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Simulating the urban transformation process in the Haaglanden region, the Netherlands[1]

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Abstract

This paper describes a recent modeling project on the dynamics of new housing construction, transformation of outdated dwellings and the impact of both processes on a regional social housing market. The study continues and adds to the work of Forrester and others on urban dynamics. A team of seven stakeholders and experts participated in model construction. The model was constructed over a period of about 14 months and yielded several counterintuitive insights. The housing allocation system proved to have far smaller effect than expected, while the proportion of new greenfield construction to transformation (demolition and new construction within the city) has emerged as a crucial steering factor. The migration multiplier is a very important external parameter. A strategic workshop for policy makers, managers of housing associations and other stakeholders in the region offered a chance to present the final model and operate it in the form of a flight simulator. In line with the recommendations of a recent survey of group model building projects, participants' insights and conclusions from both the project and the workshop are evaluated. The evaluation is based on the Ajzen model and focuses on the effect of group model building on attitudes, intentions and behavior.

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Measuring the effectiveness of group model building interventions is a relatively new branch of science. Whereas system dynamics interventions have been said to improve policy making from the beginning of the field in the 1950s, only recently a research program on effectiveness of modeling has been outlined. Andersen, Richardson and Vennix (1997) signal the need for consistent research in this field, put forward hypotheses on group model building effects and provide guidelines for case study reporting. Rouwette, Vennix and van Mullekom (2002) elaborate these guidelines into more detail and provide a review of case studies on system dynamics modeling effectiveness.
This paper is structured on the basis of these evaluation guidelines. We first describe the context of the intervention and reflect briefly on the relation to the existing literature on urban dynamics. Next we report on the process of modeling and the involvement of participants in the effort. Finally the resulting model is described and the evaluation of effects for the participant group.

Context characteristics and problem description

The subject of the model in this case is the impact of new construction and transformation of existing urban (social) housing on the dynamics of the social housing market. The stage is the urban region Haaglanden in the densely populated west of the Netherlands. The region includes the central city The Hague, its directly surrounding suburbs Voorburg, Leidsendam, Rijswijk and up-market Wassenaar, new town Zoetermeer, historic Delft and the horticultural area Westland.

Sociale Verhuurders Haaglanden, SVH for short, is an association of not-for-profit housing corporations in and around The Hague. Its main task is to provide strategic consultancy, represent and lobby for its twenty member organizations in various decision making fora. SVH is a relatively small networking organization and the primary client in this project. Its main partner and sometimes opponent in strategic planning is Stadsgewest Haaglanden (short SGH), a government tier uniting municipalities in the urban region. Atrivé (formerly Marco Polis Advies), an independent commercial consulting company, provided the system dynamicist/ facilitator for the project.

Housing corporations and municipalities in the Netherlands have shared responsibilities for housing policy and urban development. Until the 1980's a shred effort was directed at the construction of social housing. Unintended side effects such as selective migration out of the city, concentration of low income groups in the city and urban decay caused a shift in focus in the early 1990's. Forrester already pointed out the risks of pulling low cost housing construction out of balance in Urban Dynamics in 1969. Low-cost housing construction is listed as one of the urban-management programs aimed at improving urban conditions. Forrester defines low-cost housing as houses constructed for the *underemployed,* which may not be completely identical to the definition of low-income groups as used by Dutch housing corporations. However, sufficient similarity seems to exist to warrant a comparison of Forrester's results to the Dutch context. In the Urban dynamics model, a low-cost housing program leads to an additional inflow of underemployed into the city, more pressure on unfilled land which makes the are less favorable for other types of construction. This in turn leads to a lower number of new enterprises and a decline in mature business. The conclusion is therefore that low-cost housing construction is detrimental or neutral at best to urban renewal (see also Mass, 1974; Schroeder, Sweeney and Alfeld, 1975). At the time these conclusions seem to have been considered controversial or politically incorrect and low-cost housing construction continued to be a prominent policy in many countries for several decades.

Since the 1990's the goals of Dutch housing policy seem to have broadened. An important topic at present is the transformation of 1950's large-scale outdated housing projects. The Dutch urban transformation[2] process which has started in the 1990's is expected to lead to a better mix of housing types (i.e. more owner-occupied and commercial rental apartments) and stop or prevent negative socio-economic developments associated with the 1950's housing projects. So in addition to the earlier focus on greenfield[3] development and technical reconstruction of dwellings, changing the housing mix and thus the urban social structure is now an explicit goal of urban renewal programs. Another important change occurred in the early 1990's when housing corporations changed from state subsidized organizations, responsible for administration of houses but in fact not financially accountable, to a more independent role. At present corporations are independent from the central and local governments and responsible for their financial continuity and market and real estate strategies. Vennix (1996) describes the role of system dynamics in understanding the new strategic issues for housing associations in more detail.

