

Collective case study method and fractal geometry: Instrumental and intrinsic cases in organizational research

Abstract

In case study methods of organizations, researchers are often limited to the aggregation of individual cases within the context of the organizational case. Borrowing from Stake's (1995) use of instrumental and intrinsic case studies, this paper presents a fractal geometry case study method. For the purposes of this article, on site interviews of seventeen librarians who work in a research institution were conducted to learn more about their experiences with organizational change. Instrumental case studies of these individuals, or rather those cases that respond to other phenomena, were performed and analyzed at the micro level. A clustering technique, serving as a fractal seed, was also incorporated to draw out themes that highlighted the interconnections of individuals. These cases were then recursively integrated into an emergent framework of the intrinsic case of the organization. The use of this method suggests that observations of individuals, and the subsequent meaning they generate at the micro level, reflect the complex interconnections of these cases. At the same time, this method suggests that the recursive integration of individual cases contributes to the understanding of the complex organization at the macro level.

Keywords

case study, complexity, fractal geometry, instrumental, intrinsic, librarians.

Introduction

Case study research methods of organizations have been debated with some frequency in the social and behavioral sciences. In addition to the case findings, epistemological differences are represented in the disparate approaches performed by case study researchers. Moreover, there are ontological differences between case studies thought to be traditionally scientific and those case study methods that are purely qualitative. As an example, some scholars approach case study research as a means to generalize the findings of a case or a collection of cases to the population at large. Arguing that this must be avoided in qualitative research, however, Stake (2005) focuses primarily on the specificity of cases and how their uniqueness contributes to further understanding. “Case study has been too little honored as the intrinsic study of a valued particular, as it is in biography, institutional self-study, program evaluation, therapeutic practice, and many lines of work” (Stake, 2005, p. 448).

In case study methods of organizations, researchers are often limited to the aggregation of individual cases within the context of the organizational case. Conversely, narrative research methods are often chosen to focus on the individual but may sometimes lack coherence in their connection to the case of the organization. Borrowing from Stake’s (1995) use of instrumental and intrinsic case studies, this article presents a complexity science research methodology, using a fractal lens for case study method. For the purposes of this article, on site interviews of seventeen individuals who work in an academic unit of a research institution were conducted to learn more about their experiences with organizational change. Instrumental case studies of these individuals, or rather those cases that respond to other phenomena, were performed and analyzed at the micro level. A clustering technique, serving as a fractal seed, was also incorporated to draw out themes that highlighted the interconnections of individuals. These cases were then recursively integrated into an emergent framework of the intrinsic case of the organization. It is the purpose of this paper, therefore, to show how this fractal case study method suggests that observations of individuals, and the subsequent meaning they generate at the micro level, reflect the complex interconnections of these cases. At the same time, this method reflects the recursive integration of individual cases and how they contribute to the understanding of the complex organization at the macro level in fractal form.

Theoretical Orientation

The theoretical orientation of this paper draws from the scientific and social sciences research of complexity theory while grounding qualitative case study method in the works of Stake (1995, 2005). Stake suggests three main types of case studies: intrinsic, instrumental, and collective. Intrinsic case studies are used to understand the particular aspects of one or more cases. A researcher might utilize instrumental case studies, however, to understand another case or another issue. And collective case studies are used to draw thematically from several cases. Additionally, instrumental cases do not rely on a priori hypotheses to develop intrinsic themes; rather case study themes can emerge during the course of data collection and analyses in a continual process of interpreting and reinterpreting data. Moreover, the use of case study method enables researchers to find “interactivity” (Stake, 2005, p. 452) and connectedness between the individuals participating in case study while transferring the experiences of the participants to the reader through the development of a story or stories that describe the cases; or, as Stake (2005) suggests, description of “the case in sufficient descriptive narrative so that readers can experience these happenings vicariously and draw their own conclusions” (p. 450).

Integrating instrumental with intrinsic cases into collective case study can be a large task, however. Stake (1995) admits that researchers in the social and behavioral sciences might attempt to “serve too many audiences” (p. 135) when they combine the two methods. However, as Stake (2005) also notes, the use of multiple methods of case study can be viewed as a nonlinear approach to qualitative research:

There is no hard-and-fast line distinguishing intrinsic case study from instrumental, but rather a zone of combined purposes... I call this multiple case study or collective case study. It is instrumental study extended to several cases. Individual cases in the collection may or may not be known in advance to manifest some common characteristic. They may be similar or dissimilar, with redundancy and variety each important. They are chosen because it is believed that understanding them will lead to better understanding, and perhaps better theorizing, about a still larger collection of cases. (Stake, 2005, pp. 445-446).

Therefore, the use of these two methods in a fractal framework can be beneficial to qualitative researchers.

The generation of a fractal model of case study method draws from the theoretical framework of chaos and complexity theories. Expanding upon the works of Fournier d’Albe and Stoney (1907) on electro-magnetic theory, the iterative mathematics of Fatou (1906) and Julia (1918), and from Lévy (1948) on stochastics, Mandelbrot (1975, 2004) expanded his own work on economic theory to create visual representations of complex geometrical patterns in mathematics now known as Mandelbrot Sets. Important to this discovery are the bounded conditions of self-similarity between individual agents of a complex function viewed at the micro level in relation to the macro structure. Fractal images represent the simultaneous iteration of real with imaginary numbers, known as complex numbers. A fractal mathematical process contains two or more values--one representing the real and one representing the imaginary--while incorporating the use of a seed upon which each iterative calculation returns recursively until the computation either collapses or goes on into infinity. This use of complex mathematics reveals that, rather than the one dimensional linear points on a plane represented in Euclidian geometry, fractal iterations represent two dimensional iteratively created planes that are observable by the eye [See Figure 1] (Gribben, 2004; Mainzer, 2005; Mandelbrot, 1975). Moreover, this view of planes folding in on themselves in self-similar and attractor patterns is further understood in three dimensional images where each iteration adds further complexity to the full phase space of the image (Peitgen, Jürgens, & Saupe, 2004). Equally, the distance represented as height in a three dimensional view of a Mandelbrot set further explains the difference between one dimensional real numbers and two dimensional complex numbers.

