



Sociological Knowledge in Computer Simulations

Example:

The urban transport simulation model TRANSFER
Erich Ruppert (Schweinfurt, Germany 2013)

Sociological knowledge in computer simulations

- We assume that you have seen the small demo of the simulation model "TRANSFER". Now we explain the basics in four steps in the Powerpoint presentation:
- The epistemological assumptions
- Homans' system theory
- The formalization techniques
- The dynamization

First, a personal introduction:

- I took over my basic ideas and developed the first models at a time when the computers were still learning to walk (1967 - 1975) and sociologists used them only for statistical or logical analysis.
- Werner Killing from the Institute for Spatial Planning at the University Dortmund programmed in 1983 to FORTRAN my model **TRANSFER**, which although already had the present theoretical structure, but was still quite simple with 12 nodes and 4 diurnal periods. We presented it in Hamburg at 1983 at the World Conference on Transport Research.

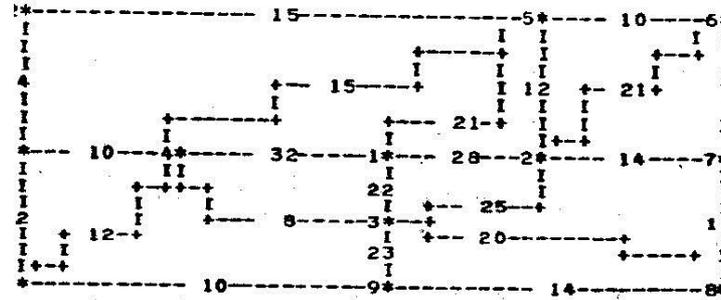
Simple network structure of TRANSFER 1983

-MITTEL (1-6), PERIODE (1-4)

F A TESTNETZ VERKEHRSMITTEL: 91
 TAGESPERIODE : 1
 STRECKENF. : 418

Fall A

16	11	20	12	0	0	0	0	0	0	0	0	0
10	10	12	4	15	10	0	0	0	0	0	0	0
13	4	5	0	0	16	13	4	4	0	0	0	0
0	0	10	0	0	0	0	6	18	0	0	0	0
8	0	0	6	4	0	0	0	0	0	0	0	6
6	0	0	6	3	3	0	0	0	0	0	0	0
4	0	0	0	4	1	2	0	0	0	0	0	0
0	10	0	0	0	9	3	5	0	0	0	0	0
0	7	6	0	0	0	9	3	3	0	0	0	0
0	0	8	0	0	0	0	7	2	7	5	0	0
0	0	0	9	0	0	0	0	0	0	5	1	1



LEN INTERNER VERKEHR

1	2	3	4	5	6	7	8	9	10	11	12
5	10	4	5	6	3	1	3	3	2	2	1

-MITTEL (1-6), PERIODE (1-4)

F A TESTNETZ VERKEHRSMITTEL: 91
 TAGESPERIODE : 2
 STRECKENF. : 360

13	11	9	10	0	0	0	0	0	0	0	0
14	16	8	3	9	8	0	0	0	0	0	0
15	0	0	0	0	0	5	0	0	0	0	0
10	10	5	6	0	0	0	0	10	14	0	0
8	7	0	1	0	0	0	0	0	0	0	0
0	5	0	2	2	5	2	0	0	0	0	0
0	6	0	0	0	3	6	6	0	0	0	0

Personal remarks:

- Due to the technical advances of PCs in the 1990s it was able to develop the existing model, which I introduced again in 1998 on the 8th. World Conference on Transport Research in Antwerp and in 2000 at the “Soziologentag“ in Cologne.
- The mathematician Marius Constantinescu programmed the model and supervises the newer versions until today.

To the flow of the presentation:

- The arguments are **briefly** formulated. More specifically is the cited literature.
- If I used thoughts of **other** authors, they are *usually cited without transition between quotes*.
- **Own** comments, **so required**, follow.
- Narrow texts are supplemented by illustrations from the model.
- The data used in the model is from 1996 to 2003

Renate Mayntz: "Formalized Models in Sociology"

Quotes from: Neuwied 1967, p. 11 ff

- *A model is a **verbal theory in symbolic language** or a formalized theory.*
- *Simulation models are operations models **of processes in social systems**, which are reconstructed in a computer, so that processes running over time (and space) are reproduced in all the details. The core of their computer programs are logical operations.*
- *Simulation models are often applied when a mathematical formalization appears too complicated or does not appear adequate to the subject, and they do not, in principle, require special mathematical knowledge.*

George C. Homans

“Fundamental social processes” New York 1967 -

Quotes from: “Grundfragen soziologischer Theorie“, Opladen, 1972, p. 122 ff

"Although the sociologists will make many empirical discoveries, the central scientific problem of sociology is not of an analytical nature

...

*The problem is rather a **synthetic** one*

- to show how the behavior of many people, corresponding to the psychological hypotheses, converges so that it forms and maintains the well-established social structures ...*
- If we make such predictions, we will, of course, have to cope with complex, mutually influencing effects, **but the computer has just been developed in time to help us solve these problems at a speed of a completely new order of magnitude.**"*

My requirements for sociological prognosis models:

A prognosis model, which should be a **useful image of reality**, must meet **four** central requirements:

- It must follow **a theoretical concept**, correspondingly show differentiated influencing variables and link them together meaningfully,
- It must have **good imaging properties**, that is
as many relevant groups as possible, as well as "sensitive to the measure"
and to provide numerically accurate descriptions,
- It may **not be exceptionally expensive** for users
- It must be **clear to the layman**.

The example: TRANSFER

- With HOMANS' system theory and its most important hypotheses, combined with numerous empirical findings, the regional transport simulation model **TRANSFER** (**TRANSPORTATION** signified as **F**amily-**E**nvironment-**R**elations) was developed, but its name also references for the **transmission of theory to practice**. The programming was supported by Delphi in the 90s.
- The model does not remaining behind simulate planning models of traffic engineers spatially and graphically, but goes far beyond their theoretical requirements. Apart from the practical value in the planning, HOMANS demonstrates the **methodical vision of synthesizing** the causative group relationships to form a regional (transport) system by means of behavioral hypotheses.

You will find a **detailed, methodical presentation** in:

ERICH RUPPERT „*Simulation räumlicher Interaktion*“ *Dortmunder Beiträge zur Raumplanung Bd. 41, Dortmund 1986, ISBN 3-88211-052-X*

Theoretical prerequisites

Sociology knows two **opposite pairs**:

"Methodological Individualism" versus **"Emergentism"**

(**What** is the subject of sociology?)

and

"Understanding" contra **"Reductionist"** explanatory strategy.

(**How** is the object to be understood or explained?)

Cognitive-theoretical assumptions:

What is the subject of sociology?

"Methodological Individualism"

- Homans proceeds methodologically from the individual and his psyche, to explain complex phenomena, e.g. the traffic in the city.
- For him, the main problem of sociology is "*a synthetic one, namely, to show how the behavior of many people, corresponding to the psychological hypotheses, is combined so that it forms and maintains stable social structures.*"

Cognitive-theoretical assumptions

What is the subject of sociology?

"Emergentism"

Emil Durkheim (1858-1917)

Quotes from: „Die Regeln der soziologischen Methode"

- *"By joining together, penetrating and merging, the individual psyches bring forth a **new psychological being**, which is, however, a psychological individuality of a new kind.*
- *In the nature of this **individuality, not in that of the units composing them**, must be sought the next and determining causes of the phenomena which take place there.*
- *Every time, if a sociological fact is directly explained by a psychological one, one **can be sure that the explanation is false.**"*

Cognitive-theoretical requirements

Notes:

- It is clear that theories, such as those of HOMANS, are a good prerequisite for a formalization and synthesis. But they also have clear limits.
- To construct development chains for generations of individuals with the fine differentiation of psychological explanations and not to omit any essential intermediate step seems practically impossible and, in addition, not necessary at all.
- However, methodological individualism is well suited to the tasks of the TRANSFER model.
- Without wishing to prove ontologically societies and their institutions as new beings, such as Durkheim, in the ontological sense, it is well possible to consider them as concrete, existing structures, and to trace valid (emergent) regularities (for example, "entropy").

Theoretical prerequisites

How is the object of sociology to be understood or explained?

- The classics Simmel, Sombart and Max Weber answer "understandably". According to Max Weber, "Sociology" is called:

*"A science which understands social action in a **meaningful way** and thus explains its course and its effects. 'Action' (Handeln) is meant to be a human behavior (...) if and in so far as the trader or traders connect with him a **subjective meaning** ... "(Max Weber: §1 in "Wirtschaft und Gesellschaft")*
- The "Understanding Sociology", however, would be unjustly shortened if the theorist were merely characterized as a searcher for the subjective sense of action. On the contrary, the modern "understanding" sociologists try to go back behind these motifs and the subjective sense of the roots in the unconscious, and to the influence of social conditions (for example, "objective hermeneutics"), despite the increased methodological difficulties.

Theoretical prerequisites

How is the object of sociology to be understood or explained?

- "*Deductively explaining*" answers reductionists, like George C. Homans, whom we have already met as a representative of methodological individualism. The reductionist explanation of a discovery consists in proving that the discovery results as a logical conclusion, as deduction from a single or several general theorems under the given specific conditions.
- The reductionists replace the search for the meaning with "*general psychological hypotheses*" (which are strongly similar to an economic-theoretical theory) and then supplement these statements with biological, chemical or physical statements.

Cognitive-theoretical requirements

Notes:

- Reductionist theories are more suitable for computer simulations.

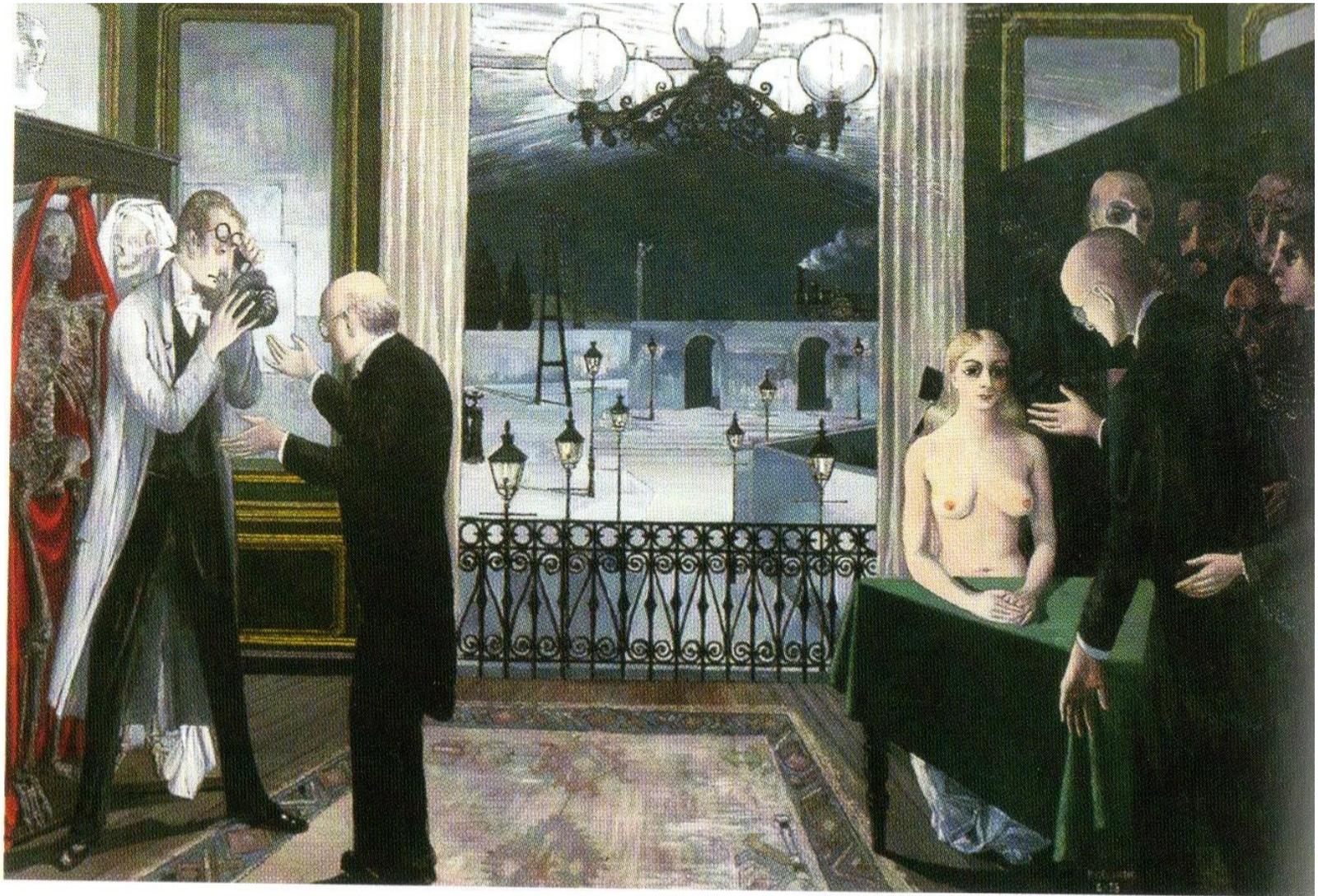
If one understands the meaning of an action as the "inner", the reductionists look more to the outside, to the observable image of the action, and their actions are evaluated, in particular, according to their *frequency*.