However, the envisaged effects of large scale greenfield housing development programs, technical reconstruction and attention for socio-economic effects have to a large extent failed to materialize. New greenfield development programs (outside the city) were expected to attract people from the city, so that the houses vacated in the city can be demolished for transformation (Ministerie van VROM, 2004). But even though existing (econometric) housing market prognosis models predicted a relaxation of the housing market, pressure increased: both on the social housing market and on

[2] Transformation means transforming existing, run-down or outdated housing into new, better quality housing. The essence is in the transformation of existing housing.

[3] Greenfield development means building new houses in previously unoccupied land.

the client organizations to resolve the issues of transformation, new construction, housing allocation and housing market dynamics in an integral fashion. Part of the explanation is the difference between short term and long term effects. On the short term, urban transformation increases pressure on the social housing market. Tenants vacating a dwelling to be demolished have priority over regular applicants when applying for another rental dwelling. Regular applicants are therefore faced with a declining success ratio[4] of finding a dwelling. On the long term, however, new construction both from greenfield development and from transformation causes migration chains[5], which eventually result in a larger supply of social housing. The mutation ration is the second important problem variable. The mutation ratio is the annual supply divided by the size of the stock of social houses, and is an important indicator of the pace of transformation of the housing stock. The main relationships are shown in the simplified model structure in the following.

Both client organizations SVH and SGH agreed to a large extent on the necessity of new construction and urban transformation for urban socio-economic vitality. They parted ways when it comes to the desired pace of transformation in relation to new construction, or desired and acceptable ways of intervening in the social housing market if not everything goes according to plan. In particular when clients, voters or other branches of government exert pressure, differences of opinions come to the fore. SGH is bound by contracts with the national government on new housing construction volume and is eager to improve the housing mix especially in the central city The Hague. Therefore SGH was not inclined to accept any delays in the transformation program. Their point of view was well documented in the 2003 Housing Policy document, which constituted the baseline simulation for the model (nr. 1, blue line). The policy target is an annual transformation volume of 2.000 existing social dwellings.

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[4] The success ratio is defined as the supply of social houses on the market, divided by the number of families on the waiting list. The reciprocal gives the average waiting time.

[5] Migration chains relate to the following: when new houses are constructed, families move in. They leave their former house, which in turn is occupied by another family. This migration chain ends when someone moves in not leaving a house (housing market starters, immigrants). The migration multiplier is the ratio of moves to the number of houses constructed. The effect can be split into effect on the social and the commercial housing market. Migration multipliers are not constant in time at all, their causal relations are unclear and their impact in this model is very high. Common policy making, however, largely ignores the dynamics of the migration multiplier (De Rooij et al, 2004).

The housing corporations and SVH are more sensitive to the decreasing success ratio of their potential clients and have less control over new construction, especially in the commercial segment. A high mutation rate means higher costs and the risk of structural vacancies, but a very low mutation rate (small supply) implies a low success ratio. SVH was therefore in favor of an alternative policy option, in which the pace of transformation was linked to the progress of greenfield development i.e. 1.500 dwellings in the first 5 years and 2.500 in the second period (nr. 2, red lines) . SVH also considered changes of the housing allocation system as a possible policy option for increasing their clients' success rate.

When the project was initiated, SVH and SGH were already in deep conflict over the problem definition and the proper policy responses to an unexpected situation. The situation can be described as a messy problem (Vennix 1996), because of the reality of multiple realities.

The problem addressed in the modeling project is complex both in an analytical sense and with regard to social aspects. Botman's work on dynamics of housing and planning (Botmans, 1981) focuses mainly on the analytical properties of regional development but does not refer to strategic questions of actors or stakeholders. Vennix (1996) gives a detailed account of a simulation model of post-1988 situation housing corporations find themselves in. The model clearly shows the complexities of accommodating demands of clients and government organizations. The Haaglanden simulation project was initiated in order to settle strategic and conflict-rich issues in a multi-party setting and put group model building into an setting for mutual persuasion.

The system dynamics intervention

Pre project activities

The problematic issues were a source of contention between SVH and its members on one side and Stadsgewest Haaglanden and the participating municipalities on the other side. SVH and the regional authority SGH could not resolve their problem by normal policy consulting or research activities. Atrivé then proposed to develop a system dynamics simulation model of the contentious issues. Both SVH and SGH welcomed this proposal, even though no a priori guarantees of the outcome could be given. The expectations of the client organization were written down in the project proposal (Eskinasi, 2002). The goal of the project was the construction of a quantitative simulation model for testing proposed policy interventions. Successful options should afterwards be implemented as 'real life policy'. The top management and board of SVH supported the modeling project. SGH and civil servants from The Hague initially reacted to the project with a mix of curiosity and skepticism.

The client organization SVH, or its director in person, acted as a gatekeeper (Richardson and Andersen, 1995) and decided whom to invite to join the project team. The composition of the seven-member project team was decided upon by the client organization. The team consisted of two senior officials (the director of SVH and a high ranking civil servant from SGH), three policy making officials (one from SGH, two from different housing corporations) and a senior housing market researcher from The Hague Urban Development Office. The researcher provided very useful input, access to many data sources and contributed to a lively debate on facts and figures. He also had strong opinions on the structure of the housing system and on the validity of the resulting model. The researcher and policy makers were recorded to engage in debates on how things work, what should be done, what had worked in the past and what had not. The senior officials engaged to a lesser extent in the debate on structure, figures and content, but in the final stages dominated the discussion on what policies to simulate. The modeling team consisted of two people: one in the role of process and content coach, modeler and one recorder who assisted also in guiding the process. Two different persons fulfilled the role of recorder during the project.

