■ Research Paper

Second-Order Intervention: Enhancing Organizational Competence and Performance

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While most managerial interventions into organizational and business processes have the character of a direct interference, the interventions of consultants are rather indirect. They are meant to improve the organization and its performance, via a dialogue with the management. To clarify the specific role of consultants we shall introduce the concept of second-order intervention, therewith sharpening or, in a certain sense, redefining that role. We shall revert to a case study, which refers to a System Dynamics (SD) modelling and simulation project, to illustrate how a series of second-order interventions has opened new paths towards superior organizational competence and performance. This was an exploratory study, in the tradition of Action Research, not a hypothesis-testing venture. Copyright © 2006 John Wiley & Sons, Ltd.

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INTRODUCTION

An intervention is commonly defined as an action of intervening or interfering in any affair so as to affect its course or issue (Simpson and Weiner, 1989, p. 3). The concept of intervention is much used in economics, where interventionism has a connotation of punctual measures, as

opposed to a comprehensive engagement. These punctual moves have a fragmented character all too common in day-to-day management (cf. Beer, 1996). Interventions of that kind are often close to what is denoted by the synonym *interference*—disturbance, hindrance, obstruction.

From a systemic point of view and considering the complexity of modern organizations, interventions should be holistic, i.e. with a view on a larger whole and a consideration of a more extensive time frame. Short-termism and myopia of managerial decisions are counterproductive in

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that they tend to jeopardize the viability of an organization. Normally, interventions should also be non-obtrusive and wary of unintended side-effects.

The purpose of this paper is to show a path towards more comprehensive and effective interventions in organizations in order to strengthen their capability and to improve their performance. We shall not look at interventions that react to an acute problem or crisis, but rather concentrate on those which prepare an organization for the future.

This paper rests on an important distinction—first-order intervention versus second-order intervention. Despite its high relevance, this distinction has hardly been used at all.¹ In the next section, the distinction between these two kinds of intervention will be elaborated. In the Case Study: Second-Order Intervention in a Pharmaceutical Firm section, we shall report on a case study to show the concept of second-order intervention in action. The Evaluation section will contain an evaluation of the results achieved with that approach. In the Insights section some insights and teachings for the design of organizational interventions will be fleshed out, prior to the Résumé and Outlook section.

TWO KINDS OF INTERVENTION

To provide a conceptual basis, it is necessary to draw a distinction between two kinds of intervention. The mode here is descriptive. Both kinds of interventions are not new. However, it is necessary to specify their characteristics in order to make the new features, which will be developed thereafter, transparent.

First-order intervention is a direct one, by which a manager 'steps into' a situation at the

level of the organization he or she is responsible for (Figure 1, arrow above). If he is up to his task, he will receive feedback and in a sense be changed by it (Figure 1, arrow below). The representation in Figure 1 is 'value-free', i.e. it does not say anything about the content or the kind of intervention under study, be it punctual, holistic or otherwise. It is merely an abstract scheme to be amended eventually, as we go along. We also demarcate the system under study (which comprises the organization with its management) by a boundary. Within this boundary a first order intervention leverages the available competencies and relationships only; it does not create new ones. In other words, an improvement of organizational performance is only possible to a limited extent.

Second-order intervention is indirect. Pertaining to a higher logical level, it impinges on a first order intervention. Traditionally, higher order interventions often take the shape of a mere influence on an element of the system-in-focus, normally its management. We conceive it, however, as a moderation (in the sense of governance or control) of a first-order intervention process. This is a more powerful approach to organizational development, as will be shown by means of the case study.

The diagram in Figure 2 is a stylized representation of this concept of second-order intervention, with a consultant moderating the interaction between an organization and its management. The arrows in the scheme denote interactions or communications—intervention above and feedback below. The vertical lines from 'consultant' to the arrows represent the second-order intervention. The dots at the ends of each line signpost a relationship in both directions, as if there were two arrows.

The line connecting with the arrow above indicates that managerial interventions are strengthened or focused by means of information or communication. The line connecting with the arrow below symbolizes signals coming from the organization that are bundled in such a way as to be meaningful for the management. The other component of these two lines consists of feedbacks which impinges on—which can mean 'change'—the consultant's behaviour.

¹Inquiries in both the JSTOR and the EBSCO Host research databases on August 2, 2005 showed no articles about second-order intervention. A Google search on the WorldWideWeb (same date) disclosed only one article in which the distinction between first- and second-order intervention is referred to, albeit only in a marginal way and without further explanation of these concepts (Basham *et al.*, 2000). In addition, a handful of pertinent references were found in slide shows and short texts from the contexts of education and psychotherapy.

Figure 1. First-order intervention: Management as intervener

System Dynamics-supported interventions are normally second-order interventions, as are most other interventions by consultants. This is not new; so why are we referring to the concept at all? In the following case study, an example will be explored which opens a new perspective on how second-order interventions can be designed to enhance organizational competence and performance.

