



Aalborg Universitet

AALBORG UNIVERSITY  
DENMARK

## GPS based mapping of cyclists' routes in Copenhagen

*A pilot survey*

Knudsen, Anne-Marie Sanvig; Harder, Henrik; Jensen, Anders Sorgenfri; Tradisauskas, Nerius; Simonsen, Anders Kvist; Hansen, Jakob Hjorth; Snizek, Bernhard; Bro, Peter; Christensen, Ann Sofie Grimshave

*Publication date:*  
2010

*Document Version*  
Early version, also known as pre-print

[Link to publication from Aalborg University](#)

*Citation for published version (APA):*

Knudsen, A.-M. S., Harder, H., Jensen, A. S., Tradisauskas, N., Simonsen, A. K., Hansen, J. H., Snizek, B., Bro, P., & Christensen, A. S. G. (2010). *GPS based mapping of cyclists' routes in Copenhagen: A pilot survey*. (pp. 1-23).

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- ? Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- ? You may not further distribute the material or use it for any profit-making activity or commercial gain
- ? You may freely distribute the URL identifying the publication in the public portal ?

### Take down policy

If you believe that this document breaches copyright please contact us at [vbn@aub.aau.dk](mailto:vbn@aub.aau.dk) providing details, and we will remove access to the work immediately and investigate your claim.



bike infrastructures

GPS BASED MAPPING OF  
CYCLISTS' ROUTES IN COPENHAGEN  
- A PILOT SURVEY

A&D FILES

ISSN: 1603-6204

VOLUME 38

TITEL

GPS based mapping of cyclists' routes in Copenhagen  
- a pilot survey

AUTHORS

Anne-Marie S. Knudsen  
Henrik Harder  
Nerius Tradisaukas  
Jakob Hjorth Hansen  
Anders Kvist  
Anders Sorgenfri  
Bernhard Snizek  
Peter Bro

LAYOUT

Ann Sofie Grimshave Christensen

COVER LAYOUT

Ann Sofie Grimshave Christensen

COVER PHOTO

Victor Andrade Carneiro da Silva

PHOTOS

Victor Andrade Carneiro da Silva

MANY THANKS TO

Town Planning Institute  
for participating in the survey

  
AALBORG UNIVERSITET



**bike infrastructures**

GPS BASED MAPPING OF  
CYCLISTS' ROUTES IN COPENHAGEN  
- A PILOT SURVEY



# contents

INTRODUCTION TO THE SURVEY	6
THE PRACTICAL SET-UP	8
TECHNICAL SET-UP	9
PRESENTATION AND ANALYSIS OF DATA	10
REFLECTIONS REGARDING SURVEY ACTIVITIES	12
REFERENCES	13
LIST OF APPENDICES	14

# introduction to the survey

As a part of the research project Bike Infrastructures, workpackage 3, the research team “DMB” at the Institute for Architecture, Design and Media Technology at Aalborg University, undertook a GPS based pilot survey of cyclists’ routes in Copenhagen in August 2010.

The overall aim of the Bikeability research project is to investigate how to promote and encourage bike-ability in urban areas. For more information about the research project please see [www.bikeability.com](http://www.bikeability.com).

The aim of the GPS based pilot survey was to collect and show how to create a database through GPS tracking from which cyclists’ routes can be visualized. The aim was furthermore to show how the survey research design works in practice and which elements of the set-up to be aware of and develop when the large scale GPS based survey of the Bikeability research project is carried out in the spring of 2011.





nib la.com



# the practical set-up

The large scale GPS based survey which is carried out in the spring of 2011 will involve a “contact-set up”, meaning the participants (cyclists) will be contacted and recruited when “in motion” at key infrastructure intersections in Copenhagen. For the pilot survey the research team decided a more “controlled” set-up as the “contact set-up” was deemed unrealistic to carry out at such a small scale.

The Danish Town Planning Institute (Dansk Byplanlaboratorium) was contacted in June 2010 and they volunteered to participate in the pilot survey . 4 men and 4 women participated in the pilot survey which ran from Monday to Friday of week 35, August 2010.