Model building meetings

The project started in October 2002 and finished in December 2003. In total ten meetings were held, varying in duration from four hours or longer for the first sessions to two hours in the later stages of the project. The participants invested about 35 hours in attending the meetings, with some of them occasionally missing out on a meeting and others spending additional time on data collection (most notably the senior researcher). The results of the different phases of the project were documented in three progress reports and a final report.

The modeling project was divided into four phases:

- start: startup and definition of causal relations;
- model construction: data collection, quantitative modeling and model validation;
- simulation: comparing the effects of policy options against the base run;
- evaluation: interviews and formulation of conclusions.

The first session of about eight hours included a Beer Game session to familiarize the participants with system dynamics. In addition the central problem for the project was discussed and expectations discussed. The client team participated fully in all phases, i.e. in discussing the definition of model variables, causal relations, data sources to be used, preliminary simulations, several validity checks and interpretation of results of policy runs. During the project, the modeler/facilitator did most of the actual modeling work off-site, i.e. analysis and cross-examination of data sources, literature research, construction of the computer model, validation by comparing model runs to reference behavior and checking unit consistency, simulation and description of policy options and compilation of reports. The recorder made agendas and meeting minutes, which formed the basis for the project reports. The total time investment of the modeling team is estimated at about 220 hours for the modeling facilitator (including the meetings and reporting) and about 80 hours for the recorder.

The following materials and software were used in the modeling effort. During the starting phase, the basic structure of the housing market was sketched in the form of causal loop diagrams. A whiteboard was used during each meeting and results were recorded with a digital camera. The report concluding the first phase contained the final causal loop diagram using Vensim. In the modeling phase, this diagram was transformed to a stock&flow diagram in Ithink 7.0. During the modeling and the simulation phases, we worked with a computer and a digital projector in combination with the whiteboard. Most meetings were held in the office of the client organization.

