Structural Couplings of Organizational Design and Organizational Engineering

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Summary

Autopoiesis research which constitutes a theory of complex, non-linear and especially living systems, provides a suitable framework for analyzing organizational systems as organizationally closed and autonomous entities. These entities are able to self-organize through what we commonly denote with organizational design. They interact with their environment through a process known as structural coupling in which they influence the structure of the environment what in turn often triggers changes in the structure of the very entity. This process is of special interest when two organizationally closed entities interact. We usually say that they are languaging, which is the process of using language. Note that the term language here is used in a much broader sense then in its usual (human) meaning. Language is here not a set of structured symbols, but a set of actions which influence the structure of the other system. In terms of organizations its effects can be changes in individual sense-making of employees, changes in a database or other computer based model, changes in money flow from customers or even changes in marketing channels.

In the following chapter the gap between organizational design and organizational engineering is approached by analyzing various entities which are part of the process of shaping organizational architecture and its computer based embodiment in form of IS/IT alignment. If we observe an organization as an autopoietic entity we might conceptualize its interactions with IT as a structural coupling the result of which should be a functional and up-to-date software system which suits the needs of the entity's strategic endeavors. But this often isn't the case and we might ask the question why is that so? If we observe this coupling in more detail we find that it is much more complex than initially envisaged. The organizational system in fact couples not to IT directly,

but indirectly through a software product like an ERP system or similar, which has been implemented or adapted for the entity. The result of this coupling are the data and "knowledge" bases of the organization. This software system is in turn a product of some other social system like a software firm, the IT department or even an open source community. Thus, the organization couples to this software producing entity as well by communicating its organizational design artifacts to it. The software producing entity then couples to the actual IT, while the result of this coupling is the software product. These couplings can become even more complex if the software producing, adapting, support and administering entities are not one and the same.

Now, since this intermediary between the organization and IT cannot be circumvented (except maybe for IT firms) the bottleneck of this complex system seems to be the coupling between the organization and the software producing/adapting/administering entities. The result of this coupling is a mutual sense-making between the entities about the actual design of the organization which might be described in terms of languaging. The analysis of this language should bring us a few steps closer to the answers to some of the following questions: How should the organization communicate its organizational design artifacts in order to ensure that the software product suits its needs and is always up-to-date? Another question might be, could the software agent produce systems that allow for more profound coupling between the organization and the IT product? Or we might ask the opposite question: how should the internal organizational design process be adapted to produce valuable results in both couplings?

Keywords. structural coupling, languaging, autopoiesis theory, organizational design and organizational engineering

1 Introduction

The theory of autopoiesis, which is less known to both organizational design and organizational engineering (ODE) practice, is a theory of complex, non-linear, autonomous and especially living systems, that found its way from biology, through the social sciences to organization theory and information systems [38]. Autopoiesis, a pseudo Greek word that comes from *αυτό* (auto – self), and ποίησις (poiesis – a "making", the process of forming, creation, or production), was introduced by the Chilean biologists Humberto Maturana and Francisco Varela in 1973 [22] to label the type of phenomenon which they had identified as the definitive characteristic of living systems [47]. Autopoietic or living, in contrast to alopoietic systems, are systems which produce the network of processes that produced them.

Using this metaphor of autopoiesis a whole theory of social systems based on communication was later developed by Niklas Luhmann [13]. He also applied the concept of autopoiesis to formal organization theory, basing his reasoning on decisions as a special subset of communication [14].

Since information systems can be considered as subsystems of organizations [3], [49], this theory has also been applied to them, describing them as systems which support the self-creation of organizations [36] or even as autopoietic entities them selves [1], [18].

We will adopt a definition of organizational design in the tradition of organizational architecture research as put forward by [5], [7], [10], [24], [25], [26], [49]. From this perspective organizational design is a process which results in not merely the formal organization, but a complex organizational system that can be viewed from a number of mutually intertwined perspectives. These include organizational structure, organizational culture, business processes, strategy and individual agents (human or artificial). On the other hand, organizational engineering will be approached in terms of strategic planning of information systems [4], [40] as a methodology in which a software firm by interacting with an organization produces necessary documentation in form of models some of which reflect the above mentioned perspectives and then implements, deploys and administers a computer system based on this documentation.

