(Working Paper)

Targeted Participative Modelling
- conceptual discussion and case study presentation

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Abstract:

The purpose of the paper is to propose a modelling approach to be used in targeted organisational interventions focusing on strategic business objectives and change management. The approach builds upon prevalent participative modelling approaches with the extension of increased focus on intervention planning, stakeholder management, and structured implementation. A single-site longitude case study regarding development of a balanced R&D location strategy served as inspiration for the development of the approach – and in the paper it also serves as a practical illustration of the approach. Interesting insights include successful observations of individual learning and group communication in a modelling study, which is more targeted on predefined business objectives than usually seen in the SD community. However, generic conclusions must await further research within the area.

Keywords: participative modelling, organisational interventions, strategic objectives, change management, location strategy.

1. Theoretical foundation for the case study: System dynamics from a system intervention view point

The system dynamics field has its origin as a primarily analytical and rational oriented problem investigating and policy forming discipline (Forrester, 1961; Milling, 1984). With the emergence of participative modelling and learning approaches (Vennix, Andersen, Richardson and Rohrbaugh, 1992; Vennix, 1996; de Geus, 1988; Lane, 1992) increased focus has been put on organisational learning, creating conceptual insights, aligning mental models of decision-makers and creating consensus and commitment. This development might follow the change in hierarchical structures in many organisations. Modern organisations with a high degree of employee empowerment typically have a need for a large number of people to have

an understanding for the whole of the organisation and its strategy, including the dynamics and the interdependencies, to be able to make the right decisions in their daily work as well as for motivational factors. The challenge of interventions is therefore not only to find good solutions to problems or new situations. The solution must also often be understood and find acceptance among the major stakeholders. To reach such a solution it is necessary to plan the entire intervention process with due respect to the disciplines of planned change (Cummings and Worley, 2001).

The application of system dynamics in organisational interventions is characterised by a large variation regarding the emphasis, which is put on traditional change management methods, such as intervention planning, stakeholder management and the implementation process itself. In search for understanding why, it is useful to distinguish between modelling efforts in what could be called “targeted interventions” and “explorative interventions” (see Figure 1).

Explorative intervention modelling efforts are driven by the desire to explore and understand system behaviour and to identify possible new policies addressing a messy problem. Examples of these types of interventions are scenario testing in strategic planning and strategic problem-solving, which are typically highly iterative seek-and-learn interventions. These interventions do not have the “control” characteristics of planned interventions, for example detailed project plans, thorough stakeholder analyses and communication plans, which is due to the fact that the change process cannot be defined before the outcome of the explorative intervention is—at least to some extent—clear. Often, an explorative modelling intervention will result in changed mental models among decision-makers; frequently, implementation will not take place in an explicit, planned change manner. The difference between the two modelling types used in explorative interventions, explorative participative modelling and expert modelling, is primarily to be found in the way people are involved. In expert modelling, people—besides a few modellers—are primarily involved for information collection purposes (Forrester, 1992). Participative explorative modelling approaches involve people with “a wide variety of view-points” in the modelling process itself (Vennix, 1996).

Targeted participative modelling belongs to the planned change type of organisational interventions and has many common characteristics with the field of action research, with its dual focus on the implementation of planned change as well as on knowledge development (Cummings & Worley, 2001). Furthermore, targeted participative modelling is characterised by being driven by business objectives and targets, and being relatively result-oriented; often taking form as strategy or policy *optimisation* rather than strategy or policy *making*.

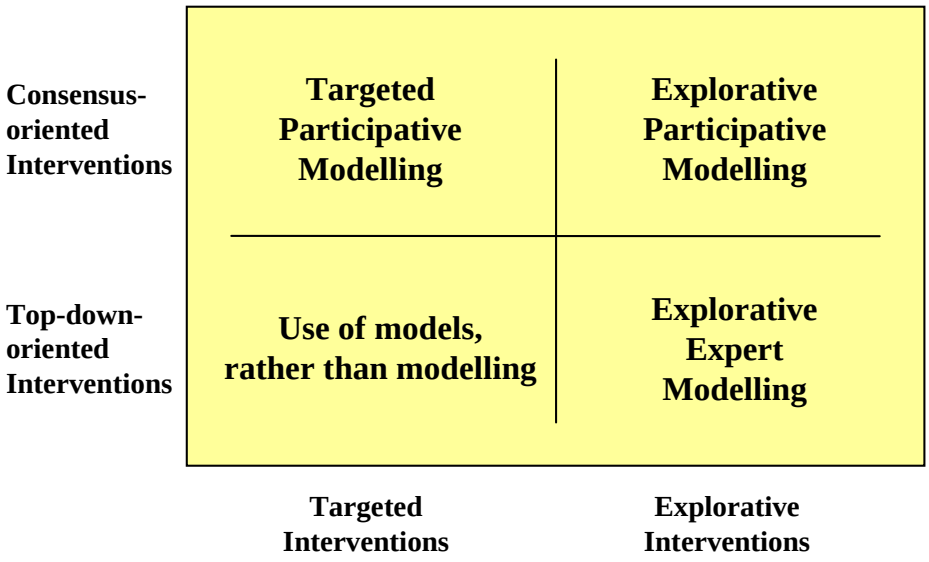


Figure 1: The use of system dynamics in different intervention situations

The targeted participative modelling intervention could be combined with explorative expert modelling or explorative participative modelling as initial efforts in the establishment of the objectives and targets that drive the targeted participative modelling approach. It is a common issue in change management that, when targeted change interventions are consensus oriented, a balance is needed between the initial detail level of the objectives and the degree of freedom to make decisions in the process (Borum, 1995). This could be called "framing" the intervention, giving participants empowerment to explore, decide and act within a given frame (e.g. "how to do"), but not to explore, decide and act outside the given frame (e.g. "what to do").

For targeted interventions, which are also top-down-oriented, modelling is less relevant. Here, system dynamics applications are more likely to be models in communication, flight simulators, educational games, etc.

Regardless of the intervention situation, the main steps of the modelling process itself remain the same. Luna-Reyes and Andersen (2003) have made a conceptual summary of the system dynamics modelling process across five selected representatives of the classical literature, from which Figure 2 is adapted[i]. The four-phased description of the iterative modelling process is also concordant with the modelling understanding in some of the most respected participative modelling approaches (Vennix, 1996; and Vennix, Andersen, & Richardson, 1992), which is important, as participative modelling is a cornerstone for the research proposed in this paper.

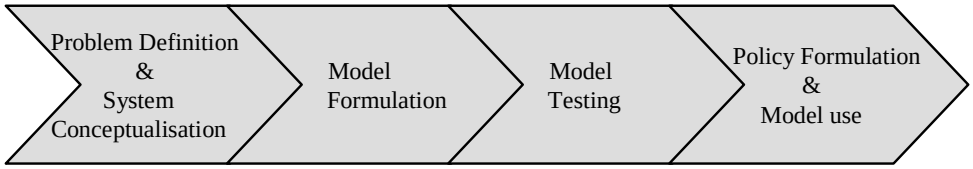


Figure 2: The prevalent system dynamics modelling process

Respecting the scientific foundation and the large number of proven successful interventions supporting the prevalent modelling process, this research has no intention of improving the modelling process as such, but merely to propose the value of placing the modelling process in a planned change organisational intervention context. It is not something new to place SD in an organisational intervention view-point. This is in accordance with the thoughts in "Total System Interventions" (Flood, 1995), and the view expressed in (Morecroft, 1992) proposing that SD models increasingly are viewed as instruments to support strategic thinking, group discussion and learning in management teams, and where "maps, frameworks and micro-worlds" are placed in an intervention viewpoint. What is new, is the use of SD in a *framed* context, using SD in an intervention with pre-established targeted business objectives and increased focus on change management. The developed approach aims at explicitly integrating SD modelling with traditional change management disciplines.

