The impact of operational closure and reflection on juncture systems

Benjamin Kuch
University of Stuttgart, Germany
Graduate School of Excellence advanced Manufacturing Engineering (GSaME)

Keywords
Business Strategy, Case Study Design, Operational Closure, Social Systems, Strategic Change, and System Dynamics.

Abstract

Business organisations can be seen as social systems encompassing multiple scales. The more functionally differentiated a system landscape becomes the higher the need to coordinate different processes between these systems is. This helps to develop sound business strategies supporting the identification of synergy potentials. Induced by turbulent markets, especially multinational enterprises have to continuously adapt their strategies and introduce new junctures between parts of their organisations. The current article contributes to the effective management of those junctures whilst adopting a systems theory perspective. Novel insights on the coordination of strategic change processes, which are most relevant to businesses in order to implement new strategies, are derived from a system dynamics model. They are subsequently applied to a single case study in the medical device industry for the purpose of discussing implications for international enterprises. It is shown how the concepts of operational closure and reflection impact on the junctures between complex social systems. Therefore, it is argued that the analysis of the systemic communication patterns should be considered an integral part of any strategic change process within multinational enterprises.

Moreover, the findings are generic enough to be transferred to the regional level as well. The presented approach on the coordination of complex social systems provides valuable impulses, even if the involved systems come from the political or scientific sector. Hence, the investigation of mixed systems coordination is suggested to be part of a future research agenda.

1. Introduction

Business organisations are often described in the literature on the basis of systems theory (Bullinger et al., 2009; Westkämper and Zahn, 2009; Schenk et al., 2014; Wiendahl et al., 2015). Especially against the backdrop of turbulent markets, the changeability of socio-technical structures becomes one of the most vital managerial capabilities with a great impact on organisational performance (Westkämper and Zahn, 2009: 47). The ongoing functional differentiation within the economy and society in general leads to a multitude of structural couplings between communication systems (Luhmann, 1997: 618). This also increases the importance of the junctures between systems due to possible synergy potentials. Given this context, it seems necessary to consider businesses as complex social systems which are operationally closed and structurally bound to their environment. Social systems are constituted by selection processes that reduce complexity (Luhmann, 2005a: 10), and especially organisations continuously try to reduce the contingency they are based on (Schoeneborn, 2011: 671). Moreover, an organisation's communications follow an idiosyncratic and selective logic (Willke, 1994: 59-61). This leads to an operational closure (OC) of the system in which controllability can only be achieved in the form of self-organisation (Willke, 2001: 1). Hence, separate social systems can only irritate each other, but never produce actual operations within the communication patterns of another system (Luhmann, 2005b: 98-99). Even when systems only observe and describe each other, this basic self-reference holds true because the logic of observation equals the logic of the describing system (Maturana, 1982: 64). Without dissolving their OC, complex systems are structurally bound to their environment and can make use of these relations in order to evolve new and beneficial characteristics. An important factor in this context is reflection (RF), which facilitates the perception and evaluation of external rationalities against the own identity (Kegelmann, 2007: 185). Therefore, RF can be seen as an internal platform that helps the system to observe itself critically and to identify risks and opportunities related to its environment.

The research technique of system dynamics (SD), which rests upon systems-thinking, has been used for a whole spectrum of case applications. Among others, the domains of supply chain management (Ge et al., 2004: 507), strategy and change (Snabe and Größler, 2006: 476; Lyneis et al., 2001: 258; Schwaninger and Groesser, 2012: 360), software (Madachy and Tarbet, 2000: 145), and operations research (Coyle, 1978: 95) have benefited from this approach. Some attention has also been paid to the combination of SD and the case study method (Williams, 2002; Papachristos, 2012). However, most approaches are lacking the theoretical equipment for the analysis of social systems, their self-referential character in particular. Therefore, systemic communications and the actual consequences of the two basic concepts of social systems, OC and RF, have been widely neglected so far. For instance, no arguments or explanations have been presented to account for the influence of communication and its patterns in terms of social systems theory on the way businesses should organise internal change processes.If OC and RF are relevant to the performance of cooperative activities between social systems, however, practitioners as well as scholars may want to consider these concepts to a larger extent in order to ground their future work in social systems theory. In this case, an approach is needed that is arrayed on the characteristics of a social system and puts emphasis on its basic constituents: communications.

Hence, assuming that synergies can cooperatively be levered on the juncture of two or more systems, this paper examines the effects of OC and RF on the performance of synergistic interface activities. In the sequel, the consequences of these effects for an international business organisation are presented. Emphasis is placed on the effective analysis of the communication structures of the focal systems. The value of the SD method as a tool to learn about the impact of OC and RF on juncture systems is stressed, as well as the opportunity to use it as a reflection platform during a case study in order to evaluate various communication-based change measures.

2. Methodology

The methodological deliberations of this article have two aspects: (1) case study design, (2) systems theory and SD. The focal research method is the case study, the framework within which the discussion shall be led is systems theory and the tool being used to approach new insights is an SD simulation. Hence, the paper aims at new insights and requirements for the coordination of complex social systems, which is most relevant to international enterprises in order to effectively implement new business strategies.

The literature provides valuable approaches concerning how to learn about the sequences of organisational processes (Van de Ven and Poole, 1990: 315; Van de Ven and Huber, 1990: 213). Building theory from case studies involves an iterative process alternating between theory and empirical data (Eisenhardt and Graebner, 2007: 30), and case studies are traditionally based on data from multiple sources involving qualitative as well as quantitative approaches (Eisenhardt, 1989: 534). It is typically stressed that, besides direct observations, also overarching data is needed to complete the canon of data collection (Yin, 1997: 69-70). Hence, this approach essentially encompasses grounded theory and mixed methods. Grounded theory is one of the basic constituents of the theoretical fundament beneath case study research (Eisenhardt, 2007:

534). The connection to mixed methods is established by the concept of triangulation, which means a multi-perspective analysis, e.g. in terms of methods, investigators, or theories (Schneider, 2014: 20-21). Although mixed methods is considered to encompass multiple designs (Creswell and Clark, 2010: 59), the thought of triangulation serves as an implicit foundation. On a more abstract level, this means that both codified and tacit knowledge must be incorporated, analysed, and evaluated.