With help from a contact person at the Danish Town Planning Institute the survey participants were instructed in how to use the GPS (the lommy). The participants were encouraged to carry the lommy 24 hours a day of the five full days the pilot survey ran. The participants are always free to “sign out” of the survey by pushing the red bottom on the lommy (see picture on lommy instruction, appendix B)

As a part of the survey set-up, a text-message service was developed. The purpose of this service was to remind participants to bring the lommy in the morning and to charge it in the evening. A modem connected to a computer was programmed to send out messages at 7 am and 9 pm to the participants mobile phones. The service was optional and one participant did not wish to receive text messages from the research team. Due to technical problems with the computer, the text message-service only worked Monday and Tuesday.

The survey participants were furthermore encouraged to send text messages to the modem regarding their own reflections and perceptions of their chosen cycle route. It is technically simple to couple the GPS log with the time that the text was sent and this method opens up the possibility for geo-coded qualitative data collection. However, no texts were received which might also have been due to the malfunctioning of the computer.

The research team furthermore looked into the possibility of collecting picture messages from the survey participants. Due to the small scale of the pilot survey, the component was left out. Picture messages could potentially have been uploaded to a website, designed specifically for this pilot survey.

Following the GPS based data collection the survey participants were encouraged to fill out a questionnaire concerning their experiences with carrying the lommy. 3 participants answered and submitted the survey.

# technical set-up

## GPS-DATA

A lommy was employed to carry out the GPS based tracking (the Lommy Phoenix was used, for more detailed information see Kvist Simonsen et al, 2007). The lommy is about the size of a mobile phone and has a built in GPS and GSM unit. Through a GSM unit the GPS unit logs online and in real time to a server where the participant is and how long he or she spends at a given location. The GPS unit furthermore tells you how fast the participant is moving. For this particular survey the lommy was programmed to log every 5 seconds.

The batteries of the lommies lasted on average 20 hours with a logging frequency of 5 seconds. The battery duration always depends on how frequent the lommy is set to log. Please see appendix A for a detailed description of the battery test.

## ONLINE QUESTIONNAIRE

As a supplement to the trips logged by the lommy, the research team developed an on-line questionnaire which allowed the participants to log their cycle trips by typing in start-and finishing time of a given trip. The digital questionnaire automatically generates the trip from the GPS-data stored in the on-line database. The participant is furthermore given the option to fill in a brief questionnaire describing the trip (insert picture)

GPS data as well as questionnaire answers are kept in relational MySQL-database. From this database it is possible to generate "joins" and data extracts for further analysis.

# presentation and analysis of data

## GPS-DATA

Data was collected amongst 8 participants and the lomnies were in use for 5 full days, from Monday morning (defined as 00.01) to Friday midnight. The analysis was carried out using a dataset which is geographically delimited to a boundary box, which covers the entirety of Copenhagen and Frederiksberg Municipality defined by the vertices from the municipal borders polygon-theme, which have the lowest and highest Easting and Northing coordinates in the ETRS89/UTM32 reference system. The dataset contains 96168 points altogether.

The method and algorithm used to distinguish between data that represents stays and data that represents movements is described by Sorgenfri et al (2009). The procedure is basically an algorithm which scans the entire dataset and evaluates every record. Based on the attributes of each point and the attributes of adjacent points, the procedure will return a certain value. This value can later be used to determine a point as either a trip or a stay point depending on what would be most likely according to the performed calculations. Of the 96169 points, movement data was identified to 16547 points (17,2%) and stay data was identified to 79621 points (82,79%). In comparison with previous surveys, the dataset contains a large proportion of movement points.

18 trips were logged via the on-line survey. The initial dataset, drawn from a join between GPS data and the on-line survey only contained 12282 points which the research team considered insufficient to use as a basis for further analysis. The lack of data either stems from participants not registering trips via the on-line survey or discrepancy between the actual time when the trip was carried out and the time the participants noted in the on-line survey. Feedback from participants points to the former.