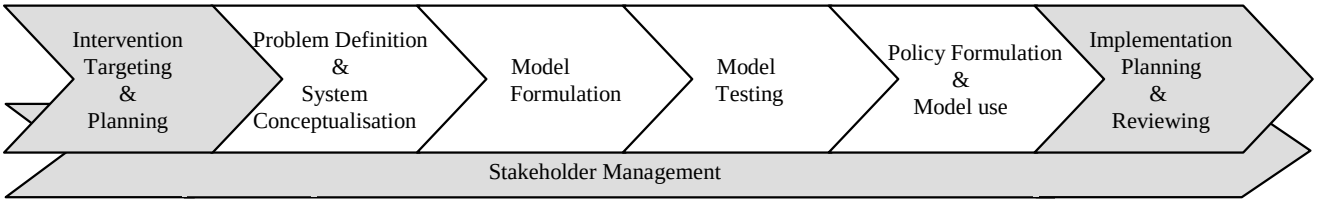


Figure 3: "Targeted participative modelling approach": The system dynamics modelling process in a targeted participative organisational intervention perspective

The targeted participative modelling approach extends the prevalent modelling process with three new phases (see figure 3). The three new phases are not mutually independent, nor are they independent from the phases shown in Figure 2. Also it is important to note that the existing prevalent modelling processes takes into account both planning, stakeholder management, and implementation activities. The difference is, that the targeted participative modelling approach makes the activities explicit and extends the scope compared to other known modelling approaches. The three new phases will be described further in the following paragraphs.

Intervention Targeting and Planning

This phase includes the definition of business objectives and targets, the framing of the intervention, the identification o f consultation relationships and roles and responsibilities in the

project organisation, and the intervention planning. Thus, this phase contains SD and non-SD activities, for instance the coordination with related projects and activities.

The phase is strongly iterative with problem identification and system conceptualisation: for example, identification of problem stakeholders and problem definition are mutually dependent. Also, the setting of business objectives and framing the intervention cannot be done independently of the system conceptualisation. For this reason it could be anticipated that a preliminary model often can be of value in the targeting and planning process. The messier a problem, the more iteration can be expected between this phase and the later phases.

Stakeholder Management

This phase is strongly iterative between all phases of the targeted participative modelling approach. The stakeholder analysis involves a thorough analysis of all the major interest groups and individuals who have significant influence—directly or indirectly—on the success of the intervention. Focus is on interests and power, importance for solution design and implementation, and relevant means of involvement and communication (Flood, 1995; Borum, 1995). The stakeholder analysis is a major input into the intervention planning, both to secure relevant parameters to be included in the process, and to secure appropriate involvement and communication with stakeholders and employees (Cummings & Worley, 2991). The communication strategy and plan develop over the phases of the intervention and includes elements such as motivating change and the communication of visions, results, implementation plan and also successes.

Implementation Planning and Review

Warren (2002) is pointing out, that major researchers within the field of strategic planning devote much attention to the discussion of problems in the strategy process, and especially the implementation of strategies and policies, as implementations far too often remain unsuccessful. A parallel to the discussion of the problems of implementation of strategies can be drawn from the view of Repenning and Sterman (2002) on improvement programs, where successful implementation of new methods presents a bigger challenge than identifying or learning new improvement methods, i.e. in this area the implementation of a solution to strategic problems constitutes a bigger challenge than finding the solution. The last phase in the targeted participative modelling approach deals with the activity planning of the implementation, including a communication plan and a clear assignment of responsibilities. The model and continuous modelling efforts might play a role in the implementation, for example as communication tool, as flight simulator or in group simulation workshops among change “ambassadors”. This implementation phase furthermore includes establishment of procedures for reviews and corrective actions.

2. Case study context: balancing a location strategy for an R&D division in a large company

The case study company is a major, international company, who is a market leader in its main product area. Research and development (R&D) is a large and critical part of the company's sustainable competitive advantage, reflected by the fact that approximately every third employee works in R&D. The company has a strong tradition for employee empowerment and is a relatively un-hierarchical organisation. The case study is carried out in one of the major R&D divisions, consisting of a number of rather different R&D business units.

The problem regards development of a balanced strategy and implementation plan for the number of R&D employees placed in high-cost countries (e.g. the USA and Western Europe) vs. the number of R&D employees placed in low-cost countries (e.g. India, China, Eastern Europe). Today, the company has significant more R&D employees in high-cost countries with the consequence of relatively high development costs compared to future competitors. The cost of an R&D employee in a high-cost country is approximately four times the cost of an R&D employee in a low-cost country. It is a sensitive issue due to the fear among employees in high-cost countries that the future could bring reduction of staff in high-country locations as is seen in many other companies in the USA and Western Europe. The situation at this company, though, includes strong growth expectations and the company has no intention of weakening existing high-cost locations. All strengthening of low-cost R&D locations will be reflecting a world-wide growth of the R&D to gain speed in time-to-market – and the motivation is not only increased capacity and cost-efficiency, but also an objective to have local presence in these growing markets with increased future sales in sight. New employees in low-cost countries will primarily take over tasks currently being carried out in high-cost countries. This way the company will free capacity of experienced senior R&D employees in high-cost countries to be used in new, challenging R&D projects.

The objective of the modelling is to understand the most influential parameters in building up capacity in low-cost locations with regards to productivity and costs, and using this to define the ideal strategy balancing board expectations to reduced cost/capacity ratio with an effective and realistic implementation plan.

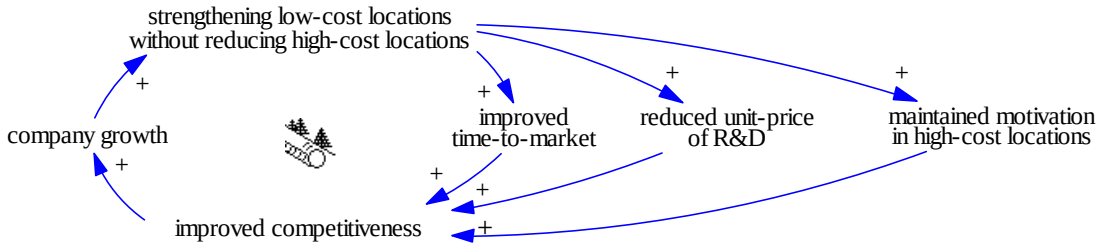


Figure 4: The reinforcing growth loop underlying the intervention[ii]

3. The intervention process

The location strategy project was first initiated with a project team in each of the five business units in the Division, but due to lack of consistency and efficiency, and lack of structure in the coordination and communication between the teams, it was decided to develop a shared, formal model on an abstract and highly aggregated level, aiming at:

- creating a structured and "objective" frame for the rather emotional and diverse discussions;
- establishing a forum for exchange of experiences and best practices;
- identifying the best way to reach the business objectives and target outlined by the board;
- improving the change process effectiveness.

The change imperative was stated as: "right now is the right time to hire people in the low-cost locations, because right now it can be done without staff reduction at high-cost locations, and the expected results are improved competitiveness and further company growth, also securing jobs at high-cost locations in the future". This was a difficult message to communicate, because of the fear of jobs moving from high-cost to low-cost locations.

An external facilitator from Mannheim University was brought in as process coach and modelling facilitator, based on the targeted participative modelling approach.

In the rest of this chapter, the intervention process is described in 4 sub-chapters: (3.a.) Intervention Targeting and Planning, (3.b.) Stakeholder Management, (3.c.) The Modelling Process, including problem definition and system conceptualisation, model formulation, model testing and policy forming & use, and (3.d.) Implementation Planning and Review.

3.a. Intervention Targeting and Planning

Targeting and planning the intervention involved initially a discussion with the project owners about the problem, the business objectives, the intervention objectives, the dynamic hypotheses, and the suitability of applying system dynamics to the problem. A preliminary model was built with the purpose to (1) justify that applying system dynamics would increase project effectiveness, and (2) for the project owners to feel confident that major learning from the model was compliant with their view of the problem. This was the basis for the decision to move forward with the modelling efforts.

After the decision to use modelling in the change process, a total system intervention planning took place, involving both SD and non-SD activities, and coordinated with other projects, most importantly the business planning and budgeting process. The project planning included establishment of roles and responsibilities in the project. Figure 5 illustrates the change process

with visioning and modelling on division level combined with project and implementation ownership on business area level. The phases 1-3 took place September to December 2004 and Phase 4 is ongoing.

