Learning by Doing:
Towards the Development of a Group Model Building Framework

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I. Abstract

Group model building is nascent the latest years. However, only few educational institutions offer professional education and research in the field. Furthermore, detailed empirical literature about group model building is rather rare. Hence, this paper will serve two purposes connected to group model building.

First, it will document and critically reflect upon a group model session and derive lessons learned. Second, it will create a group model building framework that is, on the one hand, based on existing streams of research and, on the other hand, integrates new elements derived from the lessons of the performed group model building session. The result is a framework that includes context and stakeholder analysis as basic preparation tools for a group model building project. In the more modeling session oriented stages, the approaches of Vennix and Andersen et al. are integrated. The paper contributes to increase the publicly available documentations about group model building sessions and provides a more comprehensive framework for the conductions of GMB-sessions.

Keywords: Group Model Building, Framework, Scripts, Theory Integration

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1. Introduction

The application of group model building (GMB) has increased in the recent years (Andersen, Richardson, and Vennix 1997). However in formal System Dynamics education, this approach is not often professionally taught. Group model building research in System Dynamics is attributed to only two institutions: The Radboud University and the University of Albany. A literature review puts forward that only few detailed descriptions of GMB applications exist. Hence, a substantial gap between the importance of the group model building approach in practice and the offerings in education is evident. In this paper, I will provide empirical data and methodological improvements about the group model building approach. Thus, the article contributes to close the identified gap.
The purpose of this paper is twofold: First, to document a performed group model building session at the University of Berne and reflect about it in order to carve out weaknesses and derive lessons learned. Second, I will develop a group model building framework which integrates existing group model building approaches and enlarges their scope by assimilating the lessons learned.

In the following, a brief description of a current research project is provided since the information is needed to better comprehend the context and the content of the described group model building session. The project ‘Diffusion Dynamics of Energy-Efficient Buildings (DeeB)’ aims at analyzing and accelerating managerial and organizational adaptation processes that foster the diffusion of pioneering energy efficient technologies in the building sector. Psychological, managerial, and economic theories as well as the results of empirical investigations about antecedents of behavior choices will be synthesized into a simulation model. The model will shed light on dynamic interactions between behavioral factors (e.g., planning, decision making and routines of the relevant actors in the building sector) and contextual factors (e.g., technological innovations, public initiatives, and market conditions), thus explaining the diffusion of energy efficient buildings in a community (Kaufmann-Hayoz, Bruppacher, and Ulli-Beer 2005; Ulli-Beer et al. 2006). For the ‘DeeB’-project, five different workshops are planned. However, only one of them will be a real group model building workshop. The others are convened to elicit mental constructs, to establish common understanding among the participants, to foster their networking activities and to present the results of the research. Table 1 shows the planned meetings with the project participants.

No.	Content of Meetings	Type	Time Period
1	Individual Cognitive Mapping Interview	Interview	Feb. 06 - Jul 06
2	Consolidation of the System Expert Group	Actor Analysis	March 06
3	Feedback and Elaboration of Concepts Model	GMB	Nov 06
4	Elaboration and Feedback about Dynamic Model, Needs and Questions for Transformation Support Tool	Model Assessment and Policy Design	Oct 07
5	Introduction into Transformation Support Tool	Monitoring of Key Performance Indicators	Sept 08

Table 1: Planned Meetings with Project Participants

After having sketched the research project, the outline of the paper will be described in the following. In Chapter 2, a literature review about GMB is conducted carving out existing threads in GMB. Chapter 3 is dedicated to the description of a performed group model building session. Results as well as possible improvements of the workshop design and planning will be shown. Chapter 4 concentrates on the elaboration of a more comprehensive group model building framework structured in the four parts: Context and shareholder analysis, pre-meeting activities, meeting activities, and follow-up activities.

2. Literature Review about Group Model Building Streams

In the following, literature especially about Group Model Building shall be reviewed. Zagonel has performed an extensive literature review about modeling approaches in general and identified five major streams: Classic System Dynamics, direct System Dynamics modeling with clients, decision conferencing, System Dynamics used in decision conferencing, and Group Model Building (Zagonel do Santos 2002). I will concentrate distinctively on the last stream about Group Modeling Building. Research about this group model building with System Dynamics is pushed forward mainly by two institutions: the System Dynamics Group at the Rockefeller College of Public Affairs and Policy, University of Albany[2] and the Methodology Department at the Nijmegen School of Management, Radboud University, Nijmegen[3]. The content of the approaches are distinct to a certain degree what enriches the concept of group model building, particularly because both approaches can be integrated in a useful manner (cf. Chapter 4.4). The characteristics of both approaches will be described after the main objectives of GMB have been explained.

Objectives of Group Model Building

One objective of the GMB approach, which has been specified at the individual level, is learning, i.e., the improvement of mental models (Andersen, Richardson, and Vennix 1997); particularly helping the participants to gain more insights about the structure and behavior of a system. A second objective of GMB is to cause a change of attitude towards a proposed policy (Vennix 1996).

Vennix's Approach as Start-Up Framework

Vennix defines a group model building process as an initiative to support a decision making group in structuring a messy problem and designing effective policies to deal with it (Vennix 1996). **Error! Reference source not found.** shows what Vennix calls the alignment of mental models. It is one of the key processes and results of group model building. Vennix provides a useful start-up framework about the group model building approach and addresses important questions about the principal setup of a GMB conference, for instance, if System Dynamics is an adequate method for the ill-defined situation; further, if qualitative or quantitative System Dynamics should be used, and if a preliminary model should be employed in the first modeling session. Figure 1 shows Vennix's setup framework, developed in his book 'Group Model Building (1996)', as a decision process diagram. In Chapter 4, I will elaborate upon the dimensions created by Vennix and adapt them to the group model building session for the 'DeeB'-project. I will also keep the style of a decision process diagram its applicability during research projects.

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[2] http://www.albany.edu/rockefeller/pad/index.htm

[3] http://www.ru.nl/fm/

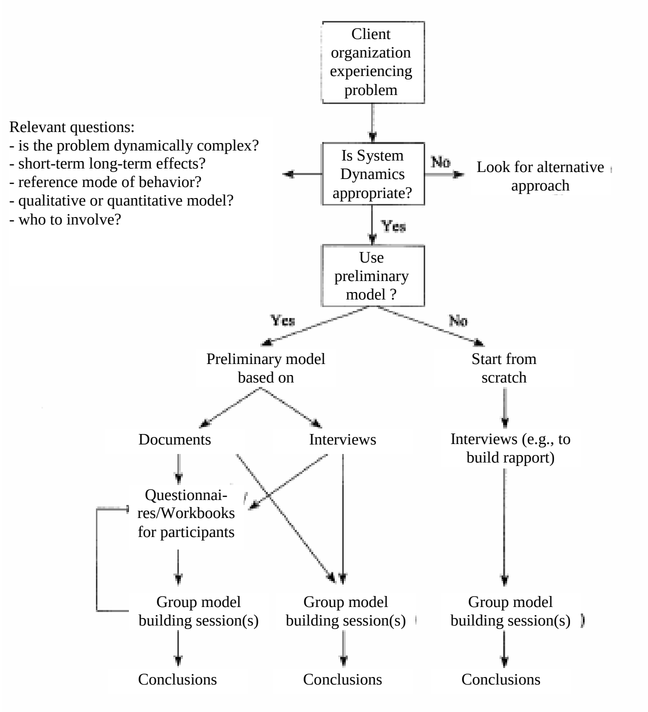

Figure 1: Group Model Building Framework (Vennix 1996)

Andersen's and Richardson's Approach as Process Detailing

Andersen et al. provide a second and distinct approach to GMB: They created handy concepts for the conduction of a group modeling session which they call 'scripts'. "Scripts are fairly sophisticated pieces of small group processes which are employed by modelers engaged in group modeling processes" (Andersen and Richardson 1997). The process of building models in a group session is a sequence of small-group activities defined by scripts resulting in partial products like a stakeholder analysis, a precise problem description, and a first sketch of the model structure or influential determinants of the system. The goal of Andersen et al. is to create a catalogue of validated, often tested and applied scripts that support high-quality client-centered System Dynamics modeling. The whole GMB process can be divided reasonably in three stages: Pre-meeting activities, meeting activities, and follow-up activities (Andersen, Richardson, and Vennix 1997).

Andersen et al. provide a catalogue of basic components for theses three stages. The developed scripts apply to the pre-meeting and meeting stage and can be further divided in four substages: Planning for group model building conference (Planning), scheduling the day (Scheduling), scripts for group model building tasks (GMB-tasks), and closing a group model building conference (Closing) (Andersen and Richardson 1997). Table 2 gives an overview of their developed scripts.

Substages	Name of Script Group	Brief Description of Script Group Content
Planning	Goal setting/managing the scope of work	Ascertain gatekeeper, select appropriate people for the workshop, and clarify final products.
Planning	Logistics	Room layout should establish positive group dynamics, white board setting for model elicitation, computer setup, roles in the room are facilitator, modeler, process coach, recorder and gatekeeper.
Planning	Types of group task structure	Types of group structure (individual, small-group, plenary) and group task (divergent, integrative, ranking and evaluation) are keys to successful modeling.

