A critical review of the use of System Dynamics for organizational consultation projects

Alexander Zock, Ph.D.
Deutsche Lufthansa AG, Future European Operations,
Ground and Inflight Processes
Lufthansa Basis
D-60546 Frankfurt am Main
Phone.: +49 (69) 696 46983
Fax: +49 (69) 696 91558
E-Mail: alexander.zock@dlh.de

Abstract

System Dynamics (SD) based organizational consulting projects show a diversity of process models, conceptual frameworks and terminology. As a consequence such practices do not meet the criteria of fully consistent and solid consultancy approaches. Nevertheless, SD based consulting contains a number of valuable elements. The author proposes to save and integrate these into an existing consultancy framework, namely the systemic intervention practice, that is derived from a systemic theory of social systems, which is based on Maturana's concept of autopoiesis. This strengthens the already existing subjective worldview in parts of the SD community and thus integrates the exploratory strength of SD, that allows a formalized reflection of the perceived logical structure of mental models, into a coherent consultancy framework based on interpretive and constructivist perspectives.

Key words: Epistemology, Luhmann's theory of social systems, autopoiesis, structural coupling, organization theory, organizational intervention theory, systemic intervention, intervention architectures

1. Introduction

The use of System Dynamics (SD) for organizational interventions is from a practical point of view a well explored terrain as can be seen from the multitude of successful field studies reported in the literature (Rouwette et al, 2002; Senge, 1990; Vennix, 1996; Sterman, 2000). Unfortunately the same is not true with respect to the theoretical foundation of such activities as can be seen from the fact that in the SD community

- no widely accepted and fully developed organizational intervention model for the use of the SD methodology in an organizational context is available in the literature (e.g. Rouwette et al. 2002),
- no clear reference to an organizational theory is established that would allow the derivation of a consistent intervention model that could be used as a framework for the use of SD methodology in an organizational context,

- the debate about the adequate epistemological interpretation ("Soft SD" versus "Hard SD") of the SD methodology is still highly controversial (e.g. Lane, 1994b).

This insight is not only theoretically unsatisfying but also highly problematic from a practical point of view. Practical consequences are for example

- that a loop like learning approach with respect to the efficacy of organizational interventions based on SD methodology is strongly hindered,
- that the SD community is split up into different practical schools for the use of SD methodology in an organizational context,
- that the communities dialogue about its organizational intervention practice is characterized by a missing standard terminology for the description of the set up of such studies,
- that there is no clear consensus available in the community with respect to the possible scope of the use of SD methodology in organizational intervention projects,
- that there are the big obstacles for the usage of SD based organizational interventions by inexperienced but interested organizational practitioners, which is mainly due to the fact that the community is not able to provide transparent and consensual answers about topics like intervention process schemes, role models and skill requirements etc..

Given the severity of these consequences it seems necessary to investigate in more detail the fragmented theoretical foundations of the SD methodology. Based on such an analysis it would then be of high interest to see if an improvement in the organizational practice of SD can be achieved through a reformulation of the theoretical framework underlying SD. The success of such a reformulation must be judged against its ability to overcome the above stated problems and to enable the derivation of satisfying answers to questions like:

- What problem contexts are suitable to the applications of SD consultancy (e.g. Lane 1994b; Vennix, 1996; Rouwette, 2003)?
- What organizational contexts are suitable for the application of such approaches (e.g. Lane 1994b; Flood and Jackson, 1991; Rouwette et al., 2002)?
- By what levers does an SD based intervention act in a given organization (e.g. Lane, 1994b; Rouwette, 2003)?
- What is the ultimate goal of the use of such interventions in an organization (e.g. Lane 1994b)?
- What is the optimum process for an organizational use of SD methodology (e.g. Vennix, 1996; Andersen and Richardson 1997; Rouwette, 2003)?
- What role models and skill requirements need to be met in a SD based organizational intervention (e.g. Vennix, 1996; Andersen and Richardson 1997; Rouwette, 2003)?

The discussion about such a reformulation might also trigger a clarification with respect to the open question of the epistemological interpretation of SD and its practice. That is not to say that there is only one interpretation, but that it might be possible to understand the consequences of an adopted epistemological interpretation in a more consistent way, so that a conscious and consistent choice of an epistemology and an accompanying practice might be enabled in the community.

Based on the above considerations the given paper proposes a possible path for such a reformulation that ranges in its scope from an epistemology to the formulation of a fully developed intervention model that can be used as a practical framework for the use of SD methodology in organizational problem contexts. A more concrete description of this path is given via the following four core hypotheses of this paper:

> **Hypothesis 1:** *"The existing SD based organizational intervention practice does not appreciate the fact, that the application of SD methodology in an organizational context represents an organizational consultation problem and consequently has to be treated as such."*

> **Hypothesis 2:** *"The missing consensus about the epistemological interpretation of SD in the SD community as well as the neglected discussion about the organizational theory underlying SD is a major cause for the existing limitations in the organizational intervention and consultation practice in the SD community."*

> **Hypothesis 3:** *A reinterpretation and reformulation of the existing organizational theory underlying SD as well as its accompanying epistemological assumptions in the frame of Luhmann's theory of social systems (Luhmann, 1984) supplies a consistent subjectivist interpretation of SD and its practice due to the constructivist implications of Luhmann's theory and thus provides a more suitable theoretical framework for the derivation of an organizational intervention practice.*

> **Hypothesis 4:** *The existing "systemic intervention" paradigm in organizations and its accompanying practice derived from Luhmann's theory of social systems provides a theoretically consistent and operationally elaborated consulting framework, in that the existing SD based organizational intervention practices can be integrated and reformulated.*

Following these hypotheses this paper will elaborate the foundation and consequences of these hypotheses in five steps. First a description of the existing organizational practice in the SD community is given. This is then complemented by some thoughts on the theoretical and epistemological foundations of SD and their relationship to the SD practice. After that an outline of the autopoiesis theory of social systems is given. Based on this discussion we will compare the organizational image of the SD community with the autopoiesis theory of social systems of Luhmann (Luhmann, 1984). Here we will find striking similarities with respect to observed organizational characteristics, but a much more coherent theoretical approach on the side of Luhmann's theory of social systems. This finding is especially interesting as Luhmanns theory has since its introduction inspired a rich literature of organizational intervention approaches that can be summarized under the labels „systemic intervention" (SI) or „systemic organizational consultation" (SOC). This body of literature holds a great potential to establish a practical framework for the use of SD methodologies in different organizational contexts.

The paper closes with a summary of the main practical conclusions of the proposed new framework for SD based organizational interventions, summarizes necessary further steps in the ongoing analysis and points towards further possible discussion directions motivated by the given analysis.

2. The existing organizational intervention practice in the System Dynamics community

Jay Forrester defined the field of Industrial Dynamics (later called system dynamics) in his book "Industrial Dynamics" (1961) in the following way:

"Industrial dynamics is the investigation of the information-feedback character of industrial systems and the use of models for the design of improved organizational form and guiding policy."

This means that System Dynamics relies for the analysis of organizations on two essential levers, namely the concept of causal feedback loops and the use of formal models to portray the policy or decision structure of such organizations. Therefore, when we talk about the use of SD methodology in the frame of organizational consulting efforts we mainly talk about the use of formal modeling either it be qualitative or quantitative (including causal feedback loops) of the causal structure of a relevant problem in an organization.

Forrester motivated this focus on formal modeling by pointing out the higher usefulness of such models relative to verbal descriptions of organizational problems, which are (Forrester, 1961; 1968)

- ill defined,
- unclear or diffuse in their assumptions,
- difficult to communicate through language,
- not suitable for an inference of the dynamics contained in the respective problem.

In contrast to that formal representations of the causal structure of an organizational problem are

- a clear expression of the structure and assumptions underlying the model,
- easy to communicate due to their formal clearness,
- suitable for the inference of the problem dynamics due to the possibility to incorporate a mathematical framework in this formal modeling process.

Formal models can never be a "realistic" picture of a real world system, but should be understood, according to Forrester (1961), as subjective mental representation of a considered system-problem complex. In such an understanding models are subjective communicative and exploratory devices for the analysis of the causal and dynamical structure of a considered system-problem complex. Putting it a bit differently one can state, that formal models enable the exploration of individual or group believe systems (Forrester, 1961).

In practice the employment of such models as exploratory devices in an organizational context has been found to be helpful from a practical point of view for a variety of organizational problems, such as (see for example Vennix, 1996; Rouwette et al. 2002 etc.):

- knowledge elicitation and management,
- problem analysis, structuring and visualization (PSM-methodology),
- improvement of internal communication (comparison and alignment of mental models, establishment of common language),

- qualitative and quantitative policy design and analysis,
- fostering agreement and commitment,
- conflict solution (explication of mental models),
- training and learning.

