


## Activity-Based Approaches for Surveying and Modelling Travel Behaviour


Geert Wets  
 Davy Janssens

*Hasselt University, Belgium*  
 IMOB

Email: geert.wets@uhasselt.be



## Surveying Travel Behaviour



- Current research:**
  - Development of AB-model for Flanders:
    - Funded by IWT 2005 - 2009
    - Forecasting effects of TDM and spatial planning scenario's


Stage 1: Activity-travel survey:

- 2401 households
- 1/2<sup>e</sup> PDA-module, 1/2<sup>e</sup> paper-and-pencil questionnaire
- Sampling through stratified cluster technique
- 1 week activity-travel diary + rescheduling decisions

Survey techniques:


- Paper-and-pencil questionnaire
- Desktop computer assisted data collection
- GPS-enabled Personal Digital Assistant

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- Paper-and-pencil questionnaire**

IDENTIFICATIE-ID	DAGBOEK-ID-201	DAGBOEK-ID-202
1. DATUM	200	200
2. BESCHRIJVING Welke activiteit voerde u uit? Geef de code en uw eigen omschrijving.	BESCHRIJVING (CODE A): A ____	BESCHRIJVING (CODE A): A ____
3. BEGINTIJD Hoe laat begon de activiteit?	BEGINTIJD: uur ____ min ____	BEGINTIJD: uur ____ min ____
4. DUUR Hoe lang duurde de activiteit?	DUUR: uur ____ min ____	DUUR: uur ____ min ____
5. PERSONEN Met hoeveel personen voerde u de activiteit uit? Met wie voerde u de activiteit uit?	PERSONEN: Aantal: <input type="checkbox"/> met partner <input type="checkbox"/> met kinderen <input type="checkbox"/> met anderen	PERSONEN: Aantal: <input type="checkbox"/> met partner <input type="checkbox"/> met kinderen <input type="checkbox"/> met anderen
6. LOCATIE Waar vond de activiteit plaats? Heeft u deze locatie gekozen omwille van een andere activiteit (op deze plek of elders)?	LOCATIE (label locatie): ..... <input type="checkbox"/> ja <input type="checkbox"/> nee	LOCATIE (label locatie): ..... <input type="checkbox"/> ja <input type="checkbox"/> nee
7. VERPLAATSING Welke vervoersmiddel hebt u achtervolgens gebruikt om op deze locatie te geraken? Hoe lang duurde de reis met elk vervoersmiddel? Met hoeveel personen hebt u deze verplaatsing samen gemaakt en met wie?	VERPLAATSING (CODE V): 1 <sup>e</sup> Wachten ____ u ____ min ____ 2 <sup>e</sup> V ____ u ____ min ____ Aantal: <input type="checkbox"/> met partner <input type="checkbox"/> met kinderen <input type="checkbox"/> met anderen	VERPLAATSING (CODE V): 1 <sup>e</sup> Wachten ____ u ____ min ____ 2 <sup>e</sup> V ____ u ____ min ____ Aantal: <input type="checkbox"/> met partner <input type="checkbox"/> met kinderen <input type="checkbox"/> met anderen



Pro:


- Simple technology
- Anywhere, anytime

Con:

- Prone to errors
- Consistency
- Complex
- Tedious

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- Desktop computer assisted data coll.



CHASE (Doherty, 1997)  
VIRGIL (UHasselt, 2004)

Pro:


- User guidance
- Data quality

Con:

- No real-time info
- Not portable
- Remember locations

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- GPS-enabled PDA



Lexington Travel Survey (1997)  
Resource Systems Group, Inc. (1999)  
PARROTS (IMOB, 2005)


Pro:

- in-situation data input
- Consistency checks
- GPS advantages

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- Activity diary: scheduling



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Planning

Wo 14/12/2005

Duw hier om planning aan te maken

20:00 Sociale activiteiten  
21:00  
18:00 Eten  
19:30

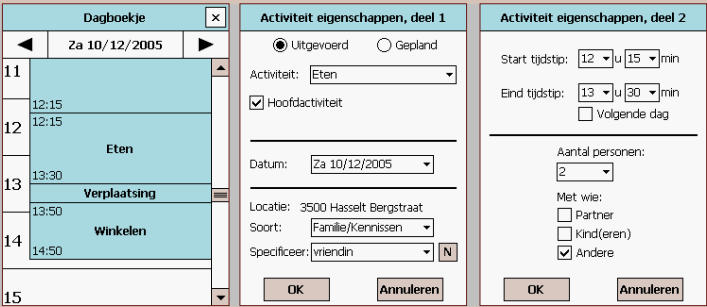
Dagboekje Planning  
Vergrendelen Afsluiten