Thus, on the one hand, figures are available, on the other hand the psychological sense interpretation is simpler. The actions, evaluated as more or less great rewards or punishments, thus fit relatively well into a worked out concept of interactions, which is developed into a system theory.

Theoretical prerequisites

Warning!

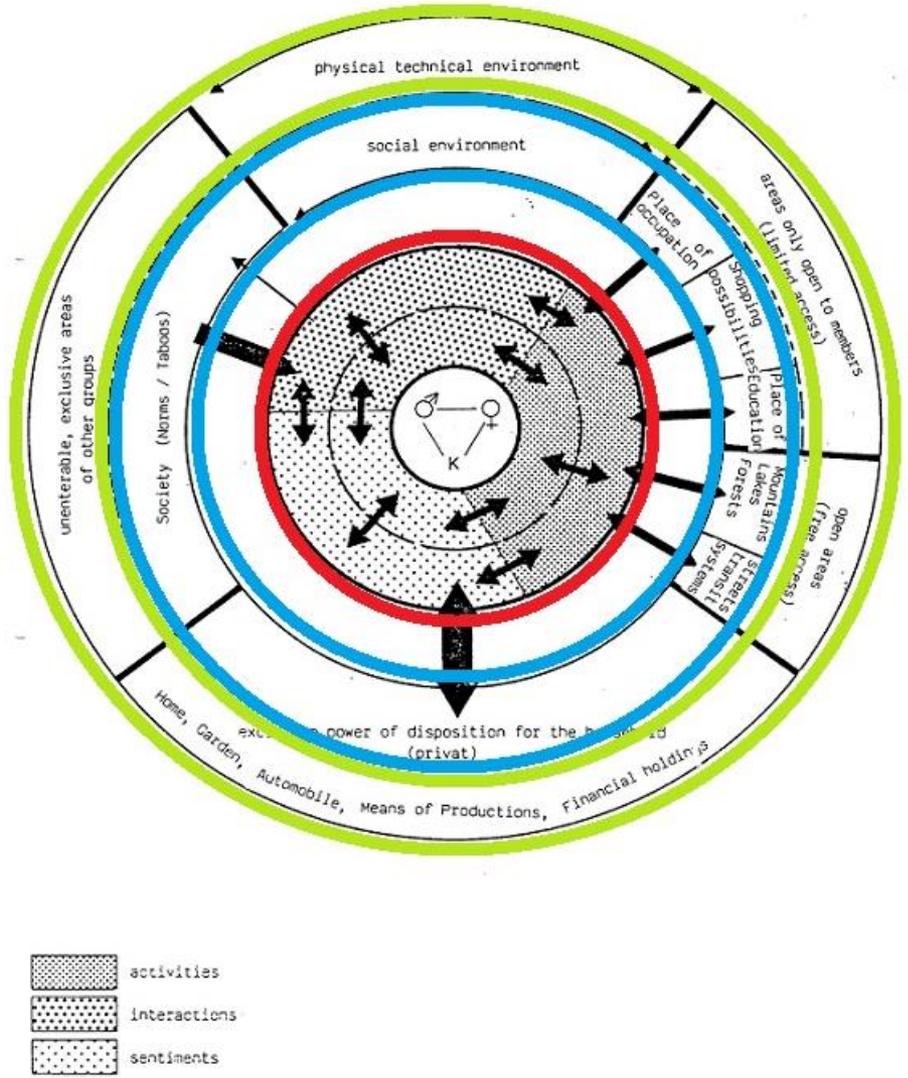
- The “factual coolness” points to a technical language.
- Models are **simplifications** of reality and thus distortions. We should know what we are doing when man is simplified to a type. If we want to reconstruct highly complex events from a particular point of view, we must simplify and use reductionist theories. But in order to do justice to living people in their actions, they are not suitable.
- The following picture of Delvaux "*The school of the scholars*" shows human scientists (right) with the eyes of natural scientists (left).



Paul Delvaux 1958 „ *The school of scholars* “

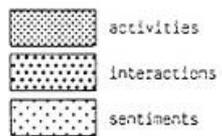
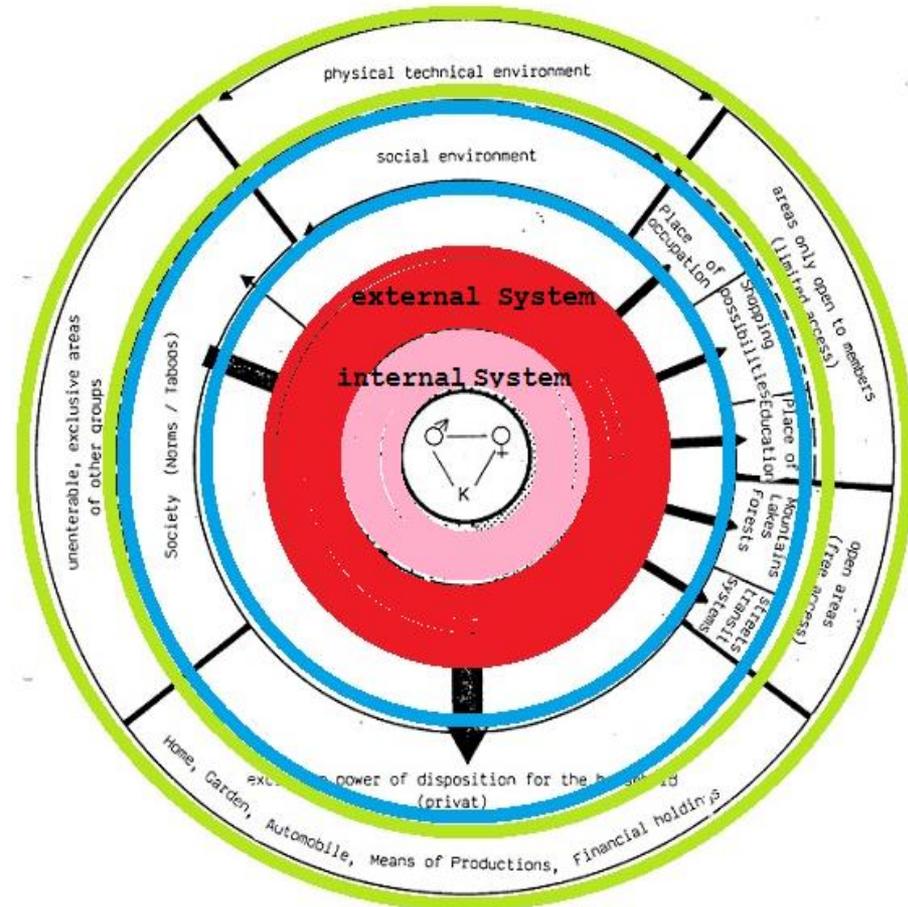
HOMANS' system theory and its specification for the model

- HOMANS sees households as groups or "**social systems**", whose members are more likely to deal with one another than with outside ones.
- The **environment** is viewed **physically, technically** and **socially**.
- dwellings are e.g. near physical environment.
- **Social environment** is expressed in the norms and expectations of society. However, it also consists of other groups that exist alongside the household (e.g. companies) and to which individual household members can belong.



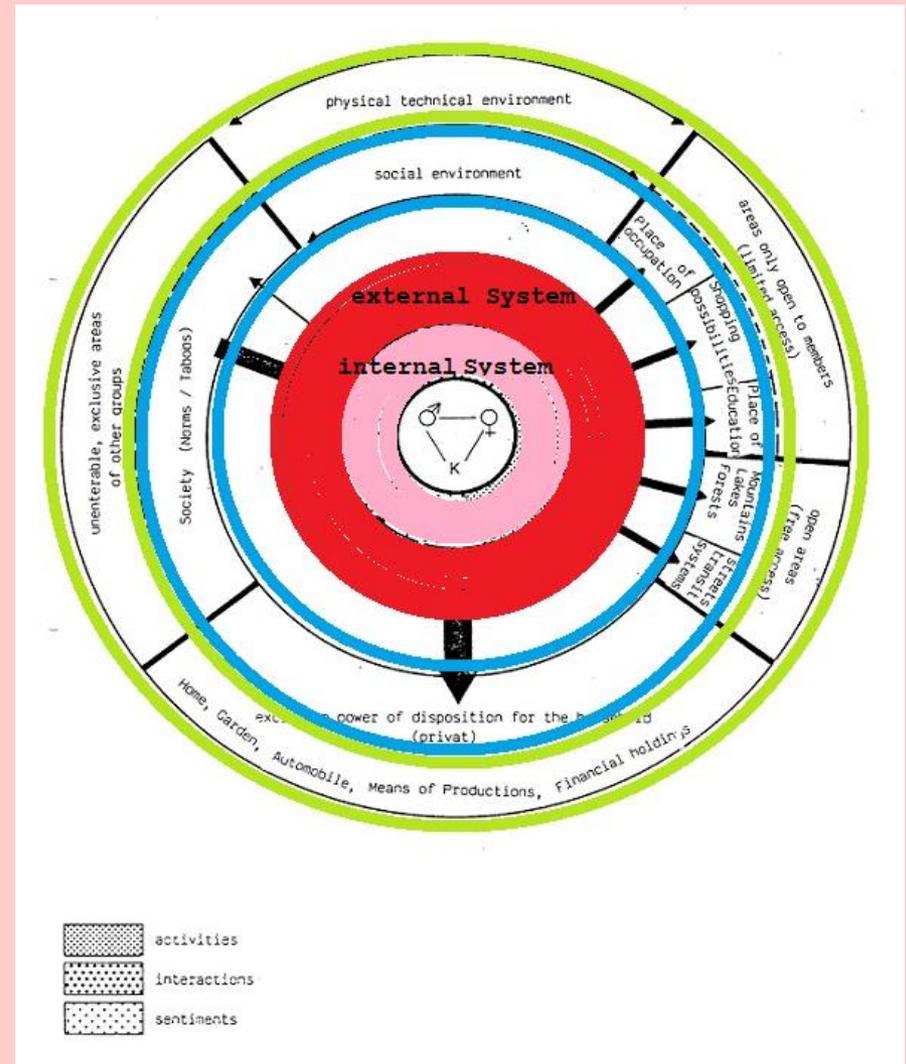
HOMANS' system theory and its specification for the model

- The social system "household" is analytically divided into an "**external system**" and an "**internal system**".
- To the **external system** belongs the interplay of the
 - **activities**, such as buying, making money, school attendance
 - **attitudes to these activities**, e.g. role expectations, evaluations
 - and **actions related to other members of the household**, such as the transport of children, provided that the **interplay serves to ensure that the group survives in its environment**. This means that the transport services of the members of the household primarily belong to the "external system".



HOMANS' system theory and its specification for the model

- In the Internal System, which is influenced by the **external system** and at the same time affects it, unfolds the group behavior. Instead of settings to specific household activities (tasks, role expectations), we have to do with **feelings that have been developed in this role ourselves**, such as the inclination or dislike for other persons or to approval or disapproval of activities done by other people.



HOMANS' system theory and its specification for the model

The model differentiates the **subjects** according to **men, women** and **children** within typed households.

The households are described according to:

- **The location of the dwelling** in the city (traffic zone)
- - The **number of members**
- - Their **professional activity** (full, part, not, pensioners, pupils)
- - The **household income** (low, medium, high)
- - The **phase in the family cycle** (not yet relevant here)
- - As well as **driving licenses** and **number of cars**

- From these characteristics and their manifestations, a large number of **household types** can be formed.
- In addition, **company types** are created for business traffic.
- From the population and workplace statistics 1987 and the current data from the local residents' office, **114 household types** and **14 similar company types** were formed and counted according to statistical districts.