Scheduling	Guiding principles for the day plan	Ice-breaking exercises at the beginning, break task or group structure several times each hour, start actively in the first 20 min, choose and maintain iconography, maintain visual simplicity, avoid one-to-many messages for more than a few min., reflect after each major piece of work, decide on the position to write the information, end the day with modeler reflection.
Scheduling	Clarifying expectations and products	Clarify expectations, introduce System Dynamics, show concept model, clarify final products
GMB-tasks	Scripts for defining the problem	Sketch reference mode over time of problematic and preferred behavior, use complete the graph-exercise, group consensus oriented phase, define the purpose and system boundary, elicit and rank policy levers.
GMB-tasks	Scripts for conceptualizing the model structure	Top-down approach, start with sectors, detail sectors, sketch in key stock- and flow structure, variable naming.
GMB-tasks	Scripts for eliciting feedback structure	Direct feedback loop elicitation, begin with a central variable, story telling about the system by means of 'two key level approach' or system archetype templates, black box means-end diagram to elicit ranked lists of policy variables.
GMB-tasks	Scripts supporting equation writing and parameterization	Data estimation by participants, refine the model by 'walk-through', use parking lots for ambiguous terms.
GMB-tasks	Scripts for policy development (but not testing!)	Elicit policy stories by using white- and black box method, create a policy-key system flow matrix and discuss significant differences, complete the graph exercise in subgroups, sketch important key indicators for a given policy, reflections about policy implications.
Closing	Scripts for ending with a bang	Provide overview of the model developed, depicting from sectors to details, provide participants with 'structural chunks'.

Table 2: Stages and Existing Scripts for a Group Model Building Conference (Andersen and Richardson 1997)

Applications of the Group Model Building Method (Zagonel!)

Even though Andersen et al. state that the application of group model building has become increasingly common in the field of system dynamics (Andersen and Richardson 1997), a review of System Dynamics related literature puts forward that only a few GMB applications are published that particularly concentrate on and state the process of group model building rather than the result (Andersen and Richardson 1997; Luna-Reyes et al. 2004; Morecroft and Sterman 1994; Richardson and Andersen 1995). To conclude, there are only few elaborations showing in detail the application of the GMB approach. This paper will contribute to provide guidance in setting up a GMB project by discussions about relevant decisions.

After having showed two major threads in the field of group model building, I will in the following, first, report about a group model building session, which took place during an introductory class in System Dynamics in October 2005 at the University of Berne/Switzerland. Main results of the session and major insights from a methodological reflection about it will be provided. And second, these insights will be used to elaborate upon the existing works in the domain of GMB research in order to create a more comprehensive and practically relevant framework.

3. Realization of a Group Model Building Project at the University of Berne and Lessons Learned

The group model building session was held at the end of a one week introductory class in System Dynamics at the University of Berne/Switzerland. The group consisted of 14 participants. The session lasted for five hours and the modeling team consisted of one facilitator, one modeler and one reflector. In the following, the five steps of the modeling workshop will be described.

3.1 Steps of the Group Modeling Workshop

Problem Formulation

The following ‘problem statement’ was handed out to the participants at the beginning of the modeling workshop (Figure 2):

> *Changes in managerial decision rules and action strategies are high leverage points for accelerating the diffusion process of energy-efficient buildings. However, the transformation process is slow due to inefficient managerial learning processes, in particular due to a lack of double-loop learning. Adaptation or modification delays result in policy resistance and in path dependency. An efficient technologically induced transformation process requires changes in cognitive structures and mental models of the relevant actors in the pertinent value creation chain.*

Figure 2: Original Problem Statement and Context for the Modeling Workshop

The problem description poses the question of how the diffusion process of energy-efficient building standards (especially the Swiss Standard called ‘Minergie®’) can be understood and managed in order to accelerate the adoption process (Groesser 2006b). With this objective being stated, the project aims at analyzing managerial and organizational adaptation processes of the relevant actors. Thus, the next step in the research project is to identify relevant actors and stakeholders via a stakeholder analysis.

Identification of Relevant Stakeholder and Actors, Respectively

Starting from the problem formulation, the participants were asked to identify key stakeholders who are active in the system ‘building environment’ at the moment. The used method was individual brainstorming. Every participant was expected to come up with three to four relevant stakeholders of the observed system. Figure 3 shows a cluster diagram of the relevant stakeholders.

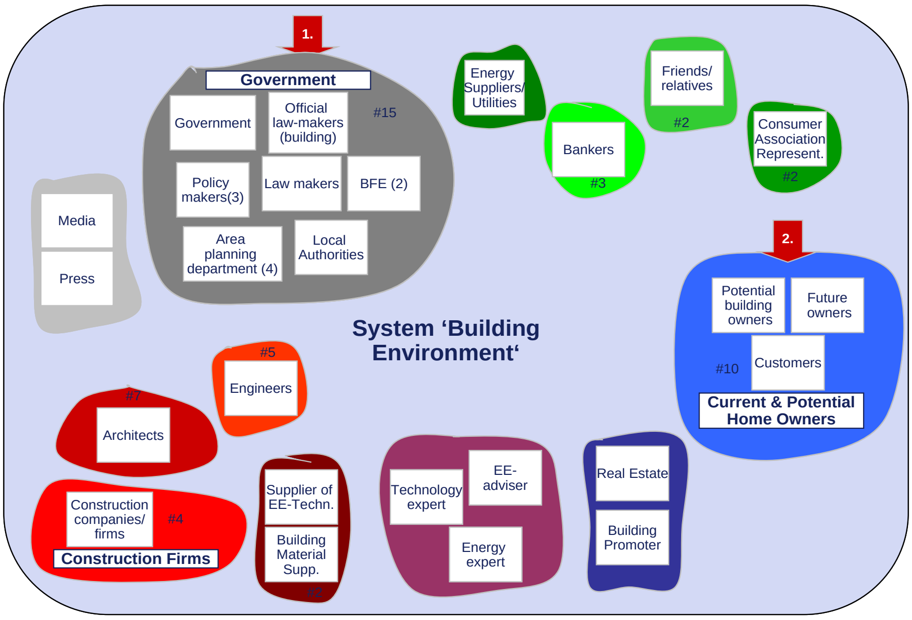

Figure 3: Important Stakeholders of the Building Environment (Modeling Workshop at Berne)

As can be seen in Figure 3, manifold statements as well as statements with related meanings were clustered together and their quantity was counted. The cluster ‘government’ was considered most often and it appears that it is a major actor in the field. The cluster ‘government’ has attributes such as law-making legitimacy, area planning tasks, and a role as overall energy sentinel. This is comprehensible given the participants’ everyday experience with the government and its commitment to foster energy-efficient technologies (BFE 2001). Moreover, the government uses the Minergie Standard as its most effective and relevant instrument in order to achieved its climate politics objectives (Groesser 2006b).
The second most frequent named group is the potential, future or current home owners. Obviously, this group decides at the end whether or not a new house or the refurbishment of an existing home, respectively, is completed according to a Swiss energy-efficient building standard that is higher than the requisite standard defined by federal laws.
After the second cluster defined the demand side of the building market, the third cluster contains actors of the supply side. Architects plan houses from the very first ideas and visions of future home owners. Engineers are consulted in order to calculate both the static requirements of the new construction and, becoming more important these days, provide documented evidence of conformity with existing energy-efficient measures. Construction firms create the physical assets according to the accepted and approved construction plans. Supplier of energy-efficient building material and technology provide required building matter.
The fourth cluster has a counseling function and is especially relevant in the first stage of a construction project. Experts of this cluster consult the potential home owner in selecting technology and using the selected technology in an energy-efficient way.
The fifth cluster consists of real estate companies and building promoters. It functions as a trend maker in favor of house ownership instead of house leasing. The participants of the modeling workshop did not consider this group very relevant. In the last group, entities such as banks, friends, utilities and consumer associations are clustered together. The participants thought about this group mainly as supportive elements, e.g., with moral, financial, and legal support. After that the participants agreed upon Figure 4 as a first summary. The next step was to elicit relevant policy variables.

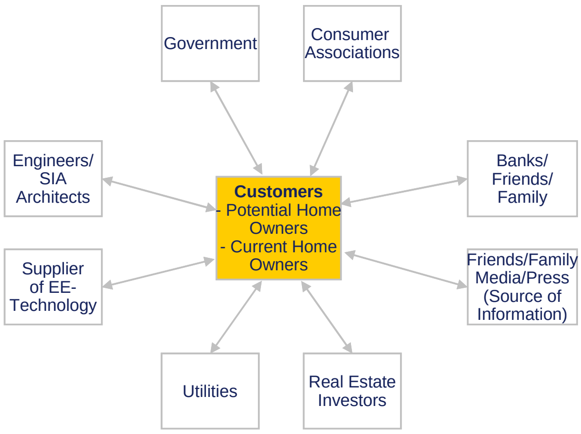

Figure 4: Summarized Stakeholder and Actor Analysis of the Building Environment

Elicitation of Policy Variables

The task for the participants was to individually brainstorm three to four policy variables. Policy variables are variables in a system which have the characteristics to be externally influenceable by certain actors and which can change system’s behavior significantly. Related to the research interest, the question can be posed “What are important levers that help you realize an energy-efficient building?” The participants where asked to answer the question on basis of the current situation in Switzerland. Figure 5 shows the resulting cluster diagram.

