal.pone.0137895.g001 ([])

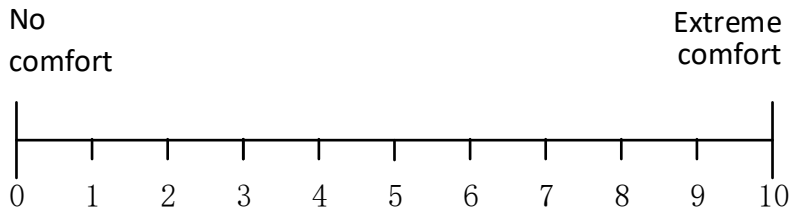
You can **skip** questions in this questionnaire if your rating is **0**.

Example

What is the your **comfort** rating now?



What is the your **comfort** rating now?



Notice: This page is only concerning your **discomfort** feeling! If you feel no discomfort, you can **skip** questions. Left and right in the figure indicates left and right in real life.

Discomfort rating

0=no discomfort at all

1=very little discomfort

2=little discomfort

3=moderate discomfort

4=somewhat high discomfort

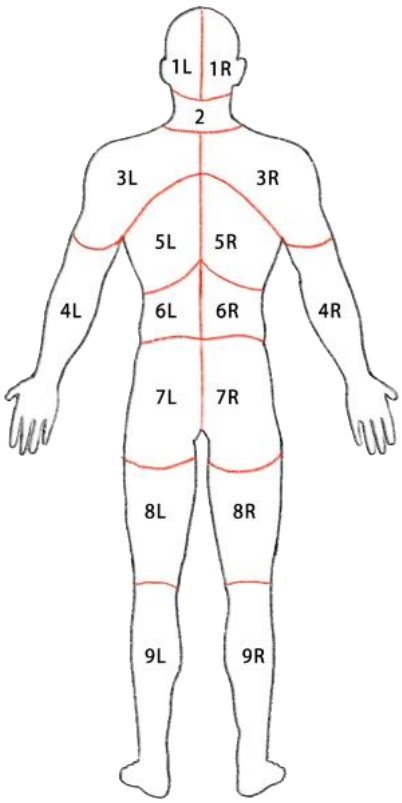
6

7=very high discomfort

8

9

10=extreme discomfort



Back view

No discomfort — Extreme discomfort

	0	1	2	3	4	5	6	7	8	9	10
1L											
1R											
2											
3L											
3R											
4L											
4R											
5L											
5R											
6L											
6R											
7L											
7R											
8L											
8R											
9L											
9R											

Notice: This page is only concerning your **discomfort** feeling! If you feel no discomfort, you can **skip** questions. Left and right in the figure indicates left and right in real life.

Discomfort rating

0=no discomfort at all

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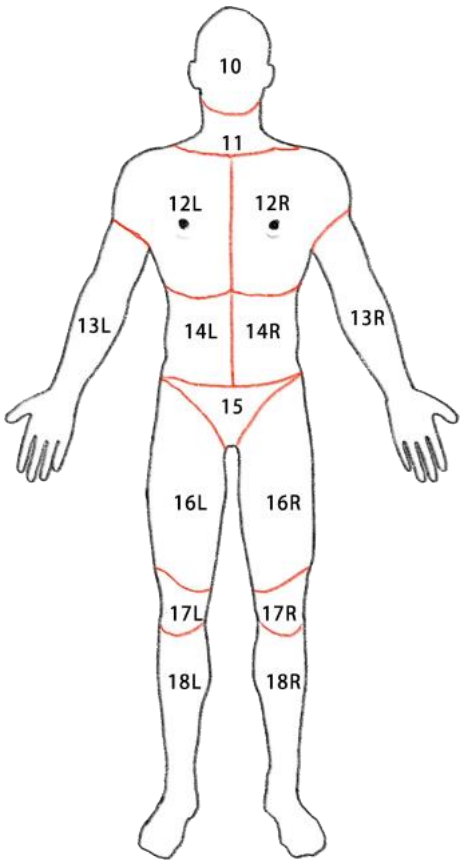
10=extreme discomfort

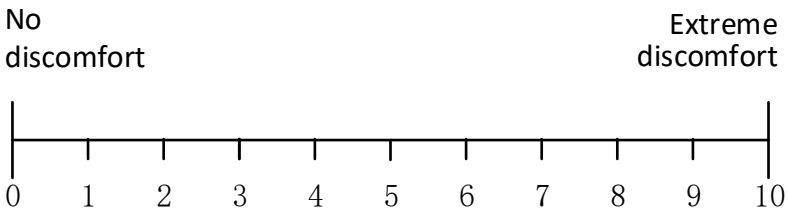


Front view

No discomfort — Extreme discomfort

	0	1	2	3	4	5	6	7	8	9	10
10											
11											
12L											
12R											
13L											
13R											
14L											
14R											
15											
16L											
16R											
17L											
17R											
18L											
18R											

What is the your **discomfort** rating now?