HOMANS' system theory and its specification for the model

- The daily household tasks are met to varying degrees by the household members.
- If more household members, corresponding to their roll set are ready for the same tasks, limits of individual time budgets as well as agreements in the "internal system" destinate the distribution .
- The objects of the model are
- dwellings, schools, work and shopping facilities, leisure facilities as well as roads, cars / lorries, public transport, bicycles.
- The road network is dynamic, i. high loads at certain times are "fed back" and change the subsequent choice of transport means.

HOMANS' system theory and its specification for the model

Possible planning measures and changes

Transport planning action

- Expansion and reduction of the road network
- Opening or closing of Underground, bus or tram lines
- Interval changes in public transport
- Changes in fare
- Gasoline price changes
- Speed changes in private and public transport
- Parking license for residents of inner cities
- Parking fee increase

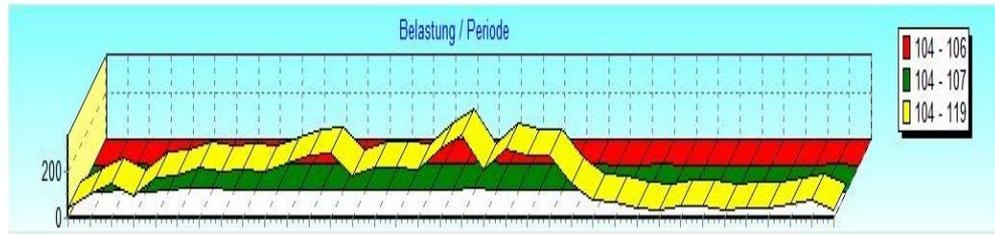
Social changes

- Aging of households in a six-year cycle (not yet realized)
- The immigration and emigration of households
- Change in the number of dwellings, jobs and their locations
- Change of the numbers of cars
- Change in disposable income (gross wages minus taxes, social contributions, expenditure on the dwellings)
- Working time reductions
- Changes in partnership standards of families

HOMANS' system theory and its specification for the model

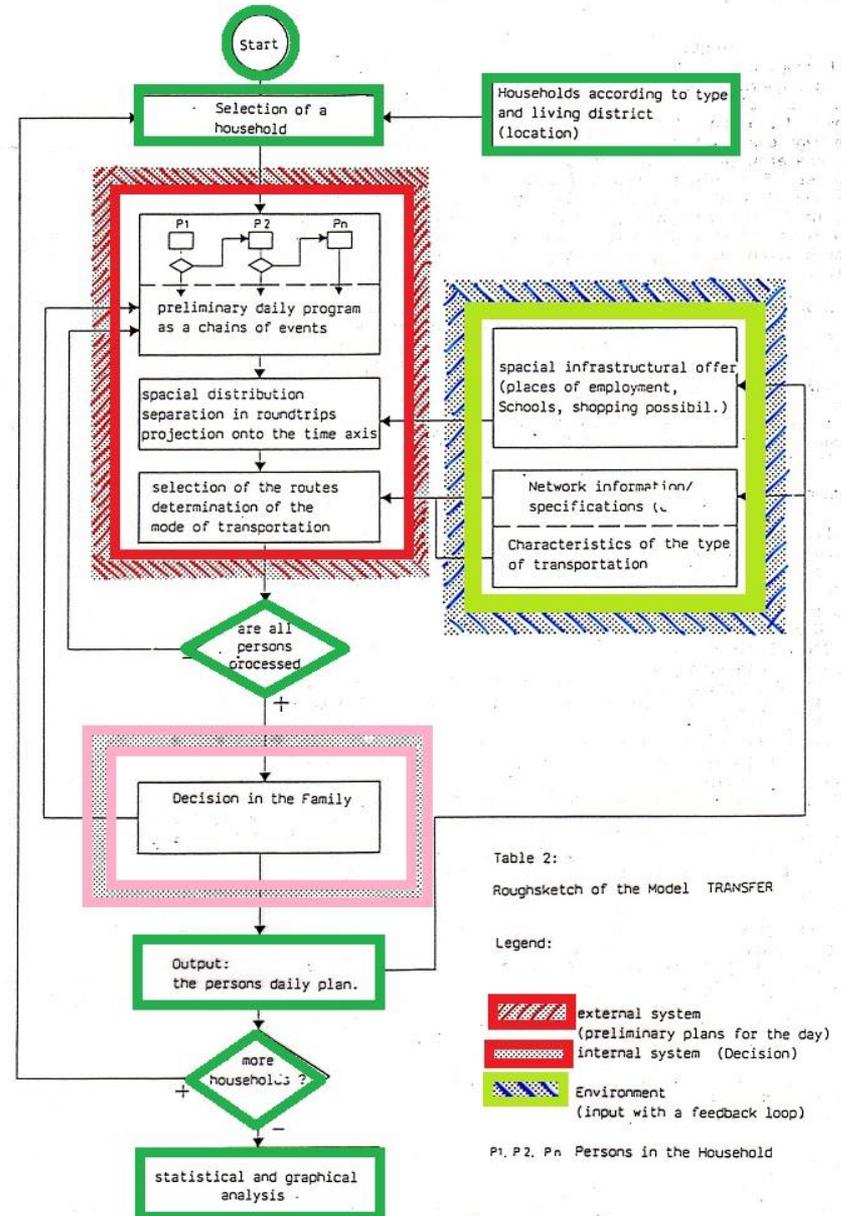
■ Results

- The simulation results are output as route loads for the four types of traffic over the day or per half hour in diurnal traffic variation, as well as turn off loads at intersections on the screen or via the printer.
- Viscous road traffic and traffic jams are marked according to time and place.
- By "Filter" the results can be differentiated according to person types.



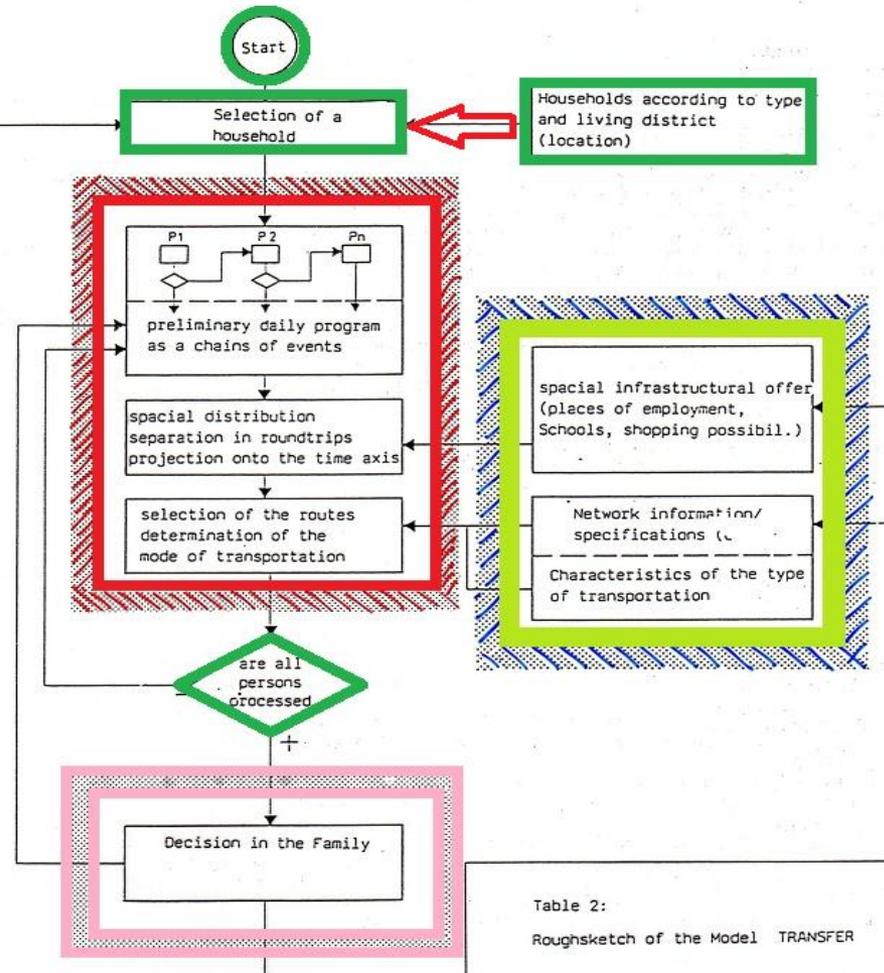
Simulation - flow diagram

- In the flow chart we find from Homans:
 - **The External System** with the
 - performed **activities**,
 - **attitudes** towards these activities,
 - and **actions related to other household members**
 - The **Internal System** with the **forms of household handling**
 - The **Environment** (physical and social)



Simulation - flow diagram

- At **start-up**, a household is chosen from the **household file** by chance.



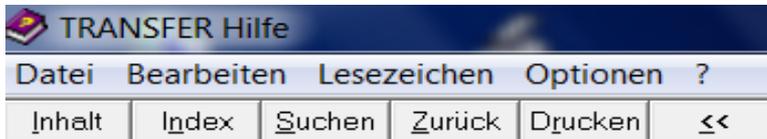
HUTyp: 427 | Grosse: 32 | Phase: Erwachsene mit jungstem Kind über 18 Jahren | Einkommenklasse: hoch | Anzahl PKW: 2 | Innere System: patriarchal

Geschlecht: M E N | Alterseinteilung: 42 - 65 Jahre | Rollen-Erwart.: Führerschein | Mann voll erwerb / Traditionell

1.Person / 2.Person / 3.Person / 4.Person

Simulation - flow diagram

- Each household type has a specific **task program** from which a **provisional daily program** is created for the **first person** according to personal probability.

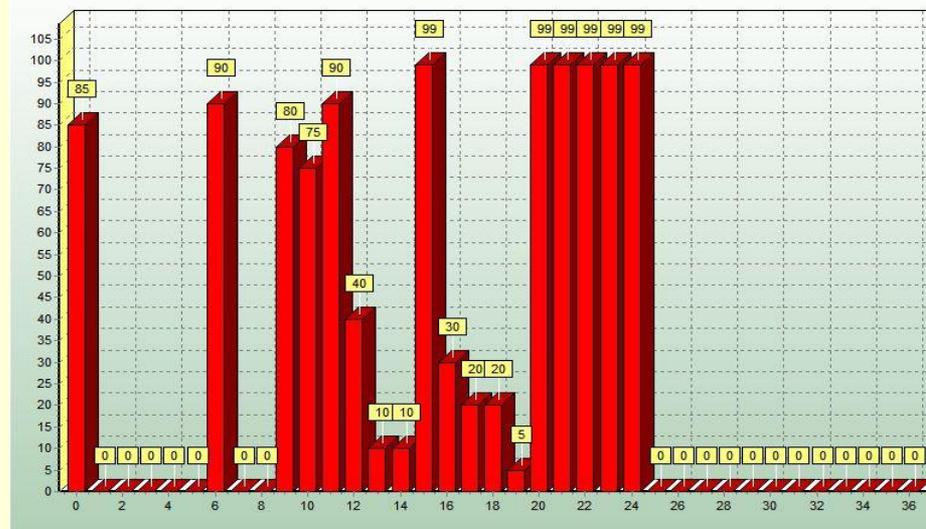


Rollset Name

- r0 Kleinkind
- r1 Großes Kind
- r2 Alleinstehender voll/teilerwerb
- r3 Nichterwerb/Hausfrau/Rentner
- r4 Student/in
- r5 Mann voll erwerb /Traditionell
- r6 Frau teil erwerb
- r7 Frau voll erwerb
- r8 Mann voll erwerb /Emanzipiert
- r9 Jng.Erwachsener voll erwerb
- r10 Gewerblicher Fahrer
- r11 Transit Pkw-Fahrer
- r12 Transit Lkw-Fahrer

H01	H02	H03	H04	H05	H06	H07	H08	H09	H10	H11	H12	H13	H14	H15	H16	H17	H18	H19	H20	H21	H22	H23	H24	H25
85	0	0	0	0	0	90	0	0	80	75	90	40	10	10	99	20	20	5	99	99	99	99	99	99
U51	U52	U53	U54	U55	U56	U57	U58	U59	U60	U61	U62													
0	0	0	0	0	0	0	0	0	0	0	0													

528 M vollb F nichtb 1grK 2kK



- 1 M erwerb voll
- 2 M erwerb teil
- 3 F erwerb voll
- 4 F erwerb teil
- 5 N erwerb voll
- 6 N erwerb teil
- 7 Schulbesuch
- 8 Schulbesuch
- 9 Schulbesuch
- 10 Kind zur Schule/Kita
- 11 Kind von Schule/Kita
- 12 Kleiner Einkauf
- 13 Großer Einkauf
- 14 Erledigung
- 15 Kleinkindaufsicht
- 16 Kinderbetreuung
- 17 Freizeit außer Haus
- 18 Freizeit außer Haus
- 19 Freizeit außer Haus
- 20 Freizeit außer Haus
- 21 Kochen/Hausarbeit
- 22 sonstige häusliche Tätigkeit
- 23 sonstige häusliche Tätigkeit
- 24 sonstige häusliche Tätigkeit
- 25 sonstige häusliche Tätigkeit
- 51 G-Fahrt1
- 52 G-Fahrt2
- 53 G-Fahrt3
- 54 G-Fahrt4
- 55 G-Fahrt5
- 56 G-Transit
- 57 Lkw-Fahrt1
- 58 Lkw-Fahrt2
- 59 Lkw-Fahrt3
- 60 Lkw-Fahrt4
- 61 Lkw-Fahrt5
- 62 Lkw-Transit

Simulation - flow diagram

- Other household members choose their tasks from the **reduced** task program.