Rank	1	2	3	4	5	6
Participants Statements clustered according to semantics	Information (targeted at lifestyle changes)	Increased oil/gas taxes	Regulations	Subsidies EE-Technology	Land and how to build house	Price of Minergie House
	Information about benefits	Price of energy	Laws /regulations	Subsidies	Area finding facilitation	
	Spread of knowledge of eeB	Taxes	Building regulations	Financial supports		
	Comparative calculations trad vs. ee	Increase in energy price	regulations	Financial support to build eeB		
	Information campaign	Taxes on energy-consumption	Regulations on EE-required	Adjust taxes energy price		
	Knowledge of Architects					
	Provide compulsory information					
	Public/NGO Information					
Quantity	#9	#6	#5	#3	#2	#1
Concept	Information	Energy Price	Regulations	Subsidies	Land	Price

Figure 5: Relevant Policy Variables for the System 'Building Environment'

The policy variables can be structured in six clusters. The first cluster with the highest quantity of statements can be named as 'information'. The participants see undirected information about energy-efficient technologies as well as about building standards, especially the consumption-reduction potential and consequently the possible savings as relevant for the decision for an energy-efficient house construction. Interestingly, one participant named the importance of the architects' knowledge about energy-efficiency indicating that a lack of further education could possibly exist in the architect group.

The second most important policy variable is 'energy price'. Two statements concentrate on the anticipated natural increase of the pure energy price, particularly for energy generated from fossil resources. This creates in turn pressure to accept energy-efficient building standards. Further, three statements emphasize the significant energy-consumption reduction potential of taxes.

The third cluster is about 'regulations' by which is meant federal and/or cantonal laws and implementation rules which foster and claim the application of specific energy-efficiency standards. Participants see by this mean a strong force to reduce the energy-consumption, however, recognize at the same time the difficultness of implementing such austere regulation at once.

The fourth cluster is tangented to federal 'subsidies' as a mean to foster the diffusion of energy-efficient buildings. Thereby, several possibilities are discussed: To subsidies (1) the construction of houses that fulfill energy-efficient standards, (2) the investment in energy-efficient technologies, or (3) to relieve certain energy-oriented taxes and levies. The last two policy variable clusters concentrate on the price and availability of land for construction and the price to construct an energy-efficient house, respectively.

Reference Mode Elicitation

The next task was to elicit reference modes for important system variables. In addition, the participants were asked to define the time horizon, i.e., the time span being important for the system behavior. Even though the task to define the time horizon was explicitly stated by the facilitator, most participants did not complete it, indicating that participants' had difficulties or were uncertain about the complex issue of the building environment. Figure 6 represents

three reference modes drawn by participants as answers to the questions “What are key variables for the system? How do you expect them to behave over time?”
In the graph, reference modes of three variables are depicted. The blue graph represents the variable ‘Relative Price of Minergie vs. Traditional Building’. It is a ratio of the price for a Minergie building compared to the price of a traditional building. The price is thereby the sum of costs for construction and costs for maintenance including energy costs. The participants believe that the price for both alternatives will be equal at the year 2015 resulting in a relative price of 1.0 [dmnl]. Before 2015, the construction and maintenance of an energy-efficient building is expected to be more expensive than a traditional house. After 2015, the price ratio will decrease with diminishing rates until the year 2050, stabilizing around a value of 0.5 [dmnl].
The second reference mode is the ‘Minimal Standard of Energy-Efficiency for New Buildings’ indicating that improvements in state-of-the-art technology will influence federal laws and requirements for building constructions. It is expected that the intensification of the energy standards will occur especially until the year 2015. Thereafter, the increase will take place with a diminishing rate of growth.
The third reference mode represents the expectations about ‘Subsidies for energy-efficient buildings’. Participants estimate that the Swiss Government subsidies measures in energy-efficiency strongly until the year 2008. Afterwards, the promotions are ideally quickly reduced.

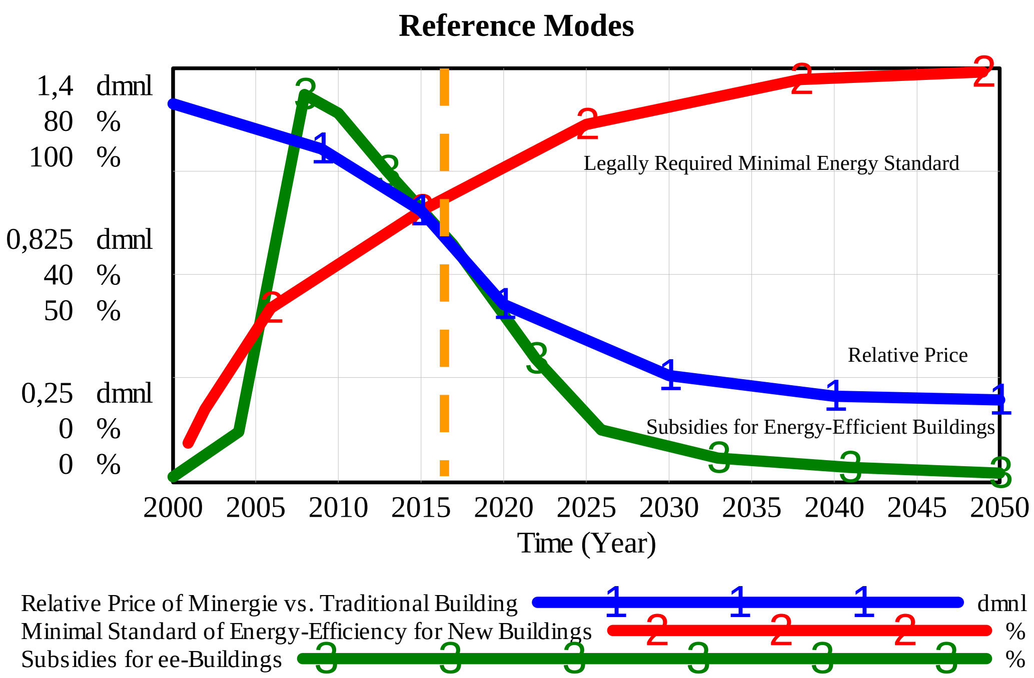

Figure 6: Reference Modes of Key Variables of the System ‘Building Environment’

Modeling of Key Variables and Sectors

The next step was to create chunks of system structure in a plenary session of two hours. The facilitator tried to elicit system structure based on the exercises done previously by asking questions about causes and consequences of certain variables and reference modes. In a step-by-step modeling approach, system structure was sketched on white boards in front of the participants. The modeler captured directly relevant and ‘approved‘ model structure by means of the Vensim simulation software.

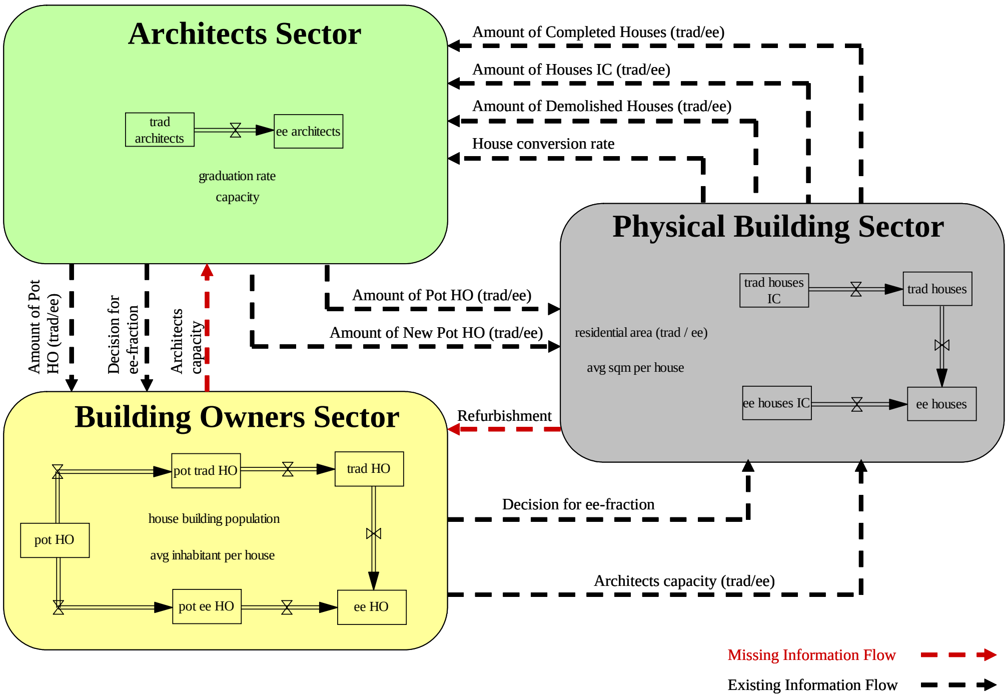

Figure 7: Key Variables and Sectors (Modeling Workshop at Berne)

During the two hours modeling workshop, not enough time was reserved to develop the simulation model in a reasonable manner, particularly because the parameterization was not addressed in the modeling workshop. Thus, the model at the end of the modeling workshop represented a first skeleton of the system ‘residential building environment’, but no flesh in form of parameters. Additional effort of the modeler was necessary to create a reasonable and to a certain extent validated simulation model. The sector model in Figure 7 consists of the three sectors ‘Building Owners Sector’, ‘Architect Sector’, and ‘Physical Building Structure Sector’ and represents also some key variables of each sector. Groesser et al. discuss and analyze the simulation model in more detail in another elaboration (Groesser 2006a).