CASE STUDY: SECOND-ORDER INTERVENTION IN A PHARMACEUTICAL FIRM

In this part we shall examine the practical case forming the basis for this paper. The case describes a project, where the overarching goal

was a high level business description capturing all the necessary complexity to enable managers to use it as a decision support tool. System Dynamics (SD) was examined and was found a suitable methodology to aid in the project.

We will divide this part into six subparts, describing the various stages of the project. These are:

1. *Examination Phase*: examination of the suitability of SD for the problem.
2. *Demonstration Phase*: demonstration of modelling possibilities with SD.
3. *Acceptance Generation Phase*: generating broader support for the modelling approach and methodology within the company.
4. *Modelling Phase*: the construction of the concrete SD model.

Figure 2. Second-order intervention: The consultant as moderator

5. *Validation Phase*: validating the model results with the help of experts and on the basis of data.
6. *Rollout Phase*: using the model as a decision support and training tool within the company and at other sites (J&J Pharma Operations).

The phases are listed in the order in which they began, although several phases have run in parallel. The modelling, acceptance generation and validation phases, for instance, have run concurrently for most of the project duration, with the weight attributed to each shifting over time. The project started with a heavier emphasis on acceptance generation and then shifted to a focus primarily on validation towards the end.

We believe it makes most sense to describe the phases consecutively according to the starting point, and to describe for each following phase where and how it complemented and built upon the previous one, as well as why the particular order and timing were chosen.

Before we start with the different phases, a short introduction to the organization in which the project took place is opportune. CILAG AG is a pharmaceutical company belonging to the Johnson and Johnson (J&J) conglomerate. There are around 1100 employees in CILAG AG in Switzerland; additionally the project with its rollout potential is of relevance to the other J&J Pharma Operations.

The client team comprises the Head of the Strategic Development and Process Excellence unit (co-author J.M.) and two of his staff, and the consulting team of two external consultants (co-authors Kristjan Ambroz and Markus Schwaninger). With reference to our scheme of the second-order intervention process (Figure 2), the client team is subsumed under 'Management': It managed the whole project internally.

Examination Phase

We will start with the examination phase, where the suitability of SD as the methodology for the project was evaluated, the goal of the project already being clear (see above).

This phase started off with the consulting team showing the client team—the Business Processes and Strategic Excellence Unit—how similar projects had been handled using SD in the past. Primary examples came from case studies in the literature, describing projects of similar scale and scope (e.g. Lane, 1997; Coyle, 1998; Lyneis *et al.*, 2001).

In addition to cases from the literature, it was important to provide the client with an understanding of SD as a methodology. Here some of the cases designed for teaching at the University of St. Gallen were used as well as examples of simple stock and flow structures in order to show the essence of SD to the client team.

While the client team had no prior experience with SD, they had accumulated a vast experience with simulation more generally, speeding up the process considerably. As most of this prior experience was with discrete event simulation (DES), the differences between the DES and SD had to be shown, so as to avoid false expectations.

In this phase the preferred SD software package was selected by the client team. A demonstration of the various available packages was deemed necessary, so as to determine if the graphic presentation of both the model and simulation results, as well as the ease of modelling (or lack thereof), suited the client team. VensimTM was eventually selected.

There were 12 key criteria that the client team wanted to be fulfilled, in order for them to decide upon adopting SD simulation. These criteria were:

1. Capability of modelling complex organizational and operational processes.
2. Causal links from input drivers to outcome measures.
3. Calculation of causal relationships using a broad possible algorithm range.
4. The possibility of including feedback loops.
5. Visibility and transparency of model structure.
6. Dynamic process optimization (sensitivity analyses, parameter calibration, randomization, delay factors. . .).

7. Capability of varying driver inputs at various stages of the simulation, simulating disturbances in the real business system.
8. Support of Validation.
9. Data import possibilities.
10. Adaptability to changes in business and easy applicability to other business situations.
11. Easy access and usage.
12. Good Dashboard/Management Cockpit presentation.

While both the consultant and client teams were quite confident that SD could fulfil most of these requirements, a demonstration with client-specific examples was needed in order to confirm this. In addition, such a demonstration was also essential to show the relative merits of SD modelling in comparison to other approaches evaluated. The consultant team's role started to be focussed on the interaction between the client team and the rest of the organization.

Demonstration Phase

In this specific project, the demonstration phase began almost in parallel with the examination phase. While the client team showed some specific characteristics which encouraged an early start for this phase, we believe in general that it is essential to run the first two phases in parallel, or at least with little delay between the start of the first and second phase. The software evaluation was part of both the examination and the demonstration phases.

In this case the vast experience that the client team had with simulation meant that there was little need for the consulting team to demonstrate the usefulness of a simulation approach.

The examination phase was rather short, therefore, and primarily involved setting the criteria that the client team wanted to see fulfilled during the demonstration phase, in order to decide whether to progress with an SD approach.