Based on the theory of Talcott Parsons, Niklas Luhmann developed a systems theory focusing on communications as primal constituents (Luhmann, 1997: 140) in order to allow for self-reference (Luhmann, 1980: 12). Essentially, communications shape and drive a social system, which remains stable through a set of implemented structures. With Luhmann, the concept of autopoiesis was for the first time applied to social systems. Autopoiesis had previously been conceptualised in a biological context, characterising systems which produced and defined their components and boundaries autonomously by their own operations (Varela et al., 1974: 192-193). In order to operationalise the concepts of systems theory, systems-thinking can be considered as the basis, which recognises the recursive relations within and between systems (Senge, 1990:73). Drawing on systems-thinking, SD is an analysis method which acknowledges the non-linearity of complex systems while implementing feedback loops with the aim to integrate several functional areas into one single concept (Roberts, 1999: 3). In terms of implementation, the software "Insight Maker" is used to build a model, including all stocks, flows, auxiliary variables, links, and parameters. "Insight Maker" is a free and web-based simulation tool which particularly covers SD and Agent-Based Modelling (Fortmann-Roe, 2014: 28).The concrete qualitative or quantitative relations between system elements are typically influenced by parameter values. Since these values are sources of uncertainty, multiple simulations with various parameter configurations are performed and conjectures are subsequently derived from a whole dataset of results.

3. The System Dynamics Simulation Model

The system under examination represents the structural coupling between two complex social systems. Hence, the framework is as follows: Two social systems, e.g. two business organisations, have a common interface, conceivably due to a function which requires cooperation between them. The aim of the communications across the juncture is to facilitate synergistic cooperation activities (SCA). A single communication, therefore, is modelled as a requirement for such an SCA. SCA could, for instance, address economies of scale or the transfer of knowhow on a particular subject matter. The performance of the juncture system is operationalised by three variables: (1) the velocity with which the confidence in the structural coupling rises, (2) the upper bound of the system's competencies in regard to SCA, and (3) the total number of successfully concluded SCA. An SD approach is employed in order to model the evolving and interconnected processes which are assumed to affect and steer the behaviour of the interface system. From a corporate change management perspective, a similar approach was followed by Schwaninger and Groesser (2012). They conducted a case study with an insurance company on organisational change and developed an SD model to obtain details about the system's behaviour. The model of the current study builds upon the insights of Schwaninger and Groesser (2012), and applies their basic logic to a scenario of SCA between social systems. Although the sources of change in both SD models are OC and RF, the objectives and structures are different. As opposed to Schwaninger and Groesser (2012), the current model does not deal with different paradigms and direct external perturbations. It rather targets the impact of making the structural coupling a system itself by implementing OC. Furthermore, Schwaninger and Groesser (2012) differentiate between OC and self-reference. However, the basic constituent of OC is a self-referential mode of the organisation-specific communications (Willke, 1994: 149).

Therefore, self-reference is a concept for operationally closed systems rather than a separate variable. Despite this shift of perspective, the crucial parameters under consideration remain the same: OC and RF.

Operational Closure (OC): Willke (1994: 59-61) considers a system to be operationally closed if there are semantic structures and principles in place which influence and design all the communications within it. Hence, OC is a condition which causes the system to reproduce itself in an autopoietic manner. For the purpose of this paper, OC manifests itself in the model by closing the link between concluding and creating organisation-specific communications, i.e. requirements for SCA.

Reflection (RF): RF of a social system is based on self-observation and self-description (Luhmann, 1991: 234), and causes the system to define and evaluate its own identity against its environment (Luhmann, 1991: 252). Therefore, RF can be seen as the observation of communications, their latent patterns and structures. RF, as a process for the generation of mutual comprehension between the various system elements, is modelled by a stock and a flow variable with values ranging from 0 to 1 and an adjustable parameter value, respectively. The flow fills up the stock until the maximum level, whereas the fill rate depends on the parameter value.

In regard to social systems theory, both concepts seem worthwhile to be anchored in the study of social systems. Whether or not their impact is significant for the analysis of a juncture system, however, is yet to be evaluated. Therefore, OC and RF are taken into account while running the SD model and their influence on the juncture system's performance is assessed.

3.1. Stock Variables of the Model

The logic of the model, as depicted in the stock-flow diagram in Figure 1, is structured by nine stock variables (S1 to S9) whose characteristics and relations shall now be explained.

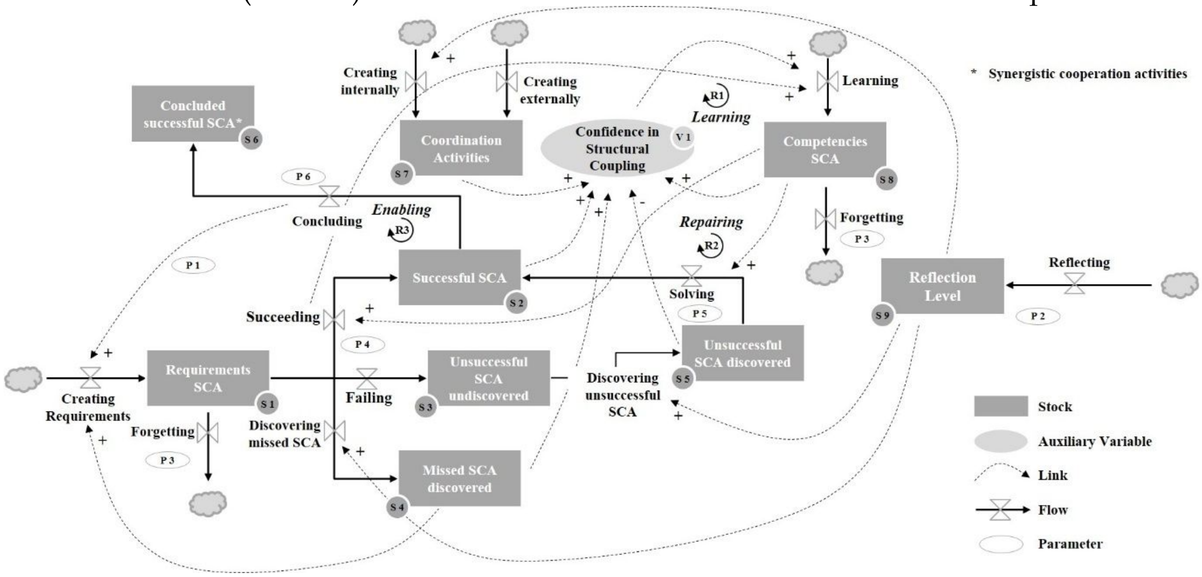


Figure 1: The SD stock-flow diagram

Requirements SCA (S1): This variable contains the requirements for synergistic cooperation activities. As an assumption of this paper, requirements are generated on a regular basis, which means that, at every interval, some requirements for SCA will emerge. In regard to the real world, this points out that every now and then an opportunity exists to lever a potential by launching a cooperation activity between two complex systems. In this context, utilising an opportunity is equal to preventing a risk from materialising. The requirements occur and are stored into the stock variable. However, they are not conserved forever but slowly disappear over time, which is comparable to the process of forgetting.