As the reader might observe in the outlined definitions, the processes of organizational design and organizational engineering are inherently disconnected and often treated as separate and independent from each other. In the following we will analyze these processes in more detail in order to provide necessary insights towards the establishment of an integral approach to ODE. We will consider ODE to be "*the application of social science, design science and computer science research and practice to the study and implementation of new organizational designs, including the integrated structuring, modelling, development and deployment of computer-based artefacts and people*" [16]. In particular we will be concentrating on the social science perspective with individual remarks on design and computer science related topics.

For the sake of this chapter, autopoiesis theory provides us with a systemic approach to organizations [15] and as we believe, yields the necessary epistemology to analyze the main interfaces between the processes in our focus: organizational design and organizational engineering. As from our perspective, organizations are meaning processing systems based on communication, and thus this theory of organization can yield insights into the ODE related issues, which might be easily overseen using other approaches.

In particular, we will consider the process of ODE through a number of structural couplings between the involved organizations, social entities and IT as well as various results of these couplings that include documentation, data and "knowledge bases" as well as software products. Structural coupling is a process in which systems mutually influence their structures. When autopoietic system structurally couple to some other alopoietic (non-living) system they change its structure whereby the structure of the other system again changes the structure of the autopoietic entity. This recursive process results not only in "trails" that an autopoietic system cause in the environment, but also in changes in behavior which (for living beings) can be described as behavioral biometric traits [35]. The interested reader is advised to consult [33] for a good overview of structural coupling.

A special case of this process is when two autopoietic entities couple and as a result a mutual language might emerge. From the perspective of autopoiesis research, organizations are organizationally closed entities which means among other things that when they use language (in a broader sense) there is no guarantee that the conversation partner will understand the meaning of the exchanged messages. Moreover, the interpretation of the received and understood messages might differ immensely among the conversation partners which can be especially true for software producing firms when languaging with their clients. These and similar issues are often neglected in common organizational engineering literature. The interested reader is advised to consult [31] for a detailed discussion on organizational closure with references to language and conversation in this regard.

In the following we will firstly in section 2 give an outline of the basic concepts of autopoiesis research relevant to the issue at hand. This initial ontology shall allow us to model a colloquial ODE situation which we will present and analyze in section 3. In the ending section 4 we will give a brief discussion on our findings, draw our conclusions and give guidelines for future research.

2 Basic Concepts in Autopoiesis Research

Autopoiesis research has its own terminology that has to be explained before applying an analysis to our concrete problem. Herein we will explain only basic concepts which are relevant to the problem at hand, but the interested reader should refer to [47] for more profound explanations. As from our perspective most relevant concepts include: (1) organizational closure, (2) the process of structural coupling, as well as (3) the process of languaging.

Organizational closure. Varela uses the term of organizational closure to describe the wholeness of a system. He states that organizationally closed systems constitute a "*(...) circular network of interactions rather then a tree of hierarchical processes.*" [42]. Organizationally closed systems are not closed systems, but neither open systems as in behaviorist direct deterministic view of stimulus – response [6]. These are systems which are able to create a distinction between them selves and the environment. Autopoietic systems are organizationally closed in terms of that their internal network of processes is recursive, which means that they are reproduced through the very network of processes which create them. The relations between these processes represent the organization of the system, while the actual processes (the components) represent its structure. Changes in the system occur through changes in the system's structure which are picked up in the continuous processes of reproduction and as such allow the system to adapt and couple to its environment.

Structural coupling denotes the interaction (mutual coordination and co-evolution) between an organizationally closed system and its environmental systems which can be both autopoietic or alopoietic [6]. Due to the organizational closure of the system, the only way for it to interact with other systems is through its structure. This process can be easily depicted for living systems like creeper or climbing plants which grow towards a house. The shape of the house (its structure) determines the shape (the structure) of the

plant. Likewise the continuous interactions of the plant, changes the structure of the house (the facade gets ravaged). The same process also applies to social systems when they couple to their environment, urban architecture through history being a good example. Cities (as social systems) couple to their natural environment through building housing facilities and other infrastructure, which continuously reshapes the environment. The characteristics of the location of the city (geography, climate etc.), on the other hand, shape the possible states of the social system like constraining possible building area or introducing various concepts into the language of the system. An example of this process of the environmental characteristics introducing concepts into a language might be found in a recent study [17] which shows that the North Saami language spoken in northern parts of Norway, Sweden and Finland has over 1,000 lexemes denoting snow, ice, freezing, and melting.