On the next page is the map showing the 8 participants' transports corridors, based on the points identified as movement by the algorithm.

## QUESTIONNAIRE

Only 3 participants answered and submitted the questionnaire following the GPS based survey. Due to the small survey sample it is not possible to generalize from the data collected through the questionnaire. Meanwhile, the answers submitted do offer relevant insight that are useful for future survey set-ups. This particularly concerns the on-line questionnaire. All 3 participants emphasize that logging each single trip was not intuitive- it was easy to forget and it was seen as too time consuming.

"It [the GPS survey] all seemed a bit heavy, there were too many things to remember. It would be nice if the system could automatically figure out when you are actually cycling, so you don't have to log the time slots yourself. It seems like too much work."

The participants found the text message service useful and it helped them remember the lommy in the morning. It did not cause any difficulties carrying or using the lommy. However, the design of the lommy was perceived a bit "old school":

"It [the lommy] wasn't really cool. It seems out-of-date and old fashioned. [I] had envisioned a device with a display [allowing to see the route in real time]."

Meanwhile, there is a valid point of maintaining an "old-school" design as the lommy does not represent any use value and therefore can't be sold on.

The questionnaire furthermore allowed the participants to elaborate on whether they sometimes cycle "against the current"-see question 14 in appendix E. Two participants answered positively which would indicate that the question is worth including in the 2011 survey.



Background map: DAV2004  
Building theme: National Survey and Cadastre topographic  
maps- TOP10DK

# reflections regarding survey activities

## TEXT- AND PICTURE MESSAGES

Due to technical difficulties this component of the survey set-up never worked as intended. Participants do however state that the text message service was helpful.

In related survey set-ups text messages have been used to collect qualitative data about the participants' experiences and perceptions of the urban environment (see <http://vbn.aau.dk/files/17053915/ZooRapport.pdf>). This component would seem relevant to include in future surveys

## ON-LINE QUESTIONNAIRE

It is relatively demanding to work with the on-line questionnaire for both participants and research team. It is perceived time-consuming by the participants to log the trips-which a relatively low return frequency also shows. In order to boost this frequency, the research team could remind survey participants to fill out the questionnaire. This activity would however show time consuming and potentially perceived intrusive by the participant.

## GPS-DATA

The method to distinguish trips from stays showed useful in identifying cycle trips. Regarding the join between GPS data and the on-line survey, this method showed less useful which also relates to the section above.

## FOLLOW-UP QUESTIONNAIRE

Inputs from the participants are useful in order to further develop the research method. Again this is a relatively time-consuming activity which demands motivation from the participant and time from the research team.

## references

Harder et al. (2009): "GPS baseret kortlægning af zoo gæster brug af Aalborgs zoologiske have, efteråret 2008." Department of Architecture and Design Working Paper Series. Institut for Arkitektur og Design, Aalborg Universitet, 98 pages

Simonsen, Anders Kvist; Bro, Peter; Harder, Henrik (2007): "The precision of the Lommy Phoenix - Tests in various urban environments". Arkitektur og Design, Aalborg Universitet, skriftserie 16

Sorgenfri, Anders; Bro, Peter; Harder, Henrik; Hjorth Hansen, Jakob; Tradisauskas, Nerius (2009): "Distinguishing movement from stays during continual GPS tracking". Conference paper presented at Geoforum Kortdage 2009 november 18. □20. 2009, Denmark.