The demonstration phase then involved building small, client-specific models. This was started early on in the project, during the second meeting, skipping all causal loop diagrams and directly progressing to building a stock and flow

model for a process due for review and improvement. While the modelling of this process was not really one of the goals of the project, it provided the client team with both a useful demonstration of the benefits of SD modelling, as well as with the first experience of how such modelling is performed and what the level of difficulty is. What we achieved in that meeting was to construct a basic stock and flow diagram of the process, and to demonstrate the way equations would be inserted later, with a short exploration of what the possible algorithm range was.

Over time this model was expanded into a fully functioning model of that specific process (a supply chain), which was both a correct representation of the real process structurally, as well as reasonably accurate as far as result predictions went. Participants grasped that SD modelling can and should achieve both rigour and relevance.

During the construction of this model the client team could evaluate how well SD could meet several of the 12 key criteria, particularly numbers 1 to 5 and 11 and 12. Others were demonstrated more broadly but were not a specific part of that model.

Over the course of several weeks a model containing the complexity necessary to accurately portray the process in question was constructed, demonstrating another vital quality of SD modeling—speed.

To demonstrate this we portray part of the model of one typical supply chain process in Figure 3. This diagram is not meant to provide a detailed description, but only to visualize the kind of model used at that stage, and the structural pattern to which we reverted—several processes made up of stocks and flows, connected by means of feedback and feedforward links.

In addition to this model, several others were constructed in order to demonstrate SD's ability to meet other key criteria. These models ranged in scope, from simple Causal Loop Diagrams (CLDs) showing the possibilities for visualization of the actual problem to be modelled, to stock and flow simulation models of smaller subsets of the actual problem. All of this was done in a rather 'playful' way, which assuaged the difficulty of

Figure 3. First supply chain demonstration model—Extract (Processing of packaging material)

the endeavour without jeopardizing its seriousness.

The acceptance by the client team, given its substantial modelling knowledge, showed itself quickly. More time and a slightly different approach were needed in order to achieve such acceptance more broadly within the whole client organization.

Acceptance Generation Phase

As an overall model of the organization was to be constructed, the acceptance of the model and its results had to be spread throughout the organization as well. It was instrumental, therefore, to figure out ways to increase both understanding and trust in the model and modelling procedure. As the SD methodology was to be used throughout the whole organization, broad acceptance was of crucial importance.

The goal of generating extensive acceptance was met primarily through two mechanisms, first of all widespread demonstration of the approach throughout the company, and secondly, through involving the various departments in the modelling process itself. The modelling process will be described in the next section, so we will only

briefly go into it here and devote the rest of the section to the demonstrations.

The models constructed in the demonstration phase all represented real company issues; therefore the relevant departments, whose issues, the models were designed to tackle, participated in model building from an early stage. While these were not related to the main model (that was the first goal of the project), the added understanding of the process and benefits such models could have for each department proved valuable. As these models were specifically tailored to smaller issues, their immediate usefulness was more apparent. This meant that all the parties involved would have a greater understanding of the general, company-wide model, where it was more difficult to show the immediate benefits, which a specific department might derive from being engaged in the modelling.

The employees partaking in the joint modelling sessions² were primarily impressed with the ability of SD modelling to portray the whole process on one sheet of paper (admittedly the

²Some of these have involved the participation of the consulting team, while others only involved the participation of the client team members.

sheets were very large—up to DIN A0 and more). This enabled members from different departments to understand the interactions and interdependencies for the first time, as well as to develop a better understanding of their role in the whole system.

Trust in the models was developed as they were able to correct the model structure and test model results against expectations and experience. While a lot of confidence amongst the various departments was generated, acceptance was also needed from the top management team (TMT).³ While the top management team would later be involved in joint modelling sessions during the construction of the whole company model, at this stage, confidence came mostly from demonstrations of the capabilities of the SD approach.

The demonstrations performed for the various departments, for Process Excellence Experts (PEE), as well as for the TMT, always involved both the consulting as well as the client team in addition to the people from the relevant department. In this way both the questions of how the approach and software worked, as well as how the company intended to apply it could be handled better than either team could have achieved it alone. As the consulting team was placed at the vertex of the interaction within the company, it was also not perceived as a group of outsiders with little knowledge of the specific issues. Preventing such a perception was instrumental in building trust in the consultants and in the new modelling approach.

At this stage the PEE and TMT were mostly interested in the way the results could be presented and whether one could get a satisfactory overview of the business. The causes-and-uses trees were deemed important features of the software, since previously those had to be laboriously constructed with each change requiring a lot of reworking. In addition, the ability to vary the amount of detail presented, from an overall view down to the specific equation, was very much appreciated.

³The top management team is part of management (as marked in Figure 2) but is separate from the client team, which is also part of management.

We also presented the TMT with various sample/demonstration models that had also been constructed within the company, again to show how an SD modelling approach could meet the 12 key criteria set out at the start.

Some of the meetings were performed in Switzerland but later meetings were additionally held at the firm's European Headquarters, with the PEE team. The acceptance from the PEE ensured there were no other favoured approaches being developed in parallel whose supporters might later be unwilling to switch to embracing and using the SD model. Most of the acceptance, however, came from joint modelling sessions, described in the section below.

