DRS2016
Design + Research + Society
Future-Focused Thinking

2016 Design Research Society
50th Anniversary Conference
27-30 June 2016, Brighton, UK

Blending Hard and Soft Design via Thematic Analysis

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Abstract: As the world becomes increasingly complex, from both a technological perspective and a sociocultural perspective, we need to adapt our problem solving and design capacity to match these changes. This paper will compare aspects of TRIZ and the emergent Frame Creation methodology as examples of design-based problem solving methodologies for resolving technical and sociocultural problems. We argue that while on the surface TRIZ and Frame Creation merely appear to diverge, a close analysis reveals noteworthy similarities, such as the drawing upon core attributes of the problem situation and building up a solution frame from first principles. We then introduce the latent thematic analysis methodology as a common ground that can lead to a possible blending of the two.

Keywords: Technological Change; Frame Creation; TRIZ; Latent Thematic Analysis

1. Introduction

As time moves forward literature surrounding technological change suggests technology is increasing at an exponential rate. Indeed Kurzweil (2005) notes the acceleration of the pace and exponential growth of the products of a technological evolutionary process exceeds Moore's law. Schmidt (2008) notes much of our past has been shaped by a number of complex convergences, and that in a real sense complex converged technologies do not exist in isolation, but in a complex socio-cultural context. Indeed, the literature discussing technological change makes it clear the increasing rate of technological change is not just about the technologies and patents, it is closely related to a number of other issues advancing at a similar rate [See for example: Girifalco (1991); Karamchedu (2005); Porter (1980)]. These include: Economic – Psychological – Institutional/ Political – Social – Technological – Legal – Environmental – issues [in short, the acronym = EPISTLE]. We contend that these larger socio-cultural EPISTLE issues must be embedded in the design

processes of our future designers and engineers. Designing purely from a technical /functional perspective alone is going to be a thing of the past.

If designers are to cope with complexity in the future we need to understand the "underlying structure" of the newly emerging problems associated with technological change. In the past designers have focused on what Checkland (2000) describes as hard systems thinking in contrast to soft systems thinking. In terms of systems thinking theories, these are seen as two distinct philosophical perspectives of thought. In the future hard and soft systems thinking will need to be integrated. It will be important to embed both these types of thinking within our future design thinking processes. We can ill afford to maintain two distinctly different philosophical perspectives if we are to address the exponentially increasing complexity of the design problems facing us.

In short, how we learn to cope with our future problems is now a problem in itself.

The design literature suggests that design problems are often ill-defined and ill-structured [See: Buchanan (1995); Kunz and Rittel (1970); Rittel and Weber (1973)]. This suggests a perplexing conundrum for us as designers in the future:

Conundrum = If technological change increases problem complexity exponentially, we need to find the "underlying structures" that allow us to get the problem complexity somewhat under control. But how may we find structure in the ill-structured?

Fundamentally, the conundrum above remains irrespective if the problems were of a technological nature, or a sociocultural nature.

In this paper we will discuss various aspects of this conundrum. Section 2 explores various common aspects in relation to Emergent Patterns/Themes found within the TRIZ methodology, and provides a brief historical background. Following on from this, in Section 3, we discuss various Emergent Patterns/Themes in relation to the Frame Creation methodology. Given the different benefits emanating from Section 2, in relation to a methodology which holds great utility for resolving technical problems, and Section 3, in relation to a methodology which holds great utility for resolving socio-cultural problems, Section 4 will discuss what we see are common aspects of the two methodologies and indicate how a third methodology [Thematic Analysis] may be seen as a bridging methodology between the two.

2. Emergent Patterns/Themes and TRIZ

As suggested earlier, technology is advancing at an exponential rate. Notwithstanding this, the TRIZ design methodology has stood the test of time. The early development of TRIZ is attributed to Genrich Altshuller who in the late 1940's began its development. His pioneering work related to developing an understanding of how engineered systems have evolved since the origin of mankind. Emerging from his theoretical studies was his work known as **Patterns of Evolution of Technological Systems**.

At its core TRIZ is grounded on technological growth patterns emerging from a careful analysis of inventions and patents. What is more, it was based on the realisation that successful solutions to problems resulted from the resolution of contradictions. From here he further developed the TRIZ model noting that most problems are complex and systemic in nature. Moreover, Altshuller stated that the initial problem [problem as given] could be related to larger more complex systems, which may be broken down and related to sub-systems, and sub-sub systems. In a real sense the problem-as-given is part of a complex network of issues. Hence, it is important to note he was of the view that despite the existence of contradictions one should strive for an ideal solution [despite the fact one may never get there]. In terms of product development the product should: cost nothing, be made from nothing, use no energy, use no resources, not cause any harm, takes up no space, require no assembly, take no time to make etc…. These basic core precepts as discussed in Altshuller (1997) formed the foundations of ARIZ, the precursor to TRIZ. This laid the groundwork for the TRIZ tools in use today.

