Organizational Change and Transformation in Technology-Oriented Firms
A Complex Adaptive Systems Perspective: Research Design

Abstract
The research design is key to success for any study or PhD project. The most interesting results and insights are worthless if the research design does not endure the critical review of the scientific community. This paper attempts to describe the research design to investigate organizational change and transformation from a complex adaptive systems perspective. To develop the research design the criteria worldview, research problem, personal experience and audience are discussed and evaluated. This resulted in a multiphase mixed-method research design. Phase one aims to contribute to theory in a multi-case study approach and in phase two a computer based modeling and simulation approach is advocated to test and expand the theory.

Criteria to Select a Research Design
The research design is one of the most important influence factors that determines the success or failure of a research effort. Its rigor determines if research questions can be answered, if the results can be published in the targeted outlets and if they are relevant for the intended audience. Various criteria can help to design the research in a way, which achieves the intended goals. The next section gives an overview about the main criteria, which should be considered for selecting a research design. They include the philosophical worldviews, the research problem, personal experience and the targeted audience (Creswell, 2009). This won’t be a comprehensive discussion of all possibilities rather than the description of the relevant assumptions and perspectives for this research project.

1.1 Worldview, Epistemology and Ontology
Making the worldview explicit will help to explain the reason of a researcher to choose a qualitative, quantitative or mixed method design (Creswell, 2009, p. 5). It also helps the reader to understand the perspective of the research applied to the work. This is important because it allows for a more effective evaluation of the approach and the rigor of potential outcomes.

From a philosophical perspective pragmatism is probably the view which best describes the assumptions applied in this research project. What is central to this perspective is that the focus lies on the problem rather than the research approach (Creswell, 2009). It also refers to the need to balance concrete and abstract with reflection and observation (Easterby-Smith, Thorpe, & Jackson, 2008). As a consequence there is no commitment towards any philosophical system or research design (Creswell,
With a pragmatic worldview the researcher chooses the best method to understand the problem under investigation. According to Creswell the pragmatist researcher looks to the „what and how to research, based on the intended consequences“. This very often results in a mixed-method approach to collecting and analyzing data in order to achieve the best possible understanding of a research problem (Creswell, 2009, pp. 10-11).

Also the basic understanding of the purpose of research and development is an important assumption that should be made explicit in a research design. This means to reflect on the classic distinction between „basic“ research (performed without practical ends, intended to develop general knowledge and an understanding of nature and its laws) and „applied“ research (performed in the service of some immediate end). One model to do so is offered by Donald Stokes (Stokes, 1997), who criticized a black and white distinction between applied and basic research as inaccurate and pernicious. Alternatively he suggests that research can be both and contribute to basic understanding (rigor) and at the same time have considerations of use, which makes the research relevant (Tushman & O'Reilly III, 2007). To target the so-called “Pasteur quadrant“, which refers to use-inspired basic research, advocated by Stokes is also the aspiration, which is underlying this research design. Advances in fundamental understanding without any perspective for useful applications whatsoever, seems to be a dead-end street. Especially in a rough economic environment when funding for research by the government or industry partners is more and more depended on the perceived value for the public.

One way to summarize this discussion is to position these perspectives in a broader context and look at a matrix with ontology on one axis and epistemology on the other axis. Ontology refers to “philosophical assumption about the nature of reality” and epistemology deals with the assumptions about the “best ways of inquiring into the nature of the world” (Easterby-Smith, et al., 2008, p. 60). Ontology therefore deals with the question if reality exist independently of the human being (objective) or does is reality just a construct of our mind (subjective). Although this can also be seen as a continuum rather than a black or white position, a clear tendency to seeing reality as objective can be identified for this research project.

When looking at the epistemological dimension we need to answer the question about how knowledge can be created. Here we can identify as well objective and subjective positions as two different ends of a continuum. An objective view points more towards quantitative methodologies and subjective to a qualitative set of methodologies while mixed-method incorporate elements of both. (Creswell, 2009; Easterby-Smith, et al., 2008). Like already mentioned the answer to this question also heavily depends on the research problem and it was already indicated that this project formulates its research question based on relevant problems rather than based on a philosophical believe of how knowledge can be created.
The graphic above (figure 1) also indicates that this project navigates in a corridor of assumptions rather than being trapped at finite and rigid position. It also tries to illustrate that subjective epistemological approaches can cover a broader area of questions and objective approaches allow for testing and verification of narrower problems in depth.