Modelling Phase

While one cannot say that either one of the phases was of greater or lesser importance, this phase was probably the most difficult one to accomplish. Depicting the whole company in 56 drivers, 60 process measures, 50 outcome measures and 12 business results, connected by 280 causal relations and 32 feedbacks was a very complex process. The model is called 'Causal Dashboard Business Model' (CDB BM). A small section is presented at Figure 4. The view gives an overall impression of the kind of issues addressed by the model and also of its complexity. The CDB BM does not show a stock-and-flow diagram (like in Figure 3). However, it differentiates between different kinds of variables (outcomes, process measures, etc.) by colours (invisible here). Also, external influences, which cannot be changed by management, are highlighted by the rhomboid shapes.

The process progressed in three different stages. In the first stage the basic model was constructed jointly by the client and consulting teams. In the second stage the client team was capable of extending the model itself, and the primary focus was on the joint modelling sessions with the client team and those departments within the company having more detailed knowledge of the individual sub-processes. In the third stage the consulting team's input was brought in selectively, to enhance the model's

Figure 4. Small subsection of the complete model (before final design of user interface)

capabilities, as well as to ensure that the model was modified appropriately where validation testing showed areas for improvement. That process led to recurrent modifications after each new round of validation testing (see next phase).

As the client team had excellent working knowledge of all the relevant processes, the basic model was not far away from the final product. In this first stage some fundamental design decisions were already taken, and thus did not need to be modified later on.

The most instrumental one of those was to base the model on an index system, meaning that in a default situation all the values in the model equalled one.⁴ If flows deviated from the default, this represented the changes in the current simulation time period, while changes in stocks represented changes over the whole modelling period thus far. Flows greater than one meant that the variable was better in the current month

than the default value, while flows below one meant that the variable performed for worse rather than better.⁵ Stock values above one meant that the variable for the simulation to date was performing above default, while values below one meant the logical opposite. Increases in stocks meant that the business performance was improving, while falls denoted a worsening situation, regardless of the absolute stock value. This means that a given area can still be better than default over the simulation to date but that it has been worsening recently.

There are several important benefits arising as a result of this decision. The first one is the added transparency. Anyone is able to see at a glance how the whole business is performing, which performance changes a different driver setting produces and the magnitude of the change. One does not need to perform mental acrobatics in order to see if a higher or lower value in a specific

⁴From a practical standpoint, this is a conceptual innovation, as one of the leading SD modelling experts told us. It is very much in line with Stafford Beer's proposal, in a nutshell, to standardize indices around a value of One (Beer, 1979).

⁵Better does not necessarily mean larger in all cases—for instance, while a better profit will mean a higher profit value, better stock management will mean lower stock values as long as they still fulfill the level of necessary safety stock.

variable means improvement or decay, and no conversions are needed in order to express the resulting changes in percentage points. In this fashion complexity for the user is reduced to a minimum, while at the same time as much complexity as necessary is captured in the model. This approach leaves the data conversion, and any decisions about what values represent an improvement, to the more specialized client team having the capacity to handle it.

It is important to stress that this is no simplification of the model itself, as the model still captures the complexity necessary for producing high-quality results. The structural and behavioural validation (Barlas, 1996; see also Sterman, 2000) has been carefully planned. It is still being carried out and reaching completion. Our use of the index system creates a special requirement—namely that of data conversion to the index system. As the validation is being carried out by a dedicated specialist team, this task remains hidden from the end user and does not reduce the usability of the model.

Another benefit of this fundamental decision is that it improves the likelihood of discussing real issues, with minute number crunching being the content of debate later on, when the model is in full use.

The basic model was soon capable of full simulation, and it performed correctly on various extreme-condition tests (as defined in Forrester and Senge, 1980; Barlas, 1996).

In the beginning the model building took the form of a joint consultant/client team effort, where the consultant team was in charge of modelling the content to be presented by the client team. Additional skill-building sessions between the two teams were scheduled, however, in which the client team would learn to perform the modelling tasks increasingly by itself, with the consulting team performing more of an oversight function.

When the basic model was constructed and validated so that it performed reasonably well against the client team's intuition, the second stage was scheduled. This involved broadening the scope to a wider audience within the company, to both increase the acceptance as well as improve the model in areas where the various

company departments had a more in-depth knowledge.

The second stage mostly involved the client team and either employees from the departments currently being modelled or PEE and TMT members. As most of the people involved had previously been exposed to either a modelling session or a presentation of the methodology, the one or two day meetings could focus on specific modelling issues, such as the weights attributed to the various influencing factors, which drivers had what influence on results, and similar.

The joint modelling sessions went through several iterations until the model was deemed to adequately represent the structure of the real business. Two obvious benefits of this approach were a model with high validity and high participant buy-in, since their views had been captured in the model, with the model being refined until it generated reasonably accurate results.