3.2 Lessons Learned from the First Group Model Building Project

After the description of the modeling workshop and the results, I will reflect critically about the performed group model building workshop to discover weaknesses and to derive improvement potential for future group model building projects.

Planning and Discussion

As stated previously, the group model building session at the University of Berne took place at the end of an introductory course about System Dynamics. It was organizationally not possible and also not intended to create a perfect GMB session. It was rather to show the participants how a GMB conference is going to be. Therefore, this experimental setting provide the participants with new knowledge about GMB and the GMB-facilitation team with valuable lessons. The first being that the different roles defined by Andersen and Richardson (Andersen and Richardson 1997) were not assign or agreed upon in advance. The System Dynamics teacher took the role of the facilitator, an experienced Ph.D. student took the role of the modeler, and the role of an observer was taken by a psychologist rather intuitively. This natural evolving approach led to several other problems. One is that the facilitator and the modeler did not agree upon or discuss the scripts which will be used in the workshop. Since the GMB workshop was an ad-hoc instance, it was not planed on this level of detail. Thus, important questions about the suitability of System Dynamics or the group model building approach were not specifically reflected upon. Also, because no planning of the workshop existed, a preliminary model could not be employed what would have been useful in consideration of the little time available. In addition, it can be argued that the case was built up just for learning purposes of the participants. Even though this is true, it is worth mentioning that a thorough discussion of the roles, and the used scripts is fundamental for the conduction of a successful GMB-session.

Organization and Interventions

A second point of critique is about the organization of the workshop during the meeting. First, the positioning of the workshop participants was not optimal because the participants sat in two rows and each person had its own desk. The furniture layout matched a classical layout used in primary and secondary schools and not the ideal layout suggested by Andersen et al. (Andersen and Richardson 1997). That is that the participants build a semi-circle around the white boards while only sitting on chairs. For individual or group tasks, desks which would be placed in the back of the room and could be utilized if needed.

A further point of critique is the behavior of the facilitator. A severe bias about the system structure and behavior can occur, when the facilitator directs the discussion to strong into one direction of thoughts. And second, it is crucial that the facilitator always manage to form a social situation in which all persons are equally treated. But evidently, the facilitation of a workshop is a highly demanding task, mishaps will occur. The process coach/observer has to intervene in these cases. But for this, the roles and tasks have to be clearly explained what did not happen in this training instance. If the roles and tasks are not clearly distributed among the GMB-team, misunderstanding can occur that hinder the facilitation process and leave the participants with an impression of unprofessional competence of the GMB-team.

An additional point of critique is that the facilitator and modeler did not have experience working together and thus the tasks and the line of responsibility was not clear defined. Furthermore, the time reserved for the modeling workshop was too short for such a complex issue like the building environment. Finally, the composition of the workshop participants was not balanced because not all actor groups were represented; only future und current building owners were present. This was because no stakeholder analysis was performed in advance by the research team and also that only students of the System Dynamics introductory class participated in the group modeling workshop.

Implications for Further Modeling Workshops

What can be learned from the experiences of the described GMB session? First, the modeler and the facilitator, or more generally, all project team members, should know their roles in advance. Discussions about tasks, competences and reliabilities ought to prepare the team members. Furthermore, it seems to be helpful to define results and products that have to be created in the course of the workshop. Having a definition of detailed objectives, a content and process planning of the workshop can more easily be performed. Third, the project team, especially the modeler and the facilitator, should have worked together in previous sessions or should have experience working together in another way. It is indispensable that both act in concert to achieve the purpose of the GMB session. Because of the previous, it is highly recommended that the team members elaborate and agree about the goals of the planned workshops. Fourth, in order to sustain the concentration and freshness of the workshop participants, it is necessary to use different group tasks structures (e.g., individual tasks, small-group tasks, plenary tasks). In other words, it is required to break the group structure several times an hour to avoid fatigue and usualness. To reach this postulation, a detailed preparation of the tasks and their duration is highly important. As last implication for further workshops, the composition of the workshop participants have to be selected to the purpose of the GMB-session. In order to determine the best participants for such a GMB-session, it seems evident that a stakeholder analysis delivers knowledge for the decision about whom to invite and include in the session.

After discussing the workshop at the University of Berne, I will concentrate on the design of a group model building framework. In addition, some efforts are undertaken to apply the framework to the research project described in Chapter 1 (Introduction).

4. Design of a Group Model Building Framework

In the following, I will develop a group model building framework which will especially consist of the approaches by Vennix (Vennix 1996) and Andersen et al. (Andersen and Richardson 1997). It will be also enriched by the insights of Chapter 3 and tools that try to institutionalize these insights. The framework will consists of the following parts that will be described in more detail: Context and content analysis, stakeholder analysis, and the aforementioned two GMB-streams.

4.1 Context and Content Analysis

Can group model building be used successfully at all? Is the group model building approach appropriate for the situation or should another method be selected? What are distinct reasons to apply GMB instead of another approach? How shall the GMB project be assign? To decide upon these questions, information about the situation, conveners and stakeholders is required. Hence, a context analysis is the very first step in conducting a group model building approach. It reveals more precise information about the system under study including the physical structure, the stakeholders, policies possible, and active large scale feedback structures. Andersen et al. name the context analysis briefly but do not elaborate it in detail (Andersen, Richardson, and Vennix 1997). But what is the difference between a context analysis and the analysis of the content? A precise definition does not exist so far.

The goal of a context analysis is to create system knowledge on which all the following stages of analysis will rest. During the literature review, I did not find a systematic framework about the analysis of the context in general. For instance, Pugh provides an example for an explicit representation of the context factors, defined by theory and literature. But the problem still exists: what dimensions are accounted for and what others are not (Pugh et al. 1969).
A similar word for ‘context’ is ‘setting’; the environmental setting of a problem under research. The review of the management and organizations literature puts forth that the research in those fields has underemphasized the role of context and has focused more narrowly on micro level stimuli and responses (Pfeffer 1998; Stokols 1995), even though Pugh et al. state that the structure of an organization is closely related to the context within which it functions, and much of the organization structures might be explained by contextual factors (Pugh et al. 1969). Some few examples of studies that consider context factors are the effects the context have on the evaluation of intensive service relationships (Conlon, Van Dyne, and Milner 2004), or the preferences a person builds depending on the context of the decision (Tversky and Simonson 1993). Theorists in these areas seem to have proceeded on the assumption that one particular contextual feature is the major determinant of structure, with the implication that they considered the others less important. I argue with Pfeffer that additional research on context is needed (Pfeffer 1998). Even though early management work acknowledged that the physical environment of context can influence attitudes, evaluations, and behavior of people and organizations (Barnard 1938, Roethlisberger & Dickson 1939), no framework existed to systematically analyze the context of a problem situation until the development of the St. Gallen Management approach by Ulrich et al. (Ulrich and Krieg 1974). The first version of

their heuristic for business management integrated the analysis of context and content and provided possible dimensions for further analysis. The St. Galler Management approach was further improved by professors of the University of St. Gallen during the last thirty years (Rüegg-Stürm 2002; Ulrich 2001). The latest version was developed by Rüegg-Stürm and comprises of the following context dimensions: Nature, society, technology, economy, resources, values, interests. In addition, a heuristic about a stakeholder analysis is provided: Investors, customers, employees, public organizations, NGOs, state, suppliers, and competitors (Rüegg-Stürm 2002).

With Schwaninger, another professor from the University of St. Gallen provides with his integrative system methodology (ISM) a heuristic about content and context analysis that focuses specifically on the methodological integration of context and content (Schwaninger 2004). The ISM explicitly considers an iterative context analysis approach which is intertwined with the content analysis indicating that the context has to be taken into account when conducting a content analysis (Schwaninger 1997). Figure 8 (left) shows the mentioned heuristics in a cyclical representation. The content loop represents the work on the subject matter of the issue at hand. The second loop of the methodology concerns the context in which the issue under study is embedded. This part of the ISM process deals with a higher-order aspect. In principle, the nature of the context defines, and delimits, how good or effective a solution at the object level, i.e., at the level of the content of the issue in hand, can be (Schwaninger 2004). On the right hand side of Figure 8, a heuristic outline of the content and context dimensions is provided. It is a disaggregated version of the conceptual model (left hand side). What is missing in this more detailed version is that this iterative process have to be performed for both the content and the context loop.

