Improving the usability of pedestrian navigation systems

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Overview

- Completed PhD research on usability of pedestrian navigation systems

- User-Centred Design of a prototype mobile cartographic interface that could help pedestrian users to orientate and navigate in unfamiliar urban areas

- UCD methodology, involving user testing during requirement analysis and prototype usability testing

Keywords:

- Pedestrian navigation
- Landmarks
- UCD
- Prototype development
- Usability testing

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Outline

- Introduction and research aim

- Research methodology

- 1st stage: Requirement analysis

- 2nd stage: Conceptual design / prototype implementation

- 3rd stage: Usability evaluation

- Qualitative analysis of the results

- Outcomes of the usability testing

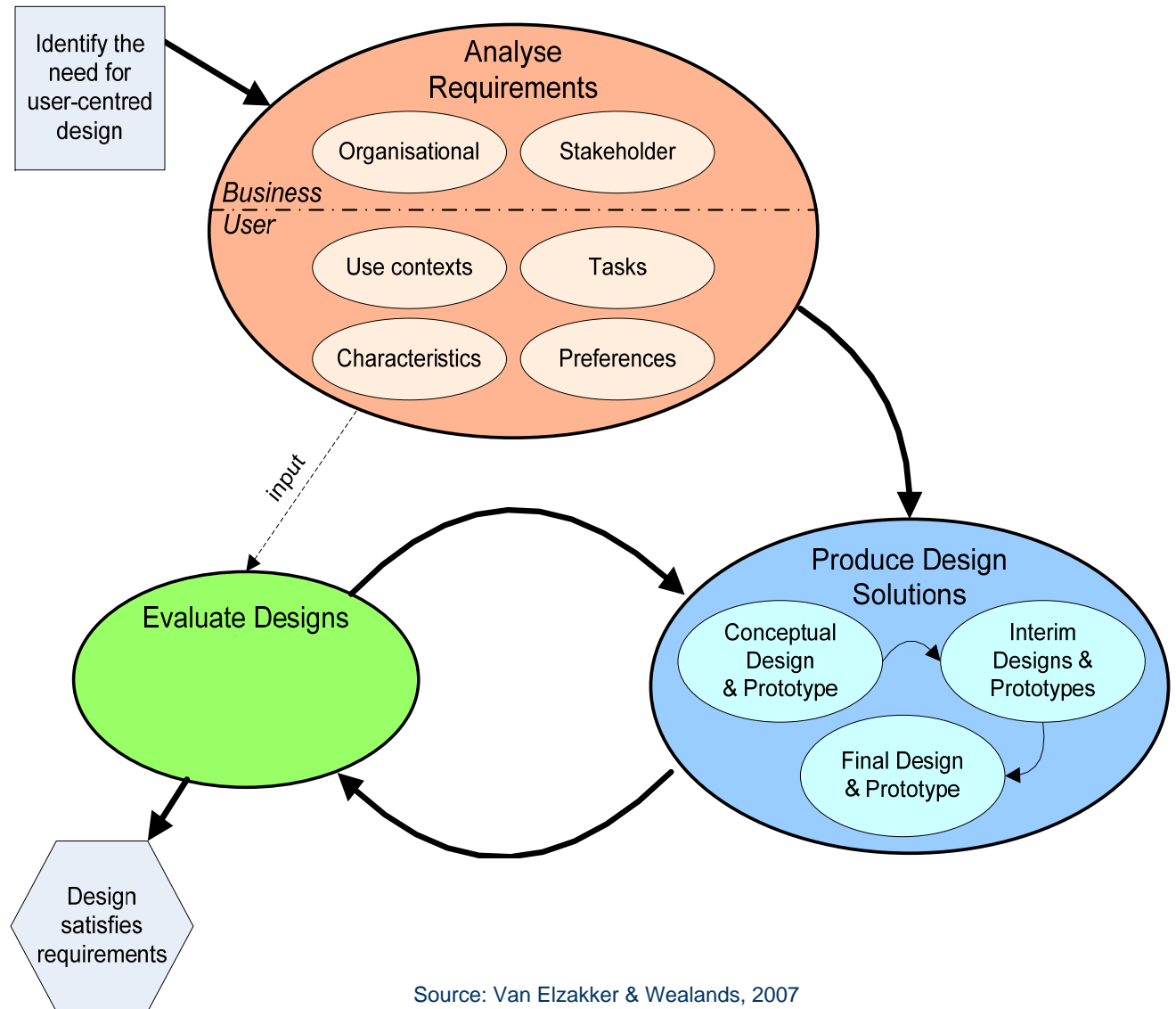- Conclusions and discussion

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Introduction

- Orientation and navigation using mobile navigation systems: interactive linking of different information sources. Fundamental question: "Where am I?"