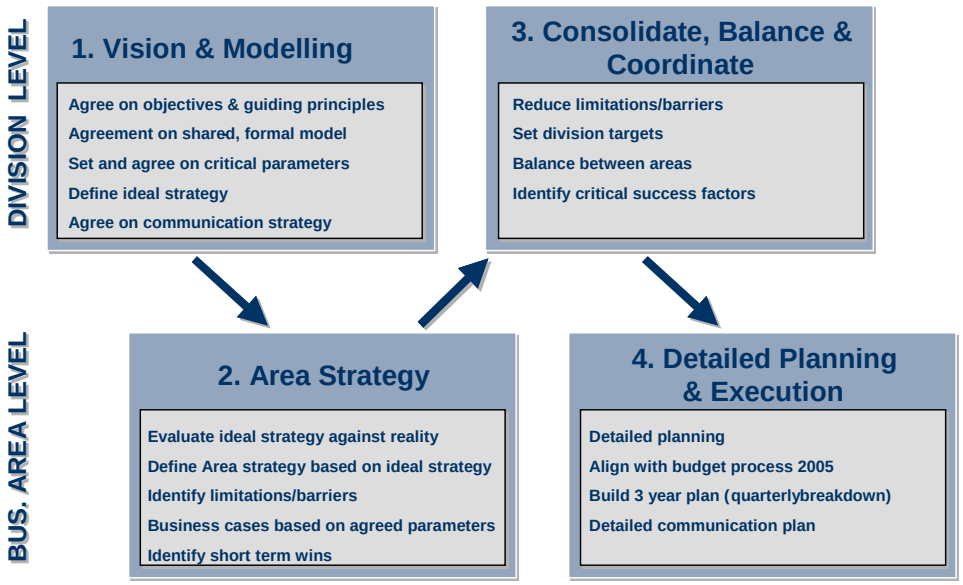


Figure 5: Iterative phases in Intervention Targeting and Planning

The project was designed to combine top-down visioning and modelling (division level) with bottom-up design and planning (business area level). Coordination and balancing of the plans from the different units was done on division level, followed by detailed planning on business area level.

The external facilitator focused on moderating the group model building processes and also worked as a process coach for the entire intervention. In the meetings and the workshops, the discussion facilitation was done by one of the project owners, with in depth knowledge of the company, the problem and the intervention goals. In planning and carrying out the modelling activities, the external facilitator draw from extensive literature studies within the field of system dynamics, and with special attention to (Sterman, 2000; Vennix, 1996; Andersen, Richardson, and Vennix, 1997; and Richardson and Pugh, 1981), as well as experiences from more than 10 years as a management consultant in business process reengineering and change management.

3.b. Stakeholder Management

Stakeholder Management explicitly deals with how to involve and communicate with major project stakeholders, and it is not only an interesting discipline itself, but also strongly integrated with major parts of the intervention planning, the modelling process, as well as the planning of implementation and reviews.

The major stakeholders were identified early in the process, and the five business units responsible were consulted about the plan for the system intervention to give their input as well as

commitment. The process was agreed upon, and the project organisation was established. The major stakeholders are the management team of the Division (senior vice presidents, each responsible for a R&D business unit), the project owners (the division chief controller and the COO of the Division), the project team chosen to find the proper strategy (called location champions), corporate controlling, corporate management, the world-wide corporate location strategy responsible, and all the day-to-day managers with high influence on the implementation of the strategy. Furthermore, all employees of the Division are stakeholders in a communication strategy point of view.

3.c. *The Modelling Process*

The solution design activities consisted of a larger number of meetings and workshops with a variety of agendas around the problem. Only around half of the activities directly involved the modelling or simulation, but all meetings typically had impact on the model, its parameters and/or the process of implementing modelling results.

The modelling and simulation process with the core project team served as a cognitive framework for objective discussions of the problem – challenging preconceived perceptions and aiming at reducing the tendency often known from budgeting and business planning processes, that each stakeholder to some degree primarily looks after his or her business unit's interests rather than corporate objectives. Using a model moves the focus and discussion towards a holistic view. In this process some important new aspects – including one additional stock and a number of additional parameters – were added to the preliminary model. Also some parameters and relationships with only little importance were excluded aiming at simplifying the model. For communicational purposes, the modelling process was focused on developing a relatively simple model that could give a picture of the overall behaviour of the problem-system without including too many details, as overview was considered more important than detailed correctness, partly due to the fact that the system dynamics Vensim model was complimented by more detailed excel-models (the actual business cases for each business unit) with the format needed in the budgeting and business planning process.

The parameter setting was a cornerstone in the change-process, as these agreed parameters formed the basis for each business unit's business cases in phase 2 of the intervention process. The discussion of the parameters often implied a discussion on how the strategy could and should be executed, as the parameter setting reflected implementation decisions; e.g. the logistics and cost model of travelling, how to structure knowledge transfer, etc.

Model testing was done partly "behind the scenes" by the modelling facilitator using some of the most respected sources as guide and "checklists" (Barlas, 1996; Forrester and Senge, 1980), partly during the modelling and simulation efforts, as „validation is the process of establishing confidence

in the soundness and usefulness of a model“ (Forrester and Senge, 1980). Also it is worth remembering Forrester's (1968) view on model validity: “Model validity is a relative matter. The usefulness of a mathematical simulation model should be judged in comparison with the mental image or other abstract model which could be used instead”, indicating that if it using a model in a given situation yields more value than using alternative images or model, this in itself is a criteria for justifying the model.

Through the simulation of different scenarios (changes in parameters and decision-rules) the discussion focussed on the most influential parameters and causal relations of the problem, and possible improvement options.

Based on the modelling and simulation, a presentation with the most important learning was developed to document the major insight reached by the core project team. This presentation, together with the Vensim model and the excel models was used in communicating with the other stakeholders to both communicate the results and to receive their input on the model, the parameters and the insights gained.

3.d. Implementation Planning and Review

Detailed planning of the implementation per business area was seen as one of the critical success factors. It states clearly which tasks are to be moved from each business unit in high-cost countries and furthermore is specific about the future tasks of the affected employees. This, and a detailed communication strategy and plan – were considered to be the cornerstones in securing motivation and morale among employees. The implementation plan furthermore includes clear delegation of responsibility for improvement of the parameters identified to be the most influential ones. Reviews and follow-ups are about to be integrated in the existing performance measurement system.

For practical reasons it was not possible to involve all managers, who have high stakes in the execution of the strategy, in the modelling process as such. It was decided to involve a number of these managers later in the process, in workshops dealing with the discussion and coordination of the change, and including a simulation session, where people will have the chance to test their own assumptions and understanding by use of the model. It was decided that the involvement and education of these “change agents” – combined with detailed implementation planning and use of the normal communication channels – was sufficient to implement the change and that it was not relevant to build a management simulator or establish formal education programmes.

(A workshop with additional key change agents is to be held in April. This group of change agents will include managers from many different lines of business, all with a direct or informal responsibility for the execution of the location strategy. The results of this meeting will be reported in the final paper).

4. The model, theoretical considerations, selected simulations, and key results

Model objective is to find an effective and realistic plan for reducing the cost/capacity ratio under board guidelines of (1) cost growth only due to inflation in high-cost and low-cost countries, and (2) increase from 10% to 25% of low-cost headcount of the total headcounts of the division, with the two main leavers being growth of the total number of employees as well as replacements not being made in high-cost but in low-cost.[iii]