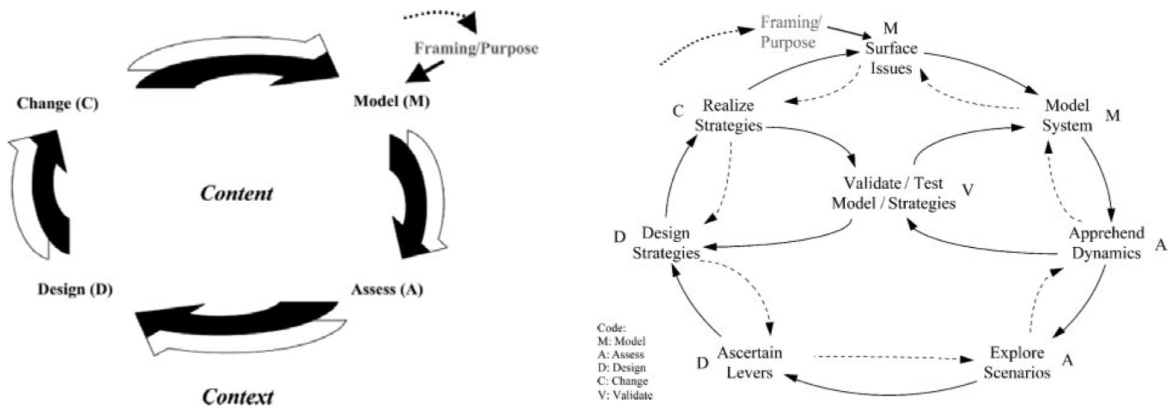

Figure 8: Integrative System Methodology (ISM): Conceptual model (left) and heuristic outline (right) to handle the content and context dimensions (Schwaninger 2004).

Schwaninger's contribution with this heuristic is remarkable by outlining the interdependencies between content and context in the research process. The terms of 'content' and 'context', however, rather have been defined by example instead of an abstract definition. Therefore, no clear boundary is provided to delimit between context and content analysis. A valuable assertion is that context and content influence each other by it definition.

In more System Dynamics oriented terms, the context and content refer to problem statement and boundary selection. It is vivid that the definition of the problem outlines the content and defines the boundary of the research and thus the context. Figure 9 shows relationship between the two concepts.

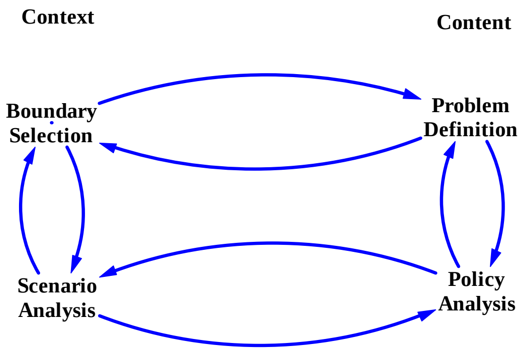

Figure 9: Context and Context Dichotomy in System Dynamics-oriented Terms

Besides boundary selection and problem definition, the methods of scenario analysis and policy analysis can also be assigned to the dichotomy. A scenario analysis concentrate more on the external factors that are not the core of the analysis. For instance, environmental changes and their impacts on an organization can be best evaluated by a scenario analysis, given that the organization is the focus of the research. On the other hand, policy analysis concentrates on internal factors and their effects on the problematic variables which are defined by the problem statement. Figure 9 shows that the four concepts depend both on their counterpart on the other side of the dichotomy and on the concepts in their own dichotomy dimension.

Obviously, the issues of the context and content analysis depend on the case but include topics such as culture of the organization, pace of environmental change which are considered by the St. Gallen Management approach. The effects of the group model building project on both the close and broad environment, and the dynamic relevance of the GMB project are mostly not considered. This would be an a priori evaluation of the GMB-project. I will not pursue this speculative undertaking in this research. Instead, I will concentrate in the following on the stakeholder analysis, which is already mentioned in the St. Gallen Management approach and which is based on the context analysis.

4.2 Stakeholder and Actor Analysis

A general accepted definition about what a stakeholder is does not exist. Mitchell et al. list in a recent article 27 different definitions of stakeholder used in the business literature only (Mitchell, Agle, and Wood 1997). For instance, “a stakeholder is any group or individual who can affect, or is affected by, the achievement of a corporation’s purpose.” (Freeman 1984). The concept of an actor is slightly distinct from the concept of a stakeholder. For system analysts, an actor is “a person who carries out one or more of the activities in the system” (Checkland 1981). Hence, the difference between actor and stakeholder is the level of activity in the system. Stakeholders can be either active or passive whereas actors are defined as active entities.

A “Stakeholder analysis can be defined as an approach for understanding a system by identifying the key actors or stakeholders in the system, and assessing their respective interest in the system” (Grimble and Chan 1995). The main purpose to employ a stakeholder analysis is to understand complexity and compatibility problems between objectives and stakeholders, e.g., in turbulent business environments by discovering existing patterns of interaction (Freeman 1984). Additional purposes are to improve interventions analytically and to guide policy-making (Grimble and Wellard 1996). The question of who is a stakeholder or actor and when to consider their opinions and knowledge is most important during a stakeholder analysis. At least, two sides can be distinguished: The convener and system stakeholders or actors, respectively.

Normally, the convener is simultaneously the person who undertakes the stakeholder analysis. Thus, thinking about the convener in this instance is a process of self-reflection and should create vividness about interests and objectives. Formally, the convener must have the power or legitimacy to (1) convene others, (2) choose the criteria for inclusion or exclusion of other system stakeholders, and (3) the authority to define both reason and theme around which the stakeholder analysis takes place (Grimble and Wellard 1996).
The second side consists of the system stakeholders who exist and act in the observed system. In order to choose relevant stakeholders for the further system analysis, each stakeholder have to be identified and analyzed. Based on the stakeholder analysis, those have to be included in the project that define the system and its behavior; in other words, those have to be invited in order to have the system in the room (Andersen, Richardson, and Vennix 1997). They should have attributes such as power, legitimacy and urgency related to the issue in order to have a 'voice' and 'being noticed' (Mitchell, Agle, and Wood 1997). Stated more pragmatically, stakeholders have to be included whose appearance and function in the system create a significant different system behavior. Additional criteria may also be based on numbers of stakeholders and on heterogeneity of the stakeholder structure. Practical considerations may include spatial distance, language situation, temporal availability, and also interdependencies and relationships between different stakeholders (Scott 2000). The following script of stakeholder review questions helps to address and evaluate complex stakeholder systems.

- *Who are our current stakeholders?*
- *Who are our potential stakeholders?*
- *How does each stakeholder affect the system?*
- *How do we affect each stakeholder?*
- *What assumptions does our current strategy make about each important stakeholder?*
- *What are the current 'environmental variables' that affect us and our stakeholders? (Inflation, GNP, crime rate, confidence in business, corporate identity, media image)*
- *How do we measure each of these variables and their impact on us and our stakeholders?*
- *How do we keep score with our stakeholders?*

Figure 10: Script of Stakeholder Review Questions for Addressing and Evaluating Complex Stakeholder Systems

The stakeholder analysis have been described and a script have been developed. In the following, I like to position the stakeholder analysis in the dichotomy of context and content. As mentioned above, the stakeholder analysis is a first assessment of possibly relevant actors and groups with respect to the research. Out of this, the most important stakeholders or actors are included in the research project. In other words, they are internalized. Hence, the stakeholder analysis has a context-oriented character, whereas the stakeholder management concentrates more specifically on the selected stakeholders and their reactions. Hence, stakeholder management is considered to fit better on the content side of the dichotomy. Figure 11 contains in addition the stakeholder analysis on the context side and the stakeholder management on the content side. In comparison to the first version of the heuristic (Figure 9), the phrases have been rearranged and have been connected to their dichotomy dimension by grey arrows. The two dark blue arrows indicate the total effects the interaction between the methods of each side of the dichotomy has: the interdependence of context and content of a research project.