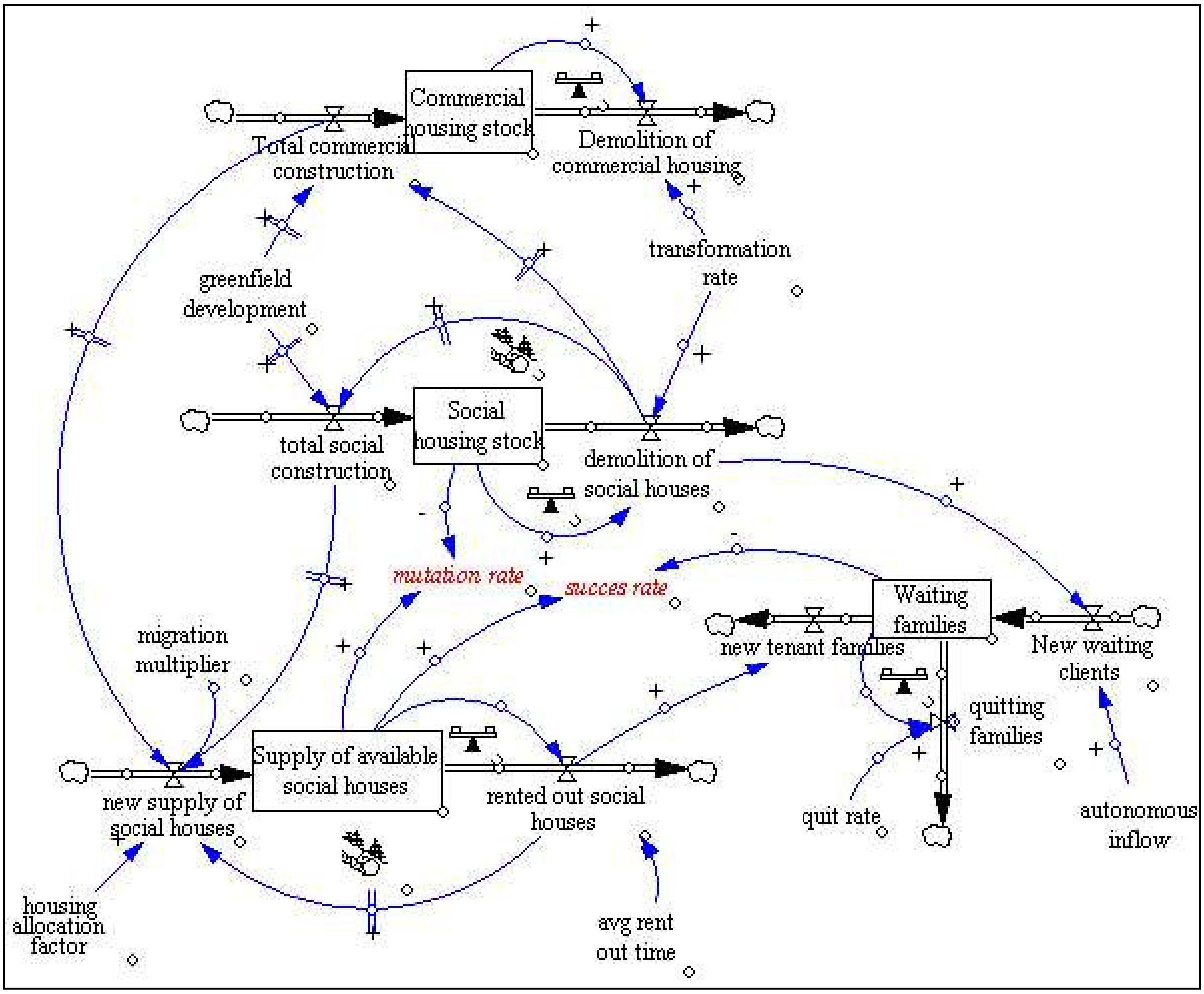
Resulting model

The basic model structure is sketched in the following diagram. Its main structure consists of four basic stocks. Two of these relate to the housing stock: social houses and commercial houses. Both have inflows (new construction) and outflows (transformation/ demolition). Two first order balancing feedback loops exist, linking the stock, the transformation program and demolition.

Demolition links back into new construction. This is a second order reinforcing feedback loop. Outdated houses are being transformed into new ones, taking into account density differentiation issues (not shown on the diagram). This feedback loop links together the social and commercial stock. The resulting inverted 'limits-to-growth' structure is the main driver for the s-shaped dynamic behavior found in both the success rate and the mutation rate. Transformation also directly increases the waiting list by adding families decanted from houses to be demolished.

New construction feeds the supply of social houses on the market (stock) with some delay, taking into account the exogenous migration multiplier, modeled as a time series input. Available houses are being rented out (first order balancing), and the housing allocation system feeds a small fraction back into new supply (second order reinforcing).

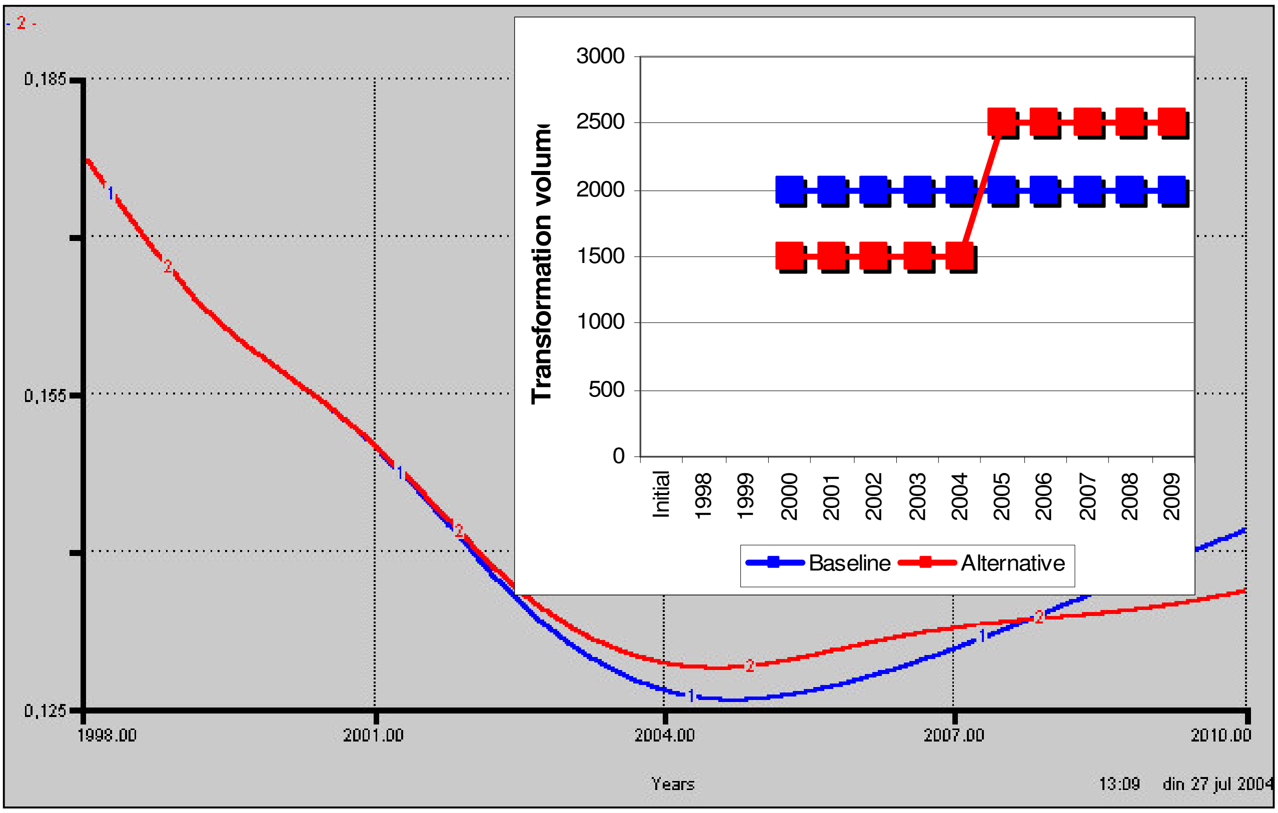
Renting out available housing directly reduces the size of the waiting list (stock). New clients flow onto the list due to transformation and other, exogenous reasons. A certain fraction of families on the waiting list quit without getting a rental house (first order balancing).