This variety of potential applications has led to the development of a rich literature of field studies based on the use of SD methodology for organizational interventions (see for example Sterman (2000) and Rouwette (2002) for extensive lists of SD based field studies).

If one takes a closer look at the way modeling has been used in these field studies it is possible to outline two principal intervention strategies, namely the use of precoded models that have been developed outside of a considered system-problem complex and the use of models that are developed in the frame of the respective system-problem complex. Typical examples of the first intervention strategy are the use of so called management flight simulators (Dörner, 1997; Sterman, 2000) for training purposes or the use of system archetypes for the discussion and reflection of typical organizational dynamics (Senge, 1990; Sastry, 1998).

The second intervention strategy relies on the construction of formal models tailored to the specific system-problem complex of interest. This strategy is the most common approach to using SD models in the frame of organizational interventions and can be applied in two working modes, namely in an expert and a participative mode. Historically the expert mode precedes the participative mode of model construction. The main characteristics of the expert mode are

- the application of a modeling process (see for example figure 1),
- the application of an expert modeling process scheme that relies heavily on back office modeling work without client involvement,
- a role model for the involved SD practitioner that focuses both on the modeling process and the content of the modeling process.

Based on these findings, the expert mode of performing SD based organizational interventions has received, a lot of criticism of which most has been directed towards its model construction practice and the implicit helping model underlying the expert mode.

The main critique of the treatment of the model construction process in the expert mode is related to

- the unavailability of a standard model construction process despite the long tradition in model creation (e.g. Forrester, 1961; Richardson and Pugh, 1981; Wolstenholme, 1994; Sterman, 2000; Keating, 1998 etc.), which hinders the proliferation of the SD modeling skills into a wider audience of organizational practitioners,
- the claim that guidelines with respect to questions like: "What is good modeling practice and what makes a good model (e.g. Forrester 1961; Richardson and Pugh, 1981; Morecroft, 1982; Sterman, 2000)? What should be the preferred modeling mode: qualitative or quantitative (e.g. Vennix, 1996)? What is the optimum size of a model (e.g. Forrester, 1961; Forrester, 1968; Sterman, 2000)?" are not answered in a consistent way in the SD community.
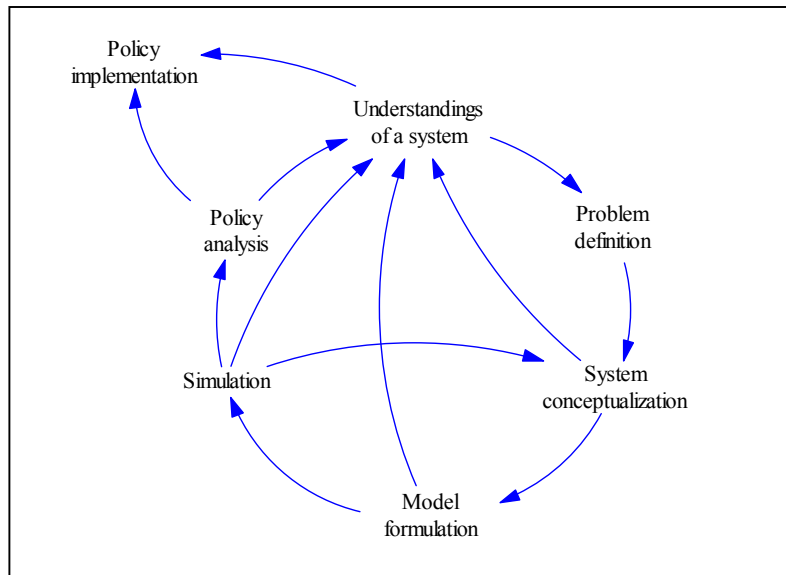
Figure 1: Seven step modeling process (Start: Problem definition) proposed by Richardson and Pugh (taken from Richardson and Pugh, 1981).

The critique related to the helping model (role models) implicitly underlying the expert mode has interestingly not been formulated as a claim to introduce a different formal helping model including for example role definitions for the practitioner and the client, but is formulated out of a less abstract perspective as deficiencies observed in practice. These deficiencies are

- that the results of the modeling process tend to lack client ownership and are therefore often rejected by the client,
- that the expert role claimed by the SD practitioner not only for the modeling process, but often also for the content of the modeling process is often rejected by the client.

It is interesting to note, that this critique is typical for the so called "doctor-patient" helping approach in consultation as it is described and discussed by Schein (1969). Under this consulting paradigm the consultant is called in to "find out what is wrong, and recommend how to fix it" (Schein, 1987), an approach that is only promising if certain requirements are fulfilled e.g. a clear mandate for the consultant from all involved clients, willingness to accept the diagnosis of a "doctor", adequate diagnosis by the consultant with respect to the organizational symptoms, cooperation of client organizations members even if they are part of the "sickness", willingness of the client organization to implement the prescription of the consultant and last but not least the ability of the client organization to stay "healthy" once the consultant leaves (sustainability of remedy). Usually these requirements are not met in real doctor-patient relationships too, as can be seen from the frequent critique of the expert mode of modeling.

To overcome part of the above critique, over the years a more participative modeling approach has been introduced into the SD community's organizational intervention practice, guided by the question: "How can we increase the commitment of a client into the use of a

model?". This participative mode originally introduced at the end of the 80s into the SD community differs from the expert mode mainly through

- its employment of a much more interactive model construction process,
- a focus in the SD practitioners role model on the task of group facilitation and client involvement.

Examples for the successful application of the participative mode are next to others the reference group approach by Randers (Randers, 1977), the strategic forum approach by Richmond (Richmond, 1987 and 1997), the modeling as learning approach by Lane (1994a) and the group modeling approach by Anderson and Richardson (1997) and Vennix (1996).

With the introduction of the participative modeling mode, the usability of SD methodology for organizational interventions has surely been improved with respect to the problem of client commitment and ownership. Nevertheless, even in the case of the participative mode the integration of the practices of organizational interventions in the SD community into an existing consultation process model e.g. process consultation (Schein, 1987) or systemic intervention in organizations (Wimmer, 1992) has not been performed. This is pitiful, as an explicit reference to an available consultation model would offer an optimum framework for the discussion of deficiencies in the current system dynamics intervention practice as they have been discussed above. Such a framework would also be very helpful for broadening the scope of the discussion of the given intervention practice with respect to questions out of the organizational consultation practice like:

- How should one establish and keep a helping relationship between the client and the practitioner based on trust?
- How is it possible to identify the relevant problems in a considered organization?
- How can we define the scope of SD for organizational problem solution?
- How can we ensure the suitability of SD for organizational problem solution?
- How can we strengthen the operational character of the SD practice?
- How can we measure and increase the efficacy of SD based intervention practices?

Despite the fact that such a reference has not been established, it is possible to find substantial contributions to the discussion of the above questions in the SD literature. A first example for such a discussion is provided through the study of Rouwette et al. (2002), who compared the modeling processes and assessments of results of 107 case studies that employed SD based intervention concepts. Their main findings are

- that the practices employed in the frame of SD based organizational interventions are still fragmented with respect to process models, role models and terminology,
- there is no research program available that would allow to generate and test hypotheses about the effectiveness of system dynamics based interventions.

The first finding clearly supports the claim that a coordination frame for the intervention practice in the SD community in the form of a consultancy model is needed to overcome the fragmentation in the communities practice. The second finding relates to the fact that in addition a clear reference between the intervention practice and a theory of social systems is required, that enables the formulation of hypotheses about the cause and effect logic behind that practice.

A second example for a discussion of part of the above questions is the work of Flood and Jackson (1991) who propose to integrate the SD intervention practice into the wider framework of a "System of Systems Methodologies" that they call Total Systems Intervention (TSI). TSI comprises besides SD several other systems methodologies out of the wider System Thinking (ST)[1] community (including Soft Operations Research (SOR) methodologies like Soft System Methodology (SSM), Viable System Diagnosis (VSD), Critical Systems Heuristics (CSH) etc.). The main idea behind this meta-approach is Flood and Jackson's assumption that all of these systems methods are only applicable in certain organizational problem contexts (they claim for example that SD is not capable of dealing with situations that are characterized by nonconsensual or coercive structures). So, through the combination of different systems methodologies into one toolbox Flood and Jackson hope to provide a framework that is applicable in diverse problem contexts (for a more detailed discussion of this issue see also Flood and Jackson, 1991 and Lane, 1994b). A similar but less structured approach has been proposed by Lane (1994a and 1994b) who hopes at increasing the practical effectiveness of SD interventions through the use of cross over techniques e.g. the combined use of SOR methods or other methods like the hexagon technique in the frame of an SD based group modeling approach etc.. Flood and Jackson's approach is a relevant contribution to the above discussion as it proposes a quasi-consulting model comprising a clear consulting process. Unfortunately, Flood and Jackson do not elaborate on the topic of the consultant-client role model issue and through this characteristic constrain their approach to a quasi-consulting model. It appears further on to be a strong limitation in their model that they do not formulate a coherent theoretical framework for their system of systems methodologies, which gives their approach a patchwork character with strong phenomenological orientation.