Coming to the third stage, the consulting team was again involved more frequently, with the primary focus of introducing some more advanced features, where the validation had shown deficiencies in the model. Here various additional feedbacks, delay functions and similar other functions were used, to enhance the model's performance. This usually took the form of the client team presenting a difficulty they were facing, which was then solved by both the client and consultant teams.

Altogether, 10 TMT members were actively involved in the model building and about 100 members of the organization were involved in the model usage (application) process, the consulting team being at the vertex of the interactions between the two groups. In addition, the core team of the client system—several members of which already had a good understanding of modelling in general—acquired a great amount of SD modelling know-how during the process. This enabled them to build certain modules of the model autonomously, but with some interaction with the consulting team.

As this stage goes hand in hand with the validation phase the client decided to intensify the relationship with the consulting team. As a result a *dedicated validation concept* was designed

and closer cooperation agreed. More will be clear from the description of the validation phase.

Validation Phase

In accordance with the principles of SD modelling, validation has been present from the start of the model building process. The joint modelling sessions had model validity as one of their primary goals, and therefore direct structure validation (see Barlas, 1996) was completed within the model building process itself. This was followed by indirect structure tests. Within this phase extensive testing of parameter variations—some of them with randomised parameter values—was accomplished; case studies had already been performed to a substantial extent, as this was written. What remained to be done were some of the behaviour replication tests (Barlas, 1996). These tests were planned separately, following the *dedicated validation concept*. We will go through the tests in more detail.

First, *systematic Sensitivity and Robustness Tests* were performed, i.e. the model was tested for the effects of input parameter and driver variations on the outcomes as well as on certain drivers through feedbacks. If the sensitivities proved to be too high or too low, weighting factors would need to be adjusted.

Firstly, possible realistic variations in all the 56 drivers had to be defined. After the definition phase the variations were performed on all the drivers and the results were assessed by the client team as well as other selected experts from within the company. As these tests revealed some needs for fine-tuning of the model, they had to be rerun after each adjustment, to avoid negative side effects elsewhere in the model. This work took up a lot of time, as there were several hundred outputs to look at for each driver variation.

Secondly, certain driver combinations and small, *focussed case studies* (e.g. impact of investment alternatives on outcomes, and impact of planned new production system on productivity) were tested to ensure the consistency and completeness of the model.

Even though the model-building phase had already included tests of driver variations and

dedicated case studies, it was the systematic sensitivity testing that entailed important model improvements. Additions and corrections amounted to three new drivers, two new process measures, 10 causal relations, 12 equation and three feedback modifications, changes of less than 10% of the model components. Although this order of magnitude may seem small, the respective changes were extremely important. They made the difference between a non-usable model and one that is useful and worthy of confidence.

Thirdly, *Stability & Capability tests* with random driver variations throughout the simulation runs were another step taken to validate the model results. Here reasonable boundaries on input parameter variation, based on the knowledge of day to day variances, were defined and then included in the model.

Whenever the results exhibited sensitivity unlike observed real-system reaction under those circumstances, this had to be noted and would lead to adjustments.

It would be ideal to perform tests of all the different driver combinations. Unfortunately, for 56 drivers, the number of combinations is so high that performing such testing would exceed all capacities a company could be reasonably expected to devote to the validation task. An alternative approach—that of constructing case studies and testing them—was chosen as a pragmatic approach to behaviour reproduction testing ('behavioural validation').

In this way, a final *Usability & Consistency Assessment* can be performed, which has already started. It consists of running simulations of a set of specially defined *key case studies*, to ensure the validity of the model for applications in day-to-day management. The model is considered fit for its purpose, once it provides the requested answers satisfactorily.

The usage of these business case studies in combination with the models has already become an integral part of the organizational learning process. The logic and the procedure of the use of the case studies are worth outlining briefly. In principle, the following applies to both the small focussed case-studies and the more comprehensive key case studies.

The client team defined several possible scenarios and designed a case study around each one of them. A case study would involve several elements. First, the scenario was described in textual form. This description then led to identification of the drivers that would change in such a scenario and to an analysis of the magnitude of those changes. With the driver changes specified, the case study participants would need to make model-behaviour predictions for the key variables, with the help of Behaviour Over Time (BOT) graphs, and to prepare reasonable explanations of the predicted behaviour, based on their real-world experiences so far. The scenario would then be simulated and the results of the simulation run presented to all the participants. In the case of discrepancies between the model-generated results and the BOT predictions, the predictions and the participants' intuitions, as well as the model, would be re-examined.

These case studies needed to be run in a recurrent fashion as, after each round of changes, the model generated new behaviour to be reassessed. Building on these case studies, a series of Turing tests was planned (see Barlas, 1996), where model generated results would be mixed with historical real system results for the various case studies. If the experts were not able to consistently distinguish between the model generated and real-system results, the Turing test would increase the trust in the validity of the model even further.

In the meantime, as a first real business application, a key case study—for a simulation of the business results 2006 and 2007 (based on the defined budget plan, organizational changes and other planned strategic activities)—has been provided and discussed with TMT members. The results and related learning cycle indicated a need to incorporate aspects of non-linear behaviour and decreasing impact of driver changes over time, in order to more closely represent the real behaviour of the organization, especially to discern leverage effects for the company's development. Pertinent adjustments to complete the behavioural validation are under way.