- The problem: current systems not very well suited to pedestrians due to special contexts of use, limitations of mobile devices, technology-focused solutions

Therefore, the overall research aim was:

- To design and evaluate a (carto-) graphic interface for geo-mobile applications that facilitates orientation and supports spatial activities of pedestrians
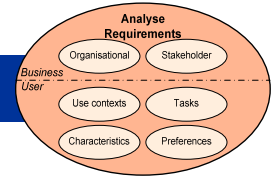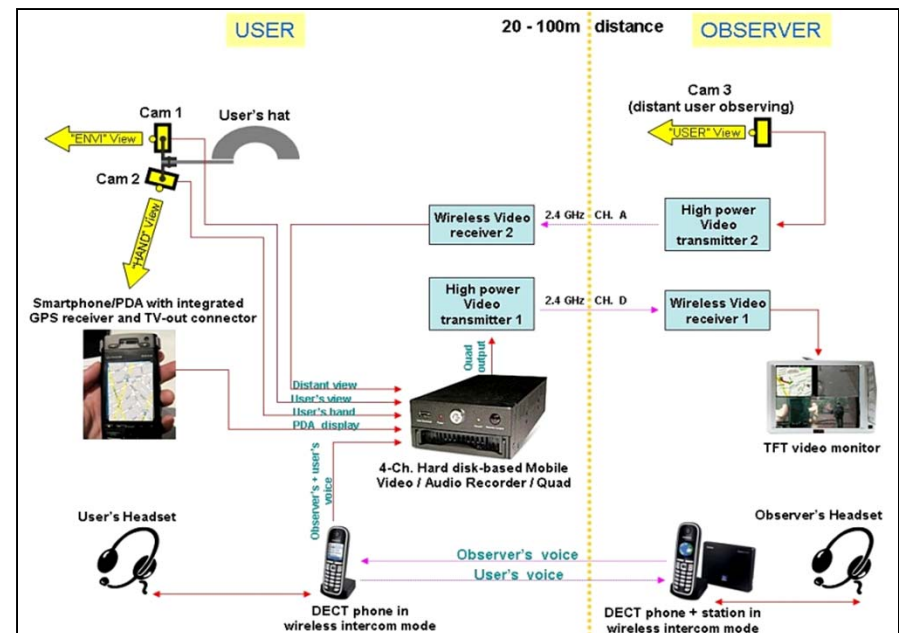
Research methodology

UCD

Identify the need for user-centred design

Analyse Requirements

Business
User

Organisational

Stakeholder

Use contexts

Tasks

Characteristics

Preferences

input

Evaluate Designs

Produce Design Solutions

Conceptual Design & Prototype

Interim Designs & Prototypes

Final Design & Prototype

Design satisfies requirements

Source: Van Elzakker & Wealands, 2007
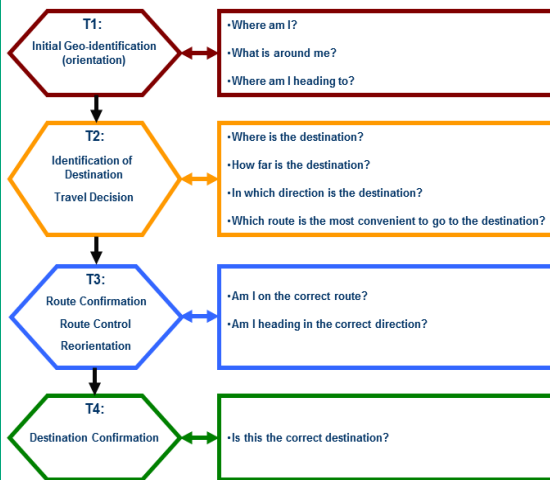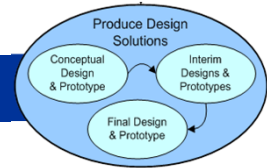
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1st stage: Requirement analysis