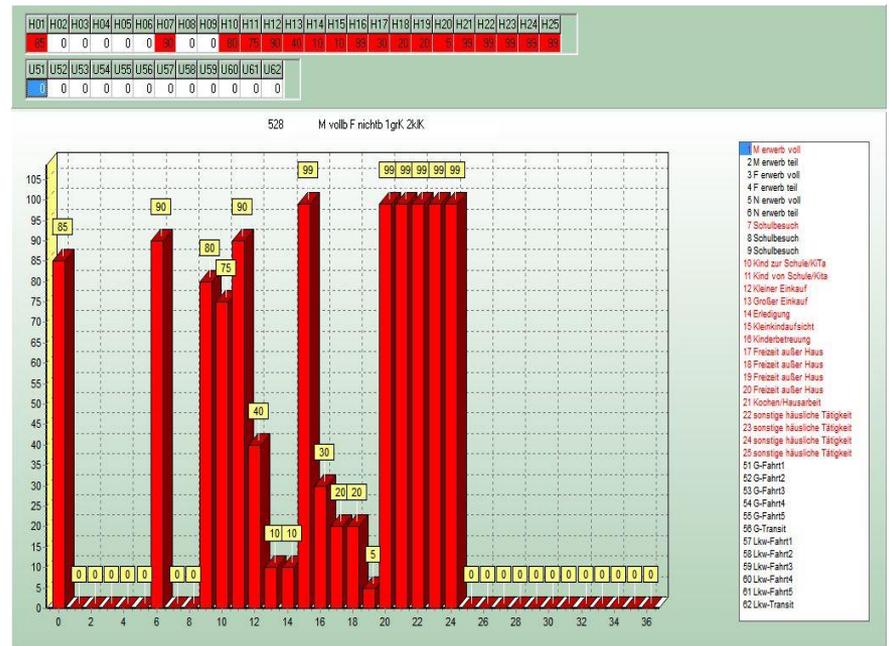
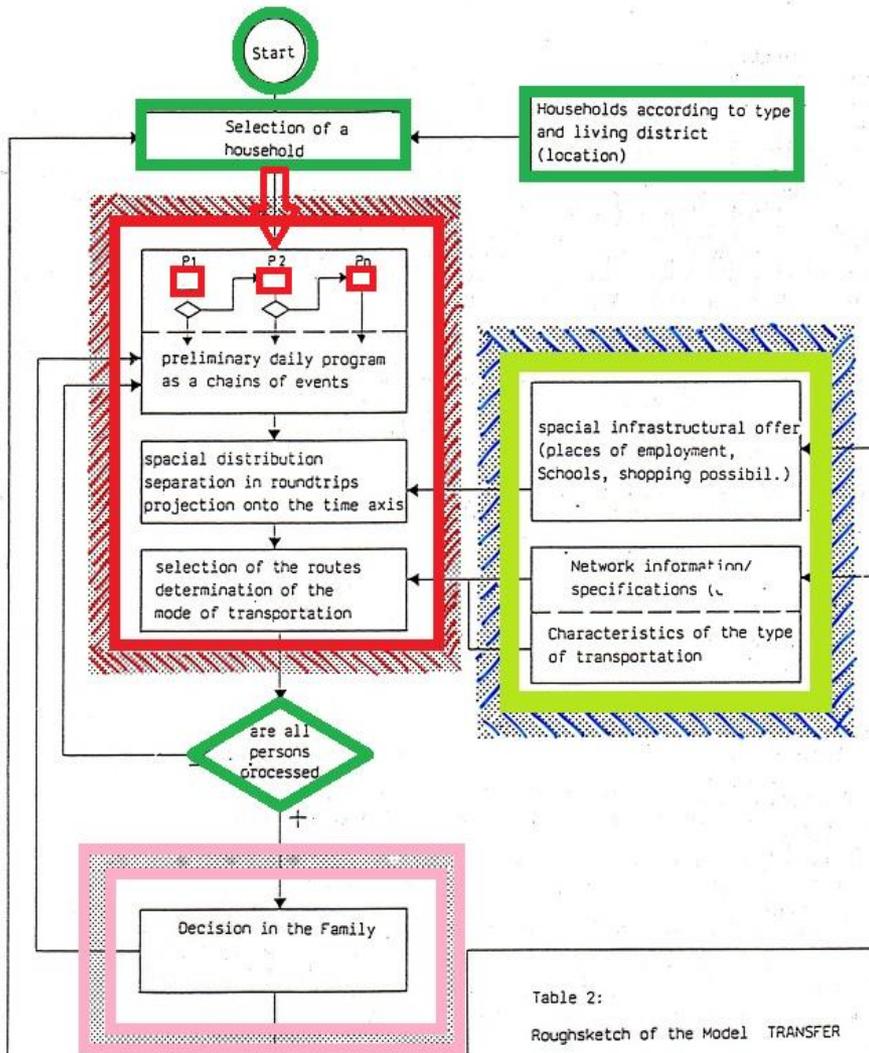
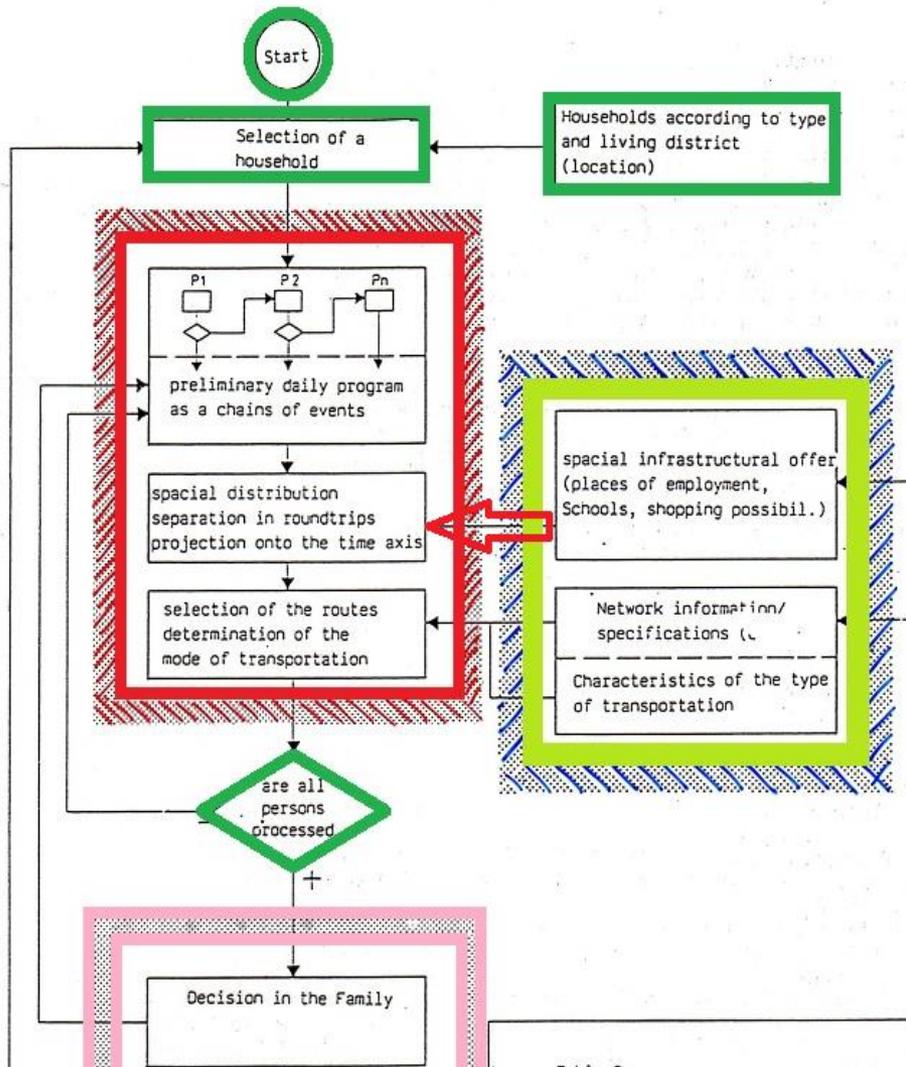


Table 2:
Roughsketch of the Model TRANSFER

Simulation - flow diagram

- After **one person** has compiled its preliminary work program, it selects **offers** for potential and location from the **infrastructure** of the region (**ENVIRONMENT**).



Infrastructure

Zell_Key	X	Y	Arbeitsplätze Vollzeit	Arbeitsplätze Teilzeit	Parkplätze	Nachbarzelle
162111	3588120	5546160	540	80	750	00.0 162111 AltstadtNW 18.0 162116 AltstadtSw 18.2 162112 AltstadtN 19.0 162133 Innenstadt-CHG 19.0 162134 Innenstadt-NWtr 25.6 162115 AltstadtS 29.4 162113 AltstadtND 30.5 162122 InnenstadtW-SU 37.2 162132 Innenstadt-LHf 40.3 162135 Innenstadt-GMik 43.0 162114 AltstadtSO 44.9 162334 N-SO 50.3 162131 Innenstadt-AuS 51.6 162123 InnenstadtW-LndR 51.9 162136 Innenstadt-KIK
Kfz.	123	25 %	102	25 %		
	124	25 %	325	25 %		
Öpriv.	99	10 %	100	90 %		
Rad/Fuß	99	50 %	127	50 %		
Schiene						
			Schulplätze	Eink.Potential	K.G.Pl.	
			0	300	333	

Simulation - flow diagram

- According to respective opening or service times, the person forms a spatial task chain and projects it on a time axis. It starts from home. If a task carries it back home, a new **home-to-home trip chain** joins.

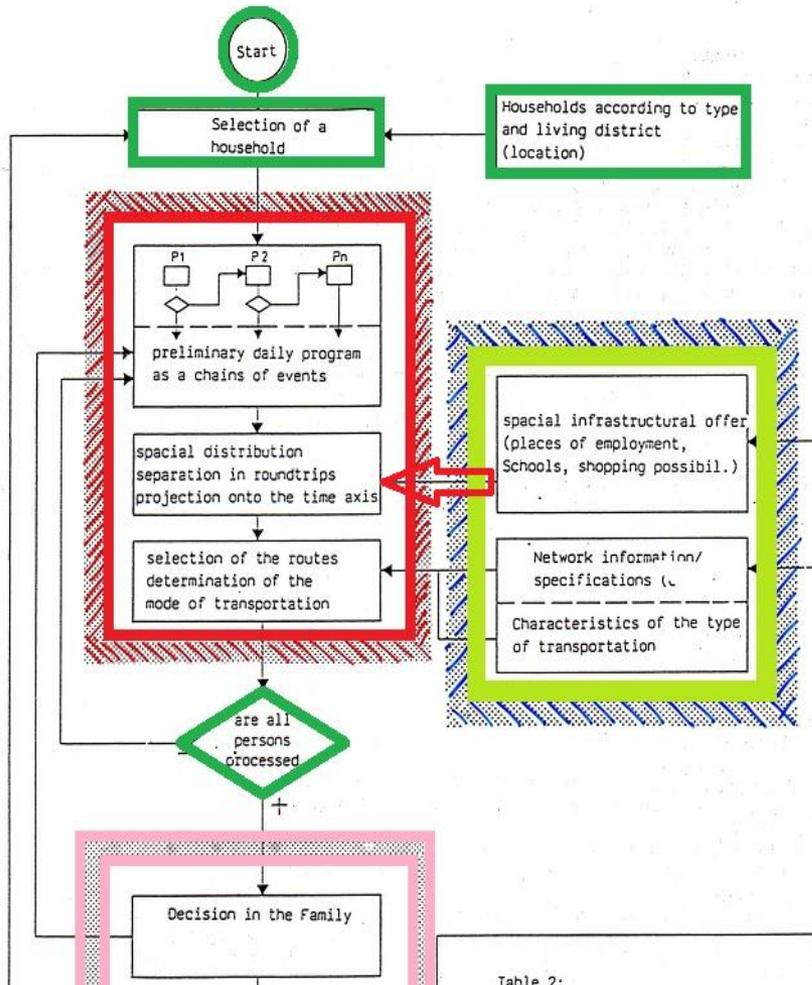


Table 2:

TRANSFER Hilfe

Datei Bearbeiten Lesezeichen Optionen ?