Step by step experiment protocol

Note: The experiment of the study is combined with Xinhe's test of the jackets.

Welcome

(Informed participants with some context with the flyer in advance. Let the participant go to the toilet in advance.)

The participant is welcomed into the fuselage, and reads and signs the consent form on the trolley near the front door.

Introduction and adaptation

1. The platform is set to the first setup. (In Latin square order, it can start with either 3-degree, 14-degree or 18-degree for different participants.) Researchers have the cellphone, wristband, jacket ready on the stool.
2. The participant wears the smart wearables (jacket first, and then wristband) and takes 5 minutes to adapt them.
3. During the adaption time, the researcher explains the experiment protocol to the participant.
    a. 3 setups
    b. How to fill questionnaires (4 pages each, 3 in one setting, 9 in total, give to Xinhe at once when finish one)
    c. What are measuring (mats, GoPro, wristband-HRV, jacket)
    d. No mask when sitting
    e. Raise a hand when start and stop.
    f. When to have a break, No coffin beverage.

Setup1

4. The participant sits on the seat and fastens the safe belt.
5. The participant fills in the first questionnaire set. It takes no more than 2 minutes.
6. Xinhe collects the questionnaire. Yayu starts camera recording, front first and then side.
7. Xinhe stays near the stool, Yayu stays next to Xsensor monitor. And try not to move during the experiment.
8. Participant raises a hand
9. Xinhe starts jacket and timer, Yayu starts pressure mats and HRV band
10. After sitting on the seat for 9.5 minutes (check by Xinhe, Mark event in HRV by Yayu), the participant fills in the second questionnaire. It takes no more than 1.5 minutes. (collected by Xinhe)
11. The participant sits for another 10 minutes. (Check by Xinhe) Participant raises a hand
12. Xinhe stops jacket and timer, Yayu stops mats and band.
13. Yayu stops camera recording, side first and then front.
14. The participant fills in the third questionnaire before leaving the seat.

Break

The participant leaves the seat and takes 5-10 minutes rest without taking off the wearables.

During that time the participant walks along the aisle and walks out of the fuselage. A cup of drinks (no coffin drinks) and snacks are provided.

Yayu checks the storage of GoPro first, cut files out if it is full. Yayu adjusts the seat to the second setup, Xinhe transfers results of the questionnaires online.

Setup2

15. The participant sits on the seat and fasten the safe belt.
16. The participant fills in the first questionnaire. This takes no more than 2 minutes.
17. Xinhe collects the questionnaire. Yayu starts camera recording, front first and then side.
18. Xinhe stays near the stool, Yayu stays next to Xsensor monitor. And try not to move during the experiment.
19. Participant raises a hand
20. Xinhe starts jacket and timer, Yayu starts pressure mats and HRV band
21. After sitting on the seat for 9.5 minutes (check by Xinhe, Mark event in HRV by Yayu), the participant fills in the second questionnaire. It takes no more than 1.5 minutes.(collect by Xinhe)
22. The participant sits for another 10 minutes.(Check by Xinhe) Participant raises a hand
23. Xinhe stops jacket and timer, Yayu stops mats and band.
24. Yayu stops camera recording, side first and then front.
25. The participant fills in the third questionnaire before leaving the seat.

Break

The participant leaves the seat and takes 5-10 minutes rest without taking off the wearables. During that time the participant walks along the aisle and walks out of the fuselage. A small number of drinks (no coffee, coca cola, redbull) and snacks are provided.

Yayu checks the storage of gopro first, cut files out if it is full. Yayu adjusts the seat to the second setup, Xinhe transfers results of the questionnaires to data collection sheet.