Languaging is a special case of structural coupling in which two autopoietic entities interact by mutually orienting themselves to each other and to a subject [48]. Languaging is a type of behavior in which one system orients another within its cognitive domain to interactions independent of the nature of the orienting interactions [19]. Only if the domains of interaction of the two systems are comparable, they will be able to develop a language that will allow them to converse and cooperate. In this sense a language constitutes a set of elements like pulses, gestures, signs, words, symbols, actions, etc., that can be combined through syntax rules to form meaningful (sense-making) semantics [6]. While this process is obvious for humans, the case of organizations as languaging entities might require additional explanation. One example can be a B2B (business to business) interaction between two firms in which the elements are transactions of various kinds, and syntax rules are the usual rules of business and signed contracts. Note that firms in a B2B languaging process influence each others structure to communicate, whereby under structure we understand the processes performed by the respective employees. Closely related to the term of languaging is the concept of enaction. Enaction is a process of interpretation in which meaning is brought forth from understanding [43]. Only continuous enaction between two organizationally closed entities can result in mutual sense making.

3 Modeling ODE as Structural Couplings

Having the basic terms defined, we will now present a colloquial ODE situation: some organization wants to update its information system with new software that will suite its organizational architecture and support its strategic endeavors. This update can be multifold: a new software system has to be implemented from scratch, a legacy system has to be updated to match the current architecture, some ERP solution has to be adapted for the particular organization, some component of the current system has to be rewritten, etc. The organization contacts a software producing agent (SPA) which shall provide the necessary service. The SPA can be an IT firm, the organizations IT department or even an open-source community. This service of developing a new system or adapting an existing one usually takes a number of phases. For sake of simplicity, assume that the organization and the SPA firstly

develop necessary documentation which includes models of the organizational architecture of the firm as well as instructions of what should be achieved with the new software system. Afterwards the SPA develops or adapts the system according to these instructions and in the end the organization starts using the newly developed system after all trial runs, usage consulting and other administering was provided by the SPA. Note that in a real world scenario each of these three phases could have been carried out by different SPAs, as well as that there might have been additional phases like in various agile methodologies or spiral development with spinning cycles etc. Also, note that this process is recursive: every time the organization needs to adapt its software system the process is re-initiated.