Successful, unsuccessful and missed SCA (S2-4): The stock of requirements in S1 serves as the basis for SCA. At each period, there is the possibility to conduct cooperative activities and a certain proportion of the SCA requirements is launched. The rest remains untouched in the repository and may be discarded by the flow "forgetting". The requirements which are recognised and transformed into SCA can either be successful or they fail, being indicated by a certain success rate. As per Schwaninger and Groesser (2012) the failure of an activity will at first be a latent issue, which has to be discovered in order for the system to be able to make use of this information. Another way of removing activities from the repository is the discovery of a missed opportunity, e.g. a possibility which has become obsolete.

Unsuccessful SCA discovered (S5): Initially, the stock of unsuccessful SCA is not obvious to the system. A process of discovering is necessary in order to gain an insight into what had happened. Controlled by a discovery rate, a portion of the latent unsuccessful activities is followed up at each period, and hence becomes visible to the system.

Concluded successful SCA (S6): Concluding a cooperative activity implies withdrawing the resources and reallocating them to other projects. Following Schwaninger and Groesser (2012), a basic assumption is that if the system under consideration is operationally closed, the conclusion of an activity leads to the creation of a new requirement in order for the system to reproduce itself.

Coordination activities (S7): The identification and implementation of SCA is supported by coordinating the requirements of the different systems. On the one hand, this is triggered by external entities, such as strategic programmes. On the other hand, requirements can also be formulated by the system itself, provided that an adequate level of reflection exists.

Competencies in SCA (S8): In order to perform SCA effectively, certain competencies are beneficial. The level of competencies is increased by a learning process and lowered by the required knowledge fading away. The learning process is supported by the confidence in the structural coupling, leading to a reinforcing cycle as the level of competencies at the same time facilitates structural coupling.

Reflection level (S9)*:* For the purpose of this paper, RF is modelled by a stock variable that is filled by a reflection process. RF is considered to be a cumulated effect, representing the ability of a system to perceive itself in the context of its environment. It is assumed that there is an upper level of RF so it cannot be increased to infinity. This level was operationalised with the value 1, implying that this is 100 % of the possible reflective capabilities of the system. RF affects the system in two different ways. Firstly, it positively influences the internal creation of coordination activities, as it combines an internal and external view with respect to the focal system. Secondly, a high level of RF provides the basis for discovering both missed chances of cooperative activities and latent unsuccessfully performed ones.

3.2. Parameters

The relations within the model are affected by certain parameter values. Most important in this context are six parameters: P1 controls the portion of concluded SCA which leads to new requirements. Since this is the linkage between source and sink, P1 represents the degree of OC of the system. P2 influences the development of the reflective capabilities of the system, represented by the stock variable S9. P3 is related to both the forgetting of SCA requirements and the fading away of SCA-related competencies. P4 equals the maximum success rate for the transformation of requirements into actual SCA. The rest of the requirements, either unsuccessful or not considered, remains latent to the system and can be discovered as missed opportunities. P5 controls the capabilities of the system to solve problems which occurred while implementing SCA. Hence, failed SCA can be reconsidered and successfully deployed on a second try. P6 defines the conclusion rate with which successful SCA are completed and discarded. All parameters have been conceptualised with values from 0 to 1 and enter the respective equations as factors.

3.3. Further Variables, Loops, and Performance Measures of the Model

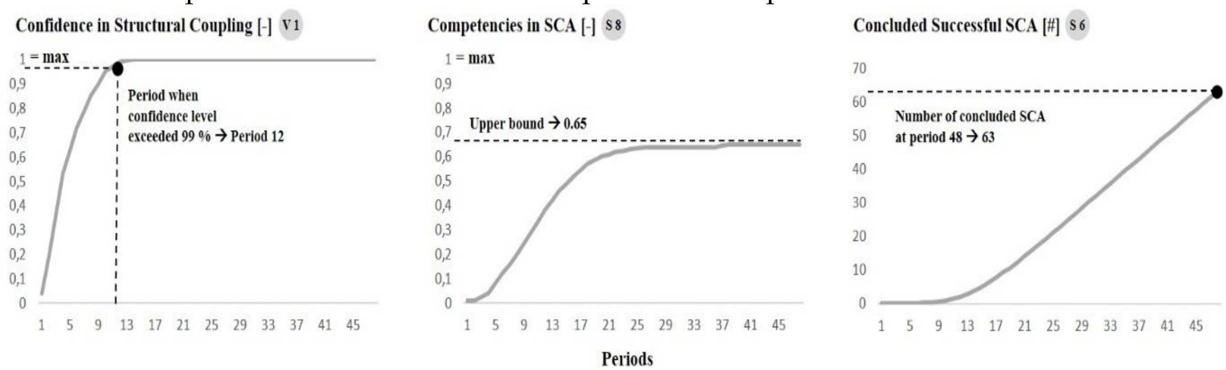
Besides the stock variables, another variable V1 was introduced to the model in order to account for an important characteristic. As the model represents the interface of two complex systems, it actually is an entity of structural coupling. The involved systems can be assumed to have a certain degree of confidence in the structural coupling, which is affected by the conditions of several stock variables. Successfully performed SCA will help to build trust and therefore increase the level of confidence in the structural coupling. Likewise, discovered missed SCA lead to the same effect, as they show opportunities the systems could have benefited from. On the contrary, discovering failed SCA will hamper confidence. The active coordination of differences between the systems should support the confidence level. Furthermore, the relations between V1 and the SCA competencies' stock variable S8 represent a reinforcing loop.