- Field-based experiment with test persons unfamiliar to the test areas (Amsterdam)
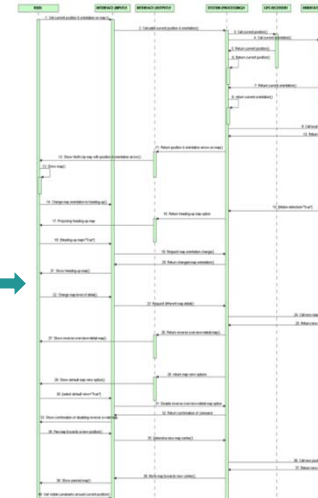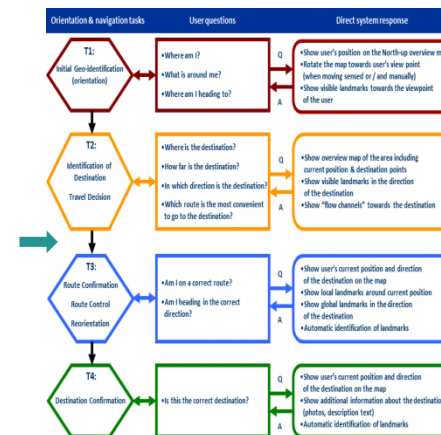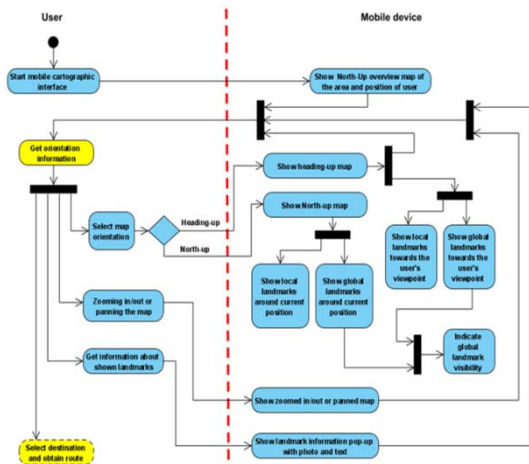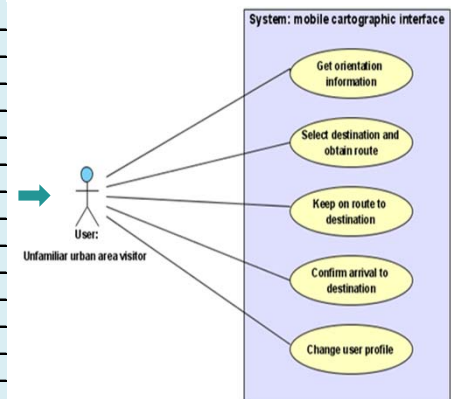- Scenario-based test sessions and navigation tasks with 2 existing applications

- Field-based usability testing system

- Information gathered on important landmarks, sources of confusion, preferred solutions

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2nd stage: Conceptual design / prototype implementation

Produce Design Solutions: Conceptual Design & Prototype → Interim Designs & Prototypes → Final Design & Prototype

Scenarios based on the requirement analysis experiment → Defining information requirements → Use case modeling → System conceptual design / interaction modeling → Software development

T1: Initial Geo-identification (orientation)
- Where am I?
- What is around me?
- Where am I heading to?

T2: Identification of Destination — Travel Decision
- Where is the destination?
- How far is the destination?
- In which direction is the destination?
- Which route is the most convenient to go to the destination?

T3: Route Confirmation — Route Control — Reorientation
- Am I on the correct route?
- Am I heading in the correct direction?

T4: Destination Confirmation
- Is this the correct destination?

N	Information Requirement	Task			
		T1	T2	T3	T4
IR1	Accurate and legible current position and orientation	✓	✓	✓	✓
IR2	Interchangeable North-Up map / heading-up	✓	✓	✓	✓
IR3	Map with zooming and panning capabilities	✓	✓	✓	✓
IR4	Street patterns and sizes on the map reflecting reality	✓	✓	✓	✓
IR5	Street names, numbers and place signs on (detail) map	✓	✓	✓	✓
IR6	Visible landmarks around current position on the map	✓		✓	✓
IR7	Legible position and symbology of the destination on map		✓	✓	✓
IR8	Direction of destination directly provided on the map		✓	✓	✓
IR9	Visible landmarks in the direction of destination		✓	✓	✓
IR10	Different routing possibilities based on user's decisions		✓	✓	✓
IR11	Additional information regarding destination		✓	✓	✓
IR13	Legible symbology, naming and information for landmarks	✓	✓	✓	✓
IR14	Legible map scale indication	✓	✓	✓	✓
IR15	Smooth zooming capability	✓	✓	✓	✓