The final validation step will be to first define and then carry out Reality CheckTM tests on the

model. This feature of the VensimTM software enables modellers to further test the validity of a model by defining various tests for the model and then simulating the model against their predicted behaviour. This step, however, is only in the planning stage, and will be used in a second validation round.

To ensure that all the tests have been met satisfactorily, a log of all the validation testing is being kept with both the tests performed and the results included. In this fashion later rechecking is made easier and results can be replicated more easily. The log can also serve as a future reference for the validation of other SD models, which are likely to follow this one in the company.

The validation phase is the longest lasting one of all the phases in this project. As the model is likely to be used on a large scale within the corporation, such high demands on model validity are no surprise, as the model is only likely to be fit for the purpose (Barlas, 1996) if the quality of results it generates is exceptionally high. This phase also places high time demands on members of the client team as well as the selected experts, who need to review the various results after each validation stage.

We concluded the validation phase by March 2006, which enabled the company to start with the final, rollout phase of the project. This does not, however, mean that validation as such is over. Regular updates, to adapt the model and results to new developments, are being scheduled. The schedule will be reviewed eventually, to check whether the frequency of updates is appropriate.

Rollout Phase

While the rollout phase will only be started when the model validation is complete, some preparations have already been made. These have mostly been built into the model, to ease rollout across the various sites at which the model will be used.

As the sites that will use the model will perform slightly different tasks along the production value chain, the rollout will imply several model adjustments for the different sites.

Basic validation tests have been performed within the possible weighting ranges that the various sites might have for the input parameters, where weighting is different from the default values. A team within the company, with some support from the consulting team has already been set up, with responsibility for the rollout.

Finally, given the whole project design, most of the end users have already been amply involved in the modelling process and are already capable of using the software as well as the model. This is a major advantage, since rollout will neither be obstructed by the end users' scepticism nor by their inability to use the tool once it becomes available. A conventional consulting approach would not have bred the degree of end-user involvement achieved in this case.

A successful presentation of the SD model to the top management of the company resulted in their approved of the SD approach. They even converged on a shared willingness to run their company on the basis of the SD models, because they clearly saw their utility.

A smaller expert team (part of the client team) will also be set up, which can then help with specific rollout/model related questions and which will ensure proper training for later user generations.

After presenting this case study of second-order intervention in a pharmaceutical firm, we shall proceed with an evaluation of the preliminary results of the project.

A presentation of the project to the Management of the J&J Global Pharma Supply Group (GPSG) EMEA (Europe/Middle East/Asia) is planned for March 2006. At that point, the same evaluation of preliminary results inside the company will take place.

EVALUATION

While the project is still ongoing and no final evaluation is possible,⁶ we find that preliminary results are already clear and that they can be

⁶The validation phase is almost finished, while the rollout phase is yet to begin.

presented here. We will divide those into general findings on modelling and those related to the client and consultant team interaction, the latter having specific relevance to the second-order intervention concept introduced in this paper.

We start with an evaluation of the modelling process. The potentially most crucial success factor in our view is the creation of an appropriate context for the early involvement of the wider organization in the process of modelling. Early involvement has been a widely known principle for a long time (cf. Lawler, 1986). However, in the case reported here, it was applied in a different way than in mainstream practice. It is common to involve people in modelling processes, but activating, as in this case, a broad basis of users in model design and familiarizing them in advance with the SD methodology, is distinctive, at least for an SD-based intervention.⁷

The introduction to SD, including the models from the demonstration phase, was instrumental in achieving early involvement of members of the organization. Those models have first of all shown conclusively that the SD approach could fulfil the 12 criteria set out by the client team. Secondly they have enabled most of the later users of the model to get acquainted with both the methodology and the modelling early on in the process. Furthermore those models were closer to their particular fields of business, where they had a deeper understanding—so that they could help build those models—and where the direct relevance was very clear to them.

This also gave the end-users sufficient understanding of the SD methodology and software to be able to contribute to the complete company model more fruitfully. No lengthy concept explanations were necessary before the model modification or validation rounds. Those were replaced by a more motivating hands-on modelling early on, where the same background knowledge was acquired.

⁷A meta-analysis by Rouwette *et al.* (2002) of 107 group model building ventures found that '... projects differ considerably with regard to the number of people involved ... The number of participants involved in face-to-face interaction is mostly between 5 and 12, and seldom larger than around 20'. However, in some cases, groups as large as 30 to 160 participants were found to have worked in subgroups, mostly using tools of qualitative modelling (p. 13).

In the same vein, there is strong evidence that the construction of the additional models, although they were not part of the project, brought benefits that outweighed the additional time and effort invested.

Now we can proceed to an evaluation of the interaction between the client and consulting teams.