1.2 Research Problem

The project is motivated by the fact that large portions of organizational change and transformation efforts, despite a vast amount of research over the past decades, still fail or fall short behind expected results and benefits. Depending on the study the failure rate lies between 60 and 80% (Aiken & Keller, 2009; Beer & Nohria, 2000; Burnes & Jackson, 2011).

The assumption is that one of the reasons for this high failure rate can be found in the application of management approaches that are still dominated by a mechanical or deterministic understanding of organizations. In addition, we are faced with an ever-increasing rate of change and a very turbulent environment, which got even more unpredictable since the world economies were upset with the financial crisis, which started in September 2008. Consequently, the complexity organizations have to deal with increased and we need a new understanding of organizational change in order to explain and understand these phenomena. Reacting quickly to changes in the environment, adjusting strategy, and implementing it all seems to be crucial for successful growth and survival (Burnes, 2005).

This is especially true for firms that are competing in technology driven industries. Changing needs in the market, a higher intensity of competition, and shorter development and innovation cycles demand the capability to implement new strategies and launch new products faster than ever before. Eisenhardt describes it this way: „... for these firms (technology driven firms, comment from the author) change is not the rare, episodic phenomenon...it is endemic to the way these organizations compete. Moreover, in high-velocity industries with short product cycles and rapidly shifting competitive landscapes, the ability to engage in rapid and relentless continuous change is a crucial capability for survival. ...Like organizations, complex systems have large numbers of independent yet interacting ac-
tors. Rather than ever reaching a stable equilibrium, the most adaptive of these complex systems keep changing continuously by remaining at the poetically termed „edge of chaos“ that exists between order and disorder (Brown & Eisenhardt, 1997).

In order to better understand the dynamics of organizational change and managing complexity we want to apply a perspective based on complexity science (Anderson, Mezer, Eisenhardt, Carley, & Pettigrew, 1999) which sees organizations as a organic, learning systems which adapt to new conditions (internally and externally). This view also accounts for stochastic and non-linear dynamics (McMillan, 2004).

This project wants to apply a complex adaptive systems perspective (Gell-Mann, 1994) and explore the reasons why some projects fail and other succeed in today’s environment. The idea is that conditions are different today and that with the application of a different perspective new insights can be generated. Also Eoyang explains in one of the most recent reviews on complexity and organizational change that “what is required is the development of theories and tools that can influence options for action through prospective application, translate into practice with both ease and insight and consistently capture both the stability and disruption that are central to the complex dynamics associated with organizational change” (Burnes, 2005; Eoyang, 2011). Therefore a new theory, which allows us to derive actionable recommendations to guide organizational change and goes beyond metaphors is needed (Brown & Eisenhardt, 1997; Burnes, 2005).

The project is lead by the following research questions:

- How can we explain success or failure of change initiatives by applying a complexity science perspective?
- What are the factors influencing success or failure?
- Which models of change do technology-based firms apply?
- What would a CAS model of organizational change look like?
- What are the necessary variables and dynamics, which should be part of an exemplary transformation process?
- Is a complex adaptive systems perspective of organizational transformation superior to other approaches when managing change?
- What are the consequences for managers?

In summary we can say that the project focuses on the research problem of understanding the complexity in organizational change and transformation processes of technology-based firms acting in a dynamic environment. In order to ad to the body of knowledge a complexity science advocacy lens will be applied (problem focus and fundamental understanding). This should help to explain success
and failure of change and transformation initiatives in a comprehensive way. Furthermore it is the intention of this research project to use this understanding for the development of tools or recommendations, which help managers to more successfully, lead their organizations in an ever-changing environment (relevance).

1.3 Personal Experience

The personal experience and skill set is also an important consideration in the selection of the research design. This is because individuals might prefer to work with methodologies they are more comfortable and experienced with (Creswell, 2009). According to this qualitative approaches would be the obvious choice for this project. Nevertheless the pragmatic perspective looks for the methodologies with the best fit – even when it requires getting additional training. Especially since this research project is part of a PhD effort, acquiring new skills to investigate research problems is an inherent intention. Consequently the application of multiple methodologies might not be driven by the research problem alone, but also reflect the intention of the researcher to increase his versatility to approach research problems. Researchers should be aware that mixed-method approaches will require additional time and effort when developing the research plan (Creswell, 2009).