In addition to thess more practically oriented comments, Flood and Jackson also formulate a more fundamental critique of the current SD intervention practice, which criticizes that

- SD diverges in its modeling practice from the normal scientific method by employing causal relationships in the models that can not be supported by sound empirical data but are more or less only "believes" of an observer about for example soft factors in an organization like employee motivation and satisfaction, that are surely of high relevance for the understanding of organizational dynamics,
- SD produces distorted and one-sided reflections of organizations that are not adequate representations of the multi-purpose and multi-perspective social complexity of a real organization,
- SD's external perspective (outside observer) on organizations is fundamentally flawed, as it does not offer any means to include the subjective intentions of human beings that are believed to be a crucial factor in the organizational dynamics,
- SD is blind for the limitations of the perspective out of which it constructs models,
- SD does not offer means to question the taken-for-granted purpose underlying every SD model.

This critique is of great interest, as it clearly highlights the importance of a profound understanding of the conceptual and epistemological theory underlying an intervention

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[1] The term ST is meant here in the way as it is used by Lane (1994b), who summarized under the term ST both SD and Soft Operational Research (SOR) methodologies. This is in contrast to Senge (1990), who attributed the term ST only to the qualitative modeling practice in the SD community.

approach. Without such an understanding the relevance, adequacy and reliability of such a practice appears to be very questionable, which might easily translate into a low credibility of such an approach. Therefore, it appears necessary to broaden the above requested establishment of a reference between SD based intervention practices on the one hand and a full consultation theory on the other hand, by including also references to

- a theory of organizations underlying SD,
- an epistemological theory underlying SD.

Such an integrated approach might also hold additional benefits as it might shed some light on why for example the observed helping model in the SD intervention practice has emerged and how it is related to the organizational theory underlying SD. The same is true for the question if the addressed theoretical constructs can be integrated in a consistent way in their current formulation and state of reflection. Therefore, to answer these questions and to diagnose if a reformulation of parts of the theoretical constructs underlying the SD framework is necessary, we will have in the next section a more detailed look at the organizations theory underlying SD as well as its epistemological basis.

3. A critique of the organizations theory underlying System Dynamics

If one surveys the existing literature in the SD community with respect to its theory of social systems, it is possible to outline a hierarchical framework consisting of the following elements:

- a system metaphor,
- a set of system principles,
- a phenomenology of system characteristics.

A system metaphor is a natural starting point for the formulation of an organizational theory as it „....implies a way of thinking and a way of seeing that pervade how we understand our world generally." (Morgan, 1986). It is a very powerful tool for the study of organizations as it defines the perspective through which we view organizations. In the case of SD, Forrester (1961) used servomechanical devices as a metaphor for the complex industrial organizations that he was interested in. Based on this metaphor he defined industrial organizations as „information feedback systems" (IFS). An IFS he defined as follows: „An information feedback system exists whenever the environment leads to a decision that results in action which affects the environment and thereby influences future decisions." (Forrester, 1961).

This system metaphor leads to a picture of organizations as self-steering entities capable of interacting with the environment in an autonomous way, whereas the self-steering capability is the result of the internal causal feedback structure of the system. Given this picture of an organization, it is not surprising, that the resulting SD theory of such an organization is one that very much focuses on the endogenous causal feedback loops that relate the system state variables with internal managerial decision making and acting (i.e. information processing). To put it a bit different, one can state, that the organizational theory underlying SD can be understood as a theory that tries to endogenously explain system behavior through the causally closed loop structure inherent in the behavioral network created through the managerial actions in an organization (Forrester, 1961; Richardson, 1991).

Principle 1	**Closed Boundary:** In concept a feedback system is a causally closed system. Its dynamic behavior arises within its internal feedback loop structure. Any causal interaction which is essential to the behavior mode of the system being investigated must be included inside the system boundary.
Principle 2	**Feedback loop – the structural element of systems:** The feedback loop is the basic structural element in systems. It is a causally closed path coupling system state (level), observation of this systems state (information), decision based on that information ("policy") with an action that changes the considered system state. Dynamic behavior is generated by feedback. The more complex systems are assemblies of interacting feedback loops.
Principle 3	**Decisions always within feedback loops:** Every decision is made within a feedback loop. The decision controls actions which alters the system levels which influence the decision. A decision process can be part of more than one feedback loop.
Principle 4	**Levels and rates as loop substructures:** A feedback loop consists of two distinctly different types of variables – levels (states) and rates (actions). Except for constants, these two are sufficient to represent a feedback loop. Both are necessary.
Principle 5	**Levels are integrations :** The levels integrate (or accumulate) the results of actions in a system. The level variables can not change instantaneously. The levels create system continuity between points in time.
Principle 6	**Levels are changed only by the rates:** A level variable is computed by the change due to rate variables, that alters the previous value of the level. The earlier value of the level is carried forward from the previous period. It is altered by rates that flow over the intervening time interval. The present value of a level variable can be computed without the present or previous values of any other level variables.
Principle 7	**Levels completely describe the system condition:** Only the values of the level variables are needed to fully describe the condition of a system. Rate variables are not needed because they are computed from the levels.
Principle 8	**Rates not instantaneously measurable:** No rate of flow can be measured except as an average over a period of time. No rate can, in principle, control another rate without an intervening level variable.
Principle 9	**Rates depend only on levels and constants:** The value of a rate variable depends only on constants and on present values of level variables. No rate variable depends directly on any other rate variable. No rate equations ("*policy statements*") of a system are of simple algebraic form; they do not involve time or the solution interval; they are not dependent on their own past values.
Principle 10	**Rate substructure – system sub-substructure – goal, observation, discrepancy, and action:** A policy or rate equation recognizes a local goal toward which that decision point strives, compares the goal with the apparent system condition to detect a discrepancy, and uses the discrepancy to guide action.
Principle 11	**Level variables and rate variables must alternate :** Any path through the structure of a system encounters alternating level and rate variables.
Principle 12	**Levels and rates not distinguished by units of measure:** The units of measure of a variable do not distinguish between a level and a rate. The identification must recognize the difference between a variable created by integration ("*level*") and one that is a policy statement in the system ("*rate*").

Table 1: List of hierarchical system principles that establish the underlying decision and action oriented theory of organizations in the SD community (adapted from Forrester, 1968).

Based on this understanding of organizations, the natural perspective in SD on a considered system is one of an outside observer ("external view") trying to outline the systems internal causal decision and action structure. Out of this perspective Forrester defined a set of hierarchical system principles for an IFS (see Forrester 1968), which are listed in Table 1 and are meant as guidelines for performing such an analysis of an organization. The basic logical structure behind these principles is depicted in Figure 2, which shows the endogenous causal decision and action structure responsible for the behavior of a system ("Structure drives behavior") that is delineated from its environment by the depicted causal boundary. This

structure is characterized by a self-referential decision operation that translates information received from an observation into system specific meaning via a differential process that compares the perceived information to a system internal expectation. This meaning is then input to a mental decision structure which drives endogenous system action. The result of this action is a change in a system state, which finally feeds back into the next observation, starting the next cycle in this circular decision operation.
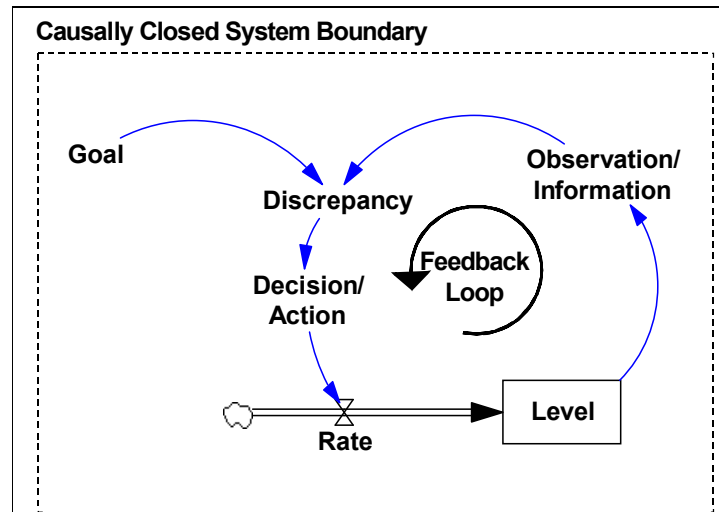

Figure 2: Causal diagram of the hierarchical system structure used for the representation of decision structures in organizations in the SD methodology (for details see Table 1).