Dynamic behavior of the model

The dynamic behavior of the model mainly follows from one important feedback loop: the limits-to-growth template around the social housing. Due to numeric differences, the migration multiplier and limitations of the housing allocation factor (10% variation is realistic), the transformation loop overpowers the supply loop by far. The model shows typical s-shaped "short-term small benefit for long-term larger setback" behavior related to this structure (see simulation graph of the success ratio and the input transformation progrm). The delays constitute an important structuring element in the model and highly influence its behavior. The long delay before transformation leads to an increase in supply interacts with the piling up in the waiting list: the success ratio plunges. But cutting down the transformation program in order to improve the short-term mutation ratio brings a large long-term decrease in supply and therefore in the success ratio.

It is especially the impact of the delays which provided strong learning experiences for the client organizations.



The Ithink interface enables to switch on and off automatic reactions and to graph a response to the perceived mutation rate. This allows testing several policy lines for their impact on the mutation rate and the success rate, the two most important problem variables. A change in the perceived mutation rate (with a one-year information delay) leads to changes in the housing allocation system, transformation density and the share of social housing in new construction and one or two important delay times in the system.

Other possible feedback loops (e.g. success ratio influences the inflow or outflow of families on the waiting list, mutation ratio or success ratio determines the pace of the transformation program) were suggested but it was not possible to define them in terms of positive, negative or non-linear relationships. In other words, some feedback loops suggested by the facilitator did not exist on the mental map of the participants. In any case, no reliable quantitative data would have been available anyway. In several cases, a fixed time series of experts' guesses was used instead of feedback processes. Moreover, in the main simulations, we compared the effect of several combinations of construction and transformation programs without using the automatic pilot policy options altogether.

Follow-up of the project

Both SVH and SGH have adopted the simulation model with noticeable enthusiasm, once it worked and produced tangible and acceptable results and strategic insights.

As a follow-up to the project, SVH has organized two working conferences. During the first conference in March 2004, the model was presented to policy makers of the member corporations. This group was used as the control group for assessment of the effects of the group model building intervention (see below) and attended a plenary slide presentation plus a demonstration of model runs. They were also given the opportunity to work with the model as a flight simulator for about 15-30 minutes.

The second working conference in May 2004 was focused on the long term strategy of SVH members. The participants were mainly directors and senior managers of the member corporations. During this session, the new draft housing construction targets of the Ministry of Housing were simulated against a quick inventory of possible greenfield development locations. The participants of the second session were not part of the control group.

Meanwhile, SGH issued its annual housing and construction monitoring report, containing realization figures and an update of existing plans. The report was extended with a chapter on possible future scenarios based on the model simulations.

Both client organizations have brought their simulation experiences under the attention of their colleagues, i.e. other urban regions and housing associations. Currently, two new follow-up activities have been initiated.

As this paper was written only several months after project completion, no system changes have yet been implemented as a result of the modeling project.

Outcome: assessment of effects

The final report, which was discussed and approved by all project group members, is an important source for conclusions on the outcomes of this intervention. The acceptance of the simulation model has brought both parties to a consensus on how things work and what are the effects of policy interventions. An important conclusion is the recognition of the significant effects of delays in the entire system. The project group also acknowledges the short-term versus long-term trade-offs typical for complex systems, and calls for more attention for long term effects of policy interventions. The high-level causal linking together of variables is also mentioned as an important learning effect. From these statements, we may safely conclude that the project group has gained new insights in the behavior of this particular complex system. The final report also discusses several policy options. New construction and the migration multiplier have emerged as crucial, whereas the housing allocation system proved to have far smaller effect than expected. The effect of linking the pace of new construction and transformation, advocated by SVH and disputed by SGH, is now being seen as complex and a matter of personal or political judgement. Furthermore, the project has pointed out several terrae incognitae in data collection and the mental maps of the housing market. The report enumerates a number of issues worthy of further investigation.

The second source for assessment of the results and outcomes is the analysis of pre- and posttest questionnaires. Before and after the modeling project, participants filled out questionnaires containing number of closed and open format questions. These questions concerned evaluations of actions in the problem, an evaluation of outcome (the resulting model and recommendations), process aspects (e.g. openness of communication), process elements (e.g. the use of causal diagrams), and a comparison to regular meetings. In the following we first describe the conceptual model and measurement procedure and then describe results.