Besides the reinforcing loop, which describes the learning process of the interface system, the level of competencies S8 leads to another loop. It takes another route through the model, but is also a reinforcing one. Starting from a rising level of SCA competencies, the solving rate will be accelerated. This produces higher numbers of successfully implemented SCA, which support the confidence in the structural coupling. As structural coupling is positively related to the level of SCA competencies, the loop closes. This, however, is not only possible in the positive direction. While the number of failed but discovered SCA rises, the confidence level regarding structural coupling decreases. In the sequel, this reduces the SCA competencies, which then leads to a higher number of failed and discovered SCA. A third loop can be identified when looking at the relation between the success flow rate and SCA competencies. A high level of competencies is assumed to strengthen the success rate. Likewise, a high success rate increases the level of competencies, as the system acquires more experience.

In order to be able to evaluate the fitness of different model configurations, three variables have been chosen as performance measures. The variables V1, S8, and S6 represent the level of confidence in the structural coupling, the level of SCA competencies and the number of concluded successful SCA, respectively. As opposed to the first two variables the stock variable S6 is not limited to a certain upper level. The restraining level for confidence in structural coupling and SCA competencies is 1. This shall express the maximum level the system under consideration can achieve. It accounts for the fact that an organisation can neither increase its confidence in itself to infinity, nor can it significantly improve its competencies for a given task without any limit.

4. Results of the SD Simulation and Development of Conjectures

The different configurations of the SD model have been evaluated against each other on the basis of three performance measures (i.e. V1, S8, and S6). The model was simulated multiple times to compare different parameter value combinations. Each simulation comprised 48 periods in which the model and its variables could evolve. Figure 2 depicts the resulting curves of the three performance measures for a specific parameter combination. Since the parameters had not been collected in the field, basically all combinations were possible. However, in order to achieve a manageable set and testing schedule, two general situations were discriminated: The parameters were assumed to be either high or low, corresponding to concrete values of 0.8 and 0.1, respectively. By this dyadic division $2^6 = 64$ combinations were left over for consideration. By means of the particular parameter combination depicted in Figure 2, the interpretation of the performance measures shall be explained. The confidence in the structural coupling (auxiliary variable V1) was limited by the value 1, which was reached by all parameter combinations. Interesting, however, was the amount of periods it took the system to do so. Hence, the particular period when the level exceeded the value of 0.99 was recorded as a proxy for the system's responsiveness. The curve of the stock variable S8 revealed the system's upper bound in regard to its SCA competencies. The horizontal asymptote in Figure 2 shows a maximum level of approximately 0.65, missing the absolute upper bound of 1. An explanation for this would be that the success parameter is set low in this particular combination. Combinations with a higher success parameter generally showed an SCA competencies level of over 0.9. However, as soon as the oblivion parameter P3 was set to a high value, the level of competencies dropped. The number of successfully concluded SCA was gathered from the curve of the stock variable S6. As it was a cumulative progression, the absolute value at the last period was especially interesting in terms of comparison. Figure 2 depicts that the curve of S6 gains momentum in period ten and then follows a quite linear slope.



Parameter	P1 Operational Closure	P2 Reflection	P3 Oblivion	P4 Success	P5 Solution	P6 Conclusion
Value	0.1	0.1	0.1	0.1	0.8	0.8

Figure 2: Curves of the performance measures for a specific parameter combination

The parameter configuration had a strong impact on the values of the performance measures. Crucial for the research task were the parameters P1 and P2 and their influence on the system's performance.

Hence, the aforementioned 64 combinations under consideration were pooled into groups of four, representing the 2^2 combinatorial configurations of P1 and P2. In each of the created groups, the configuration of the parameters P3 to P6 remained stable, whereas the values of P1 and P2 altered. Consequently, the contribution of P1 and P2 could be observed. The specific configuration that assigned low values to both parameters was chosen as a basic reference configuration and was assigned 100%. In each group, the performance measures were evaluated against this reference. Figure 3 depicts an overview over the parameter configurations, which were tested in the course of the SD simulation. It also explains the influence of other parameters on the system's performance. P4, for instance, which represents the maximum success rate of requirements implementation, has a positive impact on the SCA competencies. This is reasonable as there is a reinforcing loop connecting the success flow rate with the level of competencies. P3, however, influences competencies even more compellingly. If the value for the oblivion parameter is high, the level of competencies drops sharply.

From the SD simulation schedule the following conclusions can be drawn: (1) the increase in confidence in the structural coupling is mainly driven by RF; (2) the level of SCA competencies is mainly driven by OC; (3) the number of successfully concluded SCA at the last period is influenced by both OC and RF, but more clearly driven by OC. The arguments were derived from the simulation results by considering the rank orders within each group in regard to the performance measures. Additionally, the results were regarded as a statistical dataset and three linear regression analyses were carried out, each of which comprising one endogenous and two exogenous variables. The population in this case was the entirety of parameter configurations. The explained variables were the three performance measures (V1, S8, and S6), whereas the explanatory variables were P1 and P2. For the three regression models, the coefficients for OC and RF and their respective p-values were calculated. Model 1 had the velocity of the increase in confidence in the structural coupling (V1) as a dependent variable. The coefficients (and p-values), for P1 and P2 were -0.004 (0.70) and -0.289 ($5.14 * 10^{-36}$), respectively. This supports the aforementioned conclusion that confidence in structural coupling is mainly driven by reflection. Model 2 tried to explain the upper bound of the SCA competencies by P1 and P2. The coefficients (and p-values), for P1 and P2 were 0.223 ($1.19 * 10^{-9}$) and 0.000 (0.99), respectively. Hence, SCA competencies seem to be governed by OC. Model 3, which presented the number of concluded SCA as a dependent variable, delivered coefficients (and p-values) for P1 and P2 of 0.410 ($1.88 * 10^{-9}$) and 0.042 (0.47), respectively.