Inhalt Index Suchen Zurück Drucken << >>

Kettemf.DB

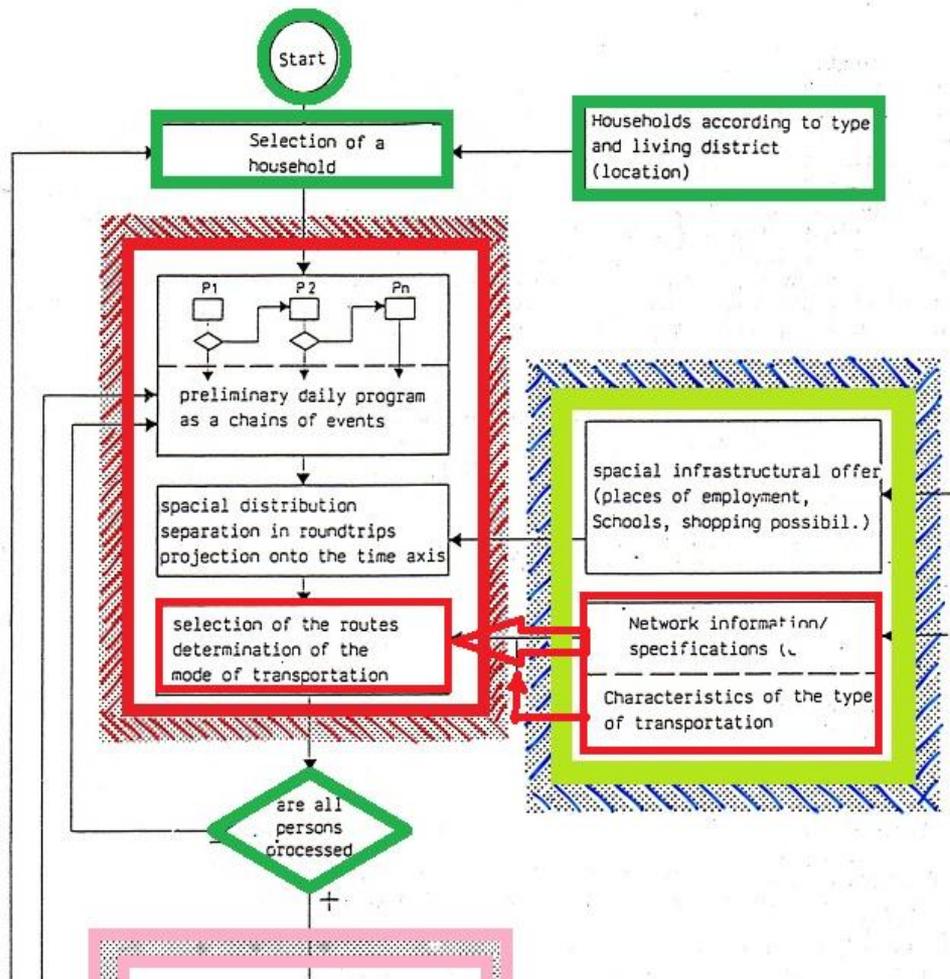
Kette [Montag-Freitag] Student/in

NR	PP	N01	N02	N03	N04	N05	N06	N07	N08	N09	N10	N11	N12	N13	N14	N15	N16	N17	N18	N19	N20	
10	70	10	7	8	9	11	16	17	22	18	24	20	12	13	23	15	15	25	0	0	0	02:00:00
11	15	10	7	8	9	11	22	12	13	23	18	24	20	16	17	19	15	25	0	0	0	12:00:00
12	15	10	7	8	9	22	10	24	20	11	23	12	13	16	17	19	15	25	0	0	0	10:20:00
20	80	5	6	12	13	14	15	21	17	22	18	24	20	23	19	25	0	0	0	0	0	10 Kind zur Schule/Kita
21	10	12	13	5	6	15	14	21	17	22	18	24	20	23	19	25	0	0	0	0	0	12 Kleiner Einkauf
22	10	15	14	12	13	9	6	21	17	22	18	24	20	23	19	25	0	0	0	0	0	13 Großer Einkauf
30	66	10	12	13	14	15	22	11	21	16	17	24	18	20	16	23	10	25	0	0	0	14 Einkaufen
31	14	10	22	19	21	14	11	16	17	12	15	15	24	18	23	20	6	25	0	0	0	15 Kleininkauf/eicht
32	20	10	22	18	24	20	15	12	13	14	11	16	21	17	6	23	18	25	0	0	0	22 sonstige häusliche Tätigkeit
40	40	10	16	22	19	21	7	8	9	11	12	13	14	15	17	24	18	23	20	6	25	11 Kind von Schule/Kita
41	30	10	12	13	14	15	22	11	16	6	18	7	8	9	24	18	23	20	21	17	25	16 Kind/einweitung
42	30	10	7	8	9	12	13	22	14	15	23	11	16	21	17	6	20	19	24	18	25	19 Freizeut außer Haus
50	75	10	1	12	13	15	22	14	17	23	18	24	20	19	25	0	0	0	0	0	0	8 Schubesuch
51	10	12	13	14	15	22	14	17	23	18	24	20	19	25	0	0	0	0	0	0	0	3 Schubesuch
52	15	10	15	12	13	14	22	14	19	24	17	20	23	10	25	0	0	0	0	0	0	24 sonstige häusliche Tätigkeit
60	40	10	4	12	13	14	15	22	11	21	16	17	23	18	24	20	19	25	0	0	0	18 Freizeut außer Haus
																						23 sonstige häusliche Tätigkeit
																						20 Freizeut außer Haus
																						21 Kochen/Hausarbeit
																						17 Freizeut außer Haus
																						25 sonstige häusliche Tätigkeit

4.WBT[20 21] / 5.WBT[17 25]

Simulation - flow diagram

The person is informed about all possible means of transport, their timetables and costs for each home-to-home trip chain .



Set Konstante, Optionen, u.a.

Route | Simulation | Datenbank | Statistik | Drucker | Allgemeines | Filter | Formel

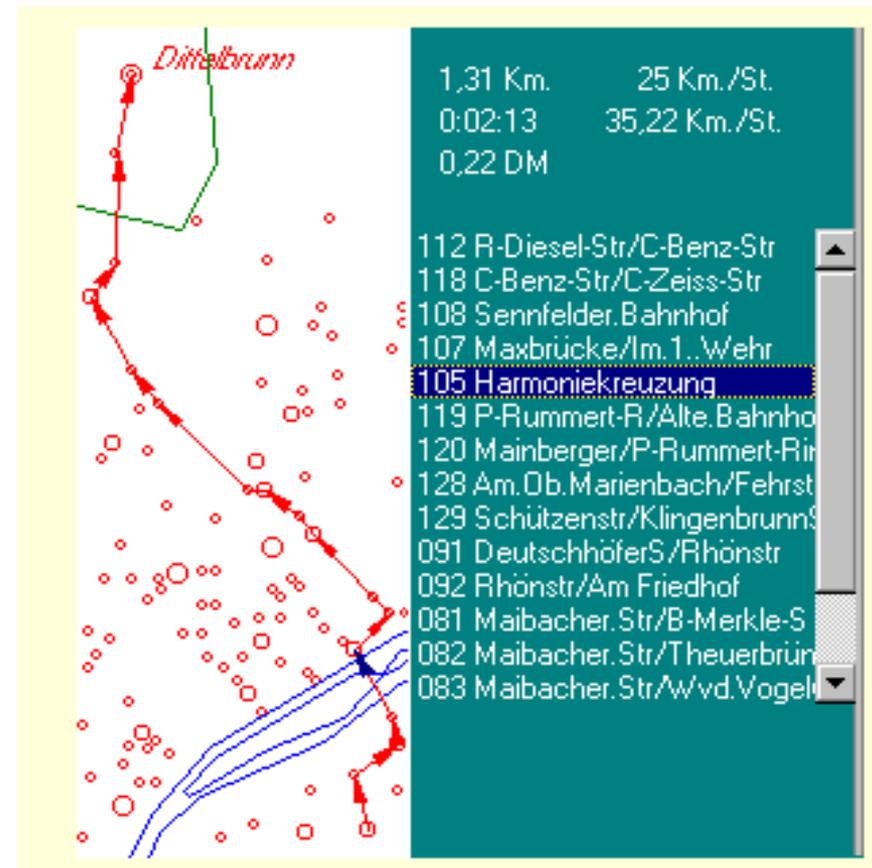
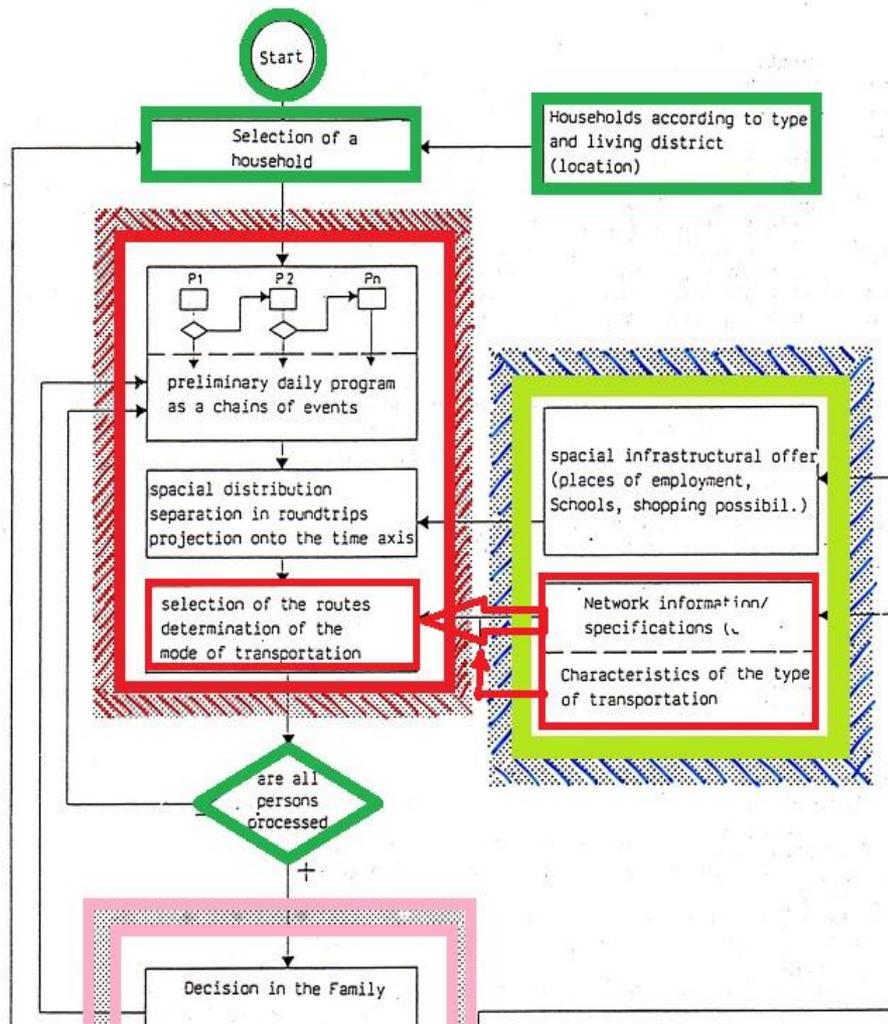
Fahrtkosten (€)	0,2	W/U
Warten/umsteigen (Min)	0	0,5
Beanspruchungsniveau	1,1	
Eusswegezeiten (Min)	5	
PKW / ÖPNV / Rad / Fuß / Schiene		
Pers.Geld (€)/Zeit Relation	niedrig	mittel
	29	36
	hoch	52
Zelldiagramm	<input type="checkbox"/>	Interval(ms) 500

