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Simulating the urban transformation process in the Haaglanden region, the Netherlands

Paper presented at International System Dynamics Conference 2004, Oxford, UK
Updated version submitted to System Dynamics Review, 2007

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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This paper describes a recent modeling project on the dynamics of new housing construction, transformation of outdated dwellings and the impact of both processes on a regional social housing market.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 a couple of 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.

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 building and renovating (low cost) housing in the urban region around The Hague in the Netherlands. 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 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 development and technical reconstruction of dwellings, changing the urban social structure is now an explicit goal of urban development programs. Another important change occurred in 1988 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 government and responsible for their financial continuity. Vennix (1996) describes the role of system dynamics in understanding the new strategic issues for housing associations in more detail.

However, the intended 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 many existing linear housing market prognosis models predicted a relaxation of the housing market, pressure increased: both on the social housing market and on 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 for are faced with a declining success ratio (new supply of social houses divided by the number of applicants waiting). On the long term, new construction both from greenfield development and from transformation causes migration chains, 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.

Municipalities and housing corporations to a large extent agree on the necessity of new construction and urban transformation for urban socio-economic vitality. They part 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. Many municipalities are bound by contracts with the national government on new housing construction volume and are eager to improve the housing mix especially in the city centers. They are not inclined to allow delays in transformation programs. Housing corporations are sensitive to the decreasing success ratio 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. Housing corporations are therefore in favor of alternative policy options, such as altering the housing allocation system or linking the pace of construction and transformation.

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 issues in a multi-party setting and made group model building into an instrument 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 enthusiasm, curiosity and some 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. In addition to the director of SVH, the team consisted of two senior officials (one from SVH and one 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:

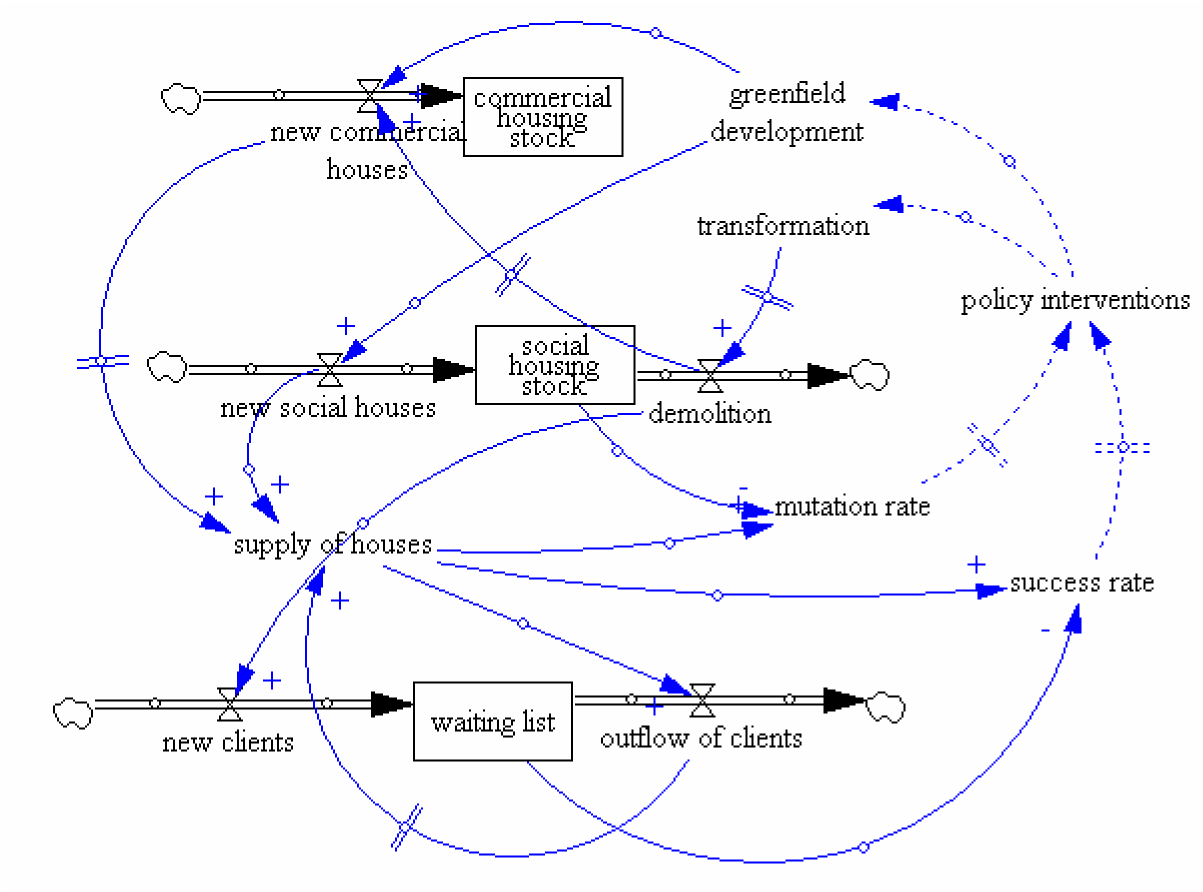
- start: startup and definition of causal relations;
- model construction: data collection, quantitative modeling and model validation;
- simulation: comparing the effects of policy options against the base run;
- evaluation: interviews and formulation of conclusions.