							absolute			relative		
ID	P1	P2	P3	P4	P5	P6	V1	S8	S6	V1	S8	S6
1	low	low	low	low	low	low	15	0,64	29	100%	100%	100%
2	high	low	low	low	low	low	14	0,78	34	93%	122%	117%
3	low	high	low	low	low	low	9	0,64	30	60%	100%	104%
4	high	high	low	low	low	low	9	0,78	35	60%	122%	123%
5	low	low	low	low	low	high	11	0,65	46	100%	100%	100%
6	high	low	low	low	low	high	11	0,81	63	100%	125%	135%
7	low	high	low	low	low	high	8	0,65	48	73%	100%	103%
8	high	high	low	low	low	high	8	0,81	65	73%	125%	141%
9	low	low	low	low	high	low	16	0,64	42	100%	100%	100%
10	high	low	low	low	high	low	16	0,8	59	100%	125%	140%
11	low	high	low	low	high	low	10	0,64	43	63%	100%	103%
12	high	high	low	low	high	low	9	0,8	61	56%	125%	146%
13	low	low	low	low	high	high	12	0,65	63	100%	100%	100%
14	high	low	low	low	high	high	12	0,83	117	100%	128%	186%
15	low	high	low	low	high	high	8	0,65	64	67%	100%	102%
16	high	high	low	low	high	high	8	0,83	121	67%	128%	192%
17	low	low	low	high	low	low	11	0,93	47	100%	100%	100%
18	high	low	low	high	low	low	11	0,96	67	100%	103%	141%
19	low	high	low	high	low	low	8	0,93	49	73%	100%	103%
20	high	high	low	high	low	low	8	0,97	70	73%	104%	147%
21	low	low	low	high	low	high	10	0,93	52	100%	100%	100%
22	high	low	low	high	low	high	10	0,96	77	100%	103%	148%
23	low	high	low	high	low	high	8	0,93	53	80%	100%	102%
24	high	high	low	high	low	high	8	0,96	79	80%	103%	153%
25	low	low	low	high	high	low	12	0,93	64	100%	100%	100%
26	high	low	low	high	high	low	12	0,96	128	100%	103%	200%
27	low	high	low	high	high	low	9	0,93	65	75%	100%	102%
28	high	high	low	high	high	low	9	0,96	132	75%	103%	207%
29	low	low	low	high	high	high	10	0,93	69	100%	100%	100%
30	high	low	low	high	high	high	10	0,96	148	100%	103%	216%
31	low	high	low	high	high	high	8	0,93	70	80%	100%	102%
32	high	high	low	high	high	high	8	0,96	152	80%	103%	222%

							absolute			relative		
ID	P1	P2	P3	P4	P5	P6	V1	S8	S6	V1	S8	S6
33	low	low	high	low	low	low	10	0,09	5	100%	100%	100%
34	high	low	high	low	low	low	10	0,09	6	100%	100%	105%
35	low	high	high	low	low	low	7	0,09	6	70%	100%	104%
36	high	high	high	low	low	low	7	0,09	6	70%	100%	110%
37	low	low	high	low	low	high	10	0,09	16	100%	100%	100%
38	high	low	high	low	low	high	10	0,11	18	100%	122%	114%
39	low	high	high	low	low	high	7	0,09	17	70%	100%	104%
40	high	high	high	low	low	high	7	0,11	19	70%	122%	119%
41	low	low	high	low	high	low	10	0,09	8	100%	100%	100%
42	high	low	high	low	high	low	10	0,1	8	100%	111%	109%
43	low	high	high	low	high	low	7	0,09	8	70%	100%	104%
44	high	high	high	low	high	low	7	0,1	8	70%	111%	113%
45	low	low	high	low	high	high	10	0,09	22	100%	100%	100%
46	high	low	high	low	high	high	10	0,12	28	100%	133%	127%
47	low	high	high	low	high	high	7	0,09	23	70%	100%	103%
48	high	high	high	low	high	high	7	0,12	29	70%	133%	131%
49	low	low	high	high	low	low	10	0,18	10	100%	100%	100%
50	high	low	high	high	low	low	10	0,23	12	100%	128%	115%
51	low	high	high	high	low	low	7	0,18	11	70%	100%	105%
52	high	high	high	high	low	low	7	0,23	12	70%	128%	121%
53	low	low	high	high	low	high	9	0,19	21	100%	100%	100%
54	high	low	high	high	low	high	9	0,29	25	100%	153%	121%
55	low	high	high	high	low	high	7	0,19	22	78%	100%	103%
56	high	high	high	high	low	high	7	0,29	26	78%	153%	126%
57	low	low	high	high	high	low	10	0,18	14	100%	100%	100%
58	high	low	high	high	high	low	10	0,25	18	100%	139%	128%
59	low	high	high	high	high	low	7	0,18	15	70%	100%	104%
60	high	high	high	high	high	low	7	0,25	19	70%	139%	133%
61	low	low	high	high	high	high	10	0,19	28	100%	100%	100%
62	high	low	high	high	high	high	10	0,3	38	100%	158%	137%
63	low	high	high	high	high	high	7	0,19	29	70%	100%	102%
64	high	high	high	high	high	high	7	0,3	39	70%	158%	140%

P1: Operational Closure
P2: Reflection
P3: Oblivion
P4: Success
P5: Solution
P6: Conclusion

V1: Confidence in Structural Coupling
S8: SCA Competencies
S6: Concluded SCA

Group 1: (ID1 to ID4)
Group 2: (ID5 to ID8)
...

Figure 3: Overview over 64 dyadic parameter configurations

On the basis of the results outlined above, three hypotheses have been derived. Most importantly, they constitute requirements for an effective management of coordination and change processes and hence are valuable anchor points for practitioners who want to apply insights from systems research to their real world challenges.

Hypothesis 1 (H1): "The operational closure of a system that represents the juncture of two (or more) social systems leads to an increase in successful interface activity." For a business organisation, this implies that direct and latent communication patterns have to be identified and analysed. The consideration of OC in particular, requires a specific understanding of communication, which is missing in most of the current case studies (or at least is not being

adequately emphasised). The precondition that allows for self-referential communications in the first place, is their threefold selection process of information, utterance, and understanding (Luhmann, 1991: 203). The difference between information (what is selected) and utterance (how it is transmitted) builds a basis for the system to attach an additional communication by understanding (observing the difference between information and utterance), and subsequently accepting or rejecting the content (Luhmann, 1991: 194). Hence, communication cannot be regarded as delivering an ontological form of information. It rather has to be seen as the ongoing process of dealing with different perspectives which significantly influence the change process.
Due to the genuine contingency, the actual occurrence of communicative events is fairly unlikely. However, communication can be facilitated by a dedicated medium which enhances connectivity and therefore increases the probability of communications to be accepted and continued (Krämer, 1998: 559). Most important in this context is the step of "understanding", for it can orient one communication toward a succeeding one (Luhmann, 1997: 87). The managerial approach has to provide the background for a detailed analysis of the several steps of communication.