Belastung

PKW ÖPNV Rad Fuß Schiene

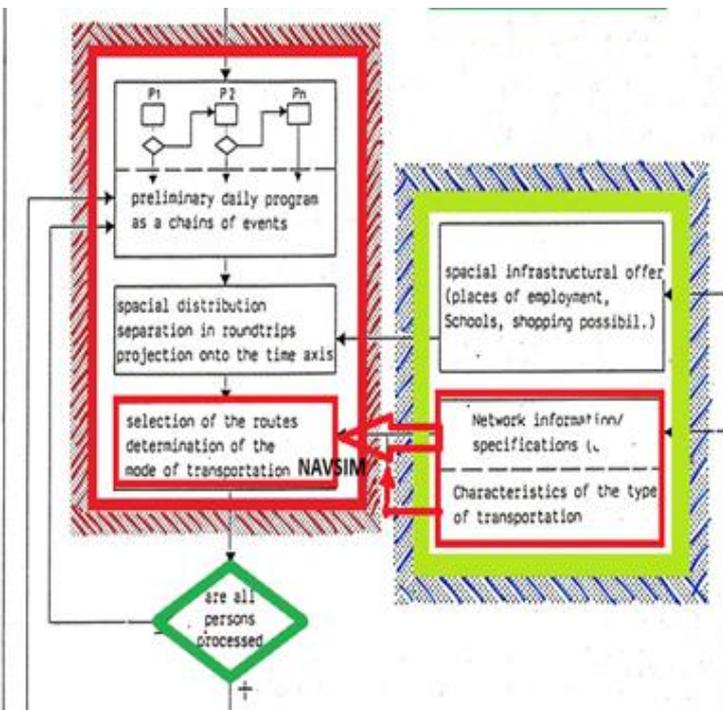
Simulation - flow diagram

The person is informed about their routes with **current** route loads for each home-to-home trip chain.



Simulation - flow diagram

- After all the means of transport have been subjectively assessed by the person for the home-to-home trip chain (see later: Submodel **NAVSIM**), it represents a **ranking** of their desired means of transport.



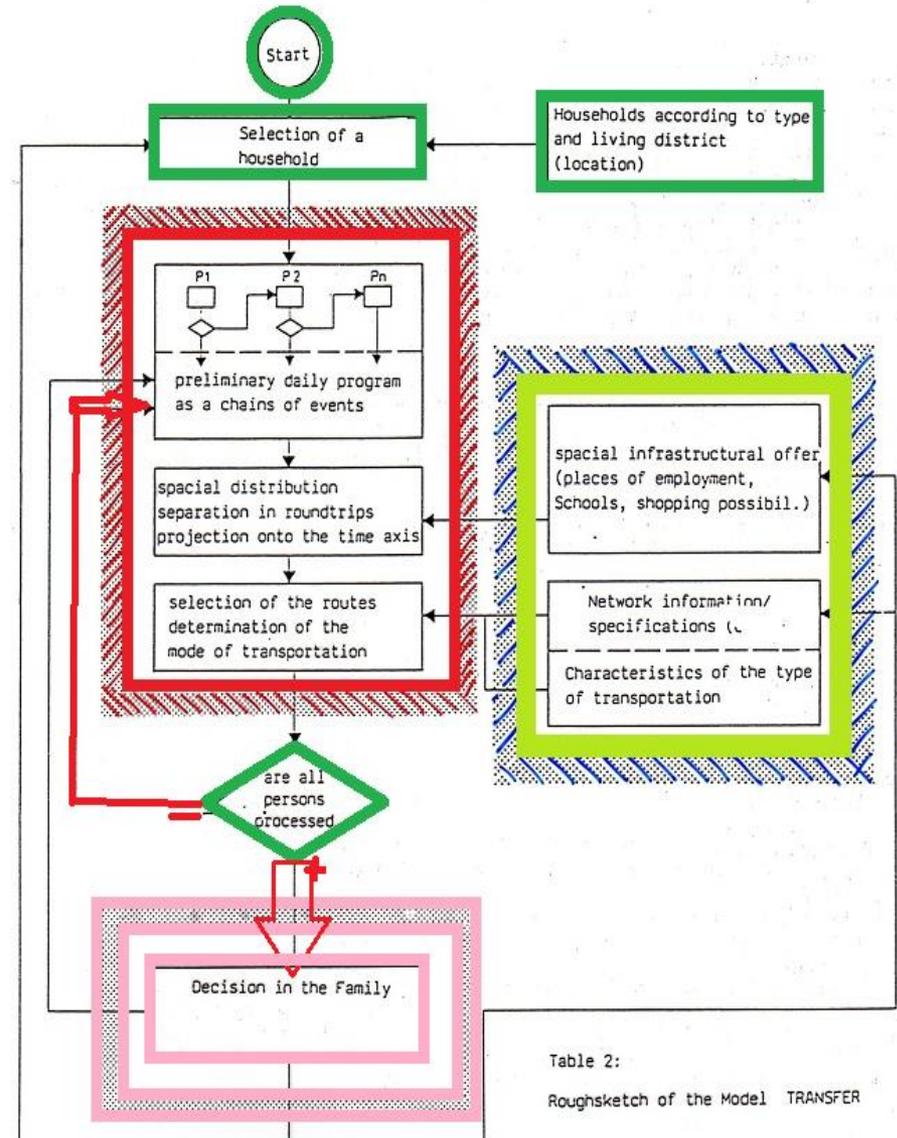
- **NAVSIM**

- Subjective total cost
- Costs (financial)
- Outward journey
- Return
- Evaluation rate

$$\begin{aligned}
 C = & \\
 & FN + P \\
 & + (FWZ \times BNF + NZ \times BN \\
 & + WUH \times BNW \\
 & + FWZ \times BNF + NZ \times BN \\
 & + WUR \times BNW) \\
 & \times RX
 \end{aligned}$$

Simulation - flow diagram

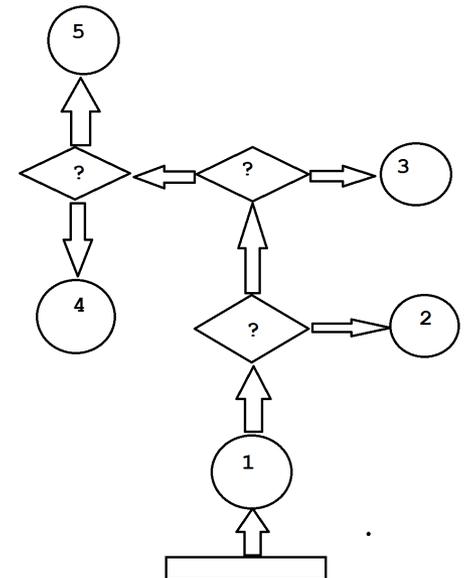
- If the person **has made a ranking** of the desired means of transport for the home-to-home trip chain, **it is checked** whether all household members have passed through this process.
- **If this is the case**, the family conference (**Internal System**) can decide on the distribution of the car (s) or tasks.



Simulation - flow diagram

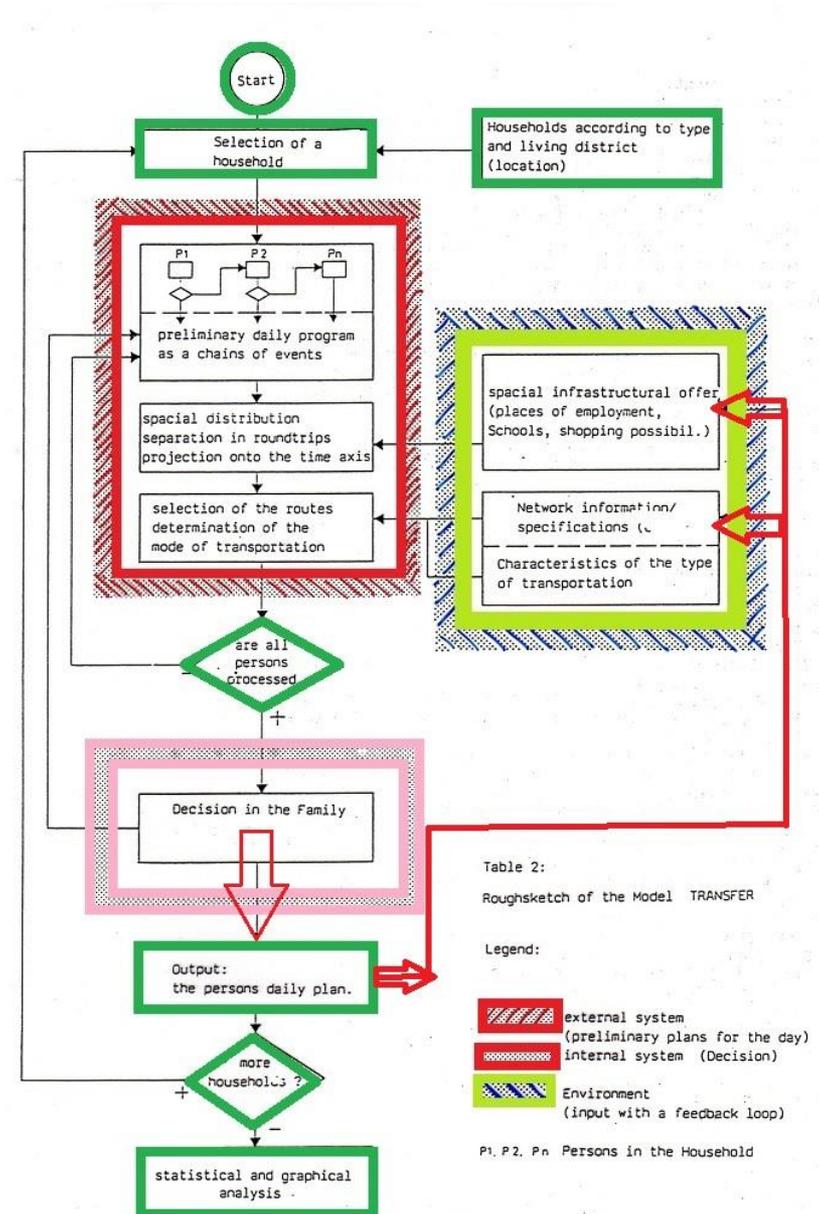
- If all persons of the household have placed orders of their desired means of transport, the family conference (**Internal System**) can decide on the distribution of the car (s).

- The model knows a **traditional** and a **liberal** decision-making climate. Accordingly, it is decided **when** and **who** gets the car (s).



Simulation - flow diagram

- It is **only after** the family decision that the personal day plans are registered and the paths on the routes are reported to the environment in a timely manner.
- The loads between the nodes are compared with the maximum load. If they are higher than 70%, the speed is reduced (by a congestion almost 0 km/h - from **light** to **dark red**).
- Later riders will meet their route and mode of transport according to the changed conditions.



Formalization techniques

- Statements about the subject-object relationships can be **descriptive**, but also **explanatory**.
- **Descriptive statements** can be formalized by multiplying the number of individuals of a type with the frequency of their behavioral pattern, or better: by the **stochastic random method of Monte Carlo Simulation**.
- **Explanatory statements** can be formalized by means of substantive logical links and the basic calculation methods. The importance of the mathematical terms has to be taken very seriously.

Descriptive formalization techniques

- The **Monte-Carlo-Simulation** formalizes descriptive frequency responding to the behavior of individual subjects in their environment. It was first used by Torsten Hägerstrand (Chicago 1967) for spatial processes. In individual cases, it takes decisions and can be expanded as required by causal model elements.