Applying these principles to the study of organizations has led to the identification of a few general behavioral characteristics of complex social systems, namely (Richardson, 1991):

- Complex systems are remarkably insensitive to changes in many system parameters.
- Complex systems counteract and compensate for externally applied corrective efforts.
- Complex systems resist most policy changes.
- Complex systems contain influential pressure points, often in unexpected places, from which forces will radiate to alter system balance.
- Complex systems often react to a policy change in the long run in a way opposite to how they react in the short run.
- Complex social systems tend toward a condition of poor performance.

Given this list of system characteristics one can easily recognize the footprint of the system metaphor described at the beginning of this section, which attributed to social systems a self-steering autonomous character analog to a servomechanical device constructed by an engineer to be able to operate in an autonomous way (e.g. auto pilot etc.). This high degree of autonomy observed in the behavior of organizations in conjunction with the servomechanical metaphor has led to a working approach in the SD community with respect to organizational interventions that is guided by the idea of system analysis, design and reengineering. The ultimate goal of such an intervention approach is according to Forrester (1961):

„… „enterprise design" to create more successful management policies and organizational structures."

The way to achieve that goal is to change the causal system architecture (causal loop structure) of the system, which is coded into the decision and action practice in the organization. The natural assumption in SD is that such a change concept can be derived in an adequate way from the insights generated in the system analysis that is performed while a SD model representation of the causal system structure is formulated.

This means that the naïve role of a system dynamics practitioner is that of a system analyst, designer and ultimately engineer, which inherently brings with it a helping approach to a client organization that resembles the before mentioned doctor-patient model (Schein, 1969), with its described problems and limitations. **Based on this result it is possible to state that the theory of organizations underlying SD is clearly responsible for the restricted helping model found in the organizational intervention practice in the SD community**. This is an important finding as it points towards the necessity of questioning the adequacy of this theory if one wants to improve the given SD based organizational intervention practice. It might even be more fruitful to consider the replacement of the given theoretical framework with an alternative theoretical construct from which one would require (next to the theoretical and epistemological questions already raised in the last section)

- compatibility with the SD methodology,
- compatibility with the main results in the SD community about organizations,
- the provision of a fully developed organizational consulting approach consistently derived from this theory that is capable of providing an alternative helping approach for the SD based organizational intervention practice.

This alternative is additionally supported by the fact, that the adapted helping model used in the participative mode of SD based interventions can not be derived from the above outlined basic SD metaphor of organizations. It is more or less imported into the practice of SD based interventions from the theory of group processes and the process consultation framework developed by Schein (1969 and 1987). **Based on these findings it will be of core interest for the rest of this paper to investigate the ability of the autopoiesis theory of social systems and its accompanying consultancy framework called systemic intervention practice to meet the above identified theoretical requirements.**

Another point of critique formulated by Flood and Jackson (1991) in the last section dealt with the principal question, if SD is an adequate methodology for the analysis of organizations based on the claim that inner states and motivations of human beings strongly influence the dynamics of such organizations. Here a positive judgment seems possible, as the policy concept in SD (see Table 1 and Figure 2) outlined above, allows for the portrayal of subjective decision making practices in organizations including soft factors like motivation or satisfaction and concepts like bounded rationality (e.g. Sterman, 2000). Nevertheless, such a decision structure does usually not represent the decision practice of a single individual, but that of a functional role in that organization that can be occupied in an organization by a single individual or a group of individuals. **This is again an interesting result as it means that the interaction of a psychological system with its respective social system is represented in the SD formalism via the decision making concept**.

To finalize the analysis of the outlined theoretical framework of SD we will turn our attention in the last part of this section to the critique formulated in the last section about the epistemological basis of SD. Here two main topics need to be evaluated. First the charge that SD diverges in its modeling practice from the normal scientific method and second the claim that the concept of observation can not be reflected in the frame of the existing theoretical framework of SD and thus leads to a fundamental blind spot in SD. Translated into other words the latter means simply that the observer of a system and his relationship to the system including for example goals, interests, sympathy or antipathy are not suitable objects of the epistemological theory underlying SD. As the second topic requires a clarification of the first charge before it can be decided, we will start in our analysis with the question of what kind of explanations (knowledge) SD provides about social systems.

If one talks about knowledge generation, knowledge communication or the formulation of explanations in the field of SD the primary device for this endeavor is, as mentioned earlier already, the construction of models. In the existing SD methodology, these models are available in two basic forms or mixtures of these forms (e.g. policy structure diagrams):

- Causal Loop diagrams (CLDs),
- Stock and Flow diagrams (SFDs).

CLDs portray the causal structure (i.e. feedback loops etc.) of a system and enable mainly so called qualitative modeling, which means that such models can not be used for quantitative predictions of the temporal behavior of a system. SFDs focus on the level, rate structure of a system and do not display the causal structure of the system as clearly. On the other hand SFDs enable a quantitative modeling of a considered system (as they can be translated into differential equations) and can therefore be used to generate dynamical behavior patterns of the system of interest via the solution of the derived differential equations.

Despite their conceptual difference both model types allow the transformation of existing knowledge about a considered organization (e.g. verbally available expert knowledge, written knowledge etc.) into a formalized logical or mathematical format. The interesting question that arises with this formalization step is what kind of knowledge we get. Do we get realistic knowledge? Or do we simply get useful knowledge and if so, how should we define the term useful? These two questions and the distinctions behind them are representative for the two epistemological schools that can be found in sociology. First the functional school with its objective realism (knowledge is true and an objective representation of the real world). This view is sometimes also called „naive realism" or „ontological view". It is the perspective of the natural sciences as it could be found for example in physics before the discovery and the debate about quantum mechanics[2]. Secondly, the interpretivism school with its subjective constructivist paradigm (see also Lane (1994b) and Forrester (1968)). This view is sometimes

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[2] Interestingly this debate is not confined to the social sciences but can be analogously found in the natural sciences (Goldstein, 1998; Whitaker, 1996; von Weizsäcker, 1985), e.g. the debate about the interpretation of quantum mechanics in physics that can be summarized by the question: Describes Q.M. a reality that exists independent of an observer or is it a theory of possible knowledge of an observer in interaction with a reality that can not meaningfully be described without an interaction with an observer. In the latter interpretation QM is sometimes called a theory of the perceptive structure of the human observer. Following this interpretation one arrives at an interpretation of the scientific endeavor that is similar to the famous inscription at the oracle of Delphi which read „Recognize yourself.".

also called epistemological view. The differentiation between both paradigms can be nicely laid out on the base of Maturana's definition of an explanation (Maturana, 2002). Explanations according to Maturana entail two conditions that must be satisfied together. The first one is an informal condition that requires the proposition of a generative mechanism. The second is a formal condition demanding the satisfaction of a criterion of validation. The key to the distinction between both paradigms lies according to Maturana now in the interpretation of the respective criteria of validation. Here he distinguishes two criteria namely, *"the experimental scientific method"* and *"the criterion of validation of scientific explanations"*. Of these the first one leads to an ontological understanding relating an explanation to the existence of a reality independent of what the observer does, whereas the second one leads to an understanding of an explanation as a generative mechanism that can be used to explain the experiential coherences experienced by an observer without any reference to some independent reality but only to the experiential coherences themselves perceived by an observer (Maturana, 2002).

This distinction has a high relevance for the above formulated questions about SD as it states that dependent on the belief one adopts about the adequacy of the above described criteria one comes to completely different interpretations of the explanations that are provided by SD. According to the belief system of the author it is most appropriate to adopt the second criteria and thus define the knowledge provided by SD as useful knowledge in that it provides an explanation for the experiential coherences perceived by the observer with respect to his past perception of experiential coherences. If one additionally assumes that belief is based on the perception of experiential coherences one gets back to the understanding, described at the beginning of the last section, that SD models need to be understood as exploratory devices for individual and group belief systems. Based on this reasoning it is possible to rephrase the first charge made about the divergence of the SD modeling practice from the normal scientific method, as a simple statement of the fact, that SD, in using this practice, does not adopt as its basic epistemological criterion of validation the *"the experimental scientific method"*, but the *"the criterion of validation of scientific explanations"*. **Due to this argument we get to the result, that the outlined charge is actually not a charge but simply a statement about a different epistemological believe**.