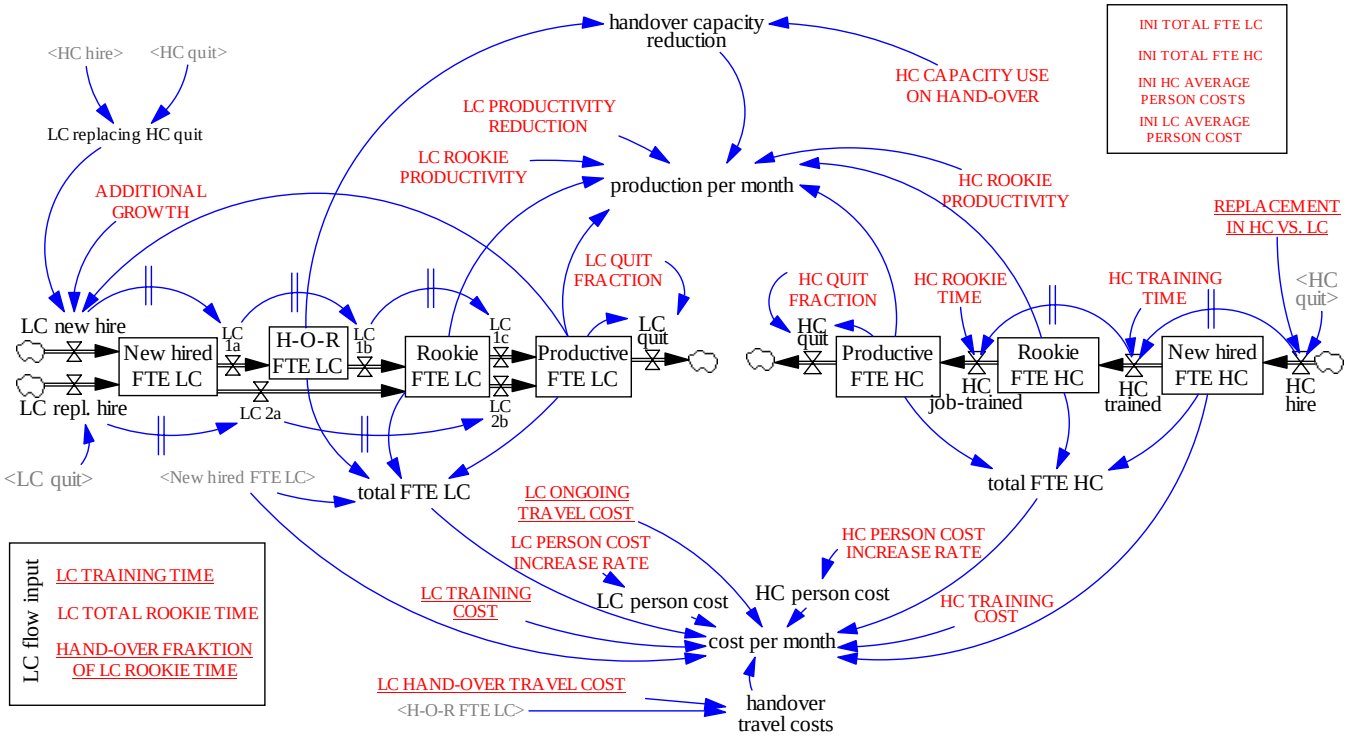


Figure 6: The location strategy model

The basic structure of the model is based on two separate aging chains, each being an extended version of Sterman's (2000) "two-level promotion chain".[iv] The right hand side aging chain represents the high-cost locations; the left side aging chain represents the low-cost locations. On each aging chain this model has three basic stages: "New hired FTE", who are newly hired employees (Full Time Equivalents) spending their time in class-room training learning the development tools of the company; "Rookie FTE", who are employees working on development projects with reduced productivity, and then finally "Productive FTE", who are fully productive employees. In the low-cost aging chain an additional stock was added: a stock containing Rookies spending time on taking over tasks from high-cost countries, which will be the case for all new employees in low-cost who are not merely replacing people who have left a position at a LC location. This stock is called H-O-R FTE (Hand-Over-Rookies), and these employees have zero productivity, and as they are spending time physically with those HC employees whose tasks they

are taking over, they furthermore tax time from fully productive employees in high-cost countries in the process of knowledge transfer.

The two main decision points of the model are:

(1) the rate "HC hire", where only a share of the employees leaving high-cost locations will be replaced at a high-cost location, depending on the factor called "replacement in HC vs. LC". Those not being replaced in HC will be replaced in LC.

(2) the rate "LC new hire", consisting partly of those HC quits that are being replaced in LC, and partly of the additional new employees joining the division. All additional new employees are allocated to low-cost countries, based on a growth factor relative to the stock of experienced employees in low-cost.[v]

It is important to notice, that tasks will be moved from high-cost to low-cost locations in bulks. If a position in a high-cost country is not being replaced with a new hiring, a person who has transferred his or her tasks to a low-cost country will take over the task. Employees in high-cost locations, who have transferred their tasks to low-cost locations, will either take over tasks from a person leaving the division or take part in totally new R&D projects within the Division.

Depending on the two main leavers – and the setting of the remaining input parameters – the two main output parameters are being calculated, these being cost per month and production per month.

The stocks in the model are initialised in equilibrium (hire rate = quit rate) through a distribution of the total number of employees for both low-cost and high-cost countries to their respective stocks of newly hired, rookies and experienced FTE's (the number of newly hired + rookies + experienced FTE = total number of employees). The distribution into the three categories is a calculation based on quit rate, training time and rookie time.

For detailed description on parameters, main equations, and the calculations of stock initialisation, please see the submitted "additional material" (also submitted anonymous).

Theoretical considerations of the model

In the modelling process, the facilitation and communication function was given priority over model correctness; especially in terms of using parameters directly useful in the budgeting process, and also in keeping the model as small as possible to avoid a "black box" effect.

The growth rate "ADDITIONAL GROWTH" could have been modelled reflecting a goal-seeking structure based on the discrepancy between the actual value and the goal-value for the fraction of LC employees out of total number employee (combined with use of a MIN-function in the LC new hire-rate to secure that the number of newly hired employees does not exceed a realistic level compared to number of experienced employees). This would have made endogenous the policy of how many additional employees to hire. But to keep the model simple and with focus on the few, most important parameters, the growth rate is simply implemented as a constant (fixed for the first period, then gradually decreasing to being zero after the 36th month). Furthermore, it was discussed if the cost policy should have been modelled endogenous. This would mean that all hiring would only by allowed when respecting the accepted cost growth (e.g. inflation). Again, with the argument of keeping the model simple, and as well as to identify the extent of cost over-runs as a consequence of different scenarios, it was decided not to handle the cost restriction policy endogenously, but to incorporate cost as an explicit auxiliary (which was then one of the most discussed parameters for each simulation run).

In Sterman's (2000) "Two-level promotion chain" the rate of employees moving from "Rookie" state to "Experienced" state was modelled as a fraction of the number of Rookies. In the location strategy model the rates between stages are calculated as delay-functions of the inflow-rate. For the training period, a high-order delay was used resembling a pipeline delay, as this is a fixed period of time for each employee. For the period of being a Rookie, a lower order delay was used, to reflect the variability in the learning curve for individuals. The variability in the difficulties of the task areas is not explicit in the model, but is considered in stipulating the average time for employees being Rookies. There is a tendency among system dynamic practitioners to prefer delays modelled with outflow-rates as a fraction of stock-level. This might have two explanations: (1) prevailing attention to macro-trends of systems with continuous parameter development rather than systems with steps in inputs, and (2) a historical tradition based on Forrester's (1968) "Principles of System", which can be dated back to a time where delay-functions constituted a computer-technical challenging effort. For the location strategy model, a new strategy implying a step in the hiring in the very beginning, is being investigated, and the use of the delay-function reflects better the true patterns of employee-flows in the start-up period, avoiding hand-over of tasks starting to take place nearly immediately instead of waiting for new employees first having to be trained. This is intuitively more acceptable for group modelling participants, but interesting enough, the major trends and learning (even regarding year 1) are the same with both ways of modelling the delays (see appendix A).

Selected Simulations

Figures 8 and 9 show four simulation runs based on a parameter-setting with only the few variations described below:

- **INI**: No changes in number of employees in low-cost or high-cost (hire rate = quit rate)
- **Base run:** Replacement in HC vs. LC = 0.2 in the first 36 months; then 1
  Additional Growth = 3% per month year 1, then linear decreasing to 0 after 36 months
- **40% HC replacement**: As base run, but Replacement in HC vs. LC = 0.4 instead of 0.2
- **Faster training and hand-over**: As base run, but with reduced time to training and hand-over

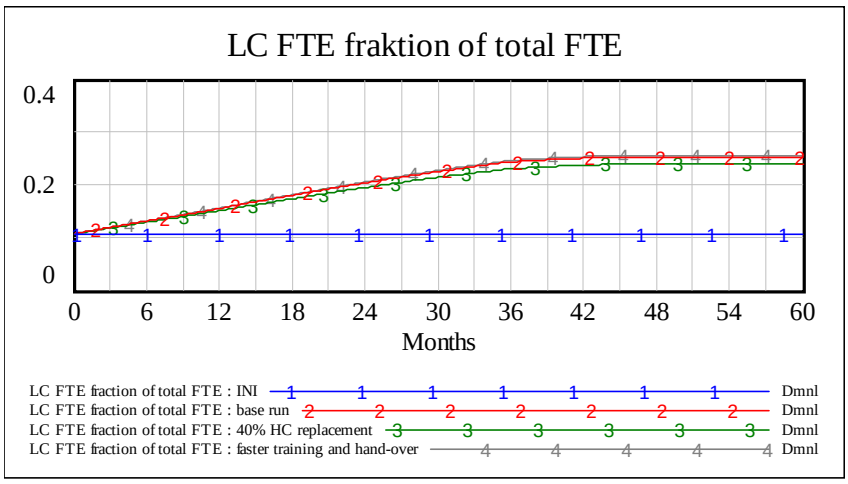


Figure 7: Fraction of employees in low-cost countries compared to total number of employees in the division