Conceptual model and measurement

Vennix, Akkermans and Rouwette (1996) describe the conceptual model we used for our evaluation. This framework links the impact of group model building on communication, learning and implementation of system changes. It is based on social-psychological theories on attitude change (Chaiken et al., 1989; Petty and Cacioppo, 1986) and the impact of attitudes on behavior (Ajzen, 1991). Its use for evaluation of group model building is its explicit description of effective elements in the intervention and the relations between different goals. Vennix, Akkermans and Rouwette (1996), Rouwette and Vennix (2003) and Rouwette (2001; 2003) provide a more elaborate treatment, but a couple of examples will hopefully clarify the conceptual model's contribution to evaluation. The model specifies that in order to change a participant's beliefs, two conditions need to be satisfied: 1. persuasive arguments for a change of position need to be presented, and 2. the participant needs to be motivated and able to process this information. The arguments generated in a group model building session will be dealt with in the following. Participants can be expected to be motivated to process information if the issue is important to them. Group model building increases participants' ability to process information, e.g. by addressing terminology differences and by providing a clear link between ideas by incorporating them in a model.

Beliefs form the basis for three central concepts in Ajzen's (1991) theory of planned behavior: attitude toward behavior, subjective norm and perceived behavioral control. Attitude, subjective norm and perceived control will be referred to as 'evaluations' for simplicity. The attitude toward behavior reflects the degree to which a person has a favorable or unfavorable appraisal of a behavior. The subjective norm is an assessment of the extent to which important referents approve or disapprove of forming a behavior. A person's perception of the ability of performing a behavior is captured by perceived behavioral control. The three factors jointly determine the intention to engage in a behavior. E.g. the intention to implement pollution reduction measures is increased if attitude towards pollution prevention, subjective norms about environmental regulation or perceived control over source reduction activities grows stronger (cf. Cordano and Frieze, 2000). Intention and perceived control determine actual behavior: the more a person intends to and thinks he is able to perform an action, the greater the likelihood that he will perform the action. The concepts in the figure above may seem unfamiliar at first sight. However, most concepts bear a strong resemblance to variables that are more common in the strategy or decision making literature. Intention closely resembles commitment to a course of action. Behavior is the counterpart of implementation or system changes on an individual level.

According to the conceptual model, beliefs are strongly related to evaluations. A person's attitude is formed on the basis of two sets of beliefs. The first is the *value* placed on outcomes of this action. The second set of beliefs concerns the *expected likelihood* that the action brings about this outcome. Consider for example the action 'labeling 50% of new supply of houses for people moving within the region'. A possible outcome of this action is an increase in the satisfaction of clients. Let us suppose that a manager of a housing association positively values this outcome. Considering only this action (labeling new supply of houses), the chance that the valued outcome will be realized is the expected likelihood that labeling leads to more satisfaction of clients. If either satisfaction of clients is valued more, or the relation between labeling and satisfaction of clients grows stronger, we expect the attitude to become more positive. In other words, values and expectancies combine to form evaluations. Fishbein and Ajzen (1975) propose to sum expectancy times value products over all beliefs.

In the questionnaire employed for this case, we measured the concepts discussed above as follows. In the pretest interview each respondent was asked to identify three relevant actions with regard to the problem to be modeled. This question prompted actions such as delay the construction of new houses, less labeling for starters on the market, increase the quality of housing stock and focus more on planning.
Subsequently for all actions the following variables were assessed: intentions, the attitude towards action, subjective norm and perceived behavioral. Each concept was measured using one or two five point Likert items. Attitude toward actions was assessed by asking 'Implementing action 1 within the coming two years is' ve*ry unfavorable* – *very favorable* and *very good* – *very bad*. Beliefs were measured in three steps. First, respondents were asked to identify three important expectancies (i.e. outcomes, referents and threats or opportunities). Second, the value of the outcomes was assessed, for example how important an increase in satisfaction of clients would be. This could be scored on a scale from 1 (very unimportant) to 5 (very important). In the third step the strength of each expectancy was measured, for example the degree to which labeling leads to an increase in client satisfaction. This could be scored from –5 (e.g. decreases outcome strongly) to 5 (contributes very much to outcome).

With regard to process, we formulated two requirements in the above. Participants will change their beliefs if they receive information (persuasive arguments) and are inclined to consider this information (able and motivated to process). If over the course of the sessions persuasive arguments relating to these actions were discovered, we can expect beliefs and evaluations about these actions to change. An example is when a participant received new information on labeling for new starters. Before the sessions, he was convinced that labeling for new starters had a large effect on the success ratio. During the sessions, several arguments to the contrary were presented and discussed. Since modeling allows this new piece of information to be fitted in with other data, the new and existing knowledge can readily be integrated. In this example, a more negative outcome of labeling has been introduced, leading us to expect a more negative attitude on labeling. Rouwette and Vennix (2003) report additional information on the questionnaire employed and scaling reliabilities.