The claim for an exchange between the two has been made in the pertinent literature (e.g. Vennix, 1996, Schaffer, 2002). Yet, an early interchange enabling the client team to undertake their own modelling has—to our knowledge, rarely been achieved. While an early exchange is a practice generally aimed at, an ample involvement is hardly ever tried, because its realization is non-trivial.

In our case, the approach of building, together with different groups of interlocutors, additional models not related to the final model, achieved an important goal: Mutual understanding was enhanced by the ongoing communication process and knowledge interchange. This applies to the interaction between management and further members of the organization, moderated by the consultants. It is also applicable to the early exchange between the client and consultant teams, which enabled the former to gain a sufficiently deep understanding of SD, while the latter learned more about the business being modelled.

By getting to understand the business better, the consulting team became able to combine the SD knowledge with the company knowledge thus gained. The consultants were therefore in a much better position to aid the interaction between the client team and the rest of the client organization. Also, the external partners were in a position to offer better advice on improving the final model, as the mechanics behind the relevant real-life process could be anticipated correctly. They could then perform the model adjustments or transfer the necessary knowledge to the client team.

The client team, on the other hand, used the knowledge of SD modelling they acquired over the course of the demonstration and later modelling phases for the assessment of possible improvements or further possibilities of SD

modelling within their company, and implementing such changes themselves.

These co-operative model-building ventures have shown a high leverage in terms of team learning and organizational learning at large (cf. Vennix, 1996). At the various sites, the relatively ample end-user involvement in the modelling has generally deepened the understanding of a new approach to management. Many members of both line and staff have started to grasp the advantages of managing complexity with the support of SD models.

Due to the capability of the SD method and the positive experiences with the applications made up to now, the company has decided to apply SD and the Vensim software in sustained and leveraged ways. After the introduction of the Causal Dashboard Model, SD has recently been used for modelling manufacturing processes for the purpose of supply-chain optimization and quality-focused risk assessment. Applications within all areas of the company's strategic imperatives are planned, in order to master and improve complex business and manufacturing processes.

All of this is promising. It can be assumed that SD will soon be broadly used and organically embedded in the organization's process management.

INSIGHTS

We shall focus on three insights from this case study, omitting the less important ones. The first insight is about the power of second-order interventions. It is contrary to the technocratic belief in the power of direct control.

The eminent economist and social philosopher Friedrich August von Hayek came to the conclusion that 'the wise statesman or manager will probably attempt to cultivate than to control the forces of the social process' (Hayek, 1967:19). Likewise, the shrewd manager will prefer the indirect approach to control, by creating favourable conditions for the occurrence of a desired pattern of events (cf. Malik, 2002). He or she will rather intervene in the context of the situation to

be influenced, than in the situation itself. He will design a context, which is propitious to the improvement of performance, and ultimately to the viability of the organization. Second-order interventions are in this class of indirect approaches; setting them up is very much an issue of context design.

This fact is not new, and so we were aware of it at the outset. However, the case under study has highlighted impressively the power of indirect control. More specifically, although second-order interventions are an indirect way of managing, they stand out for their huge potential for injecting external knowledge and energy into an organization. This is an aspect, which has not been given much attention in the literature. Exceptions are, e.g. Lane, 1997 and Rouwette et al., 2002.

Moreover, as the CILAG case demonstrates, a second-order intervention can be a milestone, or, more dynamically speaking, a catalytic force for the learning of an organization—on the way from knowledge to understanding and organizational wisdom (if something like that exists). In this context, the case study also illustrates that the management's (client's) role is crucial for the power of the intervention and its outcome, in terms of implementation and results achieved.

However, many consulting projects are ineffective or even failures altogether, even though they were conceived as second-order interventions (Argyris, 2000, Nicolai, 2000, Hirn and Student, 2001). Why then was this project effective? To answer this question, we have to revisit the concept of second-order intervention.

The second insight is about better structures to leverage the power of second-order interventions. To make this point, we have to revert to the scheme in Figure 2. As briefly mentioned earlier, the second-order interventions usually hinge on a link between the external consultant and the management of the client organization. There, the emphasis is on the impact of the intervention on an element of the system at hand—the managerial interlocutor(s). The case study, however, has uncovered or at least highlighted a more intricate connection, which has also proved to be more powerful. Here, the external consult-

ants relate to the relationship between organization and management, not primarily to the elements of the system under study. They leverage the reservoir of knowledge available, thereby enhancing the potential of the interaction between the management and the organization. In this way a context for organizational learning is created. Instead of influencing the management of the organization to make change happen, they create a context, which can bring about organizational innovation in an organic and powerful way.

The consultants moderate the interaction of management and the organization in such a way that the stability of the negotiation and learning process is supported. The arrow from right to left in Figure 2 symbolizes the amplification of signals from management to organization; consultants propose user-friendly modelling and simulation devices to help the managers interact with the organization. The arrow from left to right represents the attenuation of signals coming from the organization: Consultants bundle desires related to the design of and arguments which question the practicality of these modelling and simulation tools. They constantly provide a view of a technologically feasible and culturally viable system development to the management.