System: mobile cartographic interface
- Get orientation information
- Select destination and obtain route
- Keep on route to destination
- Confirm arrival to destination
- Change user profile

User: Unfamiliar urban area visitor

Finalizing prototype design and functionality

"LandNavin" prototype interface

3rd stage: Usability evaluation

- Usability questions related to 4 main orientation / navigation tasks identified in previous stages

- Google (Mobile) Maps used as a control application for for comparison aims

- Test areas: Amsterdam centre and living district with 2 destinations each
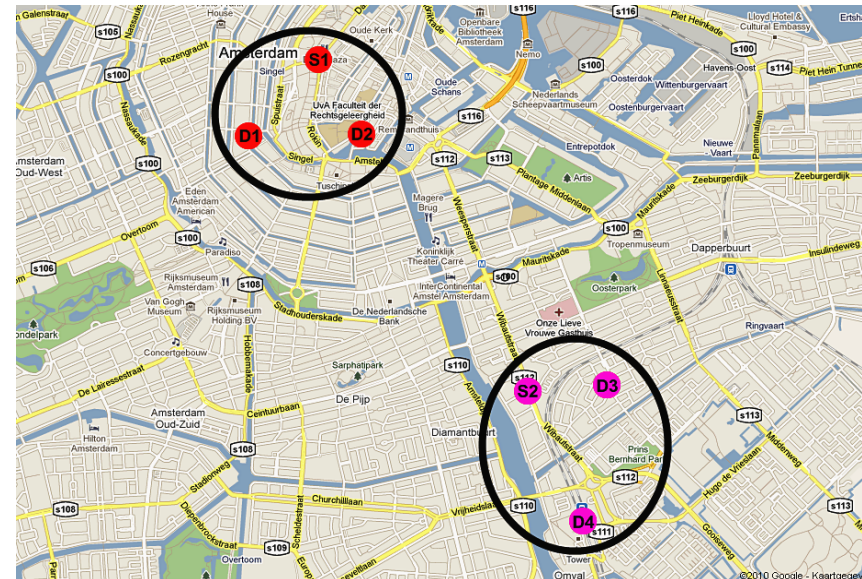
- 24 test persons with and without background in geography and GIS

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Structuring test sessions

Formation of 4 groups of test persons based on interface use sequence and test area. Time availability considered as an important parameter

TEST	AREA	TIME	START	DEST.	INTERFACE	PARAMETERS	GROUP
TP1	CENTRE	P	S1	D1, D2	LN➜GM	CPL	A
TP2	WIBAUTSTRAAT	P	S2	D3, D4	LN➜GM	WPL	B
TP3	CENTRE	L	S1	D1, D2	LN➜GM	CLL	A
TP4	WIBAUTSTRAAT	L	S2	D3, D4	LN➜GM	WLL	B
TP5	CENTRE	P	S1	D1, D2	GM➜LN	CPG	C
TP6	WIBAUTSTRAAT	P	S2	D3, D4	GM➜LN	WPG	D
TP7	CENTRE	L	S1	D1, D2	GM➜LN	CLG	C
TP8	WIBAUTSTRAAT	L	S2	D3, D4	GM➜LN	WLG	D
TP9	CENTRE	P	S1	D1, D2	LN➜GM	CPL	A
TP10	WIBAUTSTRAAT	P	S2	D3, D4	LN➜GM	WPL	B
TP11	CENTRE	L	S1	D1, D2	LN➜GM	CLL	A
TP12	WIBAUTSTRAAT	L	S2	D3, D4	LN➜GM	WLL	B
TP13	CENTRE	P	S1	D1, D2	GM➜LN	CPG	C
TP14	WIBAUTSTRAAT	P	S2	D3, D4	GM➜LN	WPG	D
TP15	CENTRE	L	S1	D1, D2	GM➜LN	CLG	C
TP16	WIBAUTSTRAAT	L	S2	D3, D4	GM➜LN	WLG	D
TP17	CENTRE	P	S1	D1, D2	LN➜GM	CPL	A
TP18	WIBAUTSTRAAT	P	S2	D3, D4	LN➜GM	WPL	B
TP19	CENTRE	L	S1	D1, D2	LN➜GM	CLL	A
TP20	WIBAUTSTRAAT	L	S2	D3, D4	LN➜GM	WLL	B
TP21	CENTRE	P	S1	D1, D2	GM➜LN	CPG	C
TP22	WIBAUTSTRAAT	P	S2	D3, D4	GM➜LN	WPG	D
TP23	CENTRE	L	S1	D1, D2	GM➜LN	CLG	C
TP24	WIBAUTSTRAAT	L	S2	D3, D4	GM➜LN	WLG	D