1.4 Audience

The last criteria influencing research design requires the researcher to reflect on the targeted audience. The most interesting research and impressive outcomes are worthless when the audience does not accept the research, because of flaws in the research design.

This research project is a PhD effort and therefore has the advisor as well as the doctoral committee as a main audience. The cumulative nature of this PhD effort also brings in journal editors as well as conference attendees as a very crucial group of audience. The acceptance of the research in VHB and ISI ranked journals as well as international conferences will be paramount to convince the doctoral committee of the quality of the research. It is therefore imperative that the research design is developed with possible outlets and target publications in mind. The project aims to target several outlets during the project with preliminary results in international conferences (e.g. European Conference on Complex Systems 2012, Brussels) and the final results in ranked and peer-reviewed journals of the field such as (Organization Science, Emergence – Complexity and Organization, Journal of Organizational Change).
Research Design

Based on the criteria explored before a multiphase mixed-method approach seems to be the best fit for the study of organizational transformation process in technology-based firms from a complexity science perspective. The description of the research problem outlines a situation where a new theory needs to be emerged. In addition an alternative perspective is applied which represents and explicit advocacy lens. This set up lends itself to a *sequential transformative* research design where qualitative and quantitative data is connected (Creswell, 2009; Hanson, Creswell, Clark, & Petska, 2005).

\[\text{Advocacy Lens (Complexity Science)} \]
\[\text{QUAL} \rightarrow \text{quan}\]

Figure 2 - Typology of Mixed-Method design on (Hanson, et al., 2005)

As indicated in figure 2 above the transformative aspect of the study is brought in by applying explicitly a complexity science perspective, which is a change to traditional views of organizations and implies a different paradigm (Tetenbaum, 1998). ‘QUAL’ in capital letters indicates that priority is given to the qualitative data above the quantitative data, which reflects that data from the first phase will serve as a basis for the second phase. The data analysis is connected and the integration will happen in at the end of the second phase. According to Hanson/Creswell et al. 2005 these designs are particularly useful “for giving voice to diverse or alternative perspectives […] and better understanding of a phenomenon” (Hanson, et al., 2005, p. 229).

This research design as displayed also has a sound review of literature as a prerequisite. Any good study should be rooted in a profound understanding of the literature, which helps to formulate an intriguing research question (Creswell, 2009; Davis, Eisenhardt, & Bingham, 2007; Eisenhardt & Graebner, 2007). In the first phase this study will explore in a multi-case study approach (Eisenhardt & Graebner, 2007) organizational change and transformation process in technology-based firms. In the second phase of the study the findings from the multi-case study research will be used to build a computational representation of an exemplary change process. This simulation and resulting experiments will be used to further enhance novel theory and test the theory at the same time (Davis, et al., 2007). Subsequently it is the intention to derive actionable recommendations for managers about organizational transformation from a complex adaptive systems perspective.
In addition to the criteria’s evaluated in the beginning there are several additional reasons to combine multi-case study research design with simulation in a sequential transformative mixed-method approach. One of the main reasons to choose a mixed method approach is that the type of research challenge, which is given the highest priority from the criteria, can benefit from the combination of qualitative and quantitative data (Tashakkori & Teddlie, 1998).

The multi-case study approach in phase one is selected because multiple cases are seen to “create more robust theory, because the proportions are more deeply grounded in varied empirical evidence” as well as the creation of data produced reflects the “rich, real-world context in which the phenomenon occur” (Eisenhardt & Graebner, 2007). This strong rooting of the theory in the real-world context contributes to the external validity and relevance. Another benefit of the rich empirical qualitative evidence is that it serves as a bridge to quantitative methods by enabling the research to develop constructs and measures which can be turned into a testable theory (Eisenhardt & Graebner, 2007). This is also where simulation complements the research design because it has its “sweet spot between theory-creating methods, such as multiple case inductive studies and formal modeling, and theory testing methods” (Davis, et al., 2007). In order to build a computational simulation it is necessary to specify the constructs, assumptions and theoretical logic very precisely. This adds a lot to the internal validity of the emerging theory. Another complimenting factor is that simulation allows experimenting with the theory in a computational laboratory which allows researches to produce data about nonlinear and interlinked processes which otherwise could not be observed (Davis, et al., 2007; Miller & Page, 2007).