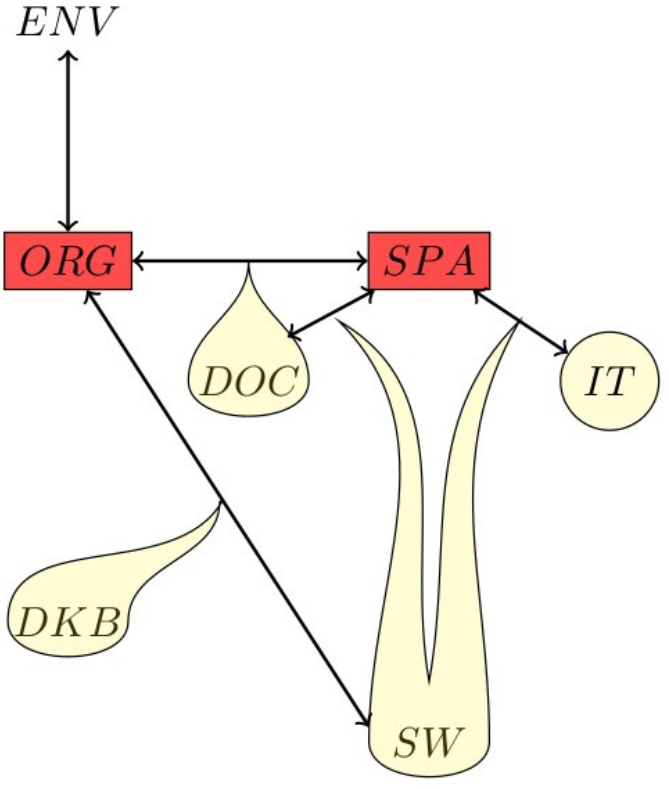

Figure 1: Model of Structural Couplings in an ODE Situation

The model of structural couplings in this system is depicted on figure 1 whereby *ORG* is the organization, *SPA* is the software producing agent, *ENV* is the environment of the organization, *DOC* is the documentation of the to be implemented software system which includes a model of the organization's architecture, *IT* is the actual information technology used to implement the system, *SW* is the software system, and *DKB* are the data and "knowledge" bases of the organization. *ORG* and *SPA* are autopoietic entities depicted as rectangles, while *DOC*, *IT*, *SW* and *DKB* are alopoietic entities depicted as ellipses. The environment is a complex system which

can include both autopoietic and alopoietic entities. A two-headed arrow symbolizes a structural coupling between entities, while a drop-like area connected to the shape of the entity denotes that an entity is the result of a particular structural coupling. There might be other couplings (for example between the organization and its *DKB*) as well as other entities (like independent consultants, or technical support and administration for example) in the given model, but are irrelevant for the analysis at hand. The two autopoietic entities represent two aspects of ODE: the organization represents the organizational design perspective, whilst the SPA represents the organizational engineering perspective.

We can read the model as follows: the organization (*ORG*) engages a number structural couplings to its environment (*ENV*). One particular coupling, namely the one to a software producing agent (*SPA*) is of special interest and thus depicted separately. The result of this structural coupling is, beside other things, a documentation (*DOC*) which includes models of the organization's architecture (including structure, processes, strategy, culture, and human resources [49]). In order to produce a software system (*SW*) which is aligned with the requirements in this documentation the *SPA* couples to both information technology (*IT*) and the documentation itself. In the end, the organization couples to this newly established software system, while the result of this coupling are the data and "knowledge" bases of the organization (*DKB*).

Note that the presented model can be used to describe a continuous process (which often is the case in real world scenarios): the couplings only initially depend on the languaging between the organization and the SPA, but are later continuous like a pipeline, which means that changes in the organization's architecture can be added to the documentation, build into the software system and later on used by the organization.

From the presented model we can now analyze the particular coupling which are relevant to answering the research questions given previously.

3.1 Structural Coupling between the Organization and the SPA

The most important and likewise most complex coupling is the one between the organization and the SPA. In this coupling two autopoietic entities interact, which induces languaging between them and the development of a mutual language since their internal languages are comparable. One of the results of this languaging process is the aforementioned documentation, whereby by result we mean stored communication on some media in the sense of [39].

Organizations develop their own internal languages (linguistic behavior), which is shaped by both internal (people's knowledge, education type, cultural background) and external factors (institutional environment, market trends and behavior etc.). These languages differ from organization to organization, but are similar across industries. For example, two IT firms will likely have similar internal languages, which could be described as different dialects. On the other hand organizational languages across different industries, might differ significantly, up to the level of misunderstanding. For example a chicken processing plant and an animal shelter will most likely develop very different languages. These internal languages can trigger

misunderstanding when two organizations have to cooperate. If we now switch to a macro level, and observe organizations as languaging entities by them selves, it becomes clear that cooperating organizations, will coordinate their actions, and will thus develop a language between them - an intermediary language which will allow them to communicate. Since the internal representations of the intermediary language might differ in both semantics and syntax, the enaction in various coordination actions can lead to misunderstandings and differences in expectations.

In our case, the internal languages of the organization and the SPA might differ significantly. The main problem for the organization is to communicate its organizational design artifacts clearly, so that they become part of the software system to be produced. If these artifacts are implemented well, the organization will be able to couple to the system more easily. On the other hand, the SPA has to communicate the possibilities of IT clearly in order to avoid wrong expectations as well as to provide information about new IT developments which might be of significant value to the organization.