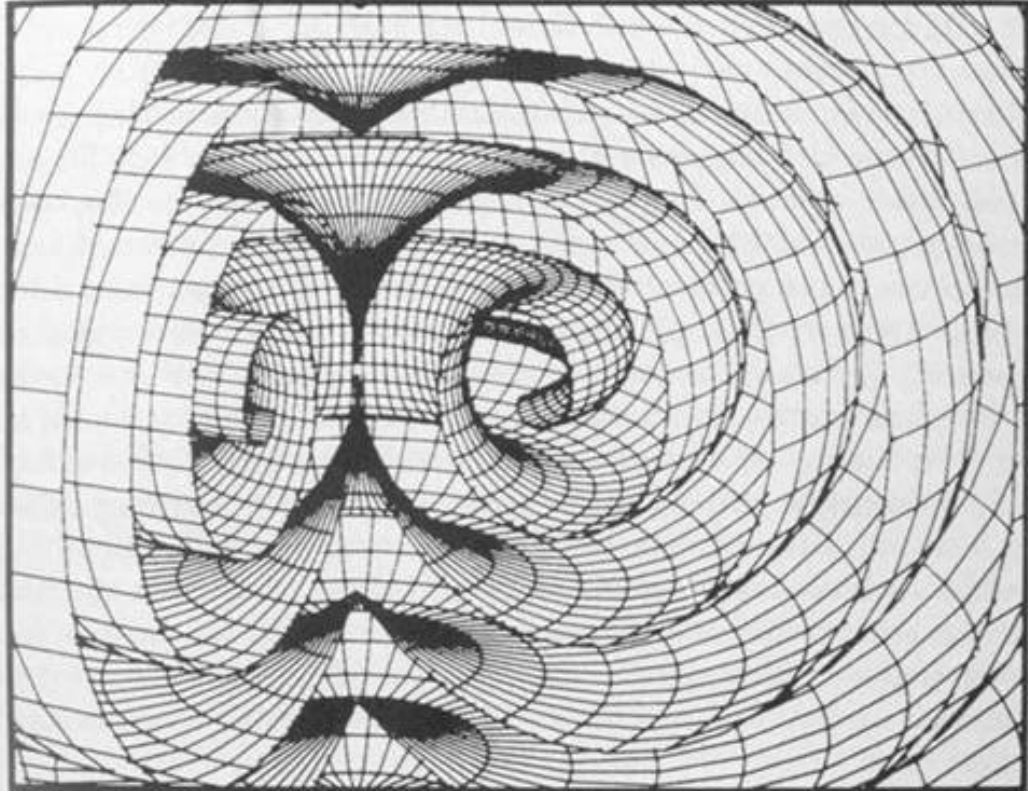


Figure 1 - Fractal Representation of Planar Space
http://www.quantumconsciousness.org/ultimatecomputing/ulti_files/image010.jpg

In Mandelbrot's (1975, 2004) view, the re-discovery of fractals provided a springboard for new types of experimentation in mathematics and subsequent re-analyses of how we view the world. While mathematics had been, for many years, subject to the empirical linearity of Euclidean geometry, Mandelbrot (2004) believed that fractal geometry provided mathematicians with the ability to begin to "see" mathematics in new ways.

Altogether, my lifetime scientific work rescued the verb "to see" from the figurative meaning to which both common usage and hard quantitative science had reduced it, and restored its concrete meaning, whose instrument is the eye... It suggests that a strong interest for mathematics is widespread among humans, but only if its links with nature and the eye are not actively suppressed, but, instead, brought out and celebrated. (Mandelbrot, 2004, pp. 3, 10).

As an example, what appeared originally to Julia (1918) and Fatou (1906) as Julia Sets disconnected from parent Mandelbrot Sets later was shown by Mandelbrot (1983, 2004) to be a reliance on specific variables chosen a priori in experimentation. By allowing the computations to choose their own course, the appearance of the connectedness of Julia and Mandelbrot sets emerged in visual representation. In some ways, Mandelbrot (2004) notes, this new, observable object forced mathematicians and other scientists to question discrepancies in empiricism, representing "a historical change and a return to a far less ideological view of their craft" (p. 36). Furthermore, the fractal nature of the Mandelbrot set yields the strange attractors found in chaotic and dissipative structures which have also been studied in organizational dynamics (Gilstrap, 2005; Gilstrap, 2007a).

Variance emerges in fractal systems in non-linear ways that can prove challenging to linear mathematical models. As is the case with the example of Julia sets, self-similarity takes on a paradoxical nature in that three-dimensional representations of fractal patterns reveal

simultaneous boundary conditions and unique internal attractor patterns. As Mainzer (2005) states, “the dynamics of a system converge neither to a fixed point nor to a closed curve but to a bounded region of a state space that is filled up by irregular and nonperiodic trajectories of self-similarity.” Furthermore, fractal images contain layers of complexity where the strange attractor pattern migrates from plane to plane rather than plot to plot (Gribbin, 2004). In effect, Mandelbrot sets reflect the associations of real, imaginary, and complex numbers found in Julia sets (Mainzer, 2005). This concept of *seeing* mathematics in new ways, therefore, extends a metaphorical, if not epistemological, framework for describing how humans interact in complex, scale independent, and self-similar ways in organizations.