# list of appendices

Appendix A: Battery test

Appendix B: Lommy instruction

Appendix C: Mail to Christian Broen, Danish Town Planning Intitute, including screen shots of online questionnaire

Appendix D: Follow-up questionnaire

Appendices, data set and map are included on a CD





malbeck

## APPENDIX A: BATTERI TEST

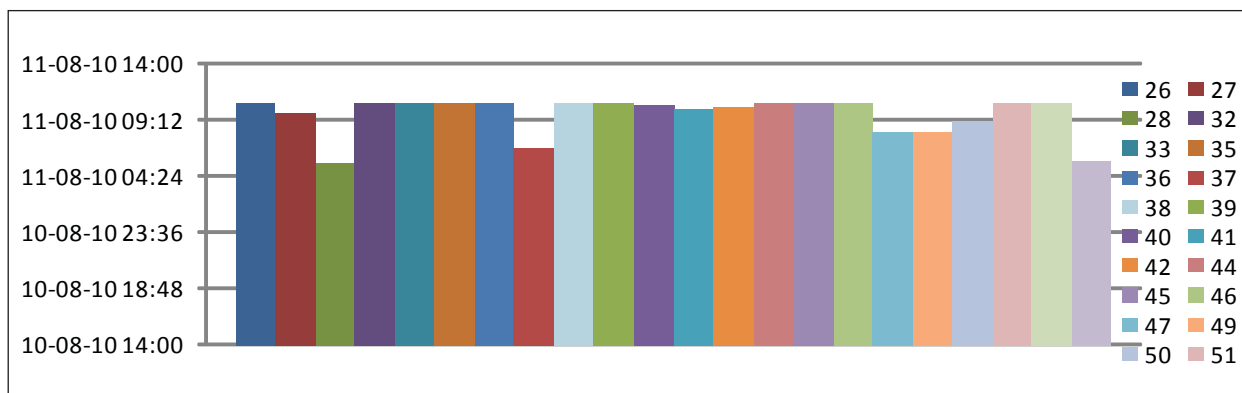
By Jakob Hjorth Hansen

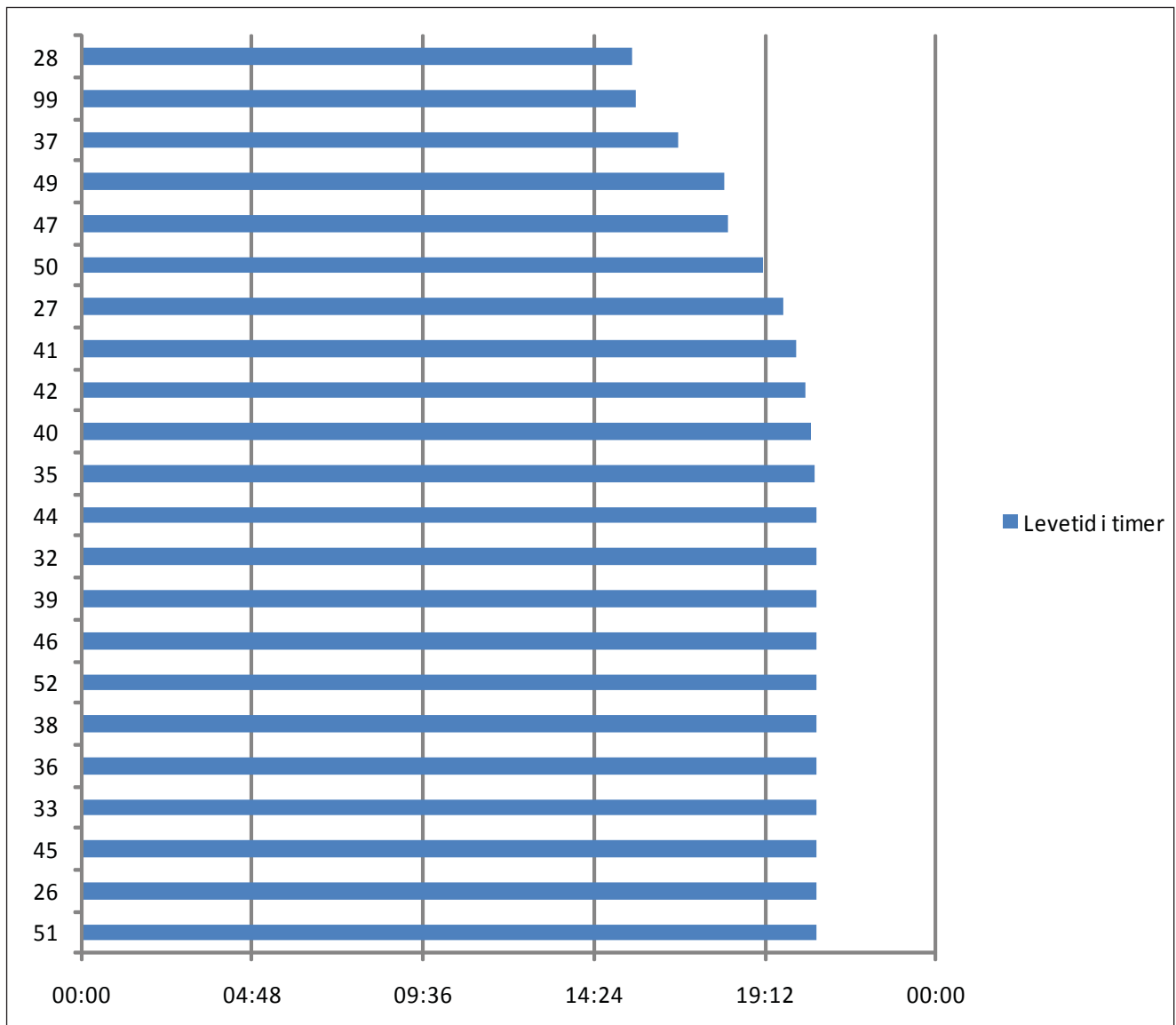
All lommyes were fully charged when they were unplugged from their chargers at 14 hours August 10th 2010.