In order to approach the problem of avoiding misunderstandings we could use a metaphorical example: what will two humans who speak different languages do in order to communicate? This simplification has its justification, since humans as well as organizations can be considered autopoietic entities which both are languaging as elaborated in [35]. We could even extend this example to two groups or social systems of people who come from different cultures and stand before a language barrier. From literature there are at least three approaches to solve this problem: (1) Learning from each other (for example through a process of mutual sense making [43]), (2) Using an interpreter who is bilingual (e.g. versed in both languages) [8], and/or (3) using a (potentially artificial) auxiliary language like Esperanto, Ido or Interlingua [32].

Taken into the organizational perspective, the first approach will likely take the most time and effort. Both organizations need to establish a continuous process of enaction to adequately understand each other - they have to mutually adapt their internal structures which in turn will shape their future behavior. Various models of mutual organizational learning and knowledge management like those proposed by [27] can be used here to achieve mutual sense making, but it is crucial to understand that the internal interpretation of exchanged communication is independent of the actual communication itself. They are in different cognitive domains, which means that the two organizations can not be expected to fully understand each other except eventually if they merge into one entity. Thus, this approach will likely work best if the SPA is the internal IT department of the organization.

The second approach subsumes that there exists a specialist entity which is both versed in the specific business of the organization as well as in IT. Such entities are hard to find, since ideally it would be a long time employee of both the organization and the SPA that understands every aspect or the organizational architecture and up-to-date IT. Other solutions might include external consultants which are specialists in IT and the industry of the firm. Such consultants, if they exists for the particular case, are often expensive, due to their very specific knowledge. This contemplation also suggests the need for multidisciplinary higher education study programs which will cover IT, ODE and special industry topics, that would yield such consultants. One also needs to take notice of the possible problems of this approach. When translating from one language to another there is always some loss of original semantics, as well as introduction of additional (wanted or unwanted) semantics in the translation.

Additionally, each communication (be it oral or stored in form of text or computer based models) is interpreted by organizationally closed entities, whereby each such interpretation can yield quite different understanding of semantics.

The third approach implies that both entities learn an auxiliary language which will allow them to communicate. This approach has its advantages against the first approach, since if the language is once learned it can be used over and over again with various entities the organizations interact with. On the other hand, the same shortcomings as in the second approach apply here as well, and the question which language that might be for our particular problem can raise a lot of dilemma. If we take into account the two organizations as autopoietic entities which are languaging we will end up with rules of conduct and business language, but since we focus on ODE we can constrain ourselves on (symbolic) languages which are designed for this particular problem. From the organizational design perspective natural (human) language is the most widely used. From the organizational engineering perspective there are a lot of various business oriented languages like organigrams, various work flow languages, cause & effect diagrams from balanced scorecards [12], or more widely used general purpose languages like UML (Unified Modeling Language) [29], ORM (Object Role Modeling) [9], ontology languages like OWL (Web Ontology Language) [45], SWRL (Semantic Web Rule Language) [11] or RIF (Rule Interchange Format) [46]. The problem with business oriented languages is that they are not expressive enough to cover all organizational design artifacts, while general purpose languages are mostly not understood by practitioners coming from an organizational design background [28]. Efforts like SBVR (Semantics of Business Vocabulary and Business Rules) [30] or RuleSpeak [34] are thus welcome to trying to close this gap.

Still, all of these mentioned languages (except for maybe natural language) have a common problem. According to McKelvey [23] (adapted from [15]) organizations as complex systems are composed of two types of elements: the natural (intangible) and the intentional (tangible). While the former present human, behavioral and action-oriented elements, the latter deals with human-made, rational and planning driven elements. All these organizational engineering languages mostly deal with the latter, since such tangible elements are easily to represent formally in appropriate models, while the former are often left out of any analysis, even if they represent at least an important, if not the most important aspect of each organizational design. In order to deal with the natural elements of organizations in a formal way, as in organizational engineering, autopoiesis research can provide all the needed building blocs to develop a formal ontology and thus a meta-model for formal analysis. Some of the basic concepts like regeneration of components, organizational closure, structural coupling, languaging, or enaction can and should be incorporated in this ontology which can then be used to construct a SBVR-like language that might be understandable to both parties, expressive enough to cover all elements of organizational design and yet formal to be implementable directly into software.