The use of fractal representations has also been expanded to qualitative research in the social and behavioral sciences. Scholars such as Davis (2004, 2005) and Fleener (2002) have investigated the use of fractals to generate visual frameworks for understanding human dynamics. Davis (2005), as an example, has described the recursive process inherent in fractal patterns that emerge at both the micro and macro levels:

Fractal images are produced by establishing a rule, applying that rule to generate a result, reapplying the rule to that initial result, and continuously reapplying the rule to results as they are determined in an unending, reiterative process... fractal images don't get simpler when you magnify them, nor more complicated when you pull back from them. Said differently, there is a scale independence to complex phenomena... Closing in on any aspect of this web, or pulling back from the image, reveals another web that is similar in detail and form to this image. Each moment is a node, connecting and collecting a new weave of associations. There is no line joining birth to death. Rather, life is presented as a complex unfolding that is always renewed, always brimming with detail. (Davis, 2005, pp. 124-126).

In a similar manner, the instrumental case of the individual can represent the micro observation of the fractal's pattern. Each of these instrumental cases holds a unique pattern yet has self-similarity with other instrumental cases. When focusing on fractal geometry at the macro level, therefore, the intrinsic case of the organization emerges where this self-similarity is reflected throughout the fractal image.

As Davis (2004) has argued, fractal geometry provides us with a representation of both the intersubjective and the interobjective. Intersubjectivity is an epistemology of the social construction of reality, knowledge, and humanistic interpretivism. In Davis' (2004) view, intersubjectivity is largely a response to the ontology that truth and knowledge exist independent of the observer. In case studies similar to this research study, intersubjectivity in group dynamics can be describes as:

How a 'common' sense of the situation emerges among the participants while engaged in a cooperative activity in a work-like context... Thus, at various points of the cooperation, the participants must make adjustments that enable them to align their private views of the situation... In work-like environments, the co-construction of intersubjective space is as much about how the participants develop their *representational practice* to avoid jointly focused, sequential grounding interaction. (Alterman, 2008, p. 816).

Interobjectivity borrows from an ecological epistemology grounded in “mutually affective relationships between phenomena and knowledge of phenomena” (p. 101). Similar to the case of Mandelbrot's (2004) description of planar phase spaces, Davis (2004) contends that an interobjective philosophy does not espouse an observer-less truth, but rather seeks out qualitative spatial representations of interconnectedness. As is the case with this research study, the author projects observations of the fractal structure of the case of the individual and the organization in a coherent system of interrelationship. However, the methodological proclivities of scholars often place the intersubjective and interobjective in conflict with one another.

Likewise, the epistemologies of qualitative and quantitative research might even “weave between induction and deduction in an iterative process,” (Bruce, 2007, p. 52), similar to qualitative research on group dynamics where simultaneous emergence and reductionism are used to analyze phenomena (Gilstrap, 2007b). Davis (2004) therefore suggests that fractal geometry provides us with a framework for understanding how the two discourses can coexist while being philosophically contradictory and simultaneously complimentary in the iterative branching of methodological thought [See Figure 2].

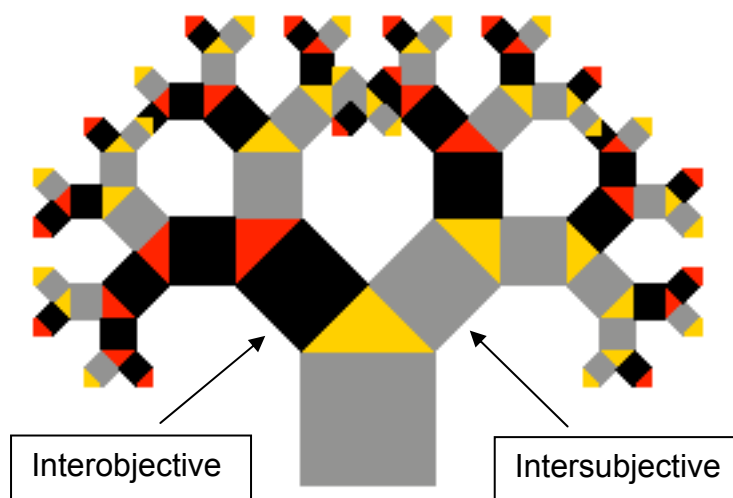


Figure 2 – Intersubjective and Interobjective Branching Discourses
 Adapted from <http://www.cevis.uni-bremen.de/fractals/index.html>

Expanding upon this use of fractal thinking, Peitgen, Jürgens, and Saupe (2004), provide great detail of the Sierpiński Gasket as a fractal representation of infinite recursion [See Figure 3]. The gasket starts with a three-dimensional, equilateral triangle. The center point of the bottom line of the triangle is used to form the top point of a new equilateral triangle within the original. Once this triangle has been formed, it is then removed from the original triangle. This process then repeats recursively with an infinite number of new triangles being formed with each iteration.

In the social and behavioral sciences, Fleener (2002) provides us with an example of the Sierpiński Triangle in explaining curriculum development [See Figure 3]. Fleener (2002) presents a visual representation of the interconnections of curriculum processes when interpreting Doll’s (1993): the Sierpiński Triangle shows the emergence of self-similarity in further definition through several subsequent iterative processes. By representing curriculum development with a fractal model, the metaphor generated reveals that curriculum processes can be simultaneous outcomes and developments. Likewise, Smitherman (2005) uses a fractal approach to curriculum development by introducing a fractal seed into preliminary classroom discussion to which she returns recursively as the conversations become more complex. In ways similar to these examples, a fractal case study method encourages a generative framework for understanding the cases of individuals, how they interact with each other, and how the instrumental case of the individual contributes to the intrinsic case of the organization.