Below are is shown the time and date when the lommys logged their last signal:

ID	End time	ID	top 10 i levetid
26	11-08-10 10:39	51	11-08-10 10:40
27	11-08-10 09:42	26	11-08-10 10:39
28	11-08-10 05:28	45	11-08-10 10:39
32	11-08-10 10:38	33	11-08-10 10:39
33	11-08-10 10:39	36	11-08-10 10:39
35	11-08-10 10:36	38	11-08-10 10:39
36	11-08-10 10:39	52	11-08-10 10:39
37	11-08-10 06:46	46	11-08-10 10:39
38	11-08-10 10:39	39	11-08-10 10:38
39	11-08-10 10:38	32	11-08-10 10:38
40	11-08-10 10:30	44	11-08-10 10:38
41	11-08-10 10:04	35	11-08-10 10:36
42	11-08-10 10:20	40	11-08-10 10:30
44	11-08-10 10:38	42	11-08-10 10:20
45	11-08-10 10:39	41	11-08-10 10:04
46	11-08-10 10:39	27	11-08-10 09:42
47	11-08-10 08:08	50	11-08-10 09:09
49	11-08-10 08:03	47	11-08-10 08:08
50	11-08-10 09:09	49	11-08-10 08:03
51	11-08-10 10:40	37	11-08-10 06:46
52	11-08-10 10:39	99	11-08-10 05:35
99	11-08-10 05:35	28	11-08-10 05:28

ID	Levetid i timer og minutter
51	20:40
26	20:39
45	20:39
33	20:39
36	20:39
38	20:39
52	20:39
46	20:39
39	20:38
32	20:38
44	20:38
35	20:36
40	20:30
42	20:20
41	20:04
27	19:42
50	19:09
47	18:08
49	18:03
37	16:46
99	15:35
28	15:28





## APPENDIX B: LOMMY INSTRUCTION



### Det mangfoldige Byrum - Aalborg - GPS Undersøgelse 2008 – GPS instruktion

Vi anbefaler, at du bringer din oplader med rundt sammen med din GPS, hvis du er væk mere end 10 timer fra dit hjem med GPS'en. GPS'en har en rød (stop/start) knap, 4 lysdioder (grøn, rød, gul og blå) og en opladerkontakt i bunden.