Setup3

26. The participant sits on the seat and fasten the safe belt.
27. The participant fills in the first questionnaire. This takes no more than 2 minutes.
28. Xinhe collects the questionnaire. Yayu starts camera recording, front first and then side.
29. Xinhe stays near the stool, Yayu stays next to Xsensor monitor. And try not to move during the experiment.
30. Participant raises a hand
31. Xinhe starts jacket and timer, Yayu starts pressure mats and HRV band
32. After sitting on the seat for 9.5 minutes (check by Xinhe, Mark event in HRV by Yayu), the participant fills in the second questionnaire. It takes no more than 1.5 minutes.(collect by Xinhe)
33. The participant sits for another 10 minutes.(Check by Xinhe) Participant raises a hand
34. Xinhe stops jacket and timer, Yayu stops mats and band.
35. Yayu stops camera recording, side first and then front.
36. The participant fills in the third questionnaire before leaving the seat.

Measurement of sitting anthropometric data

37. The participant leaves the seat and takes off all the wearables. The participant answers the last question regarding comfort ranking.
38. The participant sits on the measurement stool as instructed.
39. Yayu measures 1.hip width, 2.buc-pop depth, 3 pop height in this order
40. Xinhe records the value in the meantime and fills in the data sheet.

Height and weight measurement

The researcher measures height and weight of the participant (no shoes) with the measuring tape and weighing scale near the front door, and fills the results in the data sheet.

1. Take off shoes
2. Step on the scale (facing wall)
3. Yayu reads the weight, write down
4. Turn around, against wall
5. Xinhe: Mark height, Yayu holds the measuring board
6. Yayu: Read and write down on the data sheet

The experiment for one participant is finished. The participants can receive the voucher and help him/herself at the end of the aisle.

Wrap-up

Yayu uploads the files from gopros and upload to Teams server.
Yayu renames the pressure data and saved in a folder.
Yayu uploads the HRV data from cellphone to Teams server.

Xinhe saves and uploads the jacket data.
Xinhe collects all the paper questionnaire in a bag.

Preparation for the next

Check SD card storage, battery of GoPros. Put them in place.
Start a new file for pressure data.
Clean the wristband with disinfected wipe.
Check battery and pair the wristband, put it on the stool.
Make the stool back in default setting.
Prepare questionnaire set, consent form and data sheet

Make the jacket in order and put on the stool.

Consent Form for
[*The influence of the angle of attack on comfort of passengers*]

Please tick the appropriate boxes	**Yes**	**No**
Taking part in the study		
I have read and understood the study information dated [__/__/____] , or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
I understand that taking part in the study involves measurement of my anthropometric data, a 1.5 hours video recording participatory test on the experiment platform (The video will be used in facial analysis by software), physiological and physical signals captured by various wearable and external sensors during the experiment, and a set of questionnaires filled by the participant.	☐	☐
Use of the information in the study		
I understand that information I provide will be used for the publications of the ComfDemo project.	☐	☐
I understand that personal information collected about me that can identify me, such as personal anthropometric data, will not be shared beyond the study team.	☐	☐
Future use and reuse of the information by others. **The default choice of these questions is NO.**		
I give permission for the anthropometric data, physiological and physical signals data, and results of questionnaires (All of them are anonymised.) that I provide to be archived in TU Delft so it can be used for future research and learning. The data will be stored at a secure sever in TU Delft which only can be accessed by the researchers. The data is managed according to the data management plan.	☐	☐
I give permission for sharing the video recorded during the experiment in the graduation presentation.	☐	☐

Signatures

_____	_____	_____
Name of participant	Signature	Date

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

Yayu Ping	_____	_____
Researcher name	Signature	Date

Study contact details for further information: [*Name, phone number, email address*]

Date 05-07-2021
Contact person Ir. J.B.J. Groot Kormelink, secretary HREC
Telephone +31 152783260
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2628 BX Delft

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P.O. Box 5015 2600 GA Delft
The Netherlands

Ethics Approval Application: The influence of angle of attack on passengers' comfort
Applicant: Ping, Yayu

Dear Yayu Ping,

It is a pleasure to inform you that your application mentioned above has been approved.

Thanks very much for your submission to the HREC which has been approved. We do additionally note/advise the following:

1) Doublecheck with your Data Steward or the Privacy Team on GDPR compliance vis a vis bluetooth transfer.

Best wishes,

Good luck with your research!

Sincerely,

Dr. Ir. U. Pesch
Chair HREC
Faculty of Technology, Policy and Management