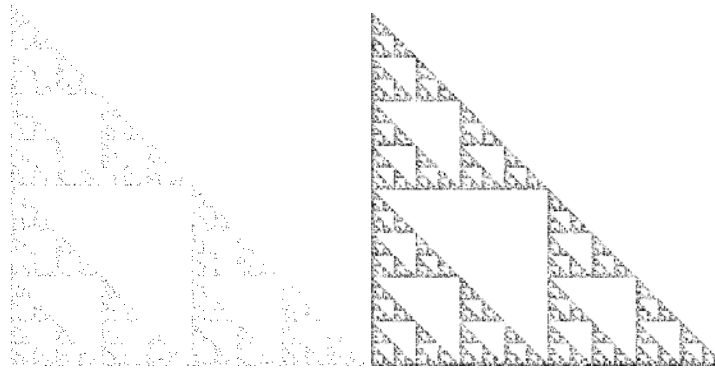


Figure 3 - Sierpiński Triangles

Method and Analysis

In qualitative case study research, Stake (2005) contends that the sampling of individuals should primarily be purposive. In this research, a study was conducted to investigate librarians' experiences with change at a large research library (Author, 2007 for blind review). Administrators at several research libraries were contacted to identify an institution that could exemplify the transformative change process. Based on their identification of particular institutions, a preliminary survey was sent to all librarians at a large research library, asking each to discuss their experiences with change in their library. Thirty librarians responded, approximately fifty percent, and seventeen librarians were then selected purposively for on site interviews based on the richness and depth of their responses. Since institutional review board policies prohibit disclosure of the institution and participants, further detail about the selection of the institution and participants cannot be provided in order to protect their anonymity. The term East Coast University (ECU) Libraries and the names of the participants, therefore, are pseudonyms used to refer to the organization and the individuals.

On site interviews consisted of a clustering technique and semi-structured interviews. The use of "clustering" was first introduced by Rico (1983) in creative writing, and the technique has been expanded for use in the social and behavioral sciences by Karpiak (2000). Participants were provided with a sheet of paper containing the phrase: "change in my library." They were then asked to write down short ideas or mental pictures they thought of while contemplating this phrase. The use of the clustering technique served as a method that allowed the participants to describe the first things that came into their minds [See Figure 4]. This researcher then allowed participants as much time as they needed to present their individual mental maps that surrounded the main phrase.

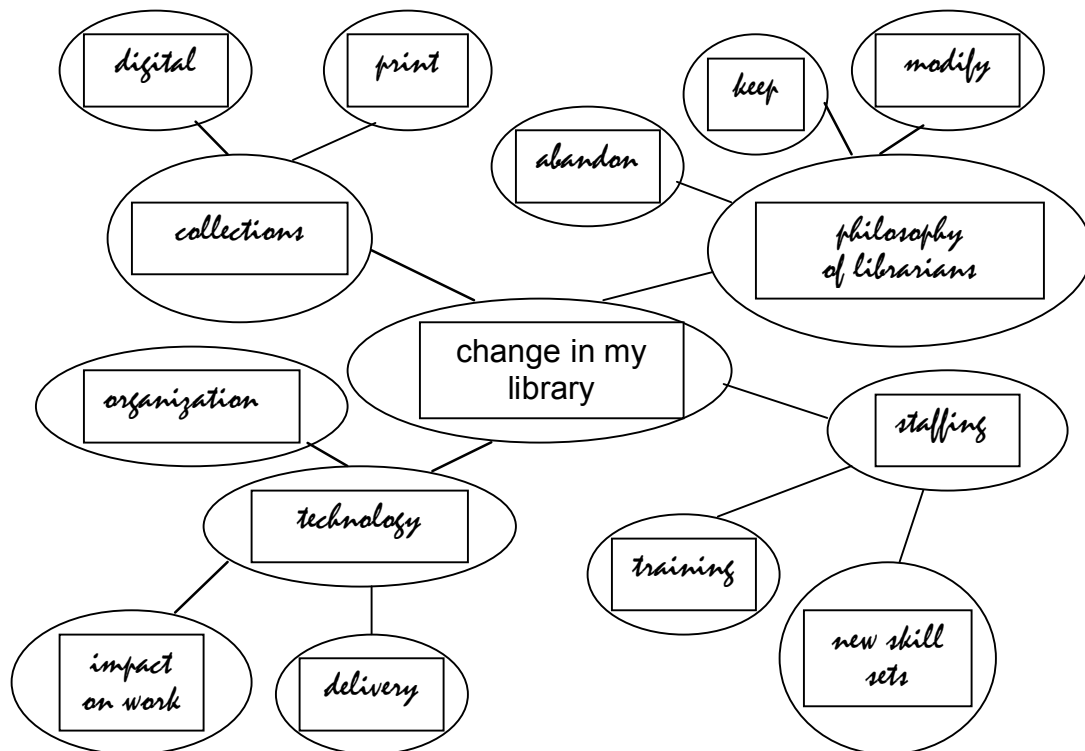


Figure 4 - Clustering Technique Used during Interviewing

After participants appeared to be finished with their clustering map, this researcher then turned on the audio recorder and asked the participant to describe what s/he was thinking about each of the concepts s/he had written down on the paper. The researcher encouraged the participants to go into as much detail about their thoughts and feelings regarding each cluster as each participant wished. When the participant felt s/he had responded sufficiently to each of the clusters, the researcher then asked the participant to provide a summary of his or her thoughts about the contents of the clusters. Participants were given as much time as they needed to describe the concepts they had written down which usually lasted around fifteen minutes.