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- Activity diary: report



Dagboekje

Za 10/12/2005

11  
12  
13  
14  
15

12:15 Eten  
13:30 Verplaatsing  
14:50 Winkelen

Activiteit eigenschappen, deel 1

Uitgevoerd  Gepland

Activiteit: Eten

Hoofdactiviteit

Datum: Za 10/12/2005

Locatie: 3500 Hasselt Bergstraat

Soort: Familie/Kennissen

Specificeer: vriendin N

OK Annuleren

Activiteit eigenschappen, deel 2

Start tijdstip: 12 u 15 min

Eind tijdstip: 13 u 30 min

Volgende dag


Aantal personen: 2

Met wie:

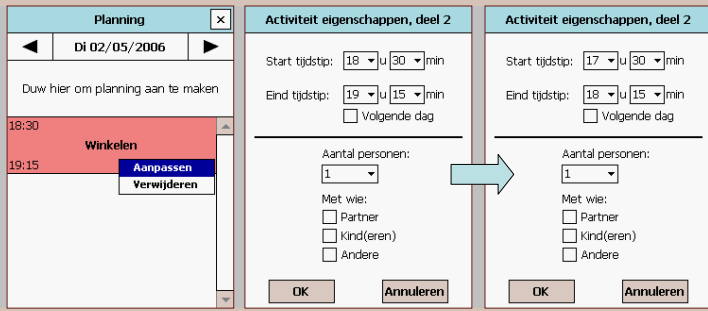
Partner  
 Kind(eren)  
 Andere

OK Annuleren


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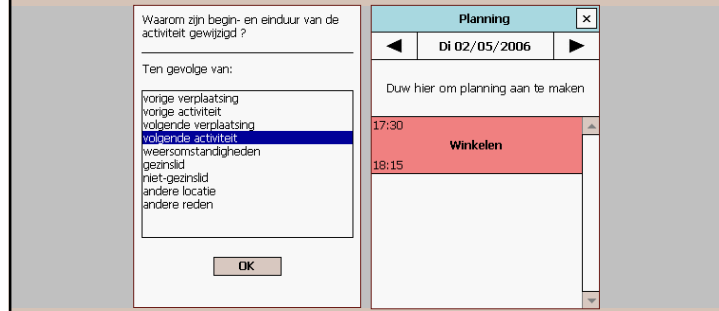
• Activity rescheduling




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• Activity rescheduling: reasons



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• GPS advantages


Supplement activity travel data:

- Trip origin, destination and route data are automatically collected without burdening the respondent
- Recovery of unreported trips as all routes are recorded
- Accurate trip start and end times, as well as trip lengths
- Verification of self-reported data

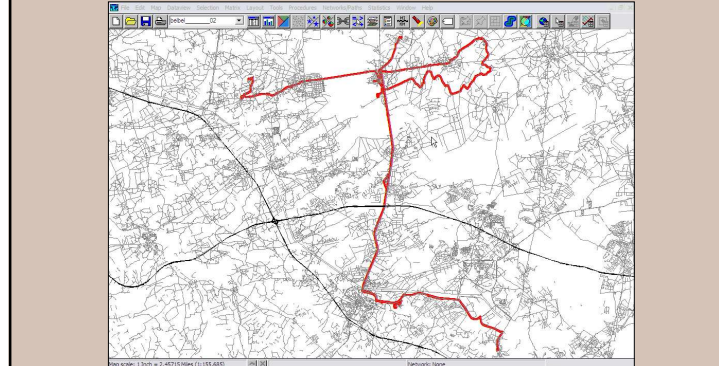
Higher quality data:

- Especially more accurate spatial information (GPS)
- + Data entry costs and pre- and post-processing costs ↓

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• GPS-tracks



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# Modelling Travel Behaviour

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## Transportation models

- Trip-based
  - Independent, isolated trips
  - No time component
  - No direction
  - No sequential information
  - Flow of traffic not linked to activities

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## Transportation models

- Activity-based
  - Travel demand derived from activities
  - Sequences or patterns of behaviour
  - Household and social structures
  - Constraints
  - Scheduling in time and space