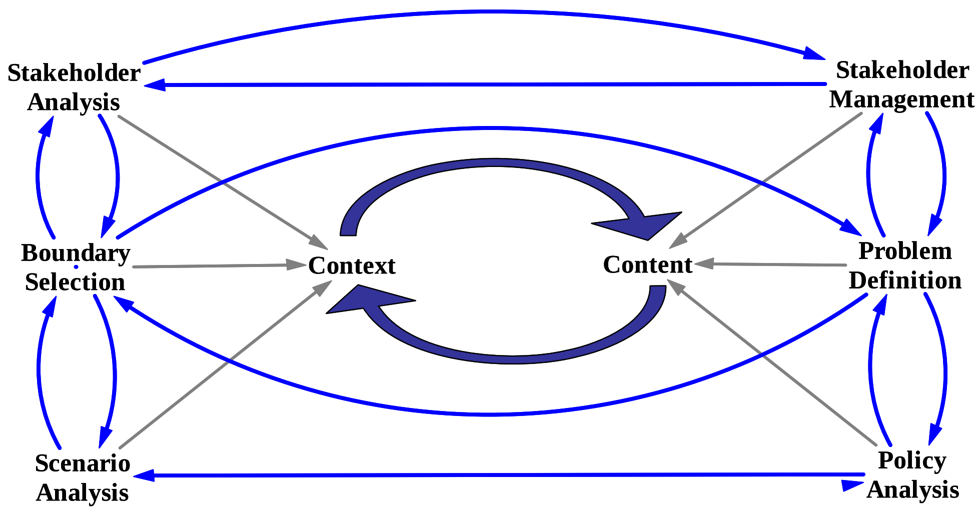

Figure 11: Context and Context Dichotomy and Methods as a Pre-Stage for a Group Model Building Session

Stakeholder Analysis for the Research Project

In the following, the above quoted elements and criteria of a stakeholder analysis will be utilized for a stakeholder analysis for the research project 'DeeB' (cf. Chapter 1).

The goal of the analysis is to involve all stakeholders relevant to the system "residential building environment" in the region of Langenthal (Canton Berne, Switzerland) in order to derive policy levers that can change the system significantly. A relevant stakeholder is an entity whose presence in the system alters its behavior. First, I will analyze the convener, thereafter the stakeholders. The project 'DeeB' is initialized by the Interfacultary Center for General Ecology, University of Berne, and is funded by the Swiss Federal Research Fund. The project team consists of three research associates with education in the fields of psychology, economics, business administration and computer simulation methodology. In addition, two temporary research assistants support the team. The City of Langenthal has agreed on the research collaboration with the University of Berne for the next three years. Consequently, the research team has both the formal legitimacy in the region and the expertise to perform the research project.[4] The research topic 'diffusions of energy-efficient building standards' is presently highly relevant to policy-makers and of general public interest (Groesser 2006b). Speaking with Grimble and Wellard (Grimble and Wellard 1996), the convener have the power to define both reason and theme around which the stakeholder analysis takes place and to choose the criteria for inclusion or exclusion of system stakeholders. However, the convener has no formal possibility to obligate system stakeholders in the research project; it has to rely on the voluntariness of the stakeholders what creates uncertainties in the research project. Since a literature review about the construction process in the building environment did neither foster an a priori identification of the most relevant nor of not relevant stakeholders and actors, respectively, the research team developed criteria to choose the stakeholders. These criteria are: temporary and spatial availability, strength of influence for the system, heterogeneity (pioneers and laggards). Existing relationships and interdependencies among stakeholders could not be assess so far, but are considered to be marginal. To conclude, the convener has formal legitimacy and professional expertise to conduct the research on the one side, depends, however, on the willingness of the system stakeholders to participant, on the other side.

[4] A more detailed description about the research project is provided by Ulli-Beer et al. (Ulli-Beer et al. 2006).

Means an analysis of the stakeholders in the system ‘residential building environment’, the following stakeholders or stakeholder clusters emerge: Government, consumer associations, banks/ family/friends, family/friends/media/press, real estate investors, utilities, supplier of energy-efficient-technology, and engineers/architects (Figure 3). A description of the stakeholders is provided in Chapter 3, Section ‘Stakeholder Identification’ and in Ulli-Beer et al. (Ulli-Beer et al. 2006). In order to analyze the questions posed in Figure 10, more detailed information is necessary. Presently, interviews are conducted to elicit relevant information for the stakeholder analyses. Results will soon be available.

To conclude, the stakeholders are an essential part of policy-making in the residential building environment, because they are fundamental pillars of the system structure. Only when the most important influential and thus most relevant stakeholders and actors are involved, the research project can be successful. Vice versa, if an important actor is not included in the stakeholder analysis, the results and policy recommendations may lose their accuracy and relevance. From the side of the convener, no hindrances should occur since all formal and professional requirements are fulfilled.

4.3 Group Model Building Approach

In the following, important questions about group model building will be posed and answered. Especially, the approach by Vennix will be used to reflect upon pre-meeting tasks. Figure 13 provides an overview of the resulting GMB-approach. Vennix starts by posing basic questions about the nature of the GMB-project: Who initiates the project? Is System Dynamics suitable? Should qualitative or quantitative SD be used? Should a preliminary model be used? I will work on these questions as next steps and discuss them with respect to the ‘DeeB’-Project.

Question 0: Is the GMB Approach appropriate?

Neither Vennix (Vennix 1996), nor Andersen et al. (Andersen and Richardson 1997), start the group model building approach methodologically with the question whether GMB is appropriate for the problem situation or not. My attempt is to broaden the implicit assessment about the suitability of GMB. Mainly three issues have to be accounted for the suitability of GMB: (1) existence of a distributed decision problem, (2) convener’s ability to invite and motivate relevant people, and (3) moderator’s ability to enable discussion between the participants. The sequence of these criteria is important. It is evident that the problem situation must be created by several groups of actors which interact in a suboptimal manner. If only a single actor is the problem owner, single model building approaches rather then group model building would be reasonable. The second criterion considers the power constellation between convener and relevant actors. An evaluation should be based upon the previously elaborated stakeholder analysis. The third criterion applies ostensibly to moderator’s capabilities. However, relationships between actors or stakeholders play a significant role for the success of the discussion during the session.

An evaluation of the three criteria for the ‘DeeB’-Project is rather brief: (1) the diffusion of energy-efficient building standards is a distributed decision problem because several actors have to interact in order to create the system ‘residential building environment’, and (2) the research team fulfills the formal and professional requirements, depends however on the willingness of the actors to participate, as pointed out previously. The third criterion cannot be evaluated at the moment because in detail information about actors’ relationships is not yet available.

Question 1: Who initiates the Group Model Building Project?

The initiation of this group model building session is modeler driven. As pointed out earlier, the group model building approach is integral part of the research project “Diffusion Dynamics of Energy-Efficient Buildings”. In case the client would demand the GMB session, the suitability of GMB or SD ought to be evaluated more critically, because in most cases the client does not possess the necessary skills to assess the suitability of GMB or SD.

Question 2: Is System Dynamics Suitable for the Problem at Hand?
The suitability of System Dynamics is according to the standard process one of the first issues to be discussed between the model-builder and the client. This most important question decides whether System Dynamics is an appropriate solving approach for the current problem or not. Especially when the client approaches the research team, it is worthwhile to consider the suitability of the approach, because the client has seldom a thorough understanding of what System Dynamics is and for what type of problems and under which circumstances it is most suited. It is, even for experienced modelers, difficult to answer the question of suitability because (1) modelers may be only familiar with one method, and (2) problems may be ill-defined and thus difficult to survey in their entirety (Vennix 1996). To answer the question of suitability, a clear view is required about the kind of problems the System Dynamics Method can effectively solve. System Dynamics related literature developed criteria for the applicability of SD (Meadows and Robinson 1985; Roberts et al. 1981; Sterman 2000; Vennix 1996):

- Problem is dynamically complex because of underlying feedback processes,
- Characterized by pattern of behavior unfolding over time which shows how the problem arose and how it might evolve in the future,
- Behavior of aggregated quantities,
- Multi-parametric,
- Intended are robust long term solutions.

In the following, the problem of the ‘DeeB’-research project will be subsumed under the criteria of suitability. First, the problem is highly dynamic and complex because it consists of several distributed but functionally and materially inter-dependent decision processes. In addition, time delays with different time lengths exist resulting in not anticipatable nonlinear behavior modes. Second, it is possible to show the problem behavior unfolding over time which shows how the problem arose and how it might evolve in the future. Third, the problem concentrates on the aggregated quantity ‘building environment’ and more particular ‘building stock’ and not on single entities and the energy consumption. Fourth, the problem is characterized by several parameters interacting with each other leading to a highly complex problem solution. And finally, the intended solution is a long term and robust strategy for the building environment in order to sustain an energy-efficient building environment. To conclude, System Dynamics is a suitable modeling and problem solving approach because the defined suitability criteria are fulfilled.

Question 3: Shall Qualitative or Quantitative System Dynamics Be Employed?
Quantitative System Dynamics involved creation of a full-fleshed system dynamics model including simulation. Qualitative System Dynamics refers to the stages of problem identification and conceptualization. In the literature, there is an ongoing discussion about qualitative vs. quantitative System Dynamics modeling (Wolstenholme 1982; Wolstenholme and Coyle 1983). Each side has good and important arguments for their position. Arguments for the ‘qualitative-only’-approach are:

- Qualitative modeling itself is already useful because it improves the process decisions are normally made (Vennix 1996),
- Qualitative SD is often sufficient in itself to generate problem understanding and ideas for change (Wolstenholme 1982),

- Optimal utilization of financial resources because the cost-benefit-ratio is particularly high at the beginning of a project (Wolstenholme 1990),
- Quantification of a simulation model cannot always be accomplished.