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 as follows. There are three main stocks in the model: a stock of commercial housing, social housing and the number of people on the waiting list for social dwellings. New construction results in supply of social houses, either directly or indirectly (in the case of commercial construction). Transformation decreases the social stock on the short term and increases both housing stocks on the long term. New clients flow into the waiting list both autonomously and as a result of transformation. Clients leave the waiting list as long as social houses are available. Both problem variables, the mutation rate and the success rate, lead to policy interventions with regard to the volumes of greenfield construction and transformation. Both the perception and the effect of the interventions are delayed.



The dynamic behavior of the model mainly follows from one important feedback loop. 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. The Ithink interface enables to switch on and of these 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.

Other possible feedback loops (e.g. success ratio influences the inflow or outflow of clients, mutation 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. Delays, however, 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 of new housing clients: 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. The model shows "short-term small benefit for long-term larger setback" behavior.

Follow-up of the project

Both SVH and SGH have adopted the simulation model with noticeable enthusiasm. SVH has organized a conference in which the model will be shown to representatives of its member organizations. SHG is interested in using the model in combination with a monitoring system for new housing construction. Both parties intend to implement the conclusions of the project in future policies. As this paper, was written only six weeks after presentation of the final report, implementation of system changes on their effect on system performance cannot be estimated yet.

Outcome: assessment of effects

The final report, which is recently 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

The conceptual model we used for our evaluation is described by Vennix, Akkermans and Rouwette (1996). 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.
Scale reliabilities and additional information on the questionnaire employed is reported by Rouwette and Vennix (2003).

A last remark is on the subjects involved in the evaluation. Five out of seven participants in the project filled out the evaluations. One subject filled out questions on the Ajzen model for only two actions, which means that for attitude, subjective norm and control we have a total of 15 measurements. In the following section we will address the results of the evaluation. We will not address behavior since the evaluation was completed immediately after the project, which is too early to expect an implementation of conclusions already. We will first go into the variables in Ajzen's theory and discuss intention, evaluations (attitude, subjective norm and perceived control) and beliefs for each evaluation. Subsequently we will address process evaluations.

Intention and evaluations

Evaluation results with regard to intentions and evaluations are not reported at this stage as the data from the strategic workshop are not yet analyzed. Results of the process evaluations are reported.

Outcome quality

Outcome 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.

Evaluation results with regard to outcome quality are not reported at this stage as the data from the strategic workshop are not yet analyzed. Results of the process evaluations are reported.

	N	Minimum	Maximum	Mean	SD
all relevant options					
all relevant goals					
all relevant values					
all relevant costs					
all relevant risks					
all relevant information for weighing options					
all relevant information is integrated					
all positive and negative consequences					
all relevant conditions					
all relevant contingencies					

Table 1. Participants' opinion on dimensions of outcome quality

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	1,67	0,47	6
Every member could promote his of her point of view	1,33	0,47	6
Generally, the modeling project was successful	1,17	0,69	6
Sufficient opportunity to discuss contentious issues	1,17	0,37	6
Attention for each others ideas and opinions	1,00	1,00	6
Clear and comprehensible communication	0,67	0,94	6
Business-like and direct approach	0,33	0,94	6
Efficient problem approach	0,00	0,89	5
High time pressure	-0,67	0,75	6
Domination of discussion by single individuals	-0,83	0,90	6

Table 2. Participants' opinion on dimensions of process quality

In general, process aspects score satisfactorily. What is striking, is the high variation of scores on time pressure. All participants feel the modeling project was successful, and on average that the approach is efficient.

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
Presence of a group facilitator	4,83	0,37	6
Computer model simulations	4,67	0,75	6
Presenting and projecting of causal diagrams	4,50	0,76	6
Use of causal diagrams	4,50	0,76	6
Opportunity for discussion	4,33	1,11	6
Data analysis	4,17	0,90	6
Same group	5,00	-	1
Repetition	-2,00	-	1
Beer Game	0,50	0,50	2
Differences between members	5,00	-	1

Table 3. Participants' opinion on modeling elements

From the table it appears that all elements score rather high. The projection of diagrams (the group memory) and facilitator contributed most to the overall effect of the sessions. Parameter estimation receives the lowest score.

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 -2 (strongly disagree) to +2 (strongly agree).

	Mean	SD	n
Faster alignment of mental models	1,17	0,37	6
More insight	1,00	0,58	6
Faster insight	0,67	0,94	6
Better alignment of mental models	0,67	0,47	6
More commitment	0,60	0,49	5
Better communication	0,50	0,50	6

Faster commitment	0,50	0,50	6

Table 4. Participants' opinion on quality of sessions compared to regular meetings

All scores are above neutral, indicating that modeling sessions indeed are more effective on these aspects than regular meetings. 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 on average score lower than the 'size' of the effect (e.g. more commitment scores higher than faster commitment). This is comparable to the data on overall success and efficiency, in that the former also scores higher than the latter.

Conclusions & discussion

The model building project, conducted by a relatively inexperienced modeler/facilitator has nevertheless produced visible results. The intervention, focused on bringing together the two parties by means of group model building, has helped the project group in better understanding the complex system they are dealing with. Critical analysis of the model may point out the lack of feedback loops as a weak point, but this argument may be countered by pointing at the learning effect about the importance of delays. If feedback loops are the bricks, delays are the mortar of system dynamics.

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