After participants finished their clustering exercises, the researcher moved to the second portion of the interviews. Questions used for the semi-structured interviews were developed based on the main research questions for this study and were asked of each of the participants. Each interview lasted approximately 60-90 minutes. Consequently, the main questions from the structured template were used, but follow up questions of a semi-structured nature were also asked based on both the participant's and the interviewer's interpretations of the questions and responses that emerged during the interview. When participants felt they had answered all of the questions sufficiently, they were given an opportunity to add any other information to the interview.

Instrumental case studies were then coordinated through collective case method into a complex systems framework for intrinsic case study, looking at the interactions and connectedness of individuals operating within an organization (Stake, 1995, 2005). Since the instrumental case studies of each individual are woven into the fabric of the intrinsic case study, the use of the fractal case study method allowed for the voices of the participants to rise through the aggregation of data themes. While analyzing the data provided from these interviews, it is also important to note the role that the researcher plays in observation and interpretation of case study participants. As the work of Heisenberg (1944) showed in quantum theory, the role of the

observer influences that which is observed. Davis (2004) also expands upon this paradox in social and behavioral science research, noting that “observed and observer are not two forms separated by space. It’s more the converse” (p. 145). In like manner, the role this researcher plays in the analysis and interpretation of data collected from study participants suggests a shared space between the observer and the observed, much like the intricacies that emerge when seeing fractal geometry with the eye as Mandelbrot (2004) has suggested. This interconnection between the instrumental and intrinsic case studies provides a framework for the complex web of associations and patterns that emerge at both the individual and organizational levels. As Alterman (2008) suggests, “intersecting sets of internal representations cannot account for the commonality of the situation. Rather, the focus should be on the organization and flow of social interaction that *produces* a common understanding” (p. 817). In like ways, this view of multiple case study analyses reveals similarities between the fractal patterns in chaotic and complex systems and those inherent in the relationships of human experiences [See Figure 5].

The following image represents a fractal map of one theme that emerged during intrinsic case study analysis of the ECU Libraries as an organization. The findings of these instrumental case studies suggest that the experiences of individuals converge toward and diverge away from intrinsic case study themes in ways that are very similar to the chaotic structures associated with a fractal image. In the case of several instrumental case studies, for example, a reflection of similarities to a general theme of the intrinsic case is observed. At the same time, the experiences of any one individual under study contribute to characteristics that are unique to that instrumental case. As Stake (1995) notes in case study research, instrumental cases are used to help understand the emergence of other phenomena. The complexity of instrumental cases represented as fractal images at the micro level therefore emphasizes how both unique and interdependent relationships therefore contribute to the emergence of complex themes at the macro level of the intrinsic case.