Therefore just the combination of the data from multi-case research with the application of computational modeling and experimentation puts us into a position where research questions like proposed above (see section 1.2) can be investigated in a valid manner.

The following sections provide more detailed descriptions of the different steps in the research design.
1.5 Phase 1 – Multi Case Study Research

1.1.1 Design of Case Study

Phase 1 of this research project will be build around a multi-case study research as suggested by Eisenhardt and Graebner (Eisenhardt & Graebner, 2007) as well as Yin (Yin, 2009). Like mentioned above it is the intention of this project to contribute to theory development which allows to develop a improved understanding of organizational transformation and adaptation. And through the ‘replication logic’, which treats each case as separate experiment, and their rich real-world context allows for inductive theory development and external validity. It will do so by investigating ‘polar types’ of successful and failed change efforts (projects or programs which reached their goals set in the beginning) in 5-7 different technology based firms. The investigation of polar types has the advantage that it helps to researches to clearly identify the patterns, constructs, relationships and logic of the phenomenon under investigation and help to address internal validity (Eisenhardt & Graebner, 2007). This also means that we have for each case two units of analysis which stands for an embedded approach (Yin, 2009). Also the selection of technology driven firms is intentional because „... for these firms change is not the rare, episodic phenomenon... it is endemic to the way these organizations compete. Moreover, in high-velocity industries with short product cycles and rapidly shifting competitive landscapes, the ability to engage in rapid and relentless continuous change is a crucial capability for survival.” (Brown & Eisenhardt, 1997). To ensure quality the researches will use multiple sources which are made accessible by the organizations such as observations, company communication, project reports with the main source being at least 5 semi-structured interviews for each polar type to establish a chain of evidence (Yin, 2009, p. 41). This means a minimum of 10 interviews in each company. These interviews will also be conducted on different levels including managers of change initiatives as well as team leads and team members of change initiatives to gain different perspectives and counteract informant bias. To counteract the retrospective bias of the interviewee the project either needs to be ongoing or not older than 1 year.

1.1.2 Preparation for Data Collection

Preparing for the case study data collection is crucial and if not done sufficiently the entire case study investigation can be jeopardized making the effort not worthwhile. The preparation work helps to develop the necessary skills as well as ensures that the data collection methods work and capture the required data. It is a widely spread misperception and wrong assumption that case study research is ‘easy or soft’ and requires minimal preparation (Yin, 2009). The case study preparation will follow the recommendations from Yin (2009) and involve the following steps: developing a protocol for the in-
vestigation, screening candidate cases and conducting a pilot case. The demand to conduct training for
case study investigators is in this case not necessary, because there will be just a single case study
investigator who can act as an independent investigator since he is also doing the entire design and
planning guided by a experienced researcher.

1.1.3 Collecting of Case Study Evidence

The case study evidence will include multiple sources of data with interviews being the primary
source. In addition to interviews will also collect documentation of the projects such as project briefs,
project reports and communication pieces such as intranet articles on the project. This of course heavi-
ly depends on the cooperation of the cases study firms and will be especially important for already
completed projects. A third source of data would be direct and participant observation (Yin, 2009).
This source is especially relevant where the cases study element is an ongoing effort. These type of
cases will require to observe the effort until completion so success or failure can be assessed. For par-
ticipatory observation elements of action research (Argyris & Schön, 1989; Baskerville, 1999; Lewin,
1946) will have to be considered. The main source for the case study evidence will consist of semi-
structured interviews. The interview guide will be developed and tested including key and potential
questions. This should allow the researcher to cover all the necessary points, make the interviews
comparable as well as allow for a certain degree of flexibility to drill deeper on interesting concepts,
which arise during the interview process. This will follow the guidelines and recommendations of
(Friedrichs, 1973; Maccoby & Maccoby, 1965; Schnell, Hill, & Esser, 2008; Silverman, 2010).

1.1.4 Analyzing Case Study Evidence

The case study evidence will be used to produce two outcomes. The first outcome is a theory about
organizational change from a complex adaptive systems perspective. The second outcome will be a
exemplary change and transformation process which will serve as a basis to build a computational
simulation.