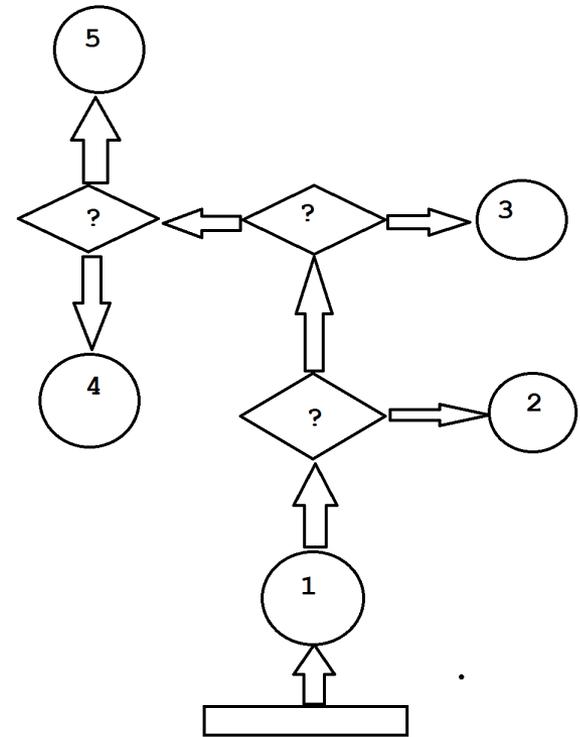
In short:

- You distribute a **spectrum** of activities or properties to a hundred fields, **mark their areas** according to their probability, and then you **roll over a kind of "roulette ball."** The activity or feature within which "the ball remains" is now applied as appropriate. In a large number of repetitions, approximately frequency distributions crystallize out, as were predicted by the size of the probability ranges.

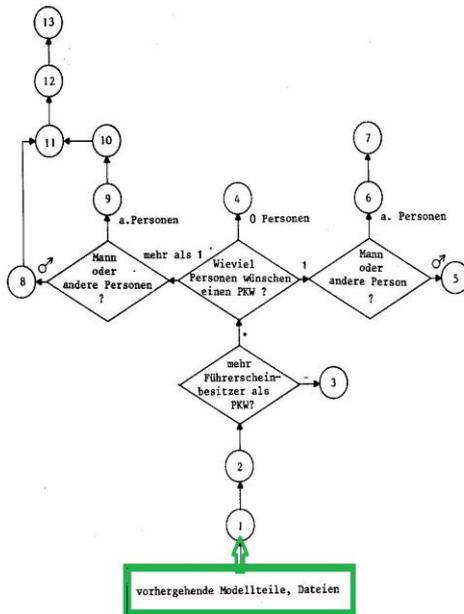
Descriptive formalization techniques

Decision trees

describe observed processes,
but also permit individual
decisions, which are explained
by these.



Simulation - Decision Tree in TRANSFER (Traditional)



- 1. If the household does not have a car, its members do not use a car.
- 2. If a person has no driving license it may not herself drive a car.
- Query 1: Are there more driving license owners as cars in the household?
- 3. If the number of cars in the household are larger or equal to the number of license holders, each of these has unlimited transport options. If fewer cars are available, these 4 to 13 apply.
- Query 2: How many people would like a car in the morning?
- 4. If no one wants a car, no one gets one. If one wishes it, these 5 to 7 apply, if more than one person, then these 8 to 13.
- Query 3: Is it the desire of the householder (man) or another person?
- 5. If the man wants the car, he receives it.
- 6. If another person wishes the car, it only receives it if its home-to-home trip chain does not last longer than an hour.
- 7. If another person wishes the car, he / she will receive it only if he / she takes over the work, is full or part-employed and has at least two smaller children in the household. If necessary, she has to bring the children to kindergarten. - Repeating the query 3.
- 8. If the man wishes the car, he will receive it, if the sentence 9 or 10 does not apply. If necessary, he has to bring the children to school or kindergarten.
- 9. If another person wishes the car, it will get it if it clearly shows the larger load per day (more than 50%). If necessary, she has to bring the children to school or kindergarten.
- 10. If another person wishes the car, he / she will receive it when he / she takes over the work, is full or part-employed and has at least two small children in the household.
- 11. If another person (including the man) receives a car and its activity is less than 360 minutes, it will take any other person's actions.
- 12. If the first local target of the person not having the car is on the route of the other or adjacent to his / her target cell, then his or her outward journey is to be counted as a car journey. Its further routes are carried out according to the evaluation without a car.
- 13. If the man does not receive the car, the not full-service person, who get the car, will drive him to his place of work.

Explaining formalization techniques

- If one wants to formalize “numbers” knowledge about relationships, the chosen forms should be respectively not only externally, but also show the **meaning** of the explanatory context. We ...
- **+** **add**, if an equal dimensioned size is added,
- **- subtract**, if an equal dimensioned size decreases,
- ***** **multiply** if we find two or more always coherent dimensions of the same object, and
- **/ divide**, if we put two real-distinguishable variables (objects) against each other.
- More complicated mathematical forms should only be used **if they are clearly interpretable**. For example, the **integral** as a particular form of the product, i. as two always connected dimensions of the same size.

Formalization Techniques

How does such a formalization take place?

- E.g. in the submodel **NAVSIM**, the household members choose alternative means of transport. They evaluate them subjectively according to the total costs on their respective route and create a wish list.

Two theses explain this evaluation process:

- The choice of a means of transport is made by the decision
 - of the respective stress during the travel period
 - and the financial claims

and

- The larger the available amounts of time or money of a decision-maker, the lower the subjective assessment of the burdens.

Formalization techniques - for the NAVSIM formula:

To the **first thesis**: *The subjective assessment of a mode of travel (= total cost **C**) is added from the fare (**FN**) and possibly park costs (**P**) as well as the demands during the whole trip. However, because money and time constraints have different units, they are separated by a parenthesis. The footpath times (**FWZ**), times in the local public transport (**NZ**) and possible waiting and switch times (**WUH / WUR**) must be weighted, then summarized and finally "converted". So the time amounts between the parenthesis will be converted to financial amounts by a subjective evaluating factor (**RX**).*

The **second thesis** says: *"The larger the available amounts of time and money, the less the respective burdens."* The subjective financial value of the requirements of the way is thus determined by the ratio of "average, daily disposable income" to "still-freely available time on a working day". Written on a fraction stroke, we get the ratio of "two distinguishable objects" by dividing their amounts .

$$\text{Evaluating factor } \mathbf{RX} = \frac{\text{disposable income on a working day}}{\text{free time on a working day}}$$

Formalization techniques - the NAVSIM formula :

Subjective Total Costs	$C =$	
Cost (financial)		$FN + P$
Outward journey		$+ (FWZ \times BNF + NZ \times BN + WUH \times BNW$
Return		$+ FWZ \times BNF + NZ \times BN + WUR \times BNW)$
Evaluating factor		$* RX$

Abbreviations:

<i>FN</i>	<i>ticket price or average operating costs of the car</i>
<i>P</i>	<i>Parking fees for the car</i>
<i>FWZ</i>	<i>walking time (e.g. door-to-garage or door-to-bus-stop, parking-office)</i>
<i>NZ</i>	<i>Time in local transport</i>
<i>WUH</i>	<i>Waiting and switch time on the outward journey</i>
<i>WUR</i>	<i>waiting and switch time on the return journey</i>
<i>BNF</i>	<i>stress level for footpaths</i>
<i>BN</i>	<i>Level of use in the means of transport</i>
<i>BNW</i>	<i>stress level when waiting and changing</i>
<i>RX</i>	<i>subjective evaluating factor money / time</i>
<i>C</i>	<i>subjective total cost of a means of transport on a particular route</i>

The dynamization: When is a model dynamic?

- B. Greuter (Dortmund, 1977) has made four interdependent demands, which I easily change for myself:
- *The important factors that are effective in the model can not be determined from the outside (exogenously) and thus constant in the considered time. They are to be determined from the model sizes and model relationships given at different points in time. This does not mean that all model sizes should be kept variable. However, future models should simulate an increasing number of model variables with feed back.*
- *It must be a causal model, i. the model variables must be expressly and conclusively formulated and clear causal relations between them must exist, in particular, (political) control variables and system state variables must be causally connected.*
- *The model must not anticipate any development of equilibrium, or assume that a system which has once come out of equilibrium like to repeat it. Otherwise structural errors will be ruled out from the outset, which in turn will prevent further equilibrium growth and often lead to the stagnation of system development.*
- *It must be possible to define an explicitly recognizable response time (time-lag) in the model. It indicates how long it takes for modified determinants to exert influence on the variables, i.e. it describes the period between the actual situation of the system and the time at which it was perceived by the subjects.*

The dynamization:

- The demands are all very strict and extremely demanding. If we want to dispense with differential equations, how can the model be dynamized according to the above criteria?

The only path that seems possible to me is that it is

- To divide the period to be considered into equal time intervals. The length of the intervals should be determined by an essential model parameter.
- For example, the duration of the family cycle (6 years) could form a useful unit.
- For the first interval, the subjects and objects as well as their initial situations and planned measures must be quantified.
- By means of a causal, *static* model, changes in the number and situations of the subjects and objects for the first interval are to be played and recorded as its final state.
- Events which are not reconstructed by the model (for example, births, deaths) are updated over the length of the interval according to empirically determined transition probabilities.
- The numerical values of the causal simulation and of the update together form the input values for the next time interval.
- The entire forecasting period is progressively followed, the respective end values and updates of an interval forming the starting position of the following.

The dynamization:

- If there are no equilibrium assumptions in the causal model and realistic response times of the subjects were taken into account, the four dynamics criteria are fulfilled.
- However, in the model "aging" and the updating are more successful in practice when the subjects are typed according to situations that contain a time or development feature. For example, if the age is part of the description of the type, legal restrictions (compulsory education, driving licenses) probabilities (marriage, fertility, retirement, death) are **type-specific**.
- If the subjects are individuals, they can be divided as a cohort, they are households, according to phases of a family life cycle. However, even longer-lived objects, e.g. residences can be typified according to their year of construction and "aging" intermittently. Renovation measures delay this process but do not stop it.



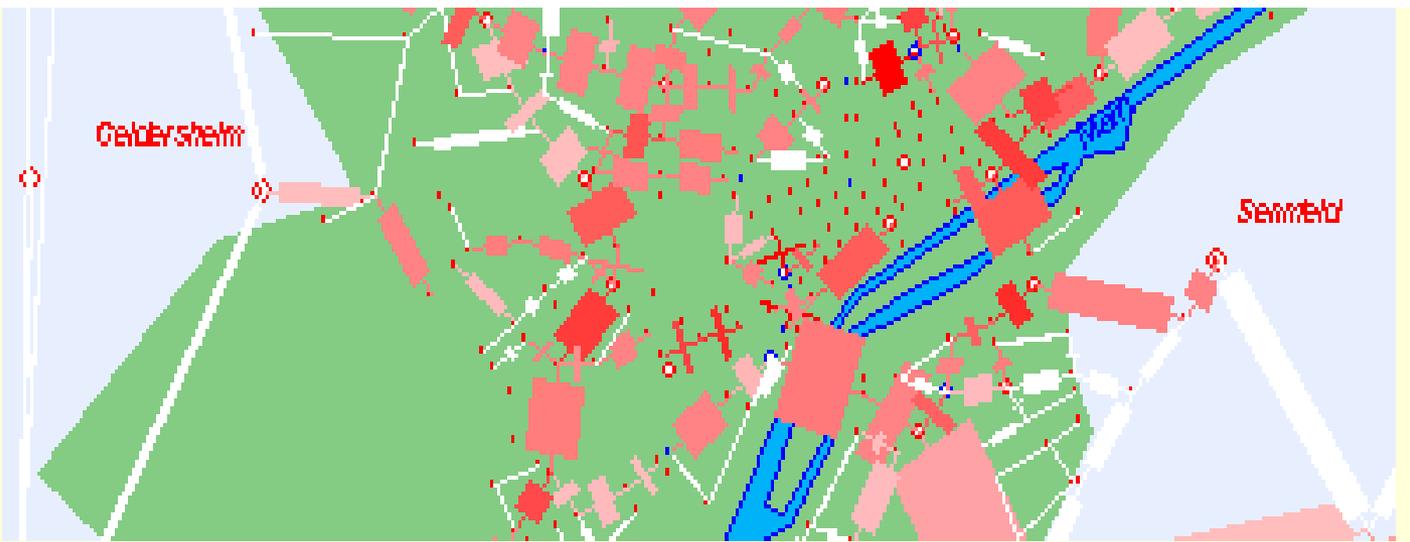
Results:

Overall presentations

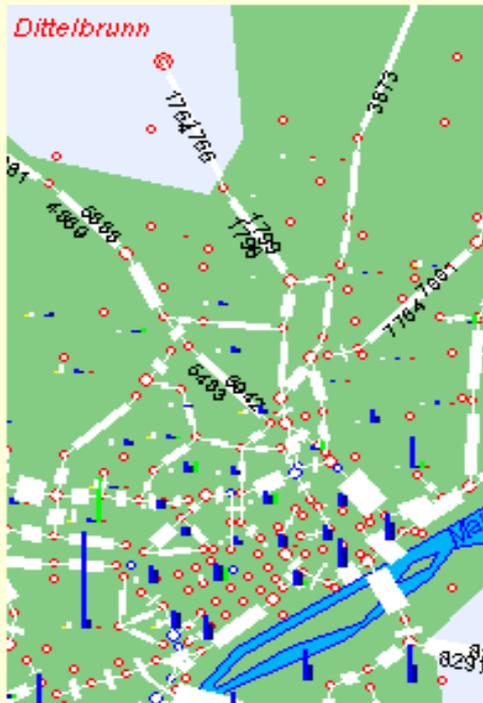
- route loads / crossings
- Diurnal traffic variation
- Involved groups

Results: route loads in car transport

with feedback (red)



Results: route loads and parties involved



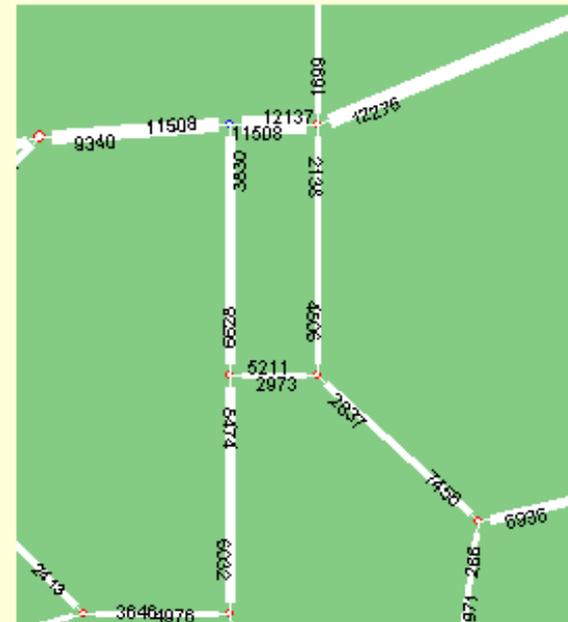
PKW Belastung	
	Schonungen: 8754
	Max-Brücke: 34820
	Hahnenhügel: 54973
	A 70: 28710
	Grafenrheinfeld: 7193
Statistik	
	Rentner: 27550
	Schüler: 11523
	Kleinkinder: 6434
	Arbeitende: 44681
	Unternehmen: 19822
	Arbeitslose: 25309
	Andere: 24463

TRANSFER Hilfe

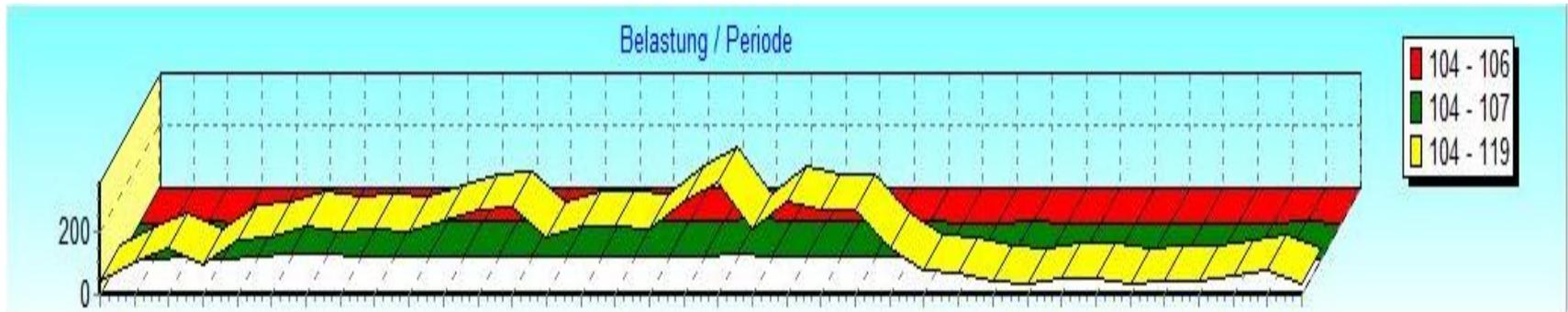
Datei Bearbeiten Lesezeichen Optionen ?

Inhalt Index Suchen Zurück Drucken << >>

PKW Belastung



Results: Diurnal traffic variation



Periode:	11 - 12	11 - 217	11 - 275
Summe	10658	3246	
05:00	105	22	
05:30	340	64	
06:00	568	148	
06:30	204	54	
07:00	310	87	
07:30	335	98	
08:00	410	110	
08:30	339	89	
09:00	393	134	
09:30	594	170	
10:00	366	129	
10:30	406	139	
11:00	377	143	
11:30	388	118	
12:00	353	119	
12:30	324	102	
13:00	283	96	
13:30	390	97	
14:00	696	165	
14:30	415	132	
15:00	311	116	
15:30	319	78	
16:00	341	114	
16:30	288	132	
17:00	262	98	
17:30	217	71	
18:00	179	66	
18:30	129	45	
19:00	116	40	
19:30	103	43	
20:00	94	29	
20:30	78	28	
21:00	83	28	
21:30	169	51	
22:00	303	84	
22:30	70	7	

Data bases

- The models need data about:
- The subjects and their situation (social data),
- The objects and their properties (spatial structure data) as well as their changes in time through natural processes, economic-social influences and political planning measures.
- The "behavior-describing" data and "explanation data" are also added to these data, which characterize the subject-object structure.

How are these data processed and where are they usually found?

■ **Social data**

- Most of the data on subjects and their situation can be found in the official statistics. The total counts carried out under uniform criteria in accordance with Article 73 (11) of the *Basic Law for the entire territory of the Federal Republic of Germany* allow for large-scale considerations.
- However, these data are only of limited use for community research. Because of the high costs, these counts occur only at relatively long intervals and therefore become "outdated" quickly. In addition, it is also very expensive to get these data broken down in a small space.
- A look at the list **yearbooks' annual of the Federal Office for Statistic** shows that as a rule the data are not processed in a small scale. Thus they are useless as immediate social data of spatial models. More suitable for our purposes are the data of the **town statistics** and the **administrative success rate**. However, "official statistics" and "urban statistics" are not clearly distinguishable. The latter collect data from the official censuses that they collect, the current administrative performance, and their own surveys. They are accordingly different from community to municipality.

How are these data processed and where are they usually found?

- The spatial structure data are mainly taken from urban files. For example:
- The building and housing censuses. The data are available with the street and house numbers. They also provide information on the building age, the type of building, the equipment as well as the ownership and financing type.
- Building files - They are based on housing censuses and are updated via the construction completion statistics and labor- or company locations statistics. The counting results are mostly available for building blocks and buildings.
- Labor- or company locations files are particularly important for traffic planning models. Trips to labor, shopping, school and leisure activities are experienced there. The road network with its cross sections, the length of the routes, the permitted speed - all of them are revealing data on the spatial structure.

Empirical effort

- As easily seen, disaggregated data can only be obtained with greater effort. Therefore, missing information must be partially "interpolated" or estimated.
- Nonetheless, differentiated estimates are better than aggregated average values, if the characteristics are reasons for different behavior (residential situation, income, number of children, ect.). The simulations then lead to more credible results.
- Reasoned estimates significantly reduce the cost of collection.

Makes this effort sense?

Econometrics *versus* Individual Simulation

- At the 8 th World Conference on Transport Research in Antwerp in 1998, **TRANSFER** could be compared with a large econometric model of **MIT** (Moshe Ben-Akiva).
- The **MIT** model, produced with a **much** greater effort, covered a much larger region, but was **much less** socially and, according to planning measures, much less differentiated.

DEMONSTRATION OF AN ACTIVITY BASED MODEL SYSTEM FOR PORTLAND

John L. Bowman, Doctoral Candidate
Massachusetts Institute of Technology
5 Beals Street #3
Brookline, MA 02146
T: (617) 232-8189 * E-mail: jlbowman@mit.edu

Mark Bradley
Mark Bradley Research and Consulting
93 Scenic Road, Fairfax, CA 94930
T: (415) 456-6531 * F: (415) 456-6921 * E-mail: mab@well.com

Yoram Shifan, Ph. D.
Lecturer
Technion
Transportation Research Institute, Technion, Technion City
Haifa, 32000, Israel
T: 972-4-8292381 * F: 972-408225716 * E-mail: yxs@technix.technion.ac.il

T. Keith Lawton
Transportation Department, Metro
600 NE Grand Avenue
Portland, OR 97232-2736
T: (503) 797-1764 * F: (503) 538 7854 * E-mail: lawtonk@ix.netcom.com

Moshe Ben-Akiva, Ph. D.
Edmund K. Turner Professor of Civil and Environmental Engineering
Director, Intelligent Transportation Systems Program
Massachusetts Institute of Technology
Room 1-181, 77 Massachusetts Avenue, Cambridge, MA 02139
T: (617) 253-3324 * F: (617) 253-0082 * E-mail: mba@mit.edu

Prof.Dr. Erich Ruppert
Institut für Soziologie
Universität Würzburg
Tel. 0931/ 8884864

Privatadresse:
Karl-Fichtel-Str. 29
D 97424 Schweinfurt
Tel. 09721/ 806007 Fax 09721/ 806008

Paper for "THE 8th WORLD CONFERENCE ON TRANSPORT RESEARCH"
To conference topic area: D 1. Passenger Transport Demand Modelling

THE REGIONAL TRANSPORTATION MODEL "TRANSFER"
(TRANSPORTATION signified as Family-Environment Relations)

It has now been 15 years since I introduced you to the basic idea of my TRANSFER - model, at the World Conference in Hamburg. At that time, there was still fierce criticism against gravitational models, as they had been developed in the 60's. However, they were becoming outdated, and a new generation of econometric models was being introduced. Led by the MIT, particularly by Moshe Ben-Akiva, the mathematic problems of models were discussed confidently, even if critically. The Americans took the lead courageously.

My sociological model, whose theoretical foundations also came from a well-known American, the sociologist and system theorist George Caspar Homans, was looked at sympathetically but remained an outsider in the discussion. Its name, TRANSFER, stood, and stands, for the transference of formulated theories in practical concepts, and at the same time it is also an abbreviation of a rough plan: TRANSPORTATION signified as Family-Environment-Relations, which therefore means, simulated household-relations in regions.

Makes this effort sense?

Competition: The four-stage model of traffic planners

- Although criticized since 40 years, consulting offices still simulate the passenger transport demand in **discrete, four stages**:
- the **production**,
- the spatial **distribution**,
- the **division** on different means of transport and
- the **allocation** on routes.
- These models attempt to reconstruct observed frequencies with the indicators of the spatial structure or means of transport with **physical analogies** (e.g. **gravitation**) and the aid of correction factors (α , β , γ , δ). The correction factors are determined by correlation calculations.
- These models are easy to use, cheap and accepted as sufficient legitimation by many local authorities.

Makes this effort sense?

Sociological criticism of the four-stage model of transport planners

- Contrary to social facts non-sociological knowledge, like physical analogies, determine the models of social behavior.
- Easy availability and weak statistical correlations "justify" the choice of indicators.
- The four-step discrete treatment of the decision-making process is contrary to the actual processes.
- The iteratively found correction factors (α , β , γ , δ) do not allow transmission to other spaces and times. Nevertheless, this is assumed.
- The rough indicators for private transport and public transport are largely insensitive to measures and social processes.
- Municipal decision-makers can not check the results.

Makes this effort sense?

- **Yes**, if one understands simulation models as:
 - “Operating models of **processes in social systems** imitated in a computer”
 - Logical operations as the **core** of their computer programs
 - and **applies it precisely** when a mathematical formalization appears to be too **complicated** or **not adequate** to the subject (*compare sociological models of the 1960s, for example, Renate Mayntz*).
- **Yes**, if one does **not want to dispense** with the complexity of theoretical and empirical knowledge. **Only in this way can convincing conclusions be substantiated and scientifically appropriately legitimate.**