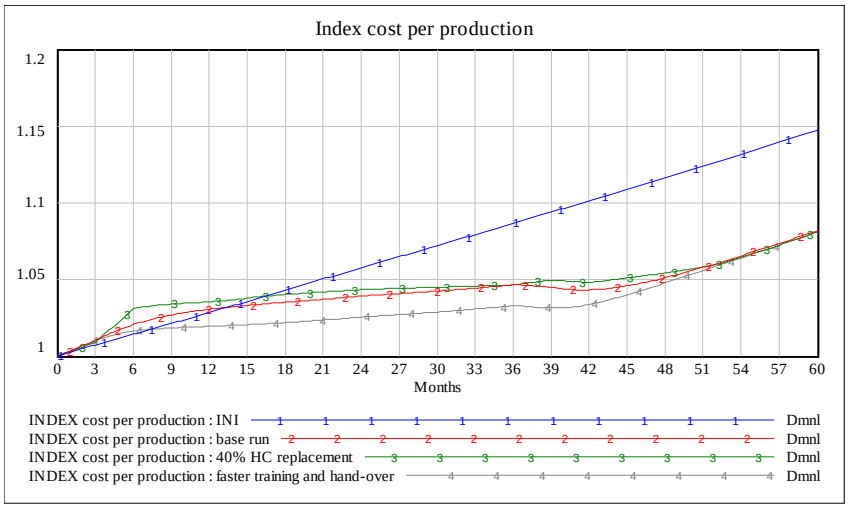


Figure 8: Development in cost-index for an average productive unit (e.g. cost for one man for a fixed period of time)

Key results of the modelling exercise

To some extent it is always a subjective exercise to interpret model results, and in this case especially because it is a subjective estimate of how much each input-parameter can realistically vary. The following is a description of the core group's understanding of key results:

- Not replacing all headcounts in high-cost locations for a 3 years period is the only practical way to build up resources at low-cost locations in a (fairly) cost-neutral scenario.
- Hand-over efforts have a strong "worse-before-better" effect on productivity, and action must be taken to optimise this process – even if this results in higher travel costs.
- Reducing training time has an accumulative productivity effect, and with the large number of new employees, investments should be made to optimise their training – even if this results in higher training costs!
- Travel expenses had less influence on the overall cost-picture than first anticipated by the group.
- Person costs at high-cost and low-cost locations were viewed as given parameters, and the rookie-period of 6 months was also perceived as a given parameter, which cannot be optimised.

Factor	Impact	Recommendation	Responsible
External Replacement Rate	Replacement hiring in LC when HC people are leaving is the only way to reach a cost-neutral solution	Very experienced internal employees in HC to take over tasks of people leaving. New tasks in LC for replacement hiring	Area SVP HR
Hand-over time and HC capacity use on handover	Hand-over efforts significantly influence productivity (due to use of HC resources). Also the length of the hand-over periods create travel costs	Optimize hand-over time to free HC capacity (and secondary also to reduce period of LC traveling)	Area SVP LABS
Training time and costs	Reducing training time will speed up productivity of new employees and thereby increase productivity in the 3 years build-up period. Reducing training costs has little influence.	Due to the large number of hiring in LC it seems relevant to continuously optimize the basic training especially time-wise (cost-wise has only little influence)	LABS Area SVP
Travel expenses	In the long run the on-going LC travel is important. On the short horizon reducing handover travel has some positive influence	Traveling should be done cost-effective but not be a limiting factor in effective knowledge transfer	Area SVP LABS

Note: Person costs in HC and LC, and a 6 month rookie period with 50% productivity, are seen as non-variable parameters.

Figure 9: Key results as presented to the steering committee

5. Evaluation of the case study

As opposed to survey approaches, a case study approach typically focuses on putting spotlight on one instance to be investigated in more detail and thereby concentrating efforts rather than trying to cover a large number of instances; aiming at illuminating the general by looking at the particular (Denscombe, 2003).

Voss, Tsikriktsis, & Frohlich (2002) categorise case research based on purpose: Exploration, Theory building, Theory testing or Theory extension/refinement. In these terms, the purpose of the present case study is "Theory building", since no particular theory regarding the use of participative modelling in an organisational intervention view-point is supporting the research, and also due to the fact that the case study alone does not have research characteristics that would qualify for testing a theory. This is in accordance with the view, that „case studies are only suitable to generate hypotheses, not to test them rigorously" (Andersen, Richardson and Vennix, 1997). An iterative seek-and-learn relationship exists between the theoretical development of "targeted participative modelling" approach and the case study; with the literature studies and the first versions of the developed approach underlying the construction of the case study – and with the case study insights at the same time serving as inspiration to the further development of the approach. As the literature study includes reports of known cases, and are supplemented with a number of informal interviews with experienced practitioners from the system dynamics field, the present research is attentive to advices in some of the major publications in the field of case study research (Eisenhardt 1989; Leonard-Barton, 1990).

The evaluation of the case study has to take the above mentioned method considerations into account. Being a longitudinal, real-time single site case, with no test group for comparison, means that even if the intervention yields good results, it is impossible to know if other intervention mechanisms would have yielded even better results. Also it is important to note, that the case study itself is subject to both content and process bounded rationality, and - so is the evaluation of the case study. The expectations and mental models of the external facilitator bias both the observations, the understanding of the interviews, as well as both the forming and the interpretation of the questionnaires

The description of the evaluation of the case study is described in the following five sub-chapters:

- 5.a: Description of evaluation framework
- 5.b: List of facilitator observations and quotes from interviews
- 5.c: Questionnaire results

5.a. *Description of evaluation framework*

The developed evaluation framework takes the theoretical point of departure in the evaluation frameworks developed by (Huz, Andersen, Richardson and Boothroyd, 1997) and later (Rouwette, 2003); and is adapted to the research focus and the data collection conditions of the case study. The evaluation is structured in three sections: evaluation of outcomes, evaluation of method, and comparative conditions that may explain intervention's effectiveness.

Evaluation of outcome:

- Evaluation of outcome on individual level
- Evaluation of outcome on group level
- Evaluation of outcome on organisational level

Evaluation of method and comparative conditions:

- Method evaluation of the use of system dynamics modelling compared to other approaches
- Method evaluation of the specifics of targeted participate modelling compared to other system dynamics modelling approaches
- Comparative conditions that may explain intervention's effectiveness (both context comparative conditions and mechanism comparative conditions)

The evaluation of both outcome and method is relevant in regard to identify benefits of the intervention. It gives some guidance to the effectiveness of the applied mechanism, but - in the nature of a seek-and-learn case study with no test group – it will not give data to support or reject conclusion about the relative effectiveness compared to alternative mechanisms. The value of the evaluation is therefore strongly connected with the search for explanations and focus on "why" certain outcomes might happen.

The data on the measure variables was collected from three sources: (1) own observation, (2) interviews, and (3) questionnaires among both core team members and non-core project participants.

The usefulness of the sources differs between the measure variables, but nevertheless it does add some information to apply all three sources to basically all the variables regarding outcome and method. In the analysis the sources are used in a weighted way regarding their appropriateness to each measure variable.

The questionnaires were designed to be answered anonymously, and short (1 page) to increase response rate, and they were aiming at providing unambiguous and objective questions about participants opinions regarding both intervention output and mechanism on a 1 to 7 scale (from strongly disagree to strongly agree, 4 being neutral). The questions refer directly to the measure variables in the framework, to reduce bias due to the researcher's own pre-coded view of the

research. Also, the use of checklists for how to use and design questionnaires was applied in search for reduced bias (Denscombe, 2003), and the questionnaires were pre-tested with both a project owner and a research colleague. The questionnaires were given to all core team members, the project owners, the most involved non-core participants and later also an extended group of change agents will take part.