The above notwithstanding, as discussed in Altshuller (1999), in 1985 / 1986 his research focus shifted to the area of creativity, diverging from the area of technology. It was around this time Altshuller concluded the technological tools for solving inventive problems did not need to be improved much further since its application had been tested on thousands of real problems and proven to be effective. Hence he now considered further evolution of the "Theory of Technical Systems Evolution" as a major step towards a **"General Theory of Powerful Thinking"**. Consequently, Altshuller switched his attention away from developing technical TRIZ to studying creative thinking. Indeed, as discussed in Altshuller and Vertkin, (1994), they studied a vast number of biographies of outstanding creative people and started developing a "Theory of Creative Personality Development" (abbreviated TRTL in Russian).

According to Orloff (2006) TRIZ is a qualitative theory, not a mathematical or quantitative one. In essence, as suggested by the later work of Altshuller, TRIZ is heavily reliant upon the thought processes of an individual. At first blush the notion of TRIZ being person dependant may appear counterintuitive as much of the TRIZ literature has a technical and engineering focus. When introducing the TRIZ methodology Orloff (2006) argues the theory's formal ideas and concepts are like categories, patterns, and metaphors. Hence, TRIZ is a conceptual, phenomenological, and finally a psychological theory.

Fundamentally a person selects and transforms information, constructs hypotheses, and makes decisions, relying on a cognitive structure to do so. Cognitive structure (i.e., schema, mental models) provides meaning and organization to experiences and allows the individual to "go beyond the information given", in our case here the "the brief as given". Constructivism relies on the notion of 'Buildable' bodies of knowledge. Each person brings to the situation/problem, a previous pattern of experience which they endeavour to map into a current experience, situation or context. In essence the user constructs new knowledge based on previous knowledge.

Once a person has gained an understanding of the fundamentals of an area, learning transference can more easily occur when they are presented with new and novel information [or a new design]. An understanding of a context, product, or problem does not occur sui generis. It occurs based on previous understandings, experiences, and associations (Orloff ,2006). We need to determine how we can find the appropriate transformations in new situations in order to use them for a new task, as a pattern or model for the search for solutions. If we use a special transformation model (like TRIZ) so that patterns are questioned and analogues for the development of solutions are made using associations and analogies, this will enrich our ability to solve complex problems.

As indicated earlier, when introducing the TRIZ methodology Orloff (2006) argues the theory's formal ideas and concepts are like categories, patterns, and metaphors. In an increasingly complex future, designers will need to use tools to both model and "navigate" through various complex competing issues directing their thinking towards a complex goal. Indeed this resonates within much of the TRIZ literature [See: Rantanen and Domb (2002); Savransky (2000); Orloff (2006); Altshuller (1997)]. Moreover, as discussed in Rantanen and Domb (2002), over time ARIZ evolved to TRIZ, which at its core moves through 5 basic phase states as in figure 1 below.

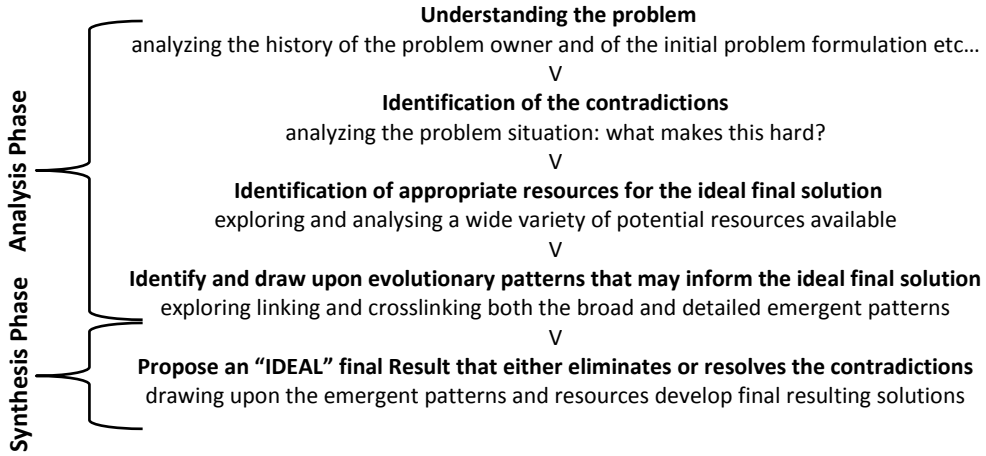


Figure 1 The five basic phases of the "TRIZ" model

At its core the TRIZ methodology has two major phases, analysis and synthesis [see Figure 1 above]. Moreover, it is a deliberate approach to changing both understanding a problem and problem situation, then changing it. In order to evolve TRIZ theories over time, extensive modeling, trials and tests were necessary in order to move towards a fully evolved methodology.