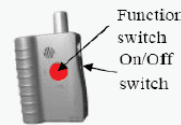
For at tænde GPS'en skal du trykke på den røde knap. En gul diode vil tænde og vise, at GPS'en starter op og etablerer forbindelse til vores server. Straks efter vil resten af lysene fra dioderne blinke. For at slukke GPS'en skal du holde den røde knap nede, indtil den gule knap blinker langsomt. Slip den røde knap og tryk den ind igen efter 2 sekunder. Nu er GPS'en slukket helt og din færden vil ikke blive registreret.

Den grønne diode viser, at GPS'en er på GSM nettet. Den grønne diode vil blinke, indtil der er kontakt til GSM netværket. Herefter vil den kun blinke, når GPS'en sender/modtager data. Hvis den bliver ved at blinke, så ring til 99 40 71 68 eller E-mail: [dus@aod.aau.dk](mailto:dus@aod.aau.dk)

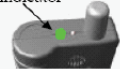
Den røde diode blinker, når GPS'en bliver opladet, og den røde diode er tændt hele tiden, når GPS'en er fuldt opladet og forbundet til oplader. Hvis den røde diode blinker, og oplader ikke er tilsluttet, så vil vi bede dig påbegynde opladningen med det samme.

Den blå diode viser, at der modtages GPS signaler. Blinker den blå diode én gang, så er der ingen GPS dækning. Er der GPS dækning, vil den blå diode give et blåt blink og en række efterfølgende korte blå blink, der fortæller, hvor mange GPS satellitter, GPS'en har kontakt med.

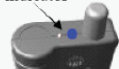
Husk at bære GPS'en højt på kroppen og så yderligt som muligt, så er forbindelsen til satellitterne bedst.



Activity indicator



Status indicator



Kontaktadresse: [dus@aod.aau.dk](mailto:dus@aod.aau.dk) – For yderligere information [www.detmangfoldigebyrum.dk](http://www.detmangfoldigebyrum.dk)

Henrik Harder, Lektor, Ph.d., HD(O), Forskningsprojektleder

## APPENDIX C: MAIL TO CHRISTIAN BROEN, DANISH TOWN PLANNING INSTITUTE AND SCREEN SHOTS OF ON-LINE QUESTIONNAIRE

From: Anne-Marie Sanvig Knudsen  
Sent: 24. august 2010 15:53  
To: 'cb@byplan.dk'  
Cc: Henrik Harder  
Subject:

Kære Christian

Nedenfor finder du linket til det spørgeskema deltagerne skal udfylde pr. cykeltur. Man logger ind ved at bruge GPSens ID nummer samt pin, som findes i vedlagte excelark. Hvornår deltageren udfylder spørgeskemaet er principielt lige gyldigt, men det er vigtigt at de mentalt eller på et stykke papir noterer i hvilket tidsrum de foretog turen. Start-og sluttidspunkt noteres som nedenfor og så finder databasen turen frem. Turen kan desværre ikke genereres automatisk men skal altså laves manuelt. Når spørgeskemaet er udfyldt trykker man SUBMIT og så gemmes turen.

Vil du notere hvem der får hvilken GPS i vedlagte excelark. Det er vigtigt at I noterer fødselsdato, så vi har et unikt ID på deltageren. Hvis de vil udfylde deres mobilnummer også, så kan vi sende daglige reminders om at medbringe/ oplade GPSen. Det er frivilligt om man vil opgive sit mobilnummer. Senere på ugen får jeg også nummeret på vores mobilmodem, således at deltagere kan sende sms'er til os om oplevelser og indtryk fra deres cykelrute (trælse lyskryds, huller i cykelstien, yndlingsstrækningen, o.lign. Ting der beskriver hvordan deres cykeltur opleves og afvikles) . Altså et lille kvalitativt input til undersøgelsen. Vi arbejder på at der også kan uploades billeder til vores server. Mere om det i løbet af ugen.