In this analysis of (symbolic modeling) languages, one should have in mind that they represent only one aspect of the languaging process between the organization and the SPA. There are yet other aspects that have to be considered. For example, according to Maturana [21] acceptance and likewise rejection within a group occurs more likely on a basis of emotions and mutual acceptance than on rational thought. Social action and especially cooperation are impossible without some kind of mutual

acceptance between participating actors [15], and thus it is crucial to build this kind of relationship between organizations which cooperate especially when they use very different languages. Emotions play a crucial role in the languaging process, and should be considered with care. This reasoning might imply that various elements of organizational culture including symbols, rituals, stories, games, heroes etc. have to be embedded into the documentation and consequently into the software system in order for it to be acceptable by the organization.

3.2 Structural Couplings between the SPA, the Documentation and IT

The structural couplings between the SPA and the established documentation as well as the SPA and the actual IT result with the implementation of a software system that is in accordance with the documentation developed in the first coupling. These couplings shape particular information technology (in form of stored communication) in accordance with the SPAs interpretation of the organizational architecture which is the result of a mutual sense making between the organization and the SPA.

The SPA uses its newly acquired knowledge (e.g. changes in structure due to languaging and enaction with the organization) as well as its knowledge about IT (acquired through a history of coupling to it) to establish a new coupling behavior which will result in a software system for the particular organization. "*This is creativity: the generation by an organism of distinctions (...) through its interactions with systems to which it is not structurally coupled (organizationally independent systems), and to which it may become structurally coupled as a result of the interactions.*" [20]. Thus, the more profoundly the SPA languages to the organization, the more completely will its structure reflect the organizational design of the organization and its coupling to IT will result in a better aligned software system.

On the other hand, the coupling to IT is of equally high importance. Having in mind that the resulting software system will be used by an organization, which, as an autopoietic entity, will structurally couple to it, it is important to implement adequate mechanisms which will foster this coupling and allow the organization to adapt the software system towards its needs [1], [39], [50], [51].

This means that the SPA has to be aware of certain technologies which enable structural coupling in organizations like the social Web or Web 2.0 technologies (including the Enterprise 2.0 paradigm [41]) on one hand, as well as Semantic Web [2], Internet of Things [44] and consequently multi-agent system technologies on the other. While the former deal with various technologies like social networking, blogs, forums, wikis, podcasting etc. which enable user involvement and thus allow the organization to shape its information system towards its communicative needs, the latter provide a suitable framework for formalizing semantics and autonomous, large-scale, distributed, "knowledge"-based systems. A combination of these technologies (sometimes refereed to as Web 3.0 [37]) like semantic wiki systems, recommender systems based on sentiment analysis, open ontology based Enterprise 2.0 solutions etc. could give the organization the opportunity to shape its software system towards its needs, without continuous SPA intervention. Such software systems might allow the organization to "directly" introduce its own organizational design artifacts into the system like various kind of rules, or to adapt to the actual coupling of the organization

through various forms of self-organizing and adaptable software. A major challenge for such systems will be to find a suitable language (broadly defined) that will be comprehensible by the organization, and yet formal enough to allow for system behavior and structure model changes. Another solution, compatible to the previous ones, is that the organization uses open source software or purchases the code of the software system. This would allow it to adapt the system towards its needs independently, but implies the need for a skilled IT department which will be able to do so.

3.3 Structural Coupling between the Organization and the Software System

The last coupling to be analyzed is the one between the organization and the implemented software system. The organization has to rearrange its structure to adapt to this new coupling. This rearrangement of structure will be easier to perform if the initial languaging between the organization and the SPA was profound enough, since some structures (like for example about the possibilities of IT) might already be in place. When this coupling is established the result of it will be the data and "knowledge" bases of the organization. If the software system is adaptable enough, the organization should be able to change its model of organizational architecture through storing its "knowledge" in the "knowledge"-base. Thus it is critical for the organization to communicate this need during the languaging process with the SPA - the SPA should be aware of the fact that the organization will change in due time, and thus the software system has to support this possibility.

Another result of this coupling is organizational knowledge about the gap between expectations and actual results. Only after interacting with a certain system can the organization perceive its shortcomings and differences with respect to the expected behavior of the system. These shortcomings can and should be communicated back to the SPA in order to enrich the mutual sense making and prevent such problems in future encounters.