A last remark is on the subjects involved in the evaluation. Five out of seven participants in the group model building sessions filled out the evaluations. One subject filled out questions on the Ajzen model for only two actions, which means that we have a total of 15 measurements for people that directly participated in the construction of the model. In addition, the model was used as a flight simulator on a study day for representatives of organisations responsible for housing policies in the Haaglanden region. Participants in the study day on March 11 attended a 45 minute presentation on the model and a plenary presentation of model runs. About half of the participants in the study day used the flight simulator individually for 15 to 30 minutes. The study group completed pretest and posttest questionnaires similar to the forms filled out by the participants in the group model building sessions. Thus there are two groups that can be compared: a group that used the model as a flight simulator for about two hours and b. the group that participated about 35 hours in constructing the model.

The questionnaires differed with regard to five points. 1. The quesionnaire for the GMB participants asked for three options, while the form for the group in the study day asked for two options. 2. The GMB participants were free to define strategic options, while in the study day the researcher defined strategic options, as by this time the main implications of the model were known. 3. The GMB questionnaire asked for three outcomes, three referents and three control items, while in the second questionnaire this was seven six and six respectively. 4. For measuring the strength of expectancies, the GMB questionnaire employed an 11 point Likert scale while for the study day questionnaire a five point Likert scale was used. 5. The GMB questionnaire contains questions on argument quality, process aspects and elements which are not addressed in the study day measurement. Both questionnaires do address intentions and evaluations and a comparison to traditional meetings.

In the following section we address the results of the evaluation. We do not address behavior since the evaluation was completed immediately after the project, which is too early to expect an implementation of conclusions. We first go into the differences between group model building and the study group with regard to a. the variables in Ajzen's theory and discuss evaluations (attitude, subjective norm and perceived control) and beliefs, and b. the comparison to regular meetings. In the second part of the results, we address the measurements for the group model building participants on a. argument quality, and b. process aspects and elements.

Evaluations and beliefs

As discussed above, we expect the change in evaluations and beliefs to be larger in the group model building group than in the study group. In total there are four conditions, in a two (group model building versus study day) by two (positive arguments versus negative arguments) design. Mean scores and number of measurements of evaluations in each condition are as follows.

Positive arguments		pretest	posttest	n
GMB	Attitude	4,3	4,2	10
	Norm	3,7	3,9	10
	Control	2,4	2,4	10
Study day	Attitude	4,5	4,5	18
	Norm	4	4	18
	Control	3,5	3	18
Negative arguments		pretest	posttest	n
GMB	Attitude	4,5	4,5	1
	Norm	4	4	1
	Control	3,5	3	1
Study day	Attitude	3,24	3,2	17
	Norm	3,29	3,15	17
	Control	3,15	3,33	17

Table 1. Participants' scores on evaluations and beliefs

A regression analysis was performed using the pretest score, group and type of argument as independent variables. Results are shown in the following table.

	beta	significance	Explained variance
Attitude	.439	.002	.622
Subjective norm	.309	.015	.581
Perceived control	-.096	.474	.389
Outcome beliefs	.099	.472	.479
Normative beliefs	.078	.527	.633
Control beliefs	-.203	.463	.266

Table 2. Regression of posttest score on pretest score, group and type of argument

As the table shows, group membership only has a significant effect (at the .05 level) on attitude and subjective norm. For perceived control and all beliefs, changes are not significant.

Comparison to regular meetings

In the last section of the questionnaire, participants were asked to compare the modeling sessions to regular meetings. An example is 'If you compare these sessions, using different techniques, with regular meetings in which you discuss similar matters, would you say the sessions result in more insight?' These questions could again be answered on a scale from 1 (strongly disagree) to 5 (strongly agree). Means and standard deviations for participants in group model building and the study day are as follows.

	Project group	Control group	significance
More insight	4.00 (.71) n=5	3.78 (.55) n=18	.54, ns
Faster insight	3.40 (1.34) n=5	3.72 (.58) n=18	.63, ns
Better communication	3.80 (.45) n=5	3.41 (.94) n=17	.22, ns
Faster alignment of mental models	4.00 (.71) n=5	3.89 (.47) n=18	.75, ns
Better alignment of mental models	3.40 (.89) n=5	3.39 (.70) n=18	.98, ns
Faster commitment	3.40 (.89) n=5	3.56 (.62) n=18	.73, ns
More commitment	3.67 (.58) n=3	3.44 (.71) n=18	.59, ns

Table 3. Mean (SD) and n for participants' opinion on quality of sessions compared to regular meetings, and significance of difference scores

With regard to the results for the group model building participants, two outcomes are similar to other modeling cases reported by Vennix and Rouwette (2000). First, the highest scores are obtained for increased insight. Second, the questions on the 'speed' of obtaining an effect mostly score lower than the 'size' of the effect (e.g. more commitment scores higher than faster commitment). This pattern is not found in this case with regard to alignment.

As the table shows, the differences between both groups are not significant.

Argument quality

Argument quality is measured using 10 Likert items, which could be scored from 1 (strongly disagree) to 5 (strongly agree). An example is 'In the meetings all relevant risks were discussed'. The following table shows the results for all dimensions of outcome quality.