This leaves us with the problem of the treatment of the observer in the theoretical framework of SD. Here it appears unavoidable to agree to the objections put up by Flood and Jackson (1991) with respect to the current practice in the SD community, which does not display the relationship of the observer to the system of interest. Nevertheless, from a principal point of view it appears possible to adopt the perspective of a meta-observer that observes the observer while observing the system of interest. Such a situation could also be portrayed in the form of a model, in which the displayed policies would be a representation of the internal goals, interests, sympathy or antipathy of the observer with respect to the system of interest. A change in the internal configuration of the observer would then translate into a change of the system representation, i.e. the SD model of the considered organization. **Thus we come to the result that the integration of the observer into the theoretical framework of SD is theoretically possible if one describes the observer-model relationship out of the perspective of a meta-observer that observes the observer while observing.**

In the remaining sections of this paper we will now concentrate on the question, if the theory of autopoietic social systems and the consultancy framework derived from this theory are suitable candidates to fill the above identified theoretical gaps in the theory of organizations underlying SD.

4. Social systems as autopoietic systems

In 1984 the German sociologist Niklas Luhmann proposed in his book "Social Systems" (Luhmann, 1984) a theory for social systems that tries to understand these systems on the base of modern system theory. His motivation for doing that was twofold. On the one hand he wanted to foster the theoretical foundation of sociology which he perceived to be in a theoretical crisis, on the other hand he was interested to see what the result of a reformulation of sociology in the framework of system theory would lead to. That he choose system theory as a framework for that endeavor was motivated by his believe that modern system theory shows the potential to develop into some kind of a "super theory" (Luhmann, 1984) with universalistic scope. Due to this potential his theoretical analysis is in part not only restricted to sociological topics but covers also much more general aspects of system theory. This broad approach to a new theory of social systems is also reflected by a three level hierarchy of system terms that Luhmann defined at the start of his analysis. Here we find at the top of this hierarchy the most general term "system", which is applicable to all possible instances of systems and is meant in its most abstract sense. On the second level he placed system terms like machines, organisms, social systems and psychological systems. These terms are examples for specific realizations of system types. On the third level Luhmann then focused on the field of sociology and introduced under the term social system three types of systems, namely interaction systems, organizations and societies. These system types are according to Luhmann representative for the possible structuring mechanisms that can lead in society as a whole to the establishment of a system (Luhmann, 1984). For Luhmann this scheme is not only a classification of system terms, but also an expression of the different degrees of abstraction underlying these terms e.g. the definition of a social system is more general and abstract than that of an organization. Due to this structure in the system term hierarchy Luhmann points out, that only certain kind of questions are meaningful with respect to the proposed terms. A comparison in between different terms is for example only meaningful for terms that are on the same level in the hierarchy. This means that it makes sense to compare organisms and social systems, but that it is meaningless to compare organisms and organizations or to try to establish an interaction theory of social systems, due to the different levels of abstraction underlying these terms.

Following this hierarchical approach Luhmann proposes in his analysis different definitions for the term system, dependent on which level of his hierarchical scheme he placed the discussion. In this context we will restrict ourself to the second and the third level of his hierarchy at which he introduced a very general operator based definition of a system. According to that definition, a system is a closed sequence of operations of a specific type (Luhmann, 1984), whereas operations in this context can be e.g. chemical operations (molecular interactions), communications, thoughts etc.. Based on this definition it is a straight forward approach to differentiate particular systems according to their base operation type. An important constraint for the system phenomenology that follows out of this definition is the fact, that there are no systems with mixed operation types. This statement also means that a human being can not be considered to be a system as he comprises more than one operation type e.g. chemical operations and thoughts. Nevertheless, it is possible to say that human beings comprise psychological (based on thoughts) and biological (based on chemical operations) systems and that if the biological system dies, also the psychological system breaks down.

If one adds to the above definition of a system a self-referential reproductive capability one gets to the definition of a so called autopoietic system (Luhmann, 1984). The term

autopoiesis was originally introduced by Maturana (Maturana, 1980), who used that term to describe the auto-reproductive capability of living cells, which are capable to reproduce themselves on the base of the molecular interactions that take place in a cell. Following this concept Luhmann translated the principle of autopoiesis from the biological context into a general principle of self referential systems. In such an abstract formulation autopoietic systems are characterized by the fact that they are capable of reproducing their system operations by the network of their operations that by themselves are produced by the system operations (Luhmann, 1984). Therefore, autopoietic systems do not only have the capability to reproduce their system elements in an autonomous way, but are further on also self organizing with respect to their structure, i.e. there is no structure import into the system from the environment. Given this more abstract definition Luhmann adopted the term autopoiesis and claimed that social systems can be understood as autopoietic systems and proposed that social systems are based on communications. This means that communications are the elements of social systems and that the communications of a social system produce patterns of communications that then again produce the communications of the social system. He further on proposed that psychological systems are also autopoietic systems that are based on thoughts. Given these assumptions it is possible to state that biological, social and psychological systems are similar with respect to their autopoietic capability but can also be clearly differentiated on the base of their specific system operation type (molecular interaction, communication, thoughts).

This operator based view on systems has important consequences for the characteristics of a system. First, as autopoietic systems are operationally closed, all processing in such a system is performed exclusively by system internal operations. There is no operational contribution of the environment to the system, so that a clear difference between the system and the environment can be established via the reach of the system and the environmental operations. The operational closure does not imply that autopoietic systems are closed systems with respect to for example material flows from the environment. Second, autopoietic systems are structure determined systems. This means that the continuation of system operations by other system operations requires the existence of system structures, i.e. patterns of operations. These patterns of operations are not stable in a static but in a dynamic sense, which means that they have to be continuously reproduced by the system operations, while they are operating.

A radical consequence of the above outlined characteristics is that social systems and psychological systems are operationally separated and can only establish a relevant environment for each other. This also means that human beings and their accompanying psychological systems do not belong to social systems but are only a relevant environment for such systems and vice versa. This brings up the question of how the relationship between social and psychological systems can be described, especially as it is obvious that social systems can not exist without human consciousness. Here Luhmann proposes the term structural coupling, which also goes back to Maturana (Maturana, 1980). Structural coupling describes the phenomena of structural congruence between a system and its environment. Typical examples for structural coupling can be found in biology e.g. the eye and the sunlight, the ear and sound etc.. The structural congruence between the system and its environment is the result of a mutual history of coevolutionary events in between system and environment. An important constraint for this adaptive dynamics in the system structuring is the requirement, that changes in the system structure must be compatible with the systems autopoiesis.

In the case of social and psychological systems, Luhmann proposes that the structural coupling between the communication in the social system and the thought structure in the individual consciousness takes place through a process of bi-directional meaning transfer via language (Luhmann, 1984). This means that communication and psychological systems have undergone a history of coevolution through the use of language. Therefore, excluding human beings and their accompanying psychological systems from social systems does not mean, that they are unimportant or not needed by social systems. As stated already before, the opposite is true as communicative systems (social systems) can not exist without individual consciousness with thoughts (psychological systems) although consciousness never directly participates in communication and communication only influences consciousness through meaning transfer via language. The term structural coupling establishes in that respect an antipode to the term autopoiesis as it represents the dependence of a social system on its environment, whereas the term autopoiesis implies the independence of a social system from the environment when it comes to its operational capability of self-creation (Luhmann, 1984).

In this context it is important to understand that due to the operational closure of social or psychological systems, external disturbances to such systems from the environment trigger a system response that is completely endogenously driven (based on the system internal operations). This also means that external disturbances can not provide information to a system but instead can only trigger the production of information in the system that then in a subsequent step can further on be translated into meaning via a process of system internal interpretation. Thus, dependent on the operational characteristics of the system, the same input that one system will consider to be meaningful information will be considered in another system as noise. Therefore, social systems as well as psychological systems need to be considered as distinct "meaning worlds" that are based on individual reconstructions of the environment in the form of internal models used for the interpretation of environmental "noise" (Teubner, 1997). Based on this insight, it appears meaningful to say that social systems and psychological systems are capable of observing their environment and themselves (through the self-referential application of this capability on themselves). The latter implies that social systems are also capable of self-reflection, through the self-referential nature of their operational structure. This capability is constrained by the nature of their operational structure, which constitutes a "blind spot" in their self-reflection that can only be seen by an external observer who could observe the system in its act of observation. This mode of observation is sometimes also called "observation of the 2nd order" (Luhmann, 2002). It is important to understand that qualitatively an "observation of the 2nd order" is only for the observer that is observed an "observation of the 2nd order". For the observer that observes the other observer it is a normal observation with its own "blind spot" determined by the operational structure of that observer (Luhmann, 2002).