Arguments for the quantitative utilization of System Dynamics are:

- The human mind is not capable to infer the dynamic characteristics of a complex structure involving delays, nonlinear relationships, and feedback loops (Sterman 1989; Vennix 1996). Humans perform poorly even in very simple feedback systems (Groesser 2005; Sweeney and Sterman 2000a, 2000b),
- Humans can learn the dynamic behavior of a complex situation only by means of a quantified simulation model (Dörner 1980).

To put the above-mentioned in the context of the 'DeeB'-project whose goal is to build a quantified simulation model, the answer to the question is evident. The System Dynamics model has to be quantified because (1) a high in-depth understanding of the system is an aspired objective of the research project, (2) resulting simulation runs are used to validate the model, (3) scenario analyses will be employed to explore policy levers, and (4) a quantitative SD model is necessary to build actor-configured management flight simulators. The quantification and validation of the simulation comes at a high price. The trade-off between system understanding and resource consumption, however, is clearly shifted towards system understanding.

Question 4: Who Has to Be Involved in the GMB Sessions?

In answering the question about whom to involve in the GMB session, the stakeholder analysis (Chapter 4.2) is useful. There, important stakeholders and actors of the system under study have already been examined. Based on these results, the following criteria provided by Vennix (Vennix 1996) become useful and realizable: On the one hand, include those who have the power to act and implement the decision, and those who have to accept the project results. In addition, attention has to be paid to the tradeoff situation between group size and participation or satisfaction of the participants, respectively. Furthermore, attention has to be paid to the tradeoff between model quality by incorporation of a higher diversity of participants. By this more view points will be incorporated (Forrester 1980), but, on the other hand, difficulties may occur to build interpersonal relationships between the participants. Even though Vennix argue that it is "better one person to many than one too few, since people who feel excluded from the process may easily resist the resulting conclusions" (Vennix 1996), he and Richardson et al. (Richardson and Andersen 1995) determine a group consisting of 10-12 people as acceptable; groups with 25 participants are considered as very large.

The 'DeeB'-project expert group will consist of 20 participants. The project team argues in favor of including more system experts in order to improve model quality and insights gained. By means of the actor analysis, the project team convened actors which constitute the system 'building environment'. Hence, these actors have the power to implement the results of the GMB project. Simultaneously, these actors are the main players who have to be convinced for an implementation of the results in their particular environment, e.g., in a company. In addition, the actor analysis puts no constraints forward about whom to not invite. No actor is seen as a possible hindrance factor for the success of the project.

Question 5: Shall a Preliminary Model Be Employed?

Vennix provides useful guideline to answer the question, if a preliminary model should be employed (Vennix 1996). Arguments for the utilization of such a model are that the modeling process will be speeded up and the group works more efficiently. The effect of faster modeling progress is an increased likelihood to involve high level decision makers in the group

model building sessions. Arguments against the usage of a preliminary model are, first, a reduced degree of ownership and therefore lower participant's commitment. Thus, in case a model is employed, it should be rather a 'kick-off'-model subject to changes than a model representing the philosopher's stone. Second, the more elaborated the preliminary model is, the more difficult it might become for the group to discover flaws in it, and the higher the likelihood that the model-builder will become defensive about the model.
The 'DeeB'-project has only one true group model building workshop (cf. Table 1 and Table 3). The other workshops are convened to create a common understanding among the participants, to foster their networking and to present the results of the research. Therefore, it is planned to employ a 'kick-off'-model about the buildings environment system in order to speed up the discussion and increase modeling effectively. Since this initial model will be build on cognitive mapping interviews conducted with the system expert group members individually, the participants should quickly recognize used system structures.

Question 6: On What Information Should the Preliminary Model Be Based?
Three possible information sources exist by which a preliminary model can be created. These are content analysis of documents (Axelrod 1976), structured or unstructured interviews, and questionnaires or workbooks (Vennix 1996) which have to be completed by individuals.
For the 'DeeB'-project, interviews and document analysis will be used to create preliminary models. The overall research design determines that the cognitive mapping technique by Ackermann et al. (Ackermann, Bryson, and Eden 2004) will be used as interview method. This approach emphasizes an emerging und thus unstructured interview process. Only the interview purpose is defined in advance. Since the 'DeeB'-project involves several actor groups (e.g., architects, company representatives, and building owners), the conducted interviews have different purposes which are explained in more detail in Ulli-Beer (Ulli-Beer et al. 2006). Highly important is that the purpose of the interviews is aligned with the overall goals of the model-building project. The objective of the interviews is to elicit three layers of variables: problem variables, their anteceding causes and their subsequent consequences that ought to be structured as 'cause maps' representing the respondent's view on the problem.

Question 7: Shall Questionnaires or Workbooks for Participants Be Used?
Questionnaires and workbooks are means to elicit information, to prepare the following group model building workshops and can be used in advance or after a group model building session. Workbooks are summaries of questions and exercises to complete organized in a booklet. Advantageous is that additional information can be gained from the participants. Workbooks are especially useful when the reference group consists of a large number of participants or when the span of time between two workshops is large. Disadvantageous is that the completion of the documents requires participant's time possibly resulting in a low acceptance and return rate. In addition, the research team has to invest time to produce and analyze the questionnaires or workbooks.
For the 'DeeB'-project, the usage of either questionnaires or workbooks is planned because the number of participants is considerably high probably leading to a lower participation and satisfaction rate of each participant due to reduced speaking and discussion time. And second, the span of time between two workshops will be several months. Furthermore, the usage of workbooks is preferred to questionnaires because workbooks elicit more relevant and accurate information about the problem at hand from the participants. The additional workload is considered low compared to the insights gained and the improved quality of the simulation model.

4.4 Resulting Group Model Building Approach

Figure 13 summarizes the envisioned GMB approach on the macro level. It comprises of the context and content differentiation and incorporates the St. Gallen Management approach dimensions. In addition, the stakeholder analysis is sketched by the representation of several stakeholders in arrowed boxes. In the center of the figure stands the content oriented Group Model Building decision diagram.

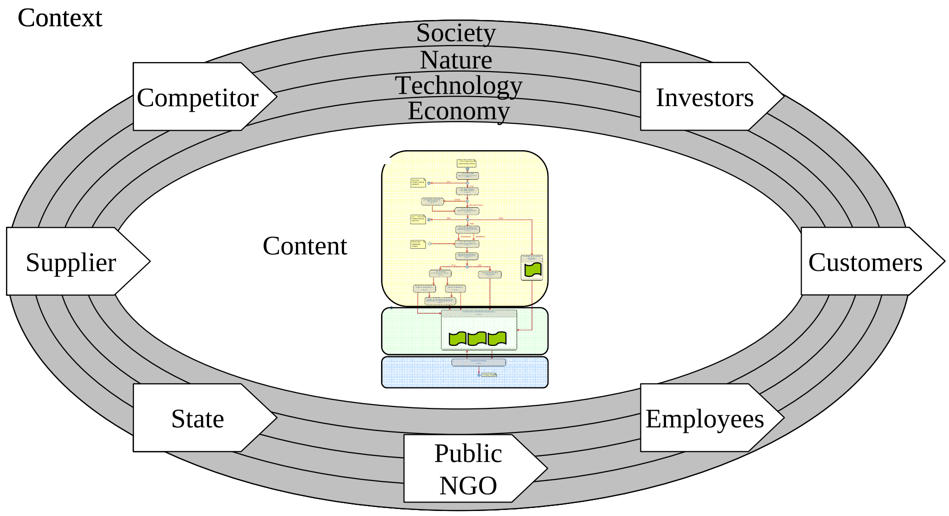

Figure 12: Group Model Building Approach on the Macro Level

The decision diagram presented in Figure 13 can be used for the group model building approach of the DeeB-Project, but shows a general structure to conduct a GMB-session. The most overarching method is the context/content analysis (Chapter 4.1). It helps to obtain important knowledge to frame the research project and to function as a basis for evaluation of the modeling results. It is important to constantly analyze the context of the project in order to include latest developments or to assess the relevance of the project. The stakeholder analysis (explained in Chapter 4.2) aims at identifying key stakeholders and actors for the system under study and provides basic information about the question whom to involve in the group model building approach. Stages one to three comprise tasks more closely related to a particular group model building session. Stage one consists of pre-meeting activities. The activity diagram (Figure 13) shows starting and end points of the group model building process, decisions during the process and required or produced documents or scripts. The in Chapter 4.3 elaborated questions (Q0 until Q7) are depicted in stage one. The ‘planning scripts’ (described in Chapter 2, Table 2) are used to establish the relationship with the client. These scripts concentrate on, e.g., obtaining accession to a gatekeeper within the organization, to select the appropriate people for the workshop, or to clarify the final products as early as possible. In stage two, the meeting scripts regarding meeting activities are integrated in the group model building process. The application sequence of the scripts is as depicted in Figure 13. First, the scheduling scripts contains bracket elements which determine the course of the group model building session, e.g., how to get the participants acquainted at the beginning, being consistent with the iconography, how the modeling team should guide the session, and when to clarify expectations and final products. The next set of scripts (GMB-tasks), comprise the standard System Dynamics modeling cycle (Andersen and Richardson 1997; Sterman 2000). Subscripts for problem definition, for conceptualization of the model structure, for elicitation of feedback structure and for policy development make use of the iterative modeling process and operationalize it in form of small and simple exercises for individuals or small groups. Sometimes, tasks are solved as plenary exercises. The script ‘Closing’ is used to end a group model building session. It is intended to close a modeling session with a bang, especially when further modeling sessions will take place.