	Mean	SD	Minimum	Maximum	n
options	3.67	.82	2	4	6
goals	4.00	0	4	4	6
values	4.00	.63	3	5	6
costs	-	-	-	-	0
risks	3.17	1.17	2	5	6
information gathered	4.00	.63	3	5	6
information integrated	4.17	.41	4	5	6
consequences	3.50	1.05	2	5	6
conditions	3.67	1.03	2	5	6
contingencies	3.00	.89	2	4	6

Table 4. Participants' opinion on dimensions of outcome quality

The participants felt the item on costs did not apply to this modeling project as financial aspects were not discussed. It seems participants feel that all information for judging policy options was integrated, information gathering was adequate and important goals and values were considered. To a lesser extent people also feel that the discussion covered important options in the policy problem, consequences of options and contextual conditions. The items on risks (in the modeling project all risks were covered) and contingencies score around neutral.

Process aspects and elements

The following table shows the results for all aspects of process quality. Scores ranged from 1 (strongly disagree) to 5 (strongly agree).

	Mean	SD	n
Open communication	4.67	.52	6
Clear and comprehensible communication	3.50	.84	6
Everybody had a chance to voice their opinion	4.33	.52	6
Ample opportunity to raise issues about which opinions diverged	4.00	-	6
A focussed approach	3.17	.98	6
Attention to each others' ideas	4.00	1.10	6
Some participants dominated discussions	2.17	1.00	6
High time pressure	2.17	1.00	6
The project was efficient	3.00	1.00	5
The project was successful	4.17	.75	6

Table 5. Participants' opinion on dimensions of process quality

Apart from the items on focused approach and efficiency, process aspects score satisfactorily. The efficiency of the approach scores around neutral and participants seem to feel that the project could have completed in less than ten meetings. All in all, participants feel the modeling project was successful.

A further question is how the separate elements of the project are evaluated. The following table shows the results for the various session elements. Answers could be scored from –5 (obstructed the sessions) to 5 (contributed very much to the sessions).

	Mean	SD	n
Projection of diagrams	4.50	.84	6
Presence of a group facilitator	4.83	.41	6
Opportunity for discussion	4.33	1.21	6
Use of causal loop diagrams	4.50	.84	6
Computer model simulations	4.67	.82	6
Data analysis	4.17	.98	6
Same group	5.00	-	1
Repetition	-2.00	-	1
Beer game	.50	.50	2
Differences between members	5.00	-	1

Table 6. Participants' opinion on modeling elements

From the table it appears that projection of diagrams (the group memory), the presence of the facilitator, opportunity for discussion, use of causal loop diagrams score rather high. The projection of diagrams, the use of causal loop diagrams and the facilitator contribute most to the overall effect of the sessions. One or two respondents added several new elements. The fact that the group did not change over the course of the sessions and consisted of people with different backgrounds is evaluated positively. Repetition in the discussion and the Beer game are score negative and neutral, respectively.

Conclusions & discussion

This model building project has produced several interesting and very concrete results.

First of all, its background setting and its mere existence indicate a shift in the basic conception of urban renewal policy in the Netherlands. Whereas 1970's urban renewal was focused on technical improvement of the housing stock, the 1990-2000 programs emphasize balancing of the urban population and housing mix in order to improve urban socio-economic vitality. An argument could be made that Dutch urban transformation policies shifted towards an approach more comparable to the findings of Urban Dynamics (Forester, 1969). Nevertheless, current policies are still focusing on improving the housing mix and not on replacing run down housing by starting business as Forester recommended. Furthermore, it is doubtful that system dynamics has played any role in this shift of policy objectives.

Secondly, the group model building intervention has helped both client organizations in settling a highly contentious issue, i.e. finding effective policy responses to counterintuitive behavior of the housing market. The project documentation clearly states several important learning aspects of the behavior of the underlying complex system, e.g. the impact of delays, the accumulation on the waiting list and the effectiveness of several alternative policy options. The group model building intervention was well targeted at the strategic question of the client organizations. The resulting model demonstrates the dynamic behavior associated to its feedback and stock & flow structure. Several findings are counterintuitive in relation to existing policy insights, but were scrutinized and finally accepted by the project group as correct. Both client organizations have organized follow-up activities very soon after project completion, which is an indication for client commitment and practical applicability of the model.

Thirdly, the group model building intervention was very rigorously evaluated on basis of the method developed by Rouwette (2004). Effectiveness assessment is not yet daily practice in system dynamics modeling. Moreover, a control group was introduced as an addition to the existing methodology. The general evaluation of the Haaglanden project indicates that both the project group and the control group think that the simulation model is more effective than regular meetings. The specific Ajzen evaluation demonstrates that system dynamics modeling has most impact on the perceived efficiency of policy options when people intensively participate in a group model building project.

It would be easy to indicate several feedback loops and sectors present in other housing models that are lacking in this model. The same applies for the complexity level of feedback in the model. There are only two second order and two first order feedback loops. Nevertheless, other modeling projects in a client setting (e.g. Jones et al, 2004) also indicate that system dynamics modeling is most effective when closely connected to the mental models of real clients coping with real strategic problems. The clients' main learning effect may be in the stock & flow character and the related delays. The Haaglanden project apparently confirms that thought.

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