Due to its capability of self-reflection a social system is also capable of building an internal model of itself or parts of itself, which means that it is capable to replicate the basic distinction between system and environment in itself. Luhmann (Luhmann, 1984) calls this process, following Spencer-Brown (Spencer-Brown, 1979), "re-entry" and states that through this process, social systems are subject to an internal differentiation process that establishes in the system functionally differentiated autonomous autopoietic subsystems. An example for such an internal differentiation would be in the case of the whole society the functional differentiation into subsystems like science, economy, law or politics. Each of the resulting subsystems is characterized by Luhmann based on three references, namely the reference to the overall system which is called "function" of the subsystem, the reference to another subsystem which is called "achievement" and last but not least the reference to itself which is

simply called "self-reference". This three dimensional referencing of a subsystem is of great interest as it leads to a picture of a social system as a functionally differentiated system with no hierarchical structure, but a structure based on functionality and achievement for its autonomous and autopoietic subsystems. In such a picture every subsystem is of equal importance due to its exclusive functions and achievements (Luhmann, 2001). They are further on due to their autopoietic nature also "meaning worlds" of their own, that consequently develop also their own communicative codes (Luhmann, 2001).

A further important step in Luhmann's theory is the application of the above concepts to organizations as they can be found in highly developed social societies in the form of e.g. industrial companies, governmental agencies, non-profit organizations etc.. According to Luhmann's hierarchical scheme, organizations are social systems whose operational basis are given by the communication of decisions[3] (Luhmann, 1998). They produce decisions from decisions and attain in this way operational closure. This view on organizations implies also that any kind of organizational structuring is not only the result of the internal organizations decisions, but is actually established by these decision structures independent on if they are formal or informal decisions (Luhmann, 1998). It is further on important to understand in the context of this organizational understanding that the applied decision model is not one that is based on an intra-psychological model of an individual, but one that is defined on the base of the relationship between the meaning of an action and an expectation on that action. It is through this understanding of a decision operation in an organization, that it is possible to say that individual consciousness and action are a prerequisite for the organizational autopoiesis but not part of it. Individual action in that respect is only the trigger for an organizational decision and nothing more.

If we come back now to the questions raised at the end of the last section about what relevance the above theory for the SD community can have, the author aims at proposing a far-reaching answer. The above characteristics imply that organizations need to be understood as autonomous, functionally differentiated systems with the ability to reconstruct meaning and evolve through their interaction with themselves or the environment (including the psychological consciousness of the human being that couples to these systems). This view on organizations has profound implications for the analysis and work with organizations. **It especially has the implication that it is self-referential in that it is applicable to itself, i.e. that the autopoietic theory of social systems can be understood as a meta-theory for formulating models and reconstructing meaning for functionally differentiated and closed worlds of meaning. The theory in that respect is also a suitable theory to reflect its own way of observing social systems.** This means that through this theory we become aware of our way of observing the social systems that we are dealing with (Willke, 1997).

On the same token, one is able to consider SD to be an autopoietic entity of its own, which is part of the wider functional (autopoietic) subsystem science in our modern western society.

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[3] Luhmann proposes in his theory to understand the term decision as a relational term that is based on the relationship between the meaning of an action and the expectations on that action. In that respect a decision is a selection between the two alternatives of conformity and deviation in such a situation. An important aspect of this definition is that the attribution of meaning to an action can be done by the acting individual or an observer and is thus no absolute characteristic of an action. The same is true for the definition of the expectation on the action. This means that an individual is able to perform an organizational decision through his action without knowing that he made such a decision (Luhmann, 1984).

Based on these finding we can reformulate the question posed in the last section in the following way: "What can we learn from reflecting and reformulating the theory and practice of SD in the frame of Luhmann's system theory of social systems?". This question implies a far-reaching and voluminous scientific program which can surely not be treated in a comprehensive way in the scope of this paper. It also reaches further then the question placed at the end of the last section about the suitability of this theory to meet the theoretical requirements for an SD meta-theory deduced from the given theoretical framework of SD. Therefore, keeping this overarching programmatic question in mind, we will focus in the remainder of this paper on the treatment of three questions believed to provide a suitable start for the discussion of the above raised question. These questions are:

- How does the epistemological foundation of SD fit into the epistemological theory behind Luhmann's theory of social systems?
- In what respect differs the servomechanical metaphor of SD and its related theoretical understanding of organizations from Luhmann's theory of social systems?
- Is the systemic intervention practice derived from Luhmann's theory of social systems a suitable consultancy framework for the SD practice of organizational interventions?

Starting with the epistemological question it appears clear from the above outline of Luhmann's theory, that the subjective interpretation of the SD practice as it has been outlined in the last section is perfectly compatible with the claims made in Luhmann's theory. Both theories do not comprise ontological claims, but make only claims about the subjective structure of either belief systems about a system (in the case of SD) or internal models of a system (in the case of Luhmann), which is actually the same. Therefore, it appears that from an epistemological perspective both theories are not in contradiction to each other. Nevertheless, a difference in the kind of knowledge that is created in both theories can be stated. The reason for that is that in SD the produced knowledge is mainly based on normal observations, whereas in Luhmann's theory the preferred observational mode is that of an observer of the 2nd order. This means that the knowledge created in the latter theory comprises a higher order of reflection than that typically derived in SD. This limitation in the SD practice has already been mentioned in the last section, when we discussed the implications of Flood and Jacksons (1991) critique of the SD practice. Here we also stated that this deficiency in the SD practice is not a conceptual but mainly a practical one. This means that from a principal point of view it could be overcome by an additional level of reflection in the SD methodology, which would have to include a more thorough observation of the model creation process, including an appreciation of its constraints inherently contained in the perspective of the observer of the system of interest.

If one further on compares the major characteristics between the servomechanical metaphor underlying SD and the organizational metaphor resulting from Luhmann's work, one can outline the following similarities:

- in both theories the system boundary between the system and the environment is defined on the base of the operational closure of the system operations, that means through the reach of these operations (endogenous versus exogenous system variables),
- the dynamics of organizations is considered in both theories to be structure determined and to be endogenously generated, in that respect, that external

influences can only establish a disturbance but not an instructive authority for the system,

- based on this characteristic both theories attribute to social systems the capability of autonomy,
- both theories consider organizations to be functionally differentiated,
- both theories use an impersonal perspective to display the system structure,
- both theories use model building to analyze the structure of a system.

Despite these similarities there are also significant differences:

- in the SD practice the concept of the observation of the 2nd order is not known,
- in contrast to the practice in SD in Luhmann's theory the relationship between an external observer (e.g. consultant) and the system of interest is part of the theory,
- the modeling process in SD is mathematically oriented and highly formalized, whereas the modeling process in Luhmann's theory is an abstract process of a system, that is not formalized but an act of cognition,
- the term autopoiesis with its reproduction function has no equivalent in SD, although the causal circularity of the systems communicative operations resembles the feedback loop concept from SD,
- the policy and decision structure of SD diagrams relies heavily on intra-psychological decision models in contrast to the more contextual decision model in Luhmann's theory.

Summarizing the above one can state that both theories show on a phenomenological level some striking similarities with respect to their claims about the structure and dynamics of organizations. On the conceptual level there are some similarities but also some significant differences. Therefore, if one aims at reformulating the SD paradigm in the frame of Luhmann's autopoiesis theory of social systems it appears necessary to reflect in more detail on the identified conceptual differences to see if the SD practice can be consistently derived from the theory of autopoietic social systems. An important question in this context is for example the question of how SD methodologies like CLDs and SFDs diagrams have to be interpreted in the frame of Luhmann's theory. An answer to this question is not in the scope of this paper and will be subject to further investigations. The same is true for a detailed answer to the question about what role the practice in SD can play in the frame of the autopoietic theory of social systems. All in all it appears extremely promising to compare the structure and claims of both theories to enable a detailed reformulation of the current SD practice in the frame of Luhmann's theory, which would for example enable also the integration of the existing SD organizational intervention practice into the systemic interventions practice in organizations. This last topic, which also points to the third question ,given above, will be the subject of the next section.

5. „Systemic intervention" practice in organizations

Since the introduction of Luhmann's theory of social systems in 1984 the interpretation of Luhmann's theory has been in the focus of organizational consultants. These efforts have led to the definition of an independent consulting style derived from the main implications of the theory. This consulting practice is called "Systemic Intervention" (SI) or "Systemic Organizational Consultation" (SOC) as already mentioned before (see section 1). The term systemic relates in this context to the system based view on the considered organizations in

that a particular consultation project takes place. The term intervention is defined[4] as (Wilke, 1992):

"...a goal driven, directed communication between psychological or social systems, that respects the autonomy of the system that is the target of the intervention.".