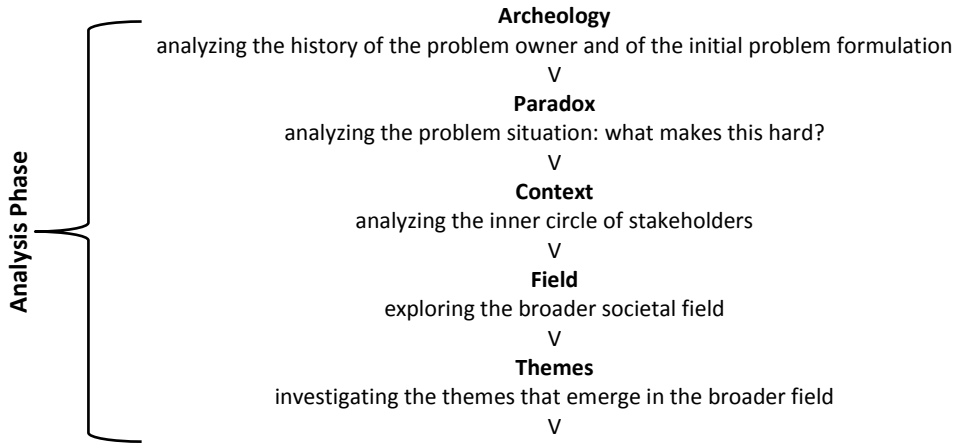
3. Emergent Patterns/Themes and Frame Creation

As with the TRIZ methodology, at the core of the Frame Creation process is a complex movement of zooming out and first considering the problem itself within the immediate context, and then on to the wider context of other important interrelated issues that need to be incorporated in the problem situation. Like phase one of the TRIZ methodology, the

key principle of Frame Creation lies in its deliberate approach to changing both ones understanding a problem and the problem situation. As suggested earlier, problems often cannot be solved directly, at least not as given. All problems and their associated formulations have their roots in a specific context. This context needs to be critically appraised and then altered before the problem itself can be attacked. Frame Creation teases out the history and assumptions behind the rationalities that have led to the original problem formulation. In a sense the problem as given is "Transformed" into something "New". Given the above, this begs the question, how does one open up new avenues of thought, critically analyse, and challenge assumptions mired in historical precedent. We assert it is the fixedness of frames of persons within organisations that cause the perception of being stalled within the entrenched normative frames of reference.

In order to shift from normative frames of reference, expert designers use nine phases as shown in figure 2 below [see: (Dorst, 2015) for an extensive description of this Frame Creation model]. A careful review of the "Frame Creation" reveals that while there are nine phases, these may be notionally characterised as having two major phases, analysis and synthesis [see Figure 2 below]. While these phases appear to be consistent with Lawson (2006), within the context of this paper we will focus on various aspects of the analysis phase. More specifically we are concerned here with the emergence and analysis of themes to facilitate the development of transformative ideas and approaches ("Frames").

From a TRIZ perspective this relates to the need for developing an understanding of where and how the problem is situated within both larger systems and associated sub-systems. As in TRIZ, in "Frame Creation" it is argued we must expand our horizon to the broader field (in Engineering terms: changing the system border). Then we establish common Themes, and from these we create new Frames for the problem situation, which then lead to proposed actions ('Futures') that can be appraised critically. Hence, it is recommended to formally map out the required transformations in the stakeholder organizations help to judge the proposed approaches on their realism.