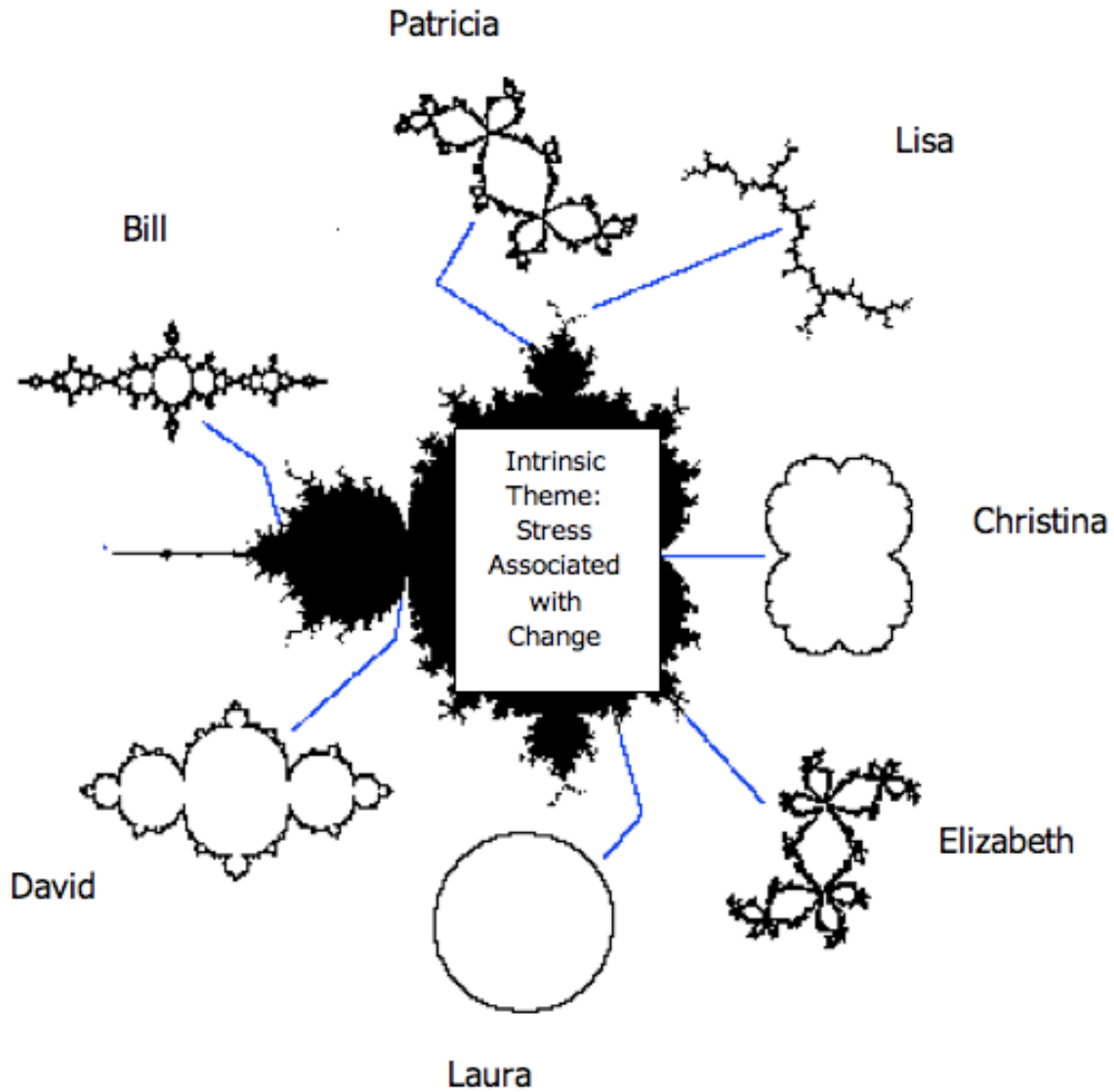


Figure 5 - Fractal Representation of Instrumental Case Studies as Julia Sets Relating to Mandelbrot Set of Intrinsic Case Study Theme

Adapted from <http://hypertextbook.com/chaos/>

Equally, when viewing these instrumental case studies through the lens of fractal geometry, analysis of data collected from interviews using the clustering technique shows how the development of themes at the individual level serves as an emergent quality of the themes generated for the intrinsic case study [See Figure 6].

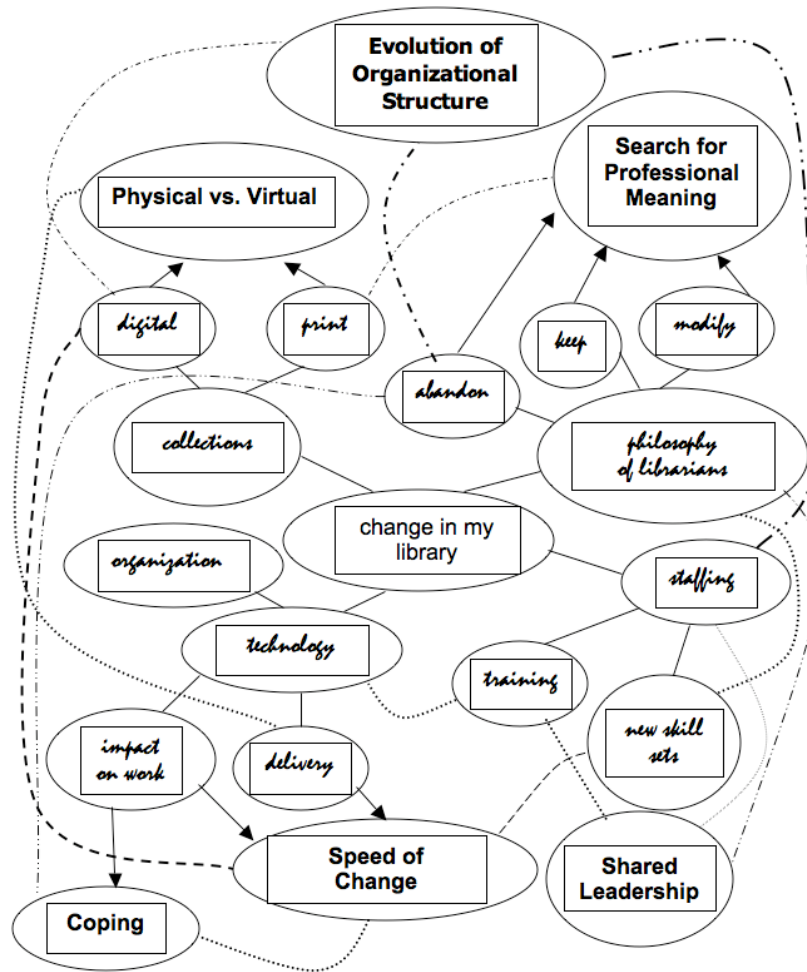


Figure 6 - Concept Map of Intrinsic Themes Emerging from Instrumental Case Clustering

Fractal Case Study Method: Instrumental Case Studies Integrating with an Intrinsic Case Study Theme

The following section provides a working example of how the fractal representation of the instrumental case studies can integrate into the intrinsic case study. As Denzin and Lincoln (2005) in qualitative research, Stake (1995, 2005) in case study research, and Davis (2004, 2005) and Doll (1993) in complexity science research have all addressed, richness in description is needed to capture the specificity, nuances, and interconnectedness of a particular research study. Although space in this article will not permit for the inclusion of this research study in its entirety, it is important to note that several additional instrumental case studies, as well as intrinsic case study themes, are included in the full research study.

There are two sections incorporated in the following pages. This first section details the analysis of data collected from the study’s participants during their interviews. Reinforcing that the clustering technique [See Figure 4] served as a fractal seed for generating emergent qualities of the semi-structured interviews, each case that follows is an instrumental case which helps to explain the individual and his or her connection to the intrinsic case of the organization [See

Figure 5]. Much like a playbill, the characters are introduced in order of appearance with short descriptions of the instrumental cases of the individuals. This provides a representative example of how the Julia sets which accompany the case are both filled in and bounded by the cases of each of these individuals. The instrumental cases are then used to understand the intrinsic case of the organization. The second section details the descriptions emerging from recursive analysis of the instrumental cases while generating themes used to encapsulate the intrinsic case of the organization. The Mandelbrot set provides a fractal representation of how these unique individuals provide self-similarity within the larger intrinsic case. This theme, in particular, focuses on how these individuals' experiences with change contribute to the overall stress within the larger far-from-equilibrium system.