Based on the above cited work and the definitions provided in the last section, the main characteristics of the SI approach can be specified as follows:

a) *Creating a consultation relationship and defining clear role models is part of SI*

Due to the operational closure of organizations a consultant is from a principle point of view not able to impose any kind of instructive change model on an organization. Therefore, it is of great importance that the consultant defines at the beginning of every organizational intervention project an adequate relationship to the client organization that reflects this fact. Usually this is done via the establishment of a consultation system with selected representatives of the client system (Simon, 2002; Wimmer, 1992). The natural role model for the consultant in such a setup is that of a structural coupling to that consultation system, which means that the consultant enters into a process of coevolution with the consultation system. In this situation it is the main task of the consultant to manage this process in an active fashion (process consultant). With respect to this management task it is important for the consultant to understand, that every disturbance that he provides to the consultation system either it be intentional or unintentional might be interpreted by the consultation system as a relevant information and might trigger a change in the system structure and behavior. This awareness is especially important at the beginning of a consultation project, when the consultant has not developed his intuition about the information processing characteristics and capabilities of the consulting system and the client organization.

b) *Consciousness about predominant schemes of observation within a client system is key and is produced through observation of observation patterns*

Through the establishment of a consultation system that comprises members of the client organization the consultant is able to create a situation in which usually typical observation patterns of the client organization become apparent in the consultation system so that they can be observed by the consultant ("2nd order observation"). This offers the possibility to bring these patterns and their consequences (e.g. "blind spots") to the attention of the client organization members that participate in consultation system.

c) *SI focuses on changing observation schemes*

Based on the identification of predominant observation schemes in the consultation system it is possible to discuss with the members of the client organization alternative observation schemes that might offer some potential benefits for the client organization.

d) *SI aims at perturbing old and introducing new communication patterns*

Analog to the identification of predominant observation schemes it is also possible to address the issue of persistent communication patterns in the consultation system. Here two principle

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[4] Translation by the authors from the original German text.

intervention path are available to the client. First, the possibility to irritate these patterns in the consultation system via system interventions by the consultant that might lead to permanent changes in the communication patterns of the consultation system and potentially the client organization. Second, the discussion of the observed communication patterns in the frame of the consultation system based on the consultants observations. These discussions might also lead to changes in the prevalent communication patterns in the consulting system and potentially also in the client organization. Such changes are usually very difficult to achieve as they are intimately related to the system structure of the client organization that due to its self organizing character does not allow the simple import of structure.

e) *SI consultants focus on becoming experts of process architectures*

As it was said before, one of the main levers for organizational change is the intentional use of communication events that are capable of triggering an internal dynamic in the consultation system of interest. Out of this perspective the consulting process is simply a coordinated sequence of interventions i.e. organizational communication events. Such a sequence is under the SI paradigm usually hierarchically structured according to the following categories (Königswieser and Exner, 1998):

1. **The process or event architecture (also called intervention architecture or social architecture).**
   The architecture of the consultation process defines the event structure of the considered consultation process. That means it describes when an event will cause a disturbance in the considered system and via what means such an event is organized. Typically it is possible to discern different events along four dimensions (TSSC), namely:

   - Time (T): When does an event takes place and what is the duration of the event.
   - Space (S): The spatial condition under which an event takes place e.g. indoor, outdoor, office, meting room etc..
   - Social (S): The number of people that are involved in the event and how they are involved. Here certain social entities have to be distinguished e.g. single person, pairs, groups etc..
   - Content (C): What is the content that is discussed in the frame of an event and from what perspective/s is it presented.

   The process or event architecture defines the amount and type of social spaces in which the structural coupling of the involved systems (consultant and client representatives) can take place via planned (and unplanned) interventions. Typical architectural elements are: Group-Workshops, Interviews, Steering Board sessions etc.. Königswieser and Exner (1998) differentiate in total 12 typical architectural elements. A process architecture is usually displayed by an **event diagram**. Figure 3 displays a schematic example for such a diagram.

2. **The intervention design.**
   The design of an intervention describes the "interior" of a certain intervention that takes place in a social space provided by the process architecture. The structure of a design can range from simple to complex designs, whereas the latter can comprise Sub-Designs. Like architectures, designs also need to be specified along the four

dimensions TSSC. An example for a simple design would be an interview comprising two people of a duration of 2 hours taking place in an office with the aim of data collection. An example for a complex design could be a daily WS with six participants, taking place in a hotel, that comprises four interventions of 2 hours length each having a specific design. Königswieser and Exner (1998) provide in their book a collection of about 70 designs for a multitude of intervention goals.
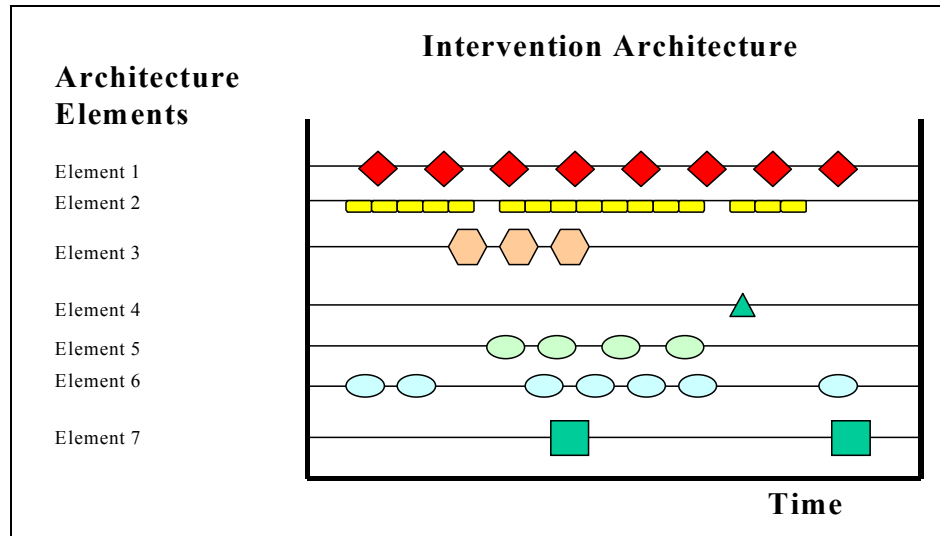

Figure 3:   Schematic event diagram (intervention architecture) of a consultation process. The different shapes and colors display different architectural elements (after Königswieser and Exner, 1998)[5].

3. **Intervention Techniques**

Interventions techniques are used by a consultant while working in an intervention design and are used to facilitate the process of the ongoing intervention. Typical examples of intervention techniques are story telling, use of metaphors, circular questioning, reframing, splitting, positive attributing etc. (for further details see Königswieser and Exner, 1998). Intervention techniques are used in the frame of an ongoing intervention to punctuate the process, regulate distance between the consultant and the client, to add perspectives or emotions to the process.

This process framework is highly operational and characterized by a clear standard terminology that is very well accepted throughout the SI community (e.g. Königswieser and Exner, 1998). The typical working mode of a consultant working in this framework is, as it was outlined before already, that of a process consultant or architect that is responsible for directing the involved client representatives through for example a WS design etc., a working approach or role model very much in agreement to the one used in the participative modeling mode in SD.

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[5] In the original publication of Königswieser and Exner (1998) the symbols are standardized and have a distinct meaning e.g. a triangle represents a group of three people, whereas a rectangle represents four people. Such a pictographic use of displayed symbols is not adopted here.

6. A new operational framework for the use of SD methodologies in organizational interventions

Given the above analysis we can now pose the question of what the benefits of using the SI consulting approach as a framework for SD based organizational interventions could be. Here we find four main benefits, namely:

1) The SD consultant can be understood as a process consultant

When we discussed in section 2 and 3 of this paper the different role models used in the expert and the participative modeling mode in the existing SD practice, we emphasized the fact that the process oriented role model used in the latter mode appeared to be unrelated to the organization theory underlying SD. Based on this observation it appears to be of high interest that a process oriented consulting approach seems to be the natural working mode in the frame of the SI, which is not merely a coincidence but a clear consequence of the autopoietic theory of social systems underlying the SI framework and its claims for the relationship between an observer and a social system of interest.

2) The SD modeling process becomes part of an intervention architecture

In section 2 we identified the missing reference to a full consulting process model as one of the main limitations of the organizational SD intervention practice. This is mainly due to the fact that the process model underlying SD based interventions is very much restricted on the issue of how to build a good SD model and therefore neglects other important process questions that arise in the frame of an organizational consultation project (e.g. see the questions raised in section 2). This situation can now be easily overcome by applying the process model used in the SI framework and acknowledging the fact that the existing process model in the SD community is nothing more than a process description in the frame of an intervention design according to the SI terminology. This fact enables a consultant to fit the given SD practice nicely into the intervention architecture of an organizational intervention project without loosing sight of the other important elements contained in a full intervention architecture.