Vedhæftet er også en instruktion til hvordan GPSen bruges- eller lommien, som den også hedder. Deltagerne bærer GPSen på sig mandag til fredag i uge 35-hele tiden! Ikke kun når man cykler. Dog er det kun cykelturene der skal registreres i spørgeskemaet. Når man er indendøre er det en god ide at lægge GPSen i en vindueskarm, så den ikke mister signalet. Jeg vil opfordre til at man oplader GPSen hjemme, om natten, og ikke på kontoret, da der let kan gå kuk i det, hvis man har en hjemmearbejdsdag, et møde ude af huset eller lignende.

GPSerne skal videre til Ballerup i uge 36, så jeg skal have arrangeret at få dem transporteret derud mandag den 6. sept. Så hvis nogen deltagere ved at de ikke kommer på arbejde mandag den 6. sept, må de meget gerne lade GPSen blive på kontoret, når de går til weekend fredag den 3. sept. Det kan vi lige aftale nærmere i løbet af uge 35, hvordan vi gør, sådan rent lavpraktisk.

I løbet af uge 36 sender jeg et lille spørgeskema til deltagerne om hvordan deres oplevelse har været med at bære GPSen og udfylde spørgeskemaet.

Endelig, her er et par links til "moderprojekterne":

<http://www.bikeability.dk/>  
<http://www.detmangfoldigebyrum.dk/>

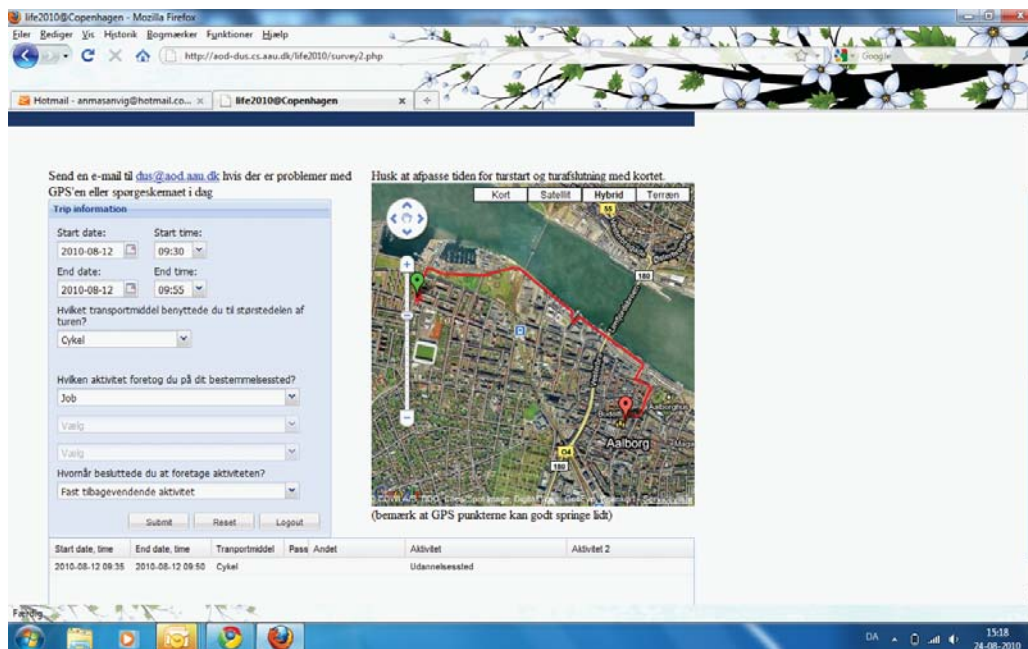
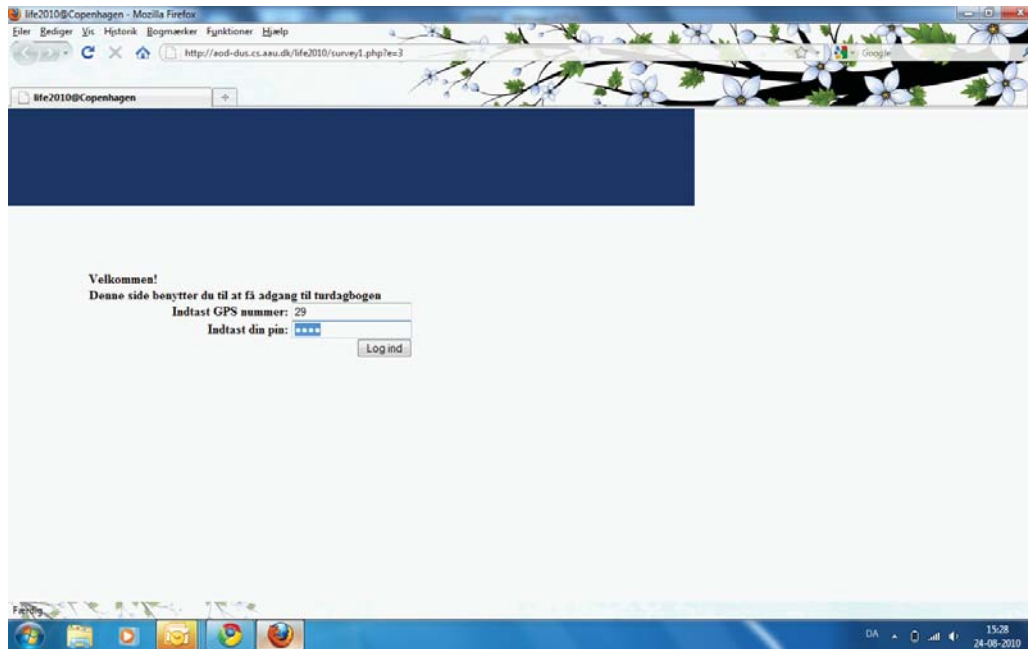
Hvis der er spørgsmål af nogen som helst art, så må I bare ringe eller skrive. Mit nummer er 51925045.