In order to give some insight into possible couplings that might happen between an organization and a software system we will use three high-level metaphors: the creeper plant, the hermit crab and the beaver.

Creeper plant. If the software system is rigid and unadaptable the organization might couple to it like a creeper plant to a house. Since the organization is flexible enough it adapts it structure to the software system, like the creeper slowly acquires the shape of the house. This is the case when organizations obtain a finished software product (like an ERP solution for example) which requires the organization to change its internal processes according to "best practices" of some industry. While this adaptation might be temporarily useful for less competitive organizations, frontier organizations might loose some of their ability to create new and better practices. In this way the future organizational design of the organization, or better said the process of organizational design is constrained by the acquired software system. This can also lead to misalignment between the organization and the software system, due to the system's rigidness.

Hermit crab. A smaller organization might choose to use one (finished) software system until it “outgrows” it, and then similarly to the hermit crab, abandon it to find a new and more suitable solution. In such a scenario the software has to allow the migration of all needed data to the new system. Also, this implies that the organization has to be adaptable enough to be able to migrate quickly, e.g. the organization has to be able to adapt its structures fast enough to prevent possible losses.

Beaver. An organization might choose to implement its software system by it self, like the beaver builds its lodge, and adapt it to its needs. In this way the software system develops with the organization, which changes through its organizational design process. In this regard the organization has to take care about updating the system, every time there is a structural change. This metaphor also applies to organizations which purchase a software system which is well suited for their needs, but adaptable enough for the organization to independently develop it further.

Regardless which of these models an organization choses or even combines them, it should be aware of the fact that its internal organizational design process will be greatly affected by this decision. Each model of coupling to a software system will bring forth changes in the organizational architecture, and thus the organization will have to adapt its organizational design to the coupling.

4 Conclusion

In this chapter we tried to approach the organizational design and organizational engineering in terms of structural couplings between an organization and its IT related environment. A simplified model of these couplings was presented and three important couplings were identified which each result in an important part of the organizational IT ecosystem.

To come back to the initially posed questions, it is important for an organization to understand the process of languaging that takes place between it and an SPA. The most important insight might be that each of the languaging entities uses its own language and that the interpretation of the resulting description (the enaction of organizational architecture) can differ significantly between them if they don’t approach the development of a mutual language seriously. Three possible approaches to this problem were identified (mutual sense making, using an interpreter, using an intermediary language) that can and should be combined in order to achieve valuable results. Another insight is that intangible (natural, cultural) elements of the organization as well as requirements for possible organizational change have to be communicated and build into the documentation and consequently the to be implemented software system. The development of tools including an organizational design and change ontology based on autopoiesis research should be subject to further research.

Further, SPAs should be aware of the fact that organizations are structurally coupling to their product, and thus implement it wisely to be adaptable to the organization’s needs and yet easy to use enough to make coupling simple. Some current technologies like Web 2.0, the Semantic Web and Web 3.0 were identified as

possible solutions, but the development of technologies that will be able to fully couple to organizations considering their nature is an open research question.

Organizations have to adapt their organizational design process with regard to the languaging process on one hand and the model of structural coupling to the software system on the other. During the languaging process organizations might learn of IT possibilities which they weren't aware of and which might greatly affect their functioning. These possibilities have to be incorporated in the future design of the organization. Further, organizations can, beside others, constrain their organizational design, choose to adapt quickly or to adapt incrementally depending on the respective software system coupling model. Constraints ("creeper plant" model) can be valuable when the organization isn't competitive and good practices should be implemented. Quick adaptation ("hermit crab" model) is desirable with smaller organizations which grow quickly and the costs of adapting the software system are to high. Incremental adaptation ("beaver" model) applies to mature organizations which try to lead their market with innovative practices.

In this chapter only few concepts from the descriptive framework of autopoiesis research were used to analyze some of the important structural couplings of organizational design and organizational engineering on a case of IS/IT alignment. There are yet other concepts like regeneration of components, preservation of organization, cognition and learning, which might be applied to the problem at hand. Additionally, there are other couplings and variations of the presented model which haven't been analyzed herein including situations in which the various processes are performed by different SPAs or couplings which take into account complex situations in the environment of the organizations. These and similar questions are subject to future research.

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