Filled Julia Sets: Instrumental Case Studies of Individuals

The Case of Bill

Bill has worked as an administrator in the ECU Libraries for many years. He is nearing retirement, and he reflects on the significant changes that have taken place at the library over the past 15 years. Bill has been through both of the reorganizations at the ECU Libraries, and he provides a broad understanding of the decision-making processes and organizational structure of the library. He also recounts how business models are becoming more common place in research libraries, and, although he supports them, he questions their longevity in higher education. Bill is near retirement, and he focuses more deeply now on how he may be able to contribute to the future of the ECU Libraries by enabling staff in his area to move forward after he is gone.

The Case of Patricia

Patricia has worked for the ECU Libraries for many years and most recently has served as an administrator in a technical area. Patricia is deeply committed to the educational mission of the university and in guiding the people in her area toward positive professional growth. She sometimes questions whether the future of librarianship is certain, however. Patricia consequently encourages all librarians working in research libraries to step back from their everyday routines and find ways to implement change that is concurrent with the shifts in higher education practices.

The Case of David

David has worked at the ECU Libraries for many years and now serves in an administrative capacity in a technical area. He is nearing retirement and questions whether research libraries are evolving and adapting fast enough to survive the future of the twenty-first century. David reflects critically on the profession and the changes that have taken place at his own library, searching for much deeper meaning associated with change and his connection to his life's work.

The Case of Lisa

Lisa is still in the beginning stages of her career and has been with the ECU Libraries for only a short time. However, she brings a great wealth of knowledge and experience, having worked at other academic libraries while currently working as one of the library's administrators. Lisa was not employed at ECU during the first major organizational restructuring and does not comment on this experience, but she identifies herself as one of the people who actively promotes change within the ECU Libraries. However, she struggles with the stress brought on by the rapidity of change in her library and recognizes this symptom in her other colleagues.

The Case of Elizabeth

Elizabeth is new to the profession of academic librarianship and new to the ECU libraries. Her primary responsibility is working in an educational capacity, and she brings a wealth of external professional experiences, having served as an educator before changing careers. Elizabeth encourages further change to take place at the ECU Libraries and challenges professional thinking among all academic librarians who hold on to traditional ideologies that primarily protect and force people to use books. She fears a future where librarians do not advocate for a futuristic role of librarianship. She also predicts that if librarians do not confront these philosophical issues at an individual level, the profession may be reduced to a servile technical role or become obsolete altogether.

The Case of Laura

Laura is a mid-career librarian who has in recent years come to ECU to serve as a manager in a public service area. She is an advocate for incorporating technologies that reflect contemporary practices in society. Additionally, her experiences in other libraries and in her participation in professional groups leads her to question whether organizations like the ECU Libraries, which are instituting transformational changes, are anomalies in the larger scale of research libraries. Since she is many years away from retirement, she fears that the traditional practices engrained in the profession at large will lead to a bleak future for librarians.

The Case of Christina

Christina is relatively new to the ECU Libraries. Although she primarily serves the library in an educational role, her previous experiences in technology development have also been utilized by the library. Christina has little tolerance for the traditional practices of the profession and strongly encourages librarians to continue to make the shift to a completely electronic environment. She has a strong desire to focus on competencies in the workplace and learn new skills. Christina provides the ECU Libraries with mechanisms for positive feedback in her continual challenges to traditional librarianship.

Intrinsic Case Study Theme and the Mandelbrot Set: Stress Associated with Change

The concept of stress associated with rapid change causes the librarians at ECU to respond with different types of emotions. Some grow despondent, others look for opportunities within the change process, and still others find particular coping methods that work best for their individual experiences. Many librarians identify with the stress that comes as a result of constant change. Librarians worry that they are not keeping up with the needed technological shifts, because there are so many skill sets required to manage hi-tech research libraries. And this angst is exacerbated if a person does not have enough knowledge to assist in decision-making or to make the correct decisions. Bill, who has worked with the conversion of print to digital resources for many years, notes for example, “it’s overwhelming in some ways--it’s often like you’re running to catch up.” As a result, librarians rely more on the collection of people with different knowledge and skill sets to make recommendations that will influence individual decision-making. Patricia, who oversees a technical services unit, expands on this example, noting that she has learned to delegate more responsibility for decision-making to her staff while relying on them to provide her with information. By letting go of control as an administrator, this process not only lowers her own stress, but her staff generally come back with more information, adding value to the decision-making process.

An overwhelming sense of stress associated with the volume of change at the ECU Libraries also takes place in the organization. Librarians comment that the amount of scenarios upon which decisions can be made are far more now than there were just a few years ago. As an example, Lisa, who oversees work in a public services area, states that she feels an increased amount of anxiety that goes along with determining whether you have made the correct decision:

It's like you're constantly searching the landscape to make sure there isn't something else ahead of you that you need to be on top of. And for me, I get over 100 email messages a day, and a lot of people have demands on my time and attention. It is hard to keep up with that. At what point do you say, "we're kind of maxed out on what we can do?"

As another example, librarians recognize emotional responses similar to these among staff whose tasks are no longer valued. This increases their own stress, because they realize that these changes must be made to maintain the relevance of the library to the university community.