The emphasis should be put on the communication medium and the juncture between communications. This insight was also applied in the course of the presented case study. In more methodological terms, a shift was required within the composition of data collection channels that is typically suggested by scholars in regard to case study designs. Codified sources of information (e.g. role descriptions, process guidelines, archive records) introduce a distance between the system under consideration and the actual communication patterns. Consequently, in order to minimise this distance, sources of tacit knowledge (e.g. deep-dive interviews, processes analyses) gain importance because they provide the opportunity to look beyond the obvious organisational structures.

Hypothesis 2 (H2): "The operational closure of a system that represents the juncture of two (or more) social systems leads to an increase in competencies in synergistic cooperation activities."In accordance with H1, this conjecture stresses the importance of tacit knowledge, a dedicated communication medium, and the threefold communication process for the managerial approach.

Hypothesis 3 (H3): "A higher level of reflection of an interface system reduces the time needed to adapt to unexpected circumstances, and therefore increases the changeability of all involved complex systems." In regard to an effective managerial change technique, this hypothesis constitutes the requirement to address meta-structures of communication. Not only is the consideration and examination of processes of relevance, but also the observation of observations, e.g. the analysis of management instruments, platforms, and approaches the system uses to reflect, discuss and alter its own procedures. This requires the design of communication platforms, for instance implemented as SD models.

5. Case Application

In order to illustrate the points made in this article, the deliberations are applied to a case study in the context of organisational change. Although some scholars suggest that multiple cases are required to reach closure in regard to the theory-building process (Eisenhardt, 1989: 545), many scientists have developed and enhanced their theoretical arguments with only one case at a time (Dyer and Wilkins, 1991: 614). This article uses a single case study to illustrate how to emphasise OC and RF while analysing a social system. The company within which the case was carried out produces medical devices (e.g. surgery equipment, custom procedure trays) and operates in several European countries. It has about 800 employees and reaches an annual revenue of approximately 65 m€ (50 m£). The issue which constituted the relevance for the current research and triggered the case study (conducted from January to May 2016), was the formation of a new juncture between several social systems within the international organisation.

The company deals with changing requirements (e.g. shifts in customer requirements, market segmentation, labelling, and regulatory affairs) and has to translate them into internal activities and processes against the backdrop of a multi-site structure. The set of social systems is composed of the top-management and the production sites. The initial situation was characterised by a strong top-management team who analysed market changes and conveyed the derived tasks to the respective locations. These tasks equal the requirements in terms of the SD model that shall be translated into synergistic activities. A collaboration of multiple social systems is needed to fulfil them. However, in the initial situation, the requirements were governed by multiple communication patterns. The case analysis showed that this was mainly due to different managerial styles, media disruptions, and alterations in the management-location combination. Notably, this was the case although there was a consistent technical platform available for all sites. In order to enhance the interface management, a new role was created and endowed with resources and competencies. The current article wanted to go beyond codified information on roles and processes and sought to study basic communication patterns within and between social systems. A new role might alter or redefine parts of the communication, but another part definitely influences and defines the new role. Hence, the decisive level of analysis remains the communication patterns in contrast to the role itself.

The main challenge was to operationally close the newly created interface system, which was addressed by a dedicated communication medium. Moreover, the observation of organisational observations was enabled while introducing interdisciplinary reflection phases to the routines. Firstly, the focus was shifted from the metaphor of information transmission, which implies an ontological understanding of information, toward an understanding of communication as the processing of different perspectives. The content, such as process dependent and codified information, is only half of the story. Instead, the emphasis was put on the analysis of how the information was processed and fed back into the system (e.g. how is an ongoing critical assessment of the delivered information encouraged? Is the information embedded in an adequate context that people can conceive of a bigger picture of the process?). Secondly, phases of analysis (e.g. in-depth interviews and process examinations) were combined with phases of creative reflection. The latter was used as a means to scrutinise and reflect on study insights and directly feed them back to the research, as recommended by the case study methodology literature (Eisenhardt, 1989: 539–540). Moreover, these phases served as platforms to evaluate alternative change measures. In particular, the parameters of the generic SD model presented earlier in this paper were altered in the course of a continuous process during the case study. Current and prospective measures within the organisation were evaluated against each other regarding their impact on the SD parameters.

In more operational terms, the analysis was structured by the threefold communication process, i.e. information, utterance, and understanding. The content level of communication, i.e. the information which changes a system's current state, requires multiple partners and systems to cooperate. The respective concept was elaborated during one of the creative reflection phases. It essentially involved the creation of discussion platforms to integrate several functions (e.g. purchasing, production planning, sales, and production site managers) in a reflection process. Thus, many issues about organisational communication surfaced for the first time. An explanation can be found in the selection process a social system performs at each communication. Reflecting on an ideal state, e.g. in terms of information or decision procedures, places emphasis on the more vital parts of the communication process. For instance, the first interviews addressed merely obvious and codified information flows. Providing space for reflection, including tabula rasa sessions during which communication goals were conceived of and analysed apart from existing restrictions, led to a focus shift. Instead of talking about operational tasks (e.g. how to evaluate weekly statistics about dwelling times of formal change requests within the system), more strategic aspects were introduced (e.g. discussion about important roles and stakeholders for the overall change process in regard to a certain product line). Hence, decisions could be made about how to select information (e.g. a more central coordination versus decentralised responsibilities), considering the peculiarities on product line level.

In regard to utterance, different possibilities were evaluated on how to convey communications. Again, the reflection phases were used in order for the system to observe its own observation strategies. This observation process was substantiated by an evaluation of the impact of a particular strategy on the SD parameters. A communication medium has been conceptualised on the basis of the existing technical structure in order to allow for a high connectivity between the different social systems (i.e. site-management teams, juncture system, and top-management). The medium is based on change requests that are processed partly within the IT-system and partly through interaction systems. This is necessary due to the interdependent and recursive character of a typical change request. On the one hand, the technical system provides a clear structure to depict linear progress. The interaction systems (e.g. meetings of involved managers from different departments), on the other hand, provide hubs for the coordination of more complex situations. The proportion of direct interaction between employees, as opposed to fully software-based organisation procedures, has been translated into higher values of the parameter driving the reflection process (P2). More specifically, an element of the communication medium is an extended image of a change request. It conveys all information about current tasks (which was the before-case standard of the organisational process), but is additionally embedded in a broader perspective (it shows previous and subsequent tasks and requirements and indicates when and in which composition, personal interaction is needed). The medium is technically implemented in an "MS-SharePoint" environment, however, transcends these technical boundaries while explicitly encompassing and requiring human interaction systems. Since the current case accompanied merely the conceptualisation and initialisation phase, long-term effects of newly defined communication media are yet to be examined.