Research methodology for usability testing

- Pre-selection questionnaires, observation, thinking aloud, screen logging, simultaneous synchronized video / audio recording and semi-structured interviews

- Mobile eye-tracking: tested and abandoned due to serious issues with current systems

- Improved version of field-based usability testing system was developed

- 2 Pilot tests
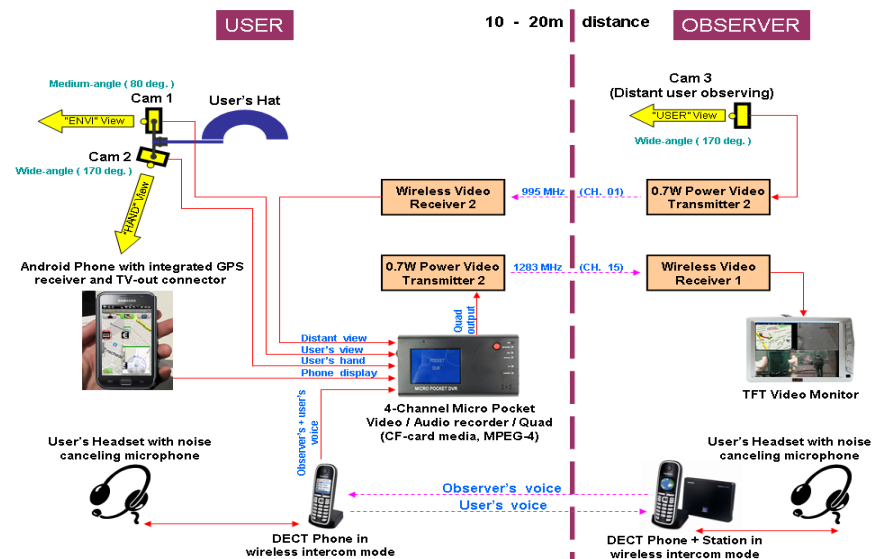
Executing the tests

Photo from an actual test session

Example of the recorded video material (screenshot).

Qualitative analysis of the results

- Resulting research material: pre-test questionnaires, video / audio recordings of the test sessions and audio recordings of the post-session interviews

- Verbatim transcription of the video and audio research material (protocols)