An illustration of the practical consequences of the above claim is shown in figure 4, which depicts the group modeling approach of Anderson and Richardson (1997) in the form of an event diagram of the implicit intervention architecture used by them. The diagram shows all in all 7 architecture elements (to be filled with intervention designs) that are more or less clearly mentioned in the group modeling process description of Anderson and Richardson (1997). It is interesting to see that the architecture diagram covers much more aspects of the typical group modeling approach than the modeling process itself. That means that Anderson and Richardson (1997) implicitly use a more complex process model for their overall organizational intervention without explicitly mentioning it. The implicit nature of the other elements is also shown by the fact that Anderson and Richardson (1997) describe the design of the modeling WS very detailed through a compilation of more than 20 so called scripts, whereas the other architecture elements are only shortly mentioned in the text without any details. The application of the SI framework does provide in this context not only a nice way of displaying this disproportion between the different architecture elements, but it also enables a structured analysis of the given approach with respect to missing architecture elements. The description of the process model of Anderson and Richardson (1997) clearly misses for example an important architecture element usually called in the SI frame "problem

diagnosis". The problem diagnosis is used to clarify issues like: who is the client, what problem needs attention of the consultant, what is the organizational context of that problem, how do different stakeholders in the organization perceive the problem of interest etc.. Therefore, based on such an event diagram it is very easy to discuss the proposed consulting process model for a given consulting project that might include SD methodology. Such an integrative perspective might also be very useful to explain to potential clients the importance and relevance of the use of SD in the frame of a consultancy project.
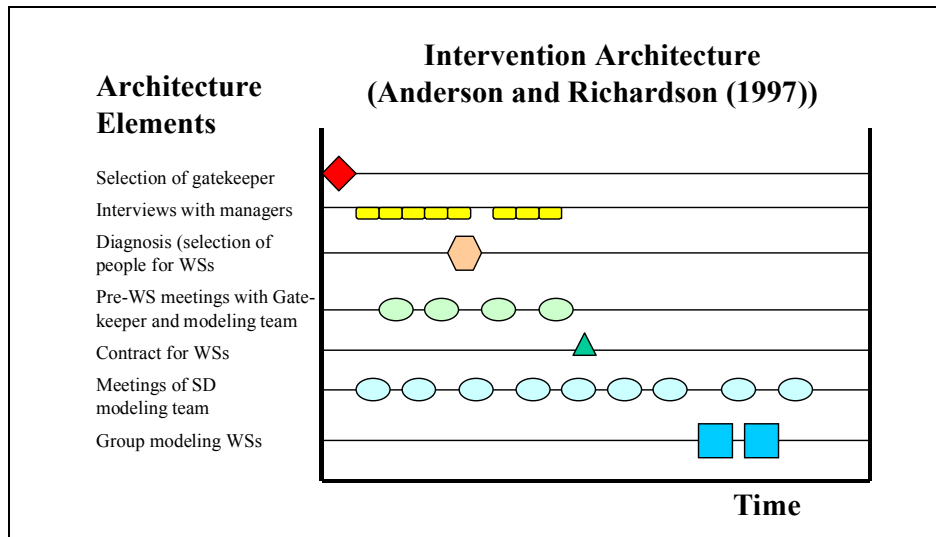

Figure 4: Schematic process architecture of the group modeling approach
by Anderson and Richardson (1997) (architecture elements
adapted by the authors).

Another important aspect of using the proposed three hierarchical categories of the SI framework is the fact, that it supplies a clear standard terminology that can help to standardize the fragmented terminology in the SD community. A nice example for this problem is depicted in table 2, which shows the corresponding terminology in the group modeling approaches of Vennix (1996) and Anderson and Richardson (1997). Here two findings can be emphasized. First, not even in the group modeling practice, which is only one of the practical schools in the SD community, a consistent terminology is in use. Actually Vennix (1996) and Anderson and Richardson (1997) use for all three SI categories completely different terms. Second, both approaches do not use a clear hierarchical distinction between the terms they apply. Both approaches are in that respect much more oriented towards a phenomenological perspective than the SI approach. Given these observations it appears very promising to call for the use of the SI terminology in future SD projects as this would establish a clearer hierarchical positioning of a discussed topic in a project description. Such a clarification of the logical positioning would decrease the danger of misunderstandings. It would also support the standardization of the elements in these categories, as is has been proposed for example by Anderson and Richardson (1997) for the documentation and use of scripts. The use of the SI framework would enable an extension of such a standardization or cataloguing effort to the two other categories of the SI framework. Here especially a standardization or cataloguing of process architectures for SD based organizational interventions could be of high interest and could trigger a loop like learning in the SD community with respect to such projects.

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SI	Vennix (1996)	Anderson and Richardson (1997)
Architecture	Project design	Process phase model
Design	Group process techniques/Formats	Scripts
Technique	Facilitation technique	Group tasks

Table 2: Comparison of terminology used under the SI and the group modeling paradigm (Königswieser and Exner, 1998; Vennix, 1996; Anderson and Richardson, 1997).

3)   The focus of attention lies on observations of observations and thus on belief systems

As stated already in the last section, it is one of the core beliefs in the SI paradigm that a consultant can best provide added value to an organization by supporting an organization in identifying its blind spots in its observation practices. Through that belief, which is also consistently supported by the underlying organizational theory of autopoietic social systems, the SI paradigm strengthens the subjectivist interpretation in the SD community. This interpretation (described already in section 2) states, that SD modeling is not targeted at a formalized description of some "real system properties", but at uncovering and aligning of believe systems (based on unconsciousness observational patterns) about such systems in an organization.

4)   SD adds value to SI by formalizing the observation analysis process of organizational believes and adding dynamical analysis capability to that process

As pointed out above the belief analysis process in organizations is in the focus of both the SI and the SD approach. Therefore, it is of great interest that the more formalized analysis approach offered by the SD methodology might also add some value to the SI approach. This can take place through the formal rigor of the SD methodology that allows also (dependent on if the modeling approach is qualitative or quantitative) for the inference of the behavioral complexities implicitly contained in a given belief system about a system or organization of interest. Thus, the use of such a more mathematically oriented analysis approach provides an additional element for the analysis of the logical consistency of a given group believe system in an organization of interest.

Summarizing the above, it appears very probable to produce some added value by incorporating the given organizational intervention practice in the SD community into the framework of the SI paradigm. The same appears to be true with respect to the uncertainty observed in the SD community about the use of SD in the frame of organizational consultation projects described in section 1 of this paper. Additionally, it appears also to be of high interest to continue with the research program outlined at the end of section 4 in this paper that called for a reinterpretation of the SD theory and methodology in the frame of the autopoiesis theory of social systems of Luhmann.

7.   Conclusions and further steps

It was the ultimate goal of this paper to propose the integration of the existing SD based organizational consulting practice into the systemic consultancy framework derived from Luhmann's autopoiesis theory of social systems. To do that, the paper has analyzed the given practice at

- the level of the consulting practice (standard terminology, role model, process model etc.),
- the level of the organizational theory underlying SD (servomechanical theory versus autopoiesis theory),
- the level of the epistemological basis of SD (constructivist interpretation of SD versus the ontological "hard SD" and OR like interpretation style),

and has shown that such an integration does not lead to theoretical inconsistencies at either of these levels. The paper further on proposes future work on all three levels with focus on:

- A translation of existing organizational SD practices into the proposed standard SI scheme to build a standard catalog of intervention architectures, designs and techniques.
- A more detailed reinterpretation of the SD methods in the frame of the autopoiesis theory of Luhmann (e.g. what is the meaning of CLDs or SFDs in this context).
- A deeper discussion of the epistemological interpretation of SD in the frame of Luhmann's theory, which might foster the understanding of SD as a formal methodology to causally analyze and dynamically explore the structure of believe systems.

To close this paper the author would like to point to the fact that according to the presented theoretical framework of Luhmann's autopoiesis theory the SD community and the community that has emerged around the work of Luhmann both constitute autonomous autopoietic subsystems of the society subsystem science. Through that characteristic they both represent distinct meaning worlds in between which "creative misunderstandings …offer an escape from the impossibility of ever being able to translate accurately the language of one world into another domain's communication system. One discourse uses the meaning materials of another as a provocative stimulus to reformulate it as something new in its own internal context. Since a real translation is impossible, something is invented. This inventiveness creates the surplus value …, which is added to the autopoietic dynamics within and between systems." (Teubner, 1997).

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9. Literature

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