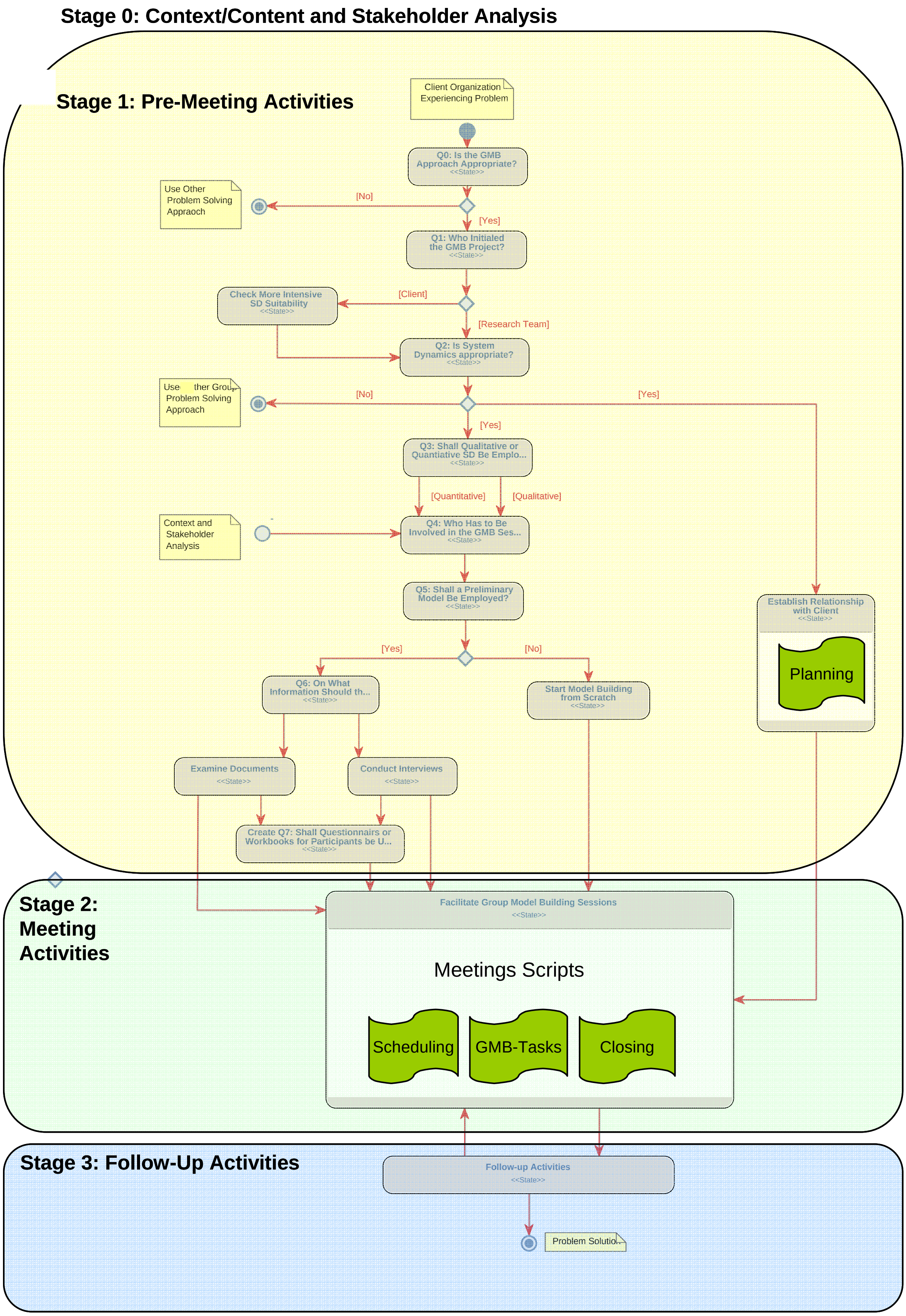

Figure 13: Group Model Building Decision Diagram (Micro Level)

Ending with a bang is most probably achieved when the work of the modeling session is summarized by the facilitator or the modeler in a consistent and reasonable manner. The participants should get a bird's eye view of the model and, in addition, some structural chunks of the system structure as take away messages.

The last stage consists of follow-up activities and can involve both the research team and the participants. The research team will certainly have to elaborate on the results of the workshop. Particularly the modeler will have to work on the simulation model in order to produce a reasonable and validated simulation model. But also the participants can be involved by means of questionnaires or workbooks which have to filled out and give the research team additional information and insights which could not be obtained during the group modeling session. And in most cases, the follow-up activities will end in new pre-meeting activities for the subsequent workshop with the clients.

5. Conclusion

A literature review puts forward that the science of group model building is nascent in the recent years. However, only two educational institutions offer professional education and research in the field of group model building with System Dynamics. Moreover, detailed literature about group model building is rather rare. Hence, this paper has elaborated upon two purposes which are centered on the group model building approach.

First, it has documented and critically reflected upon a group model session performed at the University of Berne/Switzerland. Several lessons have been learned, e.g., that the GMB design is crucial for the success of the session. The more and finer the planning, the smoother the group model session will be resulting in a higher quality of the model. Another insight is that the tasks during a workshop have to be divided between the research team in order to increase the quality. However, close coordination between the research team members is necessary to create a smooth and successful workshop; especially the facilitator and the modeler have to agree about the course of the workshop and the methods being used. Ideally, facilitator and modeler have worked together previously. The second purpose has been to create a comprehensive group model building framework based on existing streams of research. The result is a framework that includes context and stakeholder analysis as basic preparation tools for a group model building project. In the more modeling session oriented stages, the approaches of Vennix (Vennix 1996) and Andersen et al. (Andersen and Richardson 1997) have been integrated.

II. Appendix

1. Important Questions for the Group Model Building Approach

Q0: Is the GMB Approach Appropriate?
Q1: Who initiates the Group Model Building Project?
Q2: Is System Dynamics Suitable for the Problem at Hand?
Q3: Shall Qualitative or Quantitative System Dynamics Be Employed?
Q4: Who has to Be Involved in the GMB Sessions?
Q5: Shall a Preliminary Model Be Employed?
Q6: On What Information Should the Preliminary Model Be Based?
Q7: Shall Workbooks for Participants Be Used?

Figure 14: Important Questions for the Group Model Building Approach

2. The Planned Workshops in more Detail

Workshop 1:	**Consolidation of the System Expert Group**
Preparation	Selection of reference buildings Identification of relevant actors involved Contacting and inviting actors to participate
Goals	Important representatives of the system participate Members get acquainted with each other Networking of group members
Methods	Actor Analysis
Product/milestone	Consolidation of the system expert group System expert group familiar with purpose and products of the study

Workshop 2:	**Feedback and Elaboration of Concepts Model**
Preparation	Documentation of individual actors’ cognitive maps, problem definition and model concepts of static and dynamic models
Goals	Actors reflect on own strategies with respect to strategies of other actors Actors reflect on the system with help of the dynamic model Actors give feedback on the two models, discuss and elaborate models
Methods	Group model building (Andersen and Richardson 1997; Vennix 1996)
Product/milestone	Model concepts are defined

Workshop 3	Elaboration of and Feedback on Dynamic Model, Needs and Questions for Transformation Support Tool
Preparation	Testing of the dynamic model, back-casting experiments; integration of static behavioral antecedents model, Documentation of insights of both models and results of the survey of the local actors
Goals	Sharing insights with system experts group Negotiation of shared understanding of both models Formulation of hypotheses about control levers Collection of actor questions about scenarios and control levers
Methods	Model Assessment and Policy Design
Product/milestone	System expert group is familiar with main results of the research Actors' information and needs (hypotheses, questions) as basis for the transformation support tool are collected

Workshop 4	Introduction into Transformation Support Tool
Preparation	Policy experiments with dynamic model Development of transformation support tool
Goals	Introduction and feedback on transformation support tool Actors get answers to important questions, learn about the system and levers
Methods	Monitoring of Key Performance Indicators
Product/milestone	Transformation support tool which can be used by actors (especially public authorities) as basis for policy formation

Table 3: Planned Workshops for the Group Model Building Project (Kaufmann-Hayoz, Bruppacher, and Ulli-Beer 2005; Ulli-Beer et al. 2006)

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