- Coding the different segments of the transcriptions using qualitative software Atlas.ti
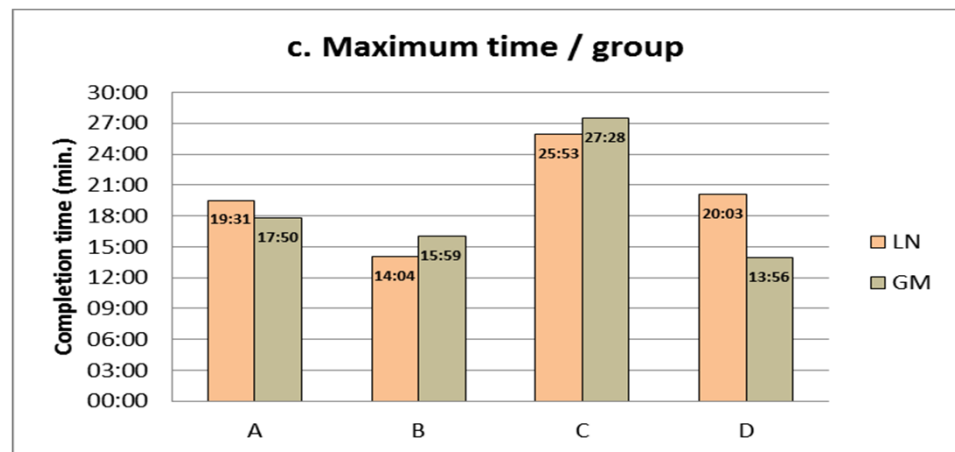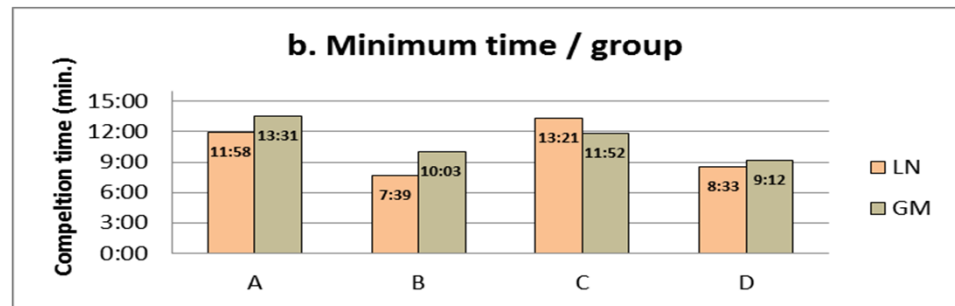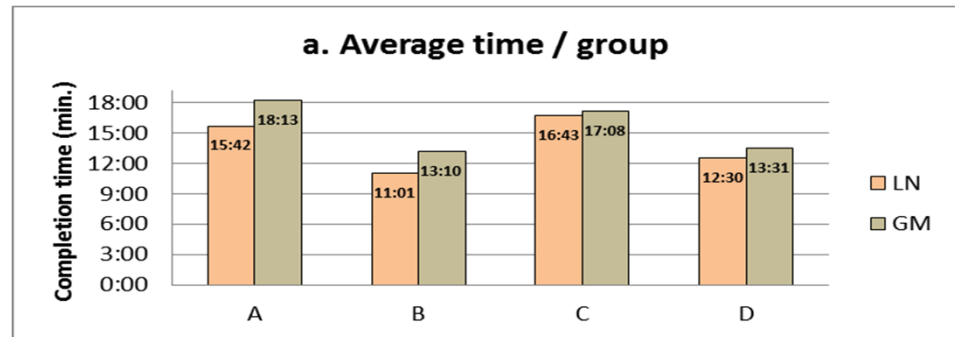
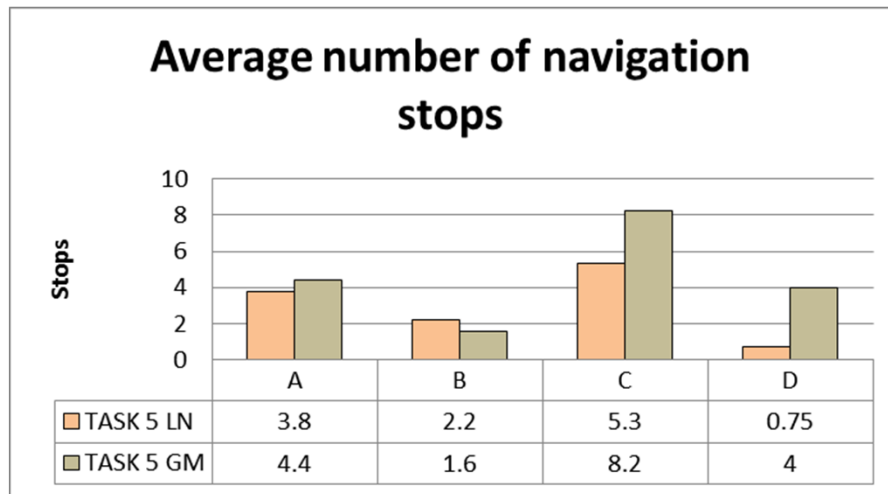|	
A: aborting task	P: positive comment
B: software / hardware bug	S: successful execution
C: confusion	U: usability problem
E: error / fail	V: verification
H: help needed	X: user stopped
N: negative comment	Z: doing zoom-in / out
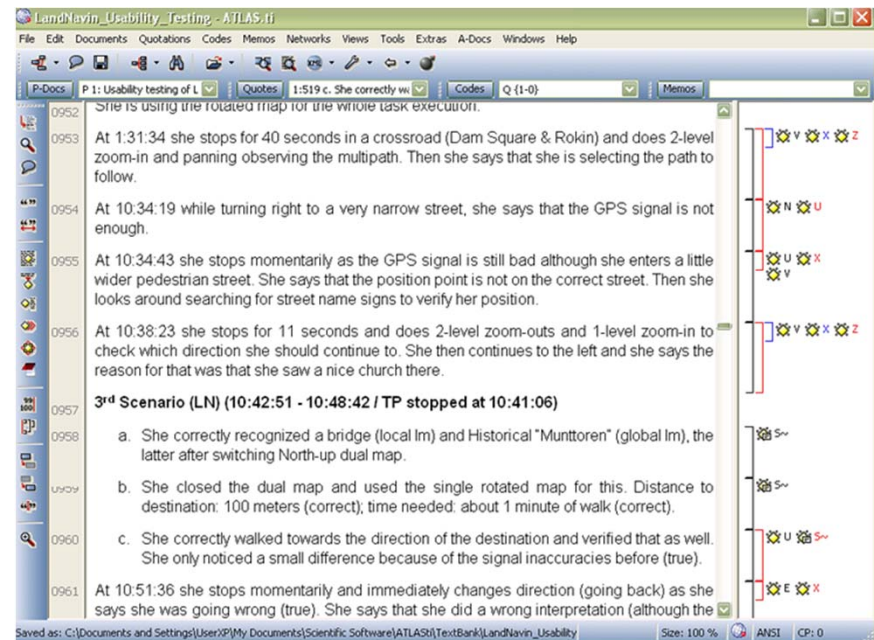
Outcomes of the usability testing