The interviews were structured around the same measure variables as the questionnaires, but with open questions, and the interviews were conducted with the two project owners. The researcher's own observations are furthermore also described in the same structure as the questionnaires and the interviews.

The following tables illustrate the applied framework's sources for data collection:

Table 1.a: Main sources for evaluation of outcomes on individual level

Measure variables	**Questionnaire self assessments**	**Interviews with project owners**	**Observations**
Personal reactions to the modelling process (see also under method)	"I believe it was useful to include the model in the project"	Project owners' perception of participants attitude towards the process	Attitudes in modelling sessions and other meetings
Gain of learning, and changes in goal structures and mental models	"I gained interesting learning from the model"	Project owners' perception of insights gained by individuals	Changes in positions in the discussions (and pre/post tests of change ambassadors)
Commitment to the outcome of the modelling sessions	"I agree with the recommendations derived from the model – and will act accordingly"	Project owners' perception of the commitment among participants	Whether participants in subsequent meetings actively argued for the results
Changes in behaviour	"The modelling effected some of my decisions"	Project owners' perception of the business case's alignment with the modelling results	Observations regarding behaviour

Table 1.b: Main sources for evaluation of outcomes on group level

Measure variables	**Questionnaire self assessments**	**Interviews with project owners**	**Observations**
Group communication	"The meta-model was a useful framework facilitating discussions"	Project owners' perception of the communication during modelling sessions	Whether the modelling process created open discussions and exchange of views
Consensus	"The modelling process helped building a shared view of the location strategy"	Project owners' perception of group consensus established through the modelling process	Weather the group seemed to get closer in opinions regarding the strategy

Common language	"The modelling efforts helped creating a common language for the location strategy"	Project owners' perception of creation of a common language through the modelling sessions	Agreement on using the same terms – also outside the modelling sessions
Transfer of insights	"The meta-model was a useful tool in the presentation of the ideal location strategy"	Project owners' perception of the usefulness of the model in transfer of insights	Effectiveness in transfer of insights to non-core project participants

Table 1.c: Main sources for evaluation of outcomes on organisation level

Measure variables	**Questionnaire self assessments**	**Interviews with project owners**	**Observations**
System changes	"I believe the recommendations from the modelling process will be implemented"	Project owners' perception of the boards reaction to the recommendations	If decision is included in budgets and overall business plans
Results	"I believe the recommendations will have positive business impact"	Project owners' expectations regarding business benefits	Business results

Table 1.d: Main sources for evaluation of SD compared to other approaches

Measure variables	**Questionnaire self assessments**	**Interviews with project owners**	**Observations**
Efficiency (compared to normal project execution in the case company)	"The use of modelling increased the efficiency of the project process"	Project owners' perception of the efficiency of the process in general	n.a.
Efficiency (compared to other approaches or methods)	"Using modelling in this case was more efficient compared to other approaches"	Project owners' perception of the efficiency – compared to if other approaches had been used	Project progress compared to other types of consulting approaches (*highly subjective*)
Quality in results	"Using modelling in this case created higher quality results compared to other approaches"	Project owners' perception of the quality of the results compared to if other approaches had been used	The importance of insights gained *(highly subjective)*
Further use of SD	"I intend to use modelling in other relevant change projects"	Project owners' perception of the general trust in the model	(later)

Table 1.e: Main sources for evaluation of the "Targeted modelling process"

Measure variables	Questionnaire self assessments	Interviews with project owners	Observations
Intervention driven by business objectives and targets	(not included)	Project owners' perception of the importance of initial business objectives and targets	How the initial established objectives and targets influenced the process
Project framing (effectiveness)	"It was useful to start with a 1st draft of the model to kick off the process"	Project owners' perception of the usage of a preliminary model	Possible conflicts concerning model boundaries
Project framing (consequences for model trust and ownership)	"I believe the model reflects the core of the problem"	Project owners' perception of the project participants' and own trust & ownership	Attitudes in modelling sessions and other meetings
Structured involvement of change agents	"It was useful to have a modelling workshop with a broad group of change agents" (later)	Project owners' perception of the importance of change agents	Change agents' influence on the modelling process as well as on the entire intervention
Other change management variables	(not included)	(to be included later)	(to be included later)

Comparative conditions that may explain intervention effectiveness (both context comparative conditions and mechanism comparative conditions) will only depend on observation, as neither questionnaire nor interviews included this.

5.b: Facilitator observations and key quotes from interviews

Table 2: Facilitator observations and quotes from interviews with project owners

Personal reactions to the modelling process: Very early in the modelling process, an engaged and vital discussion started, showing a positive attitude in the sessions. A few persons were throughout the project reluctant to the process, due to disagreement with the intervention objectives. It is an interesting point, though, that not even the core-group person disagreeing with the objectives of the process could "resist the fun of modelling" when he did take part in modelling sessions, as he and the other core members were very mathematically skilled and interested individuals.	Observation
"a few participants did not agree with the business objectives, and did therefore never really buy in"	Interview
Gain of learning, and changes in goal structures and mental models: In the development of the preliminary model, the very first results already took form as the project owners gained some interesting insights. Something first considered as a potential mistake in the model turned out to be an important insight, and it became clear that one decision, that had just been made, had stronger negative impact on year 1 than anticipated, and it was therefore decided to modify the decision, and make the transition over a longer time-span.	Observation
Through the discussions and model simulations in the modelling workshops, the core project team gained insights and exchanged experience relating to the location strategy, and the model was the framework for the setting of parameters to be used in the business case in each of the business areas.	Observation
Through investigations of effects of changes in the different parameters of the model, the core team identified effective optimisation opportunities, as well as sensitivity risks. Some of the most important insights gained were the understanding of the reinforcing growth loop motivating the intervention, of how relatively few non-replacements in high-cost countries could compensate for the costs of building up the required volume of R&D employees in low-cost countries, as well as distinct benefits of reducing training and hand-over-time compared to reducing costs of training and travelling.	Observation
Simulation as "eye-opener". In a few cases a parameter was perceived as "not possible to reduce", but through simulations with *increased* value, the strong impact was seen, and the individuals then opened up for discussion on what it would take to optimise a certain parameter, e.g. reduce hand-over time.	Observation
The initial setting of each of the most important parameters could be discussed for hours in both workshops and other related meetings. For example, it was a widely accepted "fact" among many of the project participants, that employees in low-cost countries often stayed only 1-2 years, because as soon as they attained experience in R&D, they could get a better paid job in a high-cost country. Through the parameter stipulation, facts came on the table, documenting a very low employee turnover in the low-cost countries. (Ackoff's morale: "There is nothing so deceptive as an apparent truth").	Observation
In the modelling sessions, especially in the parameter stipulation, a cross-business unit knowledge and experience exchange took place, as especially one business unit had already high-scale experience with build-up of resources in low-cost countries. The modelling approach this way served as a forum for transfer of best practices.	Observation
"The preliminary model was important to get confirmation on the feasibility of the objectives, and the preliminary model did also give better understanding of the dynamics of the problem".	Interview
"Parameter discussion effective in challenging assumptions".	Interview

"Simulation strong in showing the importance of the different parameters". "Exchange of Best Practices was one of the objectives for starting a cross-business unit process in the first place".	Interview Interview
Commitment to the outcome of the modelling sessions: Modelling participants often argued in a supporting way for the insights gained in the modelling, when presenting the results in other meetings – but there were also a few examples, when this was not the case, primarily in situations with divergence between insights and personal interests.	Observation
Changes in behaviour: "In general the team members developed business cases in compliance with the modelling insights and results, with only one exception".	Interview
Group communication: The discussion seemed to be both very structured and very open and frank. The result-oriented process, however, did not leave time to go into depth in all of the relevant discussions, but due to the structure, most of the time invested by the participants in discussions was used very effectively. A couple of times, the modelling helped to take away focus from discussions, when simulations proved the little importance of a parameter, and therefore the little relevance of the continuous discussion about the exact stipulation of the value. "The discussion improved radically compared to the rather unstructured communication we had in the project, before we decided to use system dynamics. The model directed the discussions back to the core of the problem".	Observation Observation Interview
Communication and consensus: Opinions on parameters were often very different within the core project team, and the model proved to function as a structure for fact-finding and alignment of perceptions. "the approach makes it difficult for people to play politics"	Observation Interview
Consensus: Opinions on the importance of different causal-relationships differed initially, but through the model-building process a more shared understanding of the problem and its dynamics was created. The discussion of the parameters often implied longer discussion on how the strategy could and should be executed, as the parameter setting reflected implementation decisions; e.g. the logistic and cost model of travelling, how to structure knowledge transfer, etc.	Observation Observation
Common language: Within the core project team, there was a tendency to increased alignment, but this was difficult to transfer to non-core members in the relatively short meetings with these people. Parts of the "language" did spread to some extent, such as "one employee is one employee" regardless of type of location. The factor for reduced productivity in low-cost countries only reflects a lower average experience-level. But a stronger outcome on this dimension would have required a less result-oriented process, with more time to in-depth discussion. "Even more effect – especially outside the core team – would have been better".	Observation Interview