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## Activity-based models

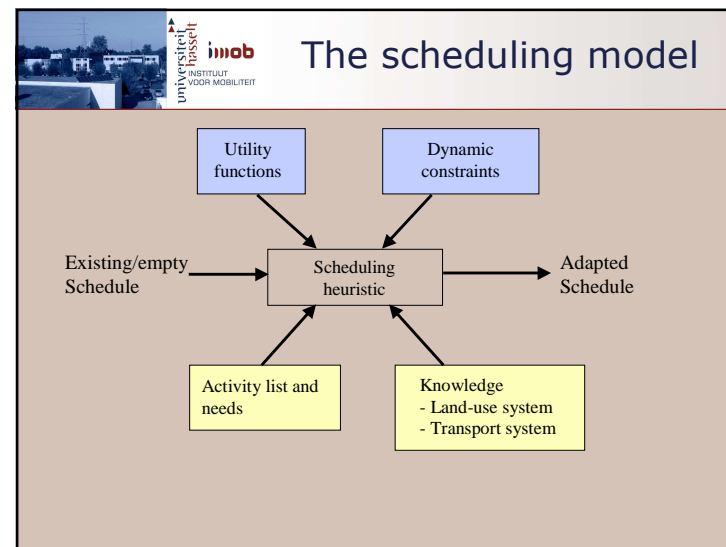
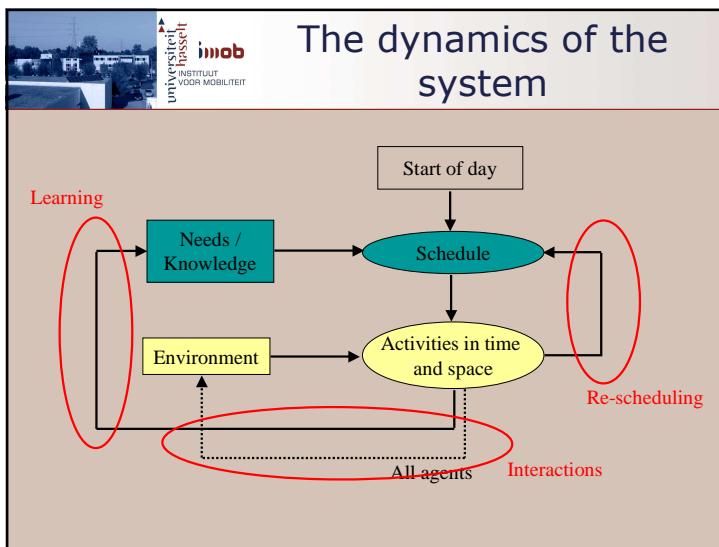
- Simulate:
  - **which** activities
  - **where**
  - **when**
  - for **how long**
  - **with whom**
  - **transport mode**
  - ideally also **route decision**


**Where are we, where are we going?**

- A lot of previous activity-based models deal with only one choice aspect
- However, full operational activity-based models also (start to) exist (Cemdap, Famos, Albatross,...)
- Despite this, there is still a lot to do and improve. Current models do not include
  - short-term dynamics (rescheduling)
  - Learning
  - Incorporation of uncertainty and non-stationary environments
  - Route choice behaviour (+aggregate impact of individual route choice on activity generation and rescheduling)

**Feathers**

- → FEATHERS (Forecasting Evolutionary Activity-Travel of Households and their Environmental Repercussions)
- Additional contributions of Feathers:
  - Model route choice behaviour (by means of detailed GPS-data: PARROTS)
  - Test and improve the conceptual framework (Accurate estimation of S-curves as utility functions, Estimate effect of context variables on maximum utility, Evaluate the scheduling component, Extend learning facets)
  - Implement additional concepts in Feathers (Impact of life trajectory events, impact of regular events, ...)
  - Calibrate the model on real-world data
  - Guide and help practitioners with the transition process from 4-step models to AB-models






## Utility functions

- Utility of a schedule 
$$U = \sum_{a=1}^A U_a + \sum_{j=1}^J U_j$$
- Utility of an activity of type  $a$ 


$$U_a = f(t_a) * f(l_a) * f(q_a) * \frac{U_a^{\max}}{1 + (\gamma_a \exp[\beta_a (\alpha_a - v_a)])^{1/\gamma_a}}$$
- Need for an activity of type  $a$ 

$$U_a^{\max} = \frac{U_{x_a}}{1 + \exp[\beta_{x_a} (\alpha_{x_a} - T_a)]}$$




## The scheduling heuristic

- Input is a consistent schedule and output is a consistent schedule with higher or equal utility
- Iteratively implements operations on an existing schedule until no further improvement is possible
- Operations are evaluated under optimal duration and timing choices




## Operations considered

- Insert an activity
- Substitute an activity
- Reposition an activity
- Change location of an activity
- Include/remove a return-home trip between activities
- Change transport mode of a trip




## Uncertainty

- Agents hold beliefs (subjective probabilities) with respect to the expected states of system variables
- Beliefs are represented by a probability distribution across possible system states:  $P^t(T)$
- The expected utility of a schedule alternative  $i$  is the weighted sum of the utilities of the schedule, dependent on the state variables, where the weights represent the beliefs.
 
$$EU^t = \max_j \left\{ \sum_i U(S_j^t | t_i) P^t(t_i) \right\}$$




## Learning

- Attribute learning
  - Updating beliefs about states of single system variables
- Conditional learning
  - Updating causal knowledge
- Associative learning
  - Learn from generalization
- Information-based learning
  - Learn from information; credibility of information source
- Social learning
  - Learn from members in social network



## Implementation Issues

- Synthetic population
- Generate planned (partial) schedules
- Possible rescheduling at every node of transportation network or after completing each activity as a function of possible discrepancies between expected and actual time
- Belief updating



## Conclusions and Discussion

- The system shows how an activity-based model can be used for micro-simulation of spatial behaviour
- Framework embraces and integrates
  - Urgency of activities as a function of time
  - Time budgets and competition between activities
  - Space-time constraints
  - Ability to re-schedule activities
  - Ability to learn from interaction with the environment
  - Deal with uncertainty
- The system allows users to analyse impacts of temporal as well as spatial variables on utilities and traffic flows