All interviews will be audiotaped and transcribed shortly after the interviews to ensure that the
memory is fresh and no important pieces are lost. Also the observation data as well as other document-
tations provided from cases will be all documented in writing so they can be analyzed afterwards with
the help of nVivo. To do so the research will develop a coding guideline based the needed elements to
develop an exemplary process and the elements required for a theory (also see 1.1.5). For this several
analytical techniques including pattern matching (Trochim, 1989) using constructs from complexity
science, explanation building as a special case of pattern matching (Yin, 2009) to explain success and
failure of the efforts as well as logical models ((Wholey, 1979) cited in (Yin, 2009)) to explain certain dynamics or chain of events (observed data) with theory will be applied. First analysis will be done after each case is captured to learn from the experience and strengthen the set up for the next case. The final analysis will be done as cross-case synthesis with some time distance to the last case done by at least two researchers independently and results will be discussed afterwards.

1.1.5 Identification and Development of Simple Theory

This is a key step in the research project where the data from the phase one is analyzed and connected to phase two and perfectly serves as bridge form a qualitative to a quantitative approach (Eisenhardt & Graebner, 2007; Hanson, et al., 2005). The simple theory is not just a first outcome form the case studies, but also the starting point for the simulation. Therefore it is crucial to reflect on what actually needs to be part of such a theory. Although different scholars (Corley & Gioia, 2011; Sutton & Staw, 1995; Whetten, 1989) have different elements they focus on when it comes to theory development according to Davis and Eisenhardt a theory needs to contain four elements: constructs, propositions that link those constructs together, logical arguments that explain the underlying theoretical rationale for the propositions and assumptions that defined the scope or boundary conditions of the theory (Davis, et al., 2007). The case study material will also provide the basis to build this simple theory, which will be tested and enhanced in the next phase.

In addition the developed theory will be a first result, which can be targeted towards publication in international conferences with potential of journal publications such as the Academy of Management conference or the Organization Science Conference. Besides publishing the first results these conferences will be used to collect feedback from other scholars on the theory as well as the phase two research approach.
1.6 Phase 2 – Simulation

In order to enter into this phase it is a prerequisite that a) a simple theory could be developed from the findings in phase 1, b) a exemplary change process could be extracted and c) that the research questions are still intriguing and valid.

1.6.1 Choose Simulation Approach

The selection of the research method depends on the fit of the research question, assumptions, ad the theoretical logic of the simple theory with the simulation approach (Davis, et al., 2007). This implies that a final decision on the simulation approach won’t be possible before the theory development was completed. However, according to different assessments of different simulation approaches towards their ability to simulate the characteristics of complex social systems multi-agent models appear to be to most likely choice (Bandte, 2007; Gilbert, 2008; Gilbert & Troitzsch, 2005; Miller & Page, 2007)

1.6.2 Build Computational Representation

Building such an agent-based model requires identifying the key variables and dynamics, which are needed to describe real world situations (Prietula, 2011). This information will be drawn from the multi-case study analysis as described for phase one. The computational representation will be build using a specialized modeling software (Merali & Allen, 2011) with NetLogo (Wilensky, 2011) as the most likely choice. Building the computational representation also involves three steps which include a) the operationalizing the theoretical constructs, b) building the algorithms that mirror the theoretical logic of the focal theory and c) specifying the assumptions that bound the theory and results (Davis, et al., 2007). For this project it will be key to simulate an exemplary change process in a dynamic environment.

1.6.3 Verify and Validation Computational Representation

The verification of the computational representation has the main purpose of ensuring that it represents the underlying theoretical logic (Davis, et al., 2007). One step is to get rid of bugs in the programing (verification) and the other one is to validate that it is a good model of the purpose it was build. There are several ways how the computational model can be verified. These might include running the model at different and extreme values and comparer the outcomes against the simple theory (sensitivity analysis) or comparing the outcomes against empirical data (Gilbert, 2008). In our case it should be possible to replicate outcomes that were observed in the case studies of phase one.
1.6.4 Experiment to Expand and Test Theory

The ability to conduct save experiments is one of the main purposes of simulation (Davis, et al., 2007). It also is one of the most natural ways of doing research in many other disciplines such as physics, but is a very new to social science (Gilbert & Troitzsch, 2005).

In our case the experiments will involve varying the values of different variables, which constitute strategies to deal with change situations. This means that the agents will be given rules and strategies to deal with the exemplary change situation. The simulation will measure the performance of different strategies against each other. This step might also be conducted in cooperation with a simulation expert.

Bibliography