Transfer of insights: The model clearly confirmed some viewpoints, that the project team was very interested in communicating to the board and corporate controlling. Whereas these insights did not have much "newness" value, it was very valuable to have a model that distinctly and clearly "proved" the matter. This type of insights included the worse-before-better effect, implying that the division even receiving a relatively large number of additional head-counts in year 1, would have no additional productivity, but rather a slightly reduced productivity. Also, the model showed very clearly, that even the relatively large growth in the fraction of low-cost employees compared to the total number of employees, does not result in a decreased cost per produced development hour, as the inflation has stronger influence than the benefits to be realized through a location strategy of the discussed scope.	Observation
Transfer of insights: It appeared to be very convincing in the discussions with non-core stakeholders to run a few simulations. "the model made the strategy very transparent , with clear definitions – and was better than words in the communication".	Observation Interview
System changes: The business cases developed in the project have been accepted by the board, and are implemented in the quarterly plans for 2005 as well as in the 3 years business plan. This should secure the implementation, as execution should follow the plans. "the business cases are approved by the board, and incorporated in the budgets and business plans"	Observation Interview
Results: The results will be evaluated later in the process (next year). "we are on track on Q1 and Q2 hiring for 2005"	Observation Interview
Efficiency: The project kept established dead-lines. Some disturbance and discussion took place due to the fact, that the intervention also encompassed many elements not included in the modelling. Especially in the beginning of the project there was a tendency among core team members to think of the modelling as an additional task, increasing the workload in an already stressed period of time. But on the other hand, the model helped both to structure and to facilitate the discussions, which is likely to have reduced the overall time spend by the core team. To obtain this efficiency, though, took a lot of efforts in workshop and meeting preparation among the facilitator and project owners. Overall, it seamed very efficient to use the chosen software to make a shared model on a high abstraction level, with easy options to simulate. But some improvement in the software would be welcomed, as quite a lot of work was needed "behind the scenes" to make nice and effective output-graphs in separate views, to avoid waist of time with derived irritation towards the modelling efforts. Also, even relatively small changes in structures could be very time-consuming to implement in the chosen software (Vensim). "it was a very structured and effective process". " the project progressed even better than planned due to discipline and focus in the process". "maybe even too efficient: more difficult to act politically in the budget-negotiation".	Observation

Quality in results: For SD practitioners, the model seems very simple, but it is interesting to notice, that the project team first tried to handle the problem with the use of a normal Excel-model, which became a complicated "black box", where it was difficult to see and understand how the different parameters influenced the model.	Observation
Further use of SD: To be observed later in the process	
Intervention driven by business objectives and targets: The intervention was initiated with clear objectives and targets (directions from the board). Only a modelling process supporting this type of intervention was considered by the project owners. No participants questioned this circumstance. "Most of our strategic projects are initiated with very clear business objectives and targets".	Observation Interview
Project framing: The project owners had no intentions to start a group model building process from clean sheets of paper with the risk of loosing control. This might be a general trend in corporate environment; that executives have a clear view of the direction they want to drive a given change, and that they will not take the risk that a model could show contradicting results, which in their view could be due to hidden errors in the model or the problem being addressed or conceptualised erroneous. Trust in the modelling process was gained through the preliminary model. Compared to explorative modelling, the targeted participative modelling approach is restricting the problem-solving process (in regards to "what to do," not in "how to do"). It is difficult to say if this had negative impact on the participants ownership and trust in the model. The questionnaires do not explicitly include questions regarding this possible impact of a preliminary model, due to the problem of measuring influencing the system (in this case creating negative attitudes). The preliminary model confirmed some intuitive expectations of the project owners, and showed to be an effective mean of communicating these cause-effect relationships, which was a cornerstone in continuing the modelling efforts. "A few participants did not agree with the business objectives, and for that reason also not with the process, but nevertheless the process forced them in the decided direction, and through the modelling they gained some of the insights motivating the intervention in the first place". "We were open about the premises for the process, and participants should therefore not feel the slightest manipulated". (This was the answer to a question, if the use of a preliminary model and fixed business objectives could have caused the participants to feel somewhat manipulated) "Initially I was a bit sceptical, but along the process I started to trust the model" "We got were we wanted to".	Observation Observation Observation Interview Interview Interview Interview
Context comparative conditions The problem was more politically sensitive than truly messy. Clear defined objectives and targets. The case company has a strong tradition for employee empowerment and is a relatively un-hierarchical organisation.	 Observation Observation

Attitude to intervention: it was a top-down decision to initiate the intervention, initially against the "true wish" of many of the participants, although most of them could agree with the rationale behind the intervention.	Observation
Technical environment with young and highly educated people with traditions for mathematical and "rational" problem solving. All participants were perceived high-performers and have been with the company for years.	Observation
<u>Mechanism comparative conditions:</u>	
Result-orientated intervention with clear objectives and targets.	Observation
A preliminary quantitative model was used to convince the project owners of the value of simulations – and it furthermore showed what main learning to anticipate.	Observation
The modelling process was focused on developing a relatively simple model that could give a picture of the overall behaviour of the problem-system without including too many details, partly because overview was considered more important than detailed correctness (avoiding black-box effect), partly due to the fact that the system dynamics Vensim model was complemented by a more detailed excel-model with the format needed in the budgeting and business planning. The result was a model, which was relatively easy to explain in even 1-2 hour meetings.	Observation
The facilitator had primarily a theoretical foundation for SD modelling, with only little SD modelling experience, but has more that 10 years of planned organisational intervention experience, including other types of modelling.	2nd order observation

5.c: Questionnaire results

The questionnaires were given to the five core-team members, to the three most involved steering committee members, and to three other participants, who were not involved in the project as such, but had only been exposed to the model in one or two meetings. The later group got a reduced version of the questionnaire, as they did not have an overview of the total project. The possible answers score from 1 (strongly disagree) to 7 (strongly agree), with 4 being neutral.

Questions	n	mean	sd
I believe it was useful to include the model in the project	8	6,00	0,76
I gained interesting learning from the model	11	5,82	0,87
I agree with the recommendations derived from the model and will act accordingly	8	5,00	1,41
The modelling effected some of my decisions	8	4,63	1,85
The model was a useful framework facilitating discussions	11	6,18	0,87
The modelling process helped building a shared view of the location strategy	11	5,73	0,90
The modelling efforts helped creating a common language for the location strategy	11	5,27	1,01
The model was a useful tool in the presentation of the ideal location strategy	11	5,09	1,14
I believe the recommendations from the modelling process will be implemented	11	4,27	1,19
I believe the recommendations will have positive business impact	11	4,91	1,22
The use of modelling increased the efficiency of the project process	8	5,13	1,13
Using modelling in this case was more efficient compared to other approaches	8	5,13	1,13
Using modelling in this case created higher quality results compared to other approaches	8	5,38	0,92
I intend to use modelling in other change projects	8	5,00	0,93
I believe the model reflects the core of the problem	8	5,38	1,19
It was useful to start the modelling with a preliminary model to kick-start the process	8	6,25	0,71

Figure 10: Questionnaire results

In general, the questionnaires confirm the positive impression based on observations and interviews. The three most positive answers, in average, were if it was believed useful to include the model in the project, the usefulness in facilitating discussions and the usefulness of starting the project with a preliminary model. Also individual learning and the building of a shared view scored relatively high. Questions about expected implementation scored relatively low, which in follow-up interviews were explained with lack of trust in the assumptions for the new strategy. The strategy reflects a new paradigm with focus on cost rather than headcount, which is a change from the previous situation with rather strict headcount control. Also, intended use of modelling in other projects scored relatively low, which can be explained with the project's lack of focus on transfer of SD skills and understanding, as learning efforts were concentrated on the location strategy issues.