The step of understanding, which serves as a juncture between two communications, has been taken into account while providing each communication with a docking point for a subsequent one. The determination of a requirement should always be linked to reflection about its impact on the current structure and future challenges leading to new requirements that take the change process further. More importantly, however, each communication in the organisational change request process equals a reduction in complexity being performed by the respective system element. Each complexity reduction is necessary for subsequent tasks to be effective. In the classical process, however, the task descriptions were rather isolated and did not provide task owners with the possibility to take on the perspective of previous or subsequent tasks. The dedicated communication medium now allows for transparency along the process. It visualises the set of tasks and triggers reflection phases in order to coordinate recursive steps.

The case study showed that a common and dedicated communication medium can connect potentials between different parts of the organisation. For instance, a problem-driven knowhow transfer along the change request process can be implemented across the organisational structure. The selection and design of the communication medium was accompanied by an impact evaluation on the SD-level. Various ideas were conceived of and explicated during reflection phases and subsequently transferred into lower or higher parameter values (in this case P1).

The benefit for practitioners, therefore, is twofold: On the one hand, the conceptualisation of a dedicated communication medium introduces transparency and a more collaborative perspective to the change process. On the other hand, the SD approach presents how the suggested reflection phases can be facilitated. Hence, the basic concepts from systems theory, operational closure and reflection, are properly being dealt with.

6. Discussion and Conclusion

The current article contributes to the understanding of managerial processes in international businesses from a systemic and communication-based point of view. It starts with theoretical deliberations on organisations as systems and uses an SD approach to build a model representing the juncture of two social systems. Emphasis is put on the influence of OC and RF, on the juncture system's performance. The results indicate that OC leads to an improvement of synergistic interface performance and that RF supports the system's changeability. Hence, synergy potentials occur on the interface between complex social systems which can be levered in the course of change processes. It requires the analysis of the communication structure and the implementation of OC and RF.

It is argued that communications should be considered as an imperative for managerial approaches addressing organisational change. On the basis of system analysis, requirements regarding such a managerial approach are formulated: (1) the approach has to put emphasis on communication within and between systems and has to provide the tools to uncover latent communication patterns. Most important in this context is the connectivity between consecutive communications in order to ensure OC. The transition from one communication to another has to be facilitated which can be addressed by the development of a dedicated communication medium; (2) the approach has to look for, support, or establish communicative platforms for the purpose of social systems' RF. Whereas OC causes communications to be compatible to one another, RF addresses the structures within which those communications flow. RF is crucial because it removes sources of opacity and exposes what can be considered the actual nature of a social system.

In operational terms, strategic business activities should be arrayed on the process steps of communication: information, utterance, and understanding. These steps address issues about what is communicated, how and why it is communicated and possible responses in order to take the communication further. The proposed SD model can help to operationalise reflection phases as the case study evolves. Particular issues and measures, e.g. different ways how to organise a change request process, can be evaluated against each other in regard to the impact on the SD model's parameters. Hence, a concrete environment is provided fostering the reflection process and helping the system to observe itself.

The article's consolidated conclusion can be formulated as follows: The insights from an SD simulation suggest a communication imperative for managerial approaches concerning the business strategy of multinational enterprises. This leads to requirements in regard to the operational closure of the systems as well as their ability to observe their own structures. It is argued that these requirements have to be met in order to allow for an effective analysis of synergistic cooperation between social systems regarding organisational change processes. This can be achieved by conceptualising a dedicated communication medium and utilising an SD approach in order to operationalise reflection platforms within the organisations.

7. Limitations and Future Research Directions

Insights obtained from an SD simulation were applied in the course of a single case study in order to substantiate the theoretical argument developed in this article. Building theory from a case methodology, however, is limited to the particular context and scope of the actual study (Eisenhardt, 1989: 547; Van de Ven and Huber, 1990: 216). Although many scholars have applied single case studies to derive their theoretical arguments from (Dyer and Wilkins, 1991: 614), increasing the number of studies could enhance the validity of results (Eisenhardt, 1989: 545).

The scope of the present case took place against the backdrop of a conceptualisation and initialisation phase of an organisational change process. This limits the insights insofar as long-term effects of newly defined communication media could not be evaluated. Since it was observed that communications come about through numerous channels (e.g. through implemented processes, regular and occasional tasks, infrequent contacts, and latent communication patterns), extending the case study would require considerable resources. Moreover, working with an SD model requires some initialisation efforts in order for the participants to familiarise with the approach. The SD environment might be perceived as rather abstract since it does not entail concrete agents. In this context, the use of a browser based SD environment is favourable because the model can be opened and analysed virtually anywhere. The points mentioned above constitute practical problems and limitations of the current study.

Some of the limitations, likewise, deliver impulses for a future research agenda. Especially the need for more sources of empirical evidence (e.g. in different contexts) and the extension of the project scope (e.g. evaluating the impact of long-term effects of dedicated communication media on the business strategy) are suggested as important research directions in order to obtain a more complete understanding of strategic change processes in multinational enterprises. Furthermore, the arguments developed in the form of the three hypotheses H1-H3 are generic in character, i.e. their relevance does not seem to be limited to organisations within enterprises. Rather, the involved systems could stem from different sectors, e.g. from the political or the scientific one. Hence, the findings of the article should be transferable to a perspective of regional development placing emphasis on the communication-based coordination between firms, political departments, and scientific institutions.

References

Bullinger, Hans-Jörg, Dieter Spath, Hans-Jürgen Warnecke, and Engelbert Westkämper. 2009. *Handbuch Unternehmensorganisation: Strategien, Planung, Umsetzung* [Handbook of Company Organisation: Strategies, Planning, Implementation]. 3rd ed. Berlin: Springer.

Coyle, R.G. 1978. “Tanker chartering.” *European Journal of Operational Research* 2 (2): 86–96.

Creswell, John W., and Vicki L. Plano Clark, 2010.*Designing and Conducting Mixed Methods Research.* Los Angeles: Sage Publications.

Dyer, W.Gibb, and Alan L. Wilkins.1991.“Better stories, not better constructs, to generate better theory: A rejoinder to Eisenhardt.”*Academy of Management Review* 16 (3): 613–619.