Venlige hilsner  
Anne-Marie



Link til spørgeskema:

<http://aod-dus.cs.aau.dk/life2010/survey2.php>



## APPENDIX D: FOLLOW-UP SURVEY

### Spørgeskema- GPS cykelsurvey september 2010

•Var GPSen overskuelig at betjene?

---

•Var det besværligt at få GPSen med og /eller at oplade den hver dag?

---

•Modtog du SMSer fra os i løbet af ugen?

---

•Hvis ja, hjælp de til at huske GPSen/opladning?

---

•Oplevede du nogen praktiske problemer ved at bære GPSen?

---

•Havde GPSen/overvågningen nogen påvirkning på den rute du valgte?

---

•Loggede du dine ture på vores online-spørgeskema?

---

•Hvis ja, hvordan oplevede du brugervenligheden af spørgeskemaet?

---

•Hvis nej, uddyb gerne (det var for besværligt, tidskrævende, brugervenlighed el. lign)

---

### Lidt om dine transportvaner

•Bruger du cyklen fra dør til dør, når du skal til og fra arbejde

---

•Hvis nej, hvilke transportmidler bruger du udover cyklen?

---

•Hvor langt har du til arbejde?

---

•Hvor lang tid bruger du dagligt på transport til og fra arbejde?

---

•Cykler du af og til "ulovligt" (mod køreretning, på fortove, over pladser el. lign) og/eller igennem private arealer (firmagrunde, porte, baggårde etc.). Motiver gerne hvorfor!

---

•Øvrige kommentarer og forslag vedr. vores undersøgelsesmetode

---

For mere information om projektet, kan du læse videre her:

<http://www.bikeability.dk>  
<http://www.bikeability.dk/wps/wp2/>

Med venlig hilsen og på forhånd tak!

Anne-Marie Sanvig Knudsen  
PhD Fellow  
Department of Architecture,  
Design and Media Technology  
Aalborg University  
Gammel Torv 6, Room 319 (Office)  
DK - 9000 Aalborg Denmark

[askn@create.aau.dk](mailto:askn@create.aau.dk)

Bernhard Snizek  
PhD Fellow  
Forest and Landscape  
KU, LIFE  
Rolighedsvej 23  
1958 Frederiksberg

[besn@life.ku.dk](mailto:besn@life.ku.dk)