Sometimes these emotional responses can be accompanied by feelings of despair. As an example, Elizabeth, who works in educating students about changing library resources, states that the stress associated with competition with the private sector leads her to feelings of hopelessness in her ability to keep up:

I think our library has been having to face how difficult it is just to stay in the present--not able to get ahead--just keeping things on. Because library users just do not understand and have absolutely no sympathy for things not working.

When a computer quits working, users must wonder why someone just does not simply replace it with a new one. Moreover, library users have little sympathy for system failures and network bottlenecks, and they do not understand what goes on behind the scenes to make all this technology work in research libraries. And as Elizabeth comments, in a research library there probably should be little sympathy.

Technology, conversely, can be viewed as contributing to increased productivity in the workplace. Many librarians at ECU comment that technology has enabled them to increase the volume of work they oversee on a daily basis. But some librarians question if this productivity can sometimes actually be unhealthy for a sustained career in research libraries. As an example Laura, who oversees a large public services unit, states that, "pretty much from the moment I step through the door to the moment I go home, it's non-stop." Moreover, librarians are also finding that the lines between their professional and personal lives have significantly blurred due to the technology they use. Since ECU librarians have access from their homes to all the technology they use at work, several joke that finding enough time to sleep is now becoming more problematic.

Many librarians characterize the ECU Libraries as "non-stop" work and also identify the resulting stress in less positive ways. They note that their typical day starts when they hit the door and does not let up until they leave. Some librarians comment that the work of teams also takes up a large portion of time when they could be working on individual projects.

Additionally, librarians identify that the stress in their work lives spills over into their private lives where they must sometimes juggle between family and work. As an example, Christina, who works in an educational capacity, states that her commute to work intensifies this stress, as she has to be away from her children for longer periods during the day. She jokes about these high levels of stress, stating, "you might as well take up smoking, you know?"

The experiences of other librarians also supports the constancy of stress brought on by working at the ECU Libraries. Librarians comment that the stress brought on by so many changes can be exhausting. Moreover, they are not sure that the university has mechanisms in place to allow librarians to relax periodically and use creativity serendipitously to stumble upon solutions. David, as an example, is coming closer to retirement which causes him to reflect on

how tiring all of the changes have been. And he highlights a key theme that can perhaps be attributed to the stress associated with research libraries in general which pertains to support of both a print and a virtual environment:

I find myself getting exhausted by it all; by the constant uphill battle with it. It became obvious to me a long time ago that it wasn't going to be either a brick *or* a byte library, but it was going to be a brick *and* a byte library... And we were going to have to maintain them both with the same amount or less staff. The same or less budget. Quite frankly... it burns you out after a while.

Conclusion

This article is intended to describe the use of fractal case study method to understand individuals and their connection to their organization. In some ways the fractal case study method described might reflect narrative inquiry in its rich description of individual, instrumental cases. Likewise, the generation of themes for the intrinsic case might resemble similar methods used in phenomenological research. But rather than copying commonly used methods, much like Davis' (2004) discussion of intersubjective and interobjective discourses, fractal case study method extends narrative inquiry and phenomenology in that it provides for interconnectivity and interrelationships between instrumental and intrinsic cases. Equally, as Davis, Sumara, and Luce-Kapler (2000) have argued, fractal geometry provides many advantages for looking at social and behavioral science research through the lens of self-similarity. "Each layer or body can be simultaneously seen as a whole, a part of a whole, or as a complex compilation of smaller wholes" (p. 73). In the previous cases, the fractal case study method reflects this self-similarity in that each instrumental case study of the individual can encapsulate that individual intrinsically, instrumentally in his or her connection to others, and collectively in the development of the intrinsic case of the organization.

As Davis (2004) describes, the fractal geometry of social and behavioral sciences research is not intended to be an exact science. In like form, the fractal representation of case study method cannot reflect in exact manners those forms generated by computer simulated models. In the human and behavioral sciences, recursive analyses generated by a fractal seed cannot, in most cases, eventually collapse in on themselves as is the case with complex numbers in Mandelbrot set construction (Peitgen, Jürgens, & Saupe, 2004). Likewise, as Gribbin describes with the human body:

Of course, the analogy breaks down at the extremes. Systems within the human kidney do not actually branch infinitely many times, just very many times; and going in the other direction, we do not find kidneys embedded with superkidneys, and so on forever, but that each system is self-contained. Nevertheless, the similarity between many living systems and fractals is more than merely an analogy... Near-fractal self-similarity is a pervasive feature of the bodies of living organisms. (Gribbin, 2004, pp. 108).

Further discussion is also needed to explore the connections between qualitative research and such fractal issues as prisoner sets, imaginary numbers, and planar spaces (Mainzer, 2005; Mandelbrot, 1983, 2004; Peitgen, Jürgens, & Saupe, 2004). And in the social and behavioral sciences, this might even traverse time-space parameters in the study of the imaginary (Korth, 2007). At the same time, however, we know that fractal models exist in nature without collapsing in on themselves or dissolving, as is the case with Cantor sets. It is also known that multi-fractal models do exist in mathematics but still have yet to be represented in three-dimensional form due to their immense complexity (Mandelbrot, 2004; Peitgen, Jürgens, & Saupe, 2004). In like manner, the possibilities of exploring multi-dimensional fractals created from numerous seeds might present a more complex perspective of qualitative research. In addition to the use of fractal geometry to develop case study methods, these concepts generate

great potential for further research on the human as a fractal geometry of nature, as well as his/her connection with others and with the world in fractal form.

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