We found that second-order intervention conceived of in this way distinguishes itself from the conventional approach. The mode outlined above appears to be innovative and more effective.

The third insight has to do with this effectiveness, more exactly, with the performance of the second-order interventions.

Performance here means clients having attained an advanced approach to reflecting and managing their business (to a required degree, and with the help of the CDB BM). The CDB BM was a crucial device to achieve that end.

Practically speaking, the SD consultants provided the first modelling and simulation of the CDB BM with a calculation of the results, potentials and development. In this perspective they enhanced the client system's strategic learning or *know-what*, that is, the understanding of directions and needs.

At the same time the clients continuously developed (and continue developing) their SD knowledge in order to complete the modelling and validation. The results of the conceptual (*know-why*) and operational (*know-how*) ways of learning are a powerful response of the client to the consultant. This has enabled the consultants to provide 'very high-performing interventions'—as one of the senior managers involved in the process put it—and to build the momentum for SD deployment. In sum, the actors at different levels were helped effectively to master business complexity in a systematic and balanced way.

What does this mean in terms of the concept of second-order intervention? The events and patterns of the case study are eminently tied to that concept. The Causal Dashboard Model was a new interface created during the project, which fundamentally influenced how the management and the other members of the organization interacted with each other.

Essentially, in CILAG, the organizational knowledge in SD built up over time furnished the context for that interaction. Against that background, the relationships of the agents involved became a creative process, enabled by the common Dashboard Model. The interaction between organization and management shifted from an action–reaction type to a collective process of sense making and learning (Weick, 1995). The former had been rather sequential and linear and without much reflection, while the latter incorporated more simultaneity, non-linearity and reflection ('self-reference').

This is also a shift towards better performance as defined above. The interventions of the consulting system were as successful as they were because they did not primarily target elements of the client system (e.g. management), but instead the interrelations between management and organization.

RÉSUMÉ AND OUTLOOK

Often, second-order interventions are more effective than first-order interventions. Why is

that so? The answer is that they, in principle, have higher leverage. As is visualized in Figure 2 they have a potentially crucial impact on the client system made up of the organization linked with its management. Second-order interventions are less visible to the general public, but they can effectuate change in more profound ways than first-order interventions.

In the case reported here, the high leverage was to a large extent a function of the procedure adopted. The quality of that process hinged on aspects such as early involvement of model users, active participation of top managers, co-operative model building, playful learning in connection with rigour and relevance of the learning activities. And it was enhanced through the gradual and iterative approach. Most importantly, the participation had two unusual features: Firstly, the population of agents involved was exceptionally broad and distributed across all levels of the organization. Secondly, the agents of the client system acquired levels of familiarity with SD models and with the methodology of modelling, which were higher than is usual in this kind of project.

We came to the conclusion that this was possible only due to the fact that a relatively new type of second-order intervention was applied. The consultants injected SD-related knowledge into the client system by intervening in the interrelations between management and organization. This way, a propitious context for organizational learning was created, which helped the members of the organization and their managers to relate to each other differently. The model co-produced by the consulting and client systems changed how they interacted. By means of this new device, they are now enabled to communicate on the basis of a better understanding of the firm and how it functions.

Notwithstanding the above, the outcomes of the project were also context-dependent in an additional way. One senior manager emphasized that 'such results can only be achieved with the help of excellent consultants'. Conversely, the same can be said about the quality of the client team: It excelled through openness, high competence and outstanding commitment. However, ultimately the decisive factor was the quality of

Example from the field of	Process: P	First-order intervention: I(P)	Second-order intervention: I(I(P))
Education	Student learning math at high school	Teacher intervening in the process of learning math by explicitly showing how to solve some equation	An expert telling the teacher that improving the students skills may be done in more effective ways
Psychiatry	Patient living with a personality disorder	Psychiatrist explaining the patient how (s)he can deal with the disorder	Experienced colleague convincing the psychiatrist that his helping the patient is outdated and should be replaced by a new method
Organizing	Part of primary organizational process showing problems	Manager trying to alter the conditions (e.g. qua personnel, technology, division of labour or culture) so that the process may run smoothly again	Someone showing the manager that the conditions can be changed in different ways

interaction between the client and the consulting system. The distinctive feature here is that the consultants in their interaction with the organization did not primarily concentrate on relating to elements of the client systems, but to a relationship: The relationship between the organization and its management.

In the firm under study, a fundamental transformation to a new logic of management took place. This was even considered a 'paradigm shift'—not only by the Head of the Strategic Development and Process Excellence unit (Matej Janovjak), but also by some of the line managers involved. It was a paradigm shift because the higher management adopted a new-shared view on how to manage their company.

The nature and functioning of second-order interventions have only been outlined roughly in this contribution. These ideas will have to be detailed further in the future. For the time being, many questions remain open, e.g.: Does the concept of second-order intervention as conceived here hold in the light of sociological theories such as Luhmann's System Theory? What exactly are the gains of second-order interventions as outlined here? What is the full range of options for the design of second-order interventions? Such questions will have to be answered by future research.

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