Efficiency measurements for the navigation sub-tasks:

Better task completion times when using LN in comparison to GM.

a. Average time / group

b. Minimum time / group

c. Maximum time / group

Outcomes of the usability testing

Average number of navigation stops

	A	B	C	D
TASK 5 LN	3.8	2.2	5.3	0.75
TASK 5 GM	4.4	1.6	8.2	4

Task 1 - Effectiveness chart

Group	a LN	a GM	b LN	b GM	c LN	d LN	d GM	e LN	e GM	f LN	f GM	g LN	g GM
A	100	100	100	100	80	80	80	90	50	100	60	100	60
B	100	100	100	100	100	100	40	70	10	100	60	100	70
C	100	83	100	83	67	83	100	50	25	83	83	100	17
D	75	100	100	100	100	33	25	50	0	88	75	100	75

Number of stops during navigation (indirect efficiency measurements): 3 out of 4 groups (A, C and D) performed better with LN.
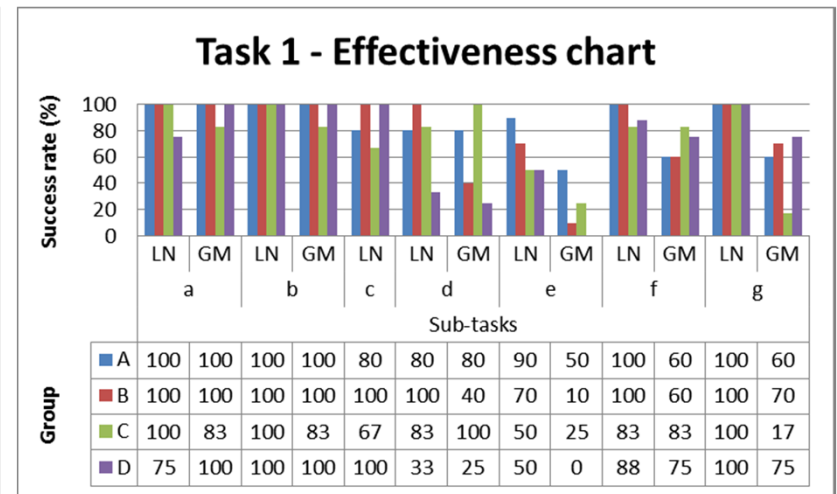
Example of effectiveness chart for task 1 (Initial Geo-identification)

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Interviews and direct feedback

Valuable information derived from observation (incl. thinking aloud and screen logging and interviews):

- Positive feedback on new functionality & design
- Needs for improvement, e.g.:
  - more landmarks
  - better accuracy for landmark visibility representation
  - reduction of icon cluttering
  - richer and more accurate pop-up information about landmarks
  - better dual map solutions
  - further parameterization of landmark type presentation
  - more distinctive multi-path colour coding.

General conclusions

- LN successfully met the majority of the design requirements which had been set initially.

- Focus was on the formulation of a sound methodological approach for the development of a usable mobile interface which would help pedestrians to orient themselves and navigate in unfamiliar urban areas.

- User research methodology worked well.

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Recommendations for further research

- Icon cluttering solutions

- More development and testing iterations (in other test areas and with other types of users)

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- Investigation of the relation between the usability of geo-mobile applications and the screen size of the mobile device used

- Automatic landmark recognition

Thank you
for your attention!

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