Eisenhardt, Kathleen M. 1989. “Building Theories from Case Study Research.”*Academy of Management Review* 14 (4): 532–550.

Eisenhardt, Kathleen M. and Melissa E. Graebner. 2007. “Theory building from cases: opportunities and challenges.”*Academy of Management Journal* 50 (1): 25–32.

Fortmann-Roe, Scott. 2014. “Insight Maker: A general-purpose tool for web-based modeling& simulation.”*Simulation Modelling Practice and Theory* 47: 28-45.

Ge, Y., J.-B. Yang, N. Proudlove, and M. Spring. 2004. “System dynamics modelling for supply-chain management: A case study on a supermarket chain in the UK. ”*International Transactions in Operational Research* 11 (5): 495–509.

Kegelmann, Jürgen. 2007. *New Public Management: Möglichkeiten und Grenzen des Neuen Steuerungsmodells* [New Public Management: Opportunities and Limits]. Wiesbaden: VS Verlag für Sozialwissenschaften.

Krämer, Sybille. 1998. „Form als Vollzug oder: Was gewinnen wir mit Niklas Luhmanns Unterscheidung von Medium und Form?" [Form as execution or: What do we win with Luhmann's distinction between medium and form?] *Rechtshistorisches Journal (Max Planck Institute for European Legal History)* 17: 558–573.

Luhmann, Niklas. 1980. "Talcott Parsons: Zur Zukunft eines Theorieprogramms." [Talcott Parsons: On the Future of a Theory Programme.] *Zeitschrift für Soziologie* 9 (1): 5–17.

Luhmann, Niklas .1991. *Soziale Systeme* [Social Systems]. 4th ed. Frankfurt am Main: Suhrkamp.

Luhmann, Niklas. 1997. *Die Gesellschaft der Gesellschaft* [Theory of Society]. Frankfurt am Main: Suhrkamp.

Luhmann, Niklas. 2005a. *Soziologische Aufklärung 2: Aufsätze zur Theorie der Gesellschaft* [Sociological Enlightenment 2: Essays on the Theory of Society]. Wiesbaden: VS Verlag für Sozialwissenschaften.

Luhmann, Niklas. 2005b. *Soziologische Aufklärung 5: Konstruktivistische Perspektiven*. [Sociological Enlightenment 5: Constructivist Perspectives]. Wiesbaden: VS Verlag für Sozialwissenschaften.

Lyneis, James M., Kenneth G. Cooper, and Sharon A. Els. 2001. "Strategic management of complex projects: A case study using system dynamics. "*System Dynamics Review* 17 (3): 237–260.

Madachy, Ray, and Danton Tarbet. 2000. "Case studies in software process modeling with system dynamics." *Software Process: Improvement and Practice* 5 (2-3): 133–146.

Maturana, Humberto R. 1982. *Erkennen: die Organisation und Verkörperung von Wirklichkeit* [Cognition: the Organisation and embodiment of reality]. Braunschweig: Vieweg.

Papachristos, George. 2012. "Case study and system dynamics research: Complementarities, pluralismand evolutionary theory development. "*Proceedings of the 30th International Conference of the System Dynamics Society* 30: 1–29.

Roberts, Edward Baer. 1999. "System Dynamics: An Introduction." In *Managerial Applications of System Dynamics*, edited by Edward Baer Roberts, 3–36. Waltham: Pegasus Communications.

Schenk, Michael, Siegfried Wirth, andEgon Müller. 2014. *Fabrikplanung und Fabrikbetrieb: Methoden für die wandlungsfähige, vernetzte und ressourceneffizienteFabrik* [Factory Planning and Operation: Methods for the Changeable, Interconnected and Resource Efficient Factory]. 2nd ed. Berlin: Springer Vieweg.

Schneider, Armin. 2014. "Triangulation und Integration von qualitativer und quantitativer Forschung in der Sozialen Arbeit. "[Triangulation and integration of qualitative and quantitative research in social work]. In *Perspektiven sozialpädagogischer Forschung* [Perspectives of socio-pedagogical research] edited by E. Mührel, and B. Birgmeier, 15-30. Wiesbaden: Springer VS.

Schoeneborn, Dennis. 2011."Organization as Communication. A Luhmannian Perspective." *Management Communication Quarterly* 25 (4): 663–689.

Schwaninger, Markus, and Stefan N. Groesser. 2012. "Operational Closure and Self-Reference: On the Logic of Organizational Change." *Systems Research and Behavioral Science* 29 (4): 342–367.

Senge, Peter M. 1990.*The fifth discipline: Mastering the five practices of the learning organization.* New York: Doubleday.

Snabe, Birgitte, and Andreas Größler. 2006. "System dynamics modelling for strategy implementation-case study and issues. "*Systems Research and Behavioral Science* 23 (4): 467–481.

Van de Ven, Andrew H., and George P. Huber. 1990. "Longitudinal Field Research Methods for Studying Processes of Organizational Change. "*Organization Science* 1 (3): 213–219.

Van de Ven, Andrew H., and Marshall Scott Poole. 1990."Methods for Studying Innovation Development in the Minnesota Innovation Research Program." *Organization Science* 1 (3): 313–335.

Varela, F.G., H. R. Maturana, and R. Uribe. 1974. "Autopoiesis: The organization of living systems, its characterization and a model." *Biosystems* 5 (4): 187–196.

Westkämper, Engelbert, and Erich Zahn. 2009.W*andlungsfähige Produktionsunternehmen: Das Stuttgarter Unternehmensmodell* [Changeable Manufacturing Firms: The Stuttgart Enterprise Model]. Berlin: Springer.

Wiendahl, Hans-Peter, Jürgen Reichardt, and Peter Nyhuis. 2015.*Handbook Factory Planning and Design.* Berlin: Springer.

Williams, Dedembe. 2002. "Integrating System Dynamics Modeling and Case Study Research Method: A theoretical framework for process improvement."*Proceedings of the 20th System Dynamics Conference* 20: 1–27.

Willke, Helmut. 1994. *Systemtheorie: Interventions theories* [Systems Theory: Theory of Intervention]. Stuttgart: G. Fischer.

Willke, Helmut. 2001. *Systemtheorie: Steuerungstheorie* [Systems Theory: Theory of Controlling]. 3rd ed. Stuttgart: Lucius & Lucius.

Yin, Robert K. 1997." Case study evaluations: A decade of progress? "*New Directions for Evaluation* 76: 69–78.