6. Lessons learned and further research

Compared to interventions typically seen in the SD literature, the targeted participative modelling approach is more oriented towards pre-established business objectives and is a more framed intervention with focus on traditional change management perspectives. This resulted in the question from a few SD colleagues, whether it is a somewhat manipulative use of SD. Truly the approach has not the same explorative focus, as often seen in successful modelling studies. But using SD as a cognitive framework to enhance learning and communication as well as transfer of insights in a structured, targeted and framed process is simply taking advantage of a subset of the benefits of the system dynamics palette. And also it can be argued that the context for which the targeted participative modelling aims, reflects a typical project set-up in corporate environments.

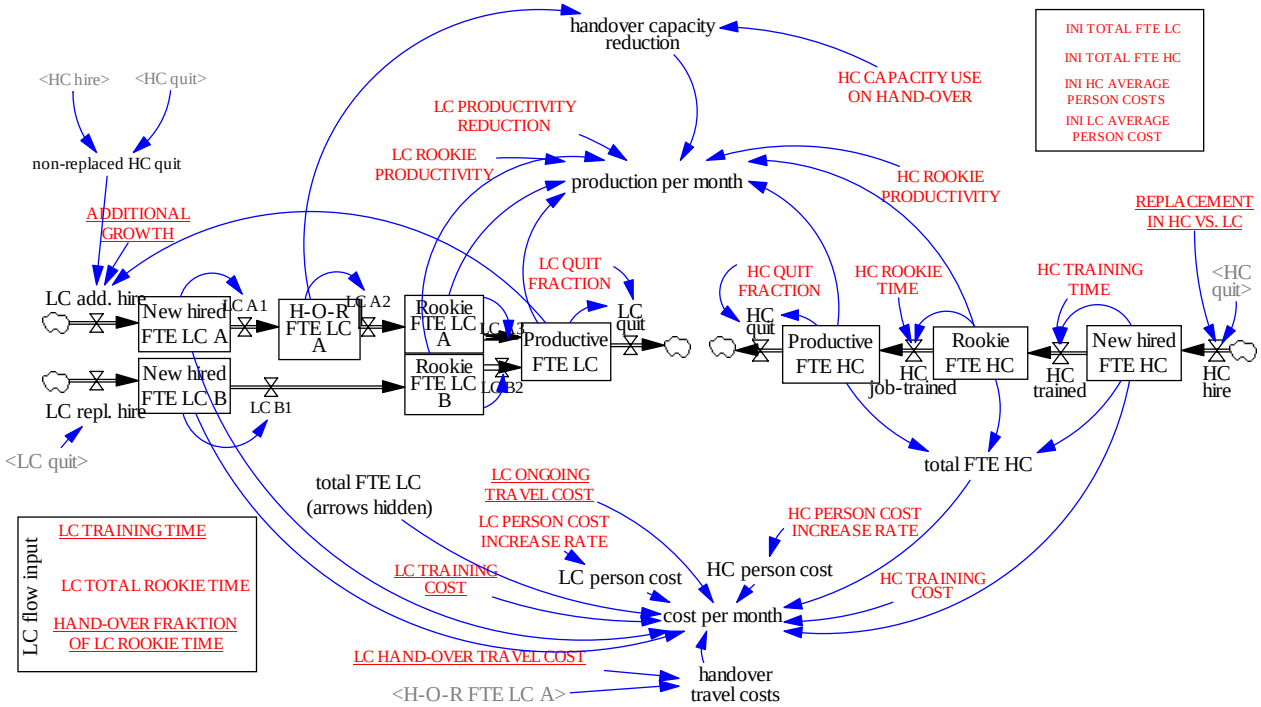
The case study yielded valuable outcome on both individual level (e.g. creation of insights among key change agents and decision-makers), on group level (e.g. facilitation of communication and exchange of best practices) and on organisational level (e.g. insights incorporated in actual budgets and business plans). From the case company perspective it seems fair to conclude, that the targeted participative modelling process was as an effective and efficient way of identifying a strategy that fulfils board objectives as well as prepares the grounds for successful implementation. Especially due to the sensitive nature of the topic, it was interesting to observe how the modelling and simulation efforts helped to direct the discussions and facilitate individual learning.

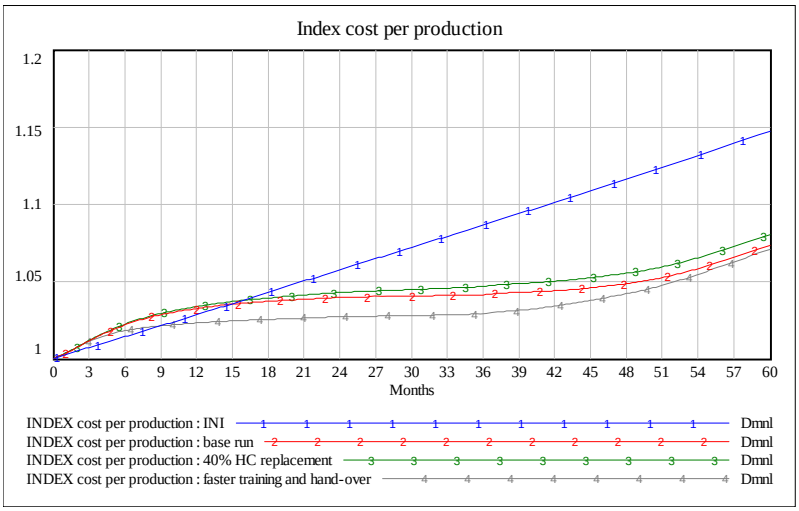
It is not possible to know, if using a different approach had been more effective or efficient, as the case study was a single-site study without any kind of test group. The purpose of the case study was primarily to serve as inspiration for the development of the approach. Based on the experience from the case study, propositions for further research include:

- is the targeted participative modelling approach an effective and efficient instrument in corporate strategic interventions with clear strategic direction and intent?
- are simulation workshops among an extended group of change agents an effective way of transferring insights gained in the core modelling project (this will be addressed in the next phase of the project)
- does the approach presented in this paper also work in organisations with members less open-minded and who do not have that level of mathematical/technical skills?
- is targeted participative modelling a way to manipulate employees or does it provide transparent and framed possibilities of employee involvement?

APPENDIX A

Below is a changed version of the model without "flow-on-flow" rates. Now out-flow rates are calculate based on level-values; opposed to inflow-rates. Some of the stocks had to be split up in two, in order to use this approach. It is interesting to note, that the main trends – and thereby the main model insights – are the same as in the original model, also for year 1, even though the model reflects a new hiring policy with a step input in very beginning of the simulation. (The rate "LC add.hire" is changing from 0 to a relatively high value in time=0).





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[i] Luis Felipe Luna-Reyes and Deborah Lines Andersen's (2003) schematically description of the prevalent modelling process is based on the following mentioned sources: Randers (1980), Richardson and Pugh (1981), Roberts et al. (1983), Wolstenholme (1990) and Sterman (2000).

[ii] Cause-Loop Diagrams are normally made in a way, where variable names do not indicate the direction of change. In figure 4 the variable names include the direction; e.g. company growth, reduced unit-price etc. This is made for communication purposes, emphasising how the reinforcing growth loop is intended to work.

[iii] No employees in high-cost locations will be laid-off due to the location strategy. Due to the non-replacements the number of employees can lower slightly in some locations. However, the total number of employees in high-cost locations will roughly stay stable due to other necessary hiring in other functions in the division.

[iv] Sterman (2000) operates with only two levels in his promotion chain, with employees leaving both levels. The location strategy model operates with 3 resp. 4 levels, with employees only leaving the latest stage as this reflects the historical data well.

[v] In Sterman's (2000) „Two-level promotion chain" the growth factor is based on the total number of employees, but in the location strategy model it makes more sense to base the growth on fully productive FTE's, due to the ramp-up limitations (ratio between experienced staff and new staff).