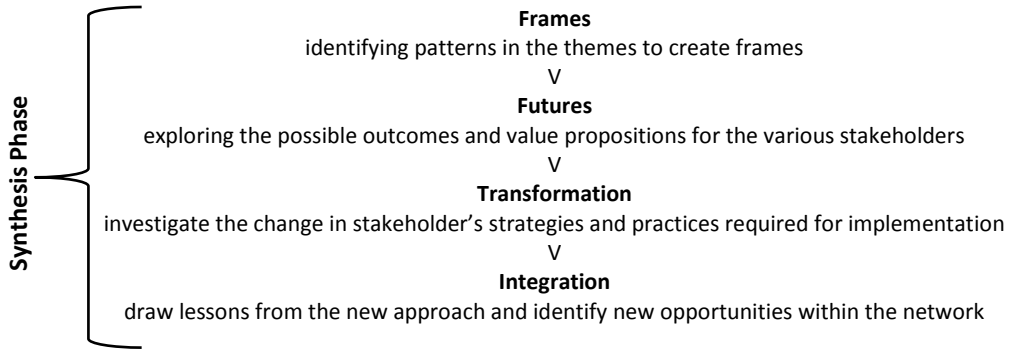


Figure 2 The nine phases of the "Frame Creation" model

As our focus here is squarely on the analysis phase it makes sense that we discuss, in general terms, the characteristics of the first five finer phase states of the "Frame Creation" model [Archeology; Paradox; Context; Field; Themes]. These phases lead to the development of new frames. As suggested earlier if we are to understand the "problem as given" we need to "dig" into its background. Given archeology deals with past/present human life, and their associated activities by studying the material worlds they inhabit, one can examine the history of the problem owner and of the initial problem formulation. This pursuit for understanding socio-cultural aspects of human nature has parallels in the TRIZ methodology where developing an understanding of where and how the technical problems are situated within both larger systems and associated sub-systems is equally important. Given both the socio-cultural and techno-physical aspects of any problem are important, understanding their pattern of associations is equally important. Consequently, these associations need to be formally mapped out and externalised.

Once the problem and their pattern of associations has been carefully developed and analysed, it is important to understand that all problems contain perplexing conundrums, contradictions, or paradoxes. In general, irrespective of the detailed nature of the problem there is a lead question. The lead question is: what makes this problem hard to solve? We need to identify both the trade-off contradictions and the inherent contradictions. These paradoxes do not exist in a vacuum, they exist in a context. Hence it is important to shift the problem situation by first studying the core group of stakeholders that is very close to the problem situation. Mapping and understanding the relationships between these stakeholders is of extreme importance. By then also mapping the broader field of both problem specifics and the players we concentrate on the EPISTLE issues, stakeholder interests, values, and the frames of reference that could push the problem in a new direction. Some deeper patterns began to emerge, where shared "underlying structures" can lead to new solutions. Through this in-depth 'creative analysis' of the broader field, common themes emerge that can shift the original paradox. This in turn will underpin the solution that will address the future EPISTLE issues discussed. By investigating the themes that emerge in the broader field this in turn leads to the development of new frames.

4. Triad of Methodologies: A common Theme

The central issue for design in the 21st century relates to the finding of emergent themes / patterns in complex and ill-structured problem situations. Where may we find methodologies to support us?

We argue that both TRIZ (on the technological side) and Frame Creation (on the human-centered side) share valuable common characteristics. Both TRIZ and Frame Creation rely on the development, mapping, and analysis of clear emergent themes and patterns in relation complex problems, sub-problems, issues, and data emerging from the complex EPISTLE issues as we move into the future. Themes could also be the "bridging" tool between the two methodologies [as suggested in figure 3 below] – but then they are defined slightly differently in TRIZ and Frame Creation. If Themes and Thematic Analysis are emerging as such an important key concept in our quest to create an integrated design methodology, we need a much clearer understanding of what Themes are, and how Thematic Analysis works. Our understanding needs to be uncoloured (untainted) by the preconceptions that come from the Technical or Social domain.

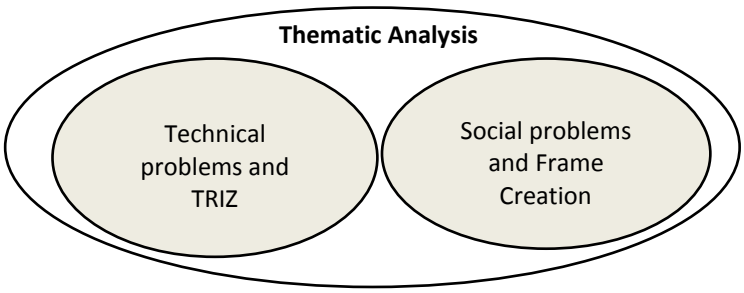


Figure 3 Thematic Analysis as a Bridging tool to help solve Future Socio-Cultural and Techno-Physical problems and issues.

We turn to the domain of social science (specifically, recent developments that link into psychology, building on earlier theories in Semantics) to introduce a third methodology, specifically aimed at the finding/emergence or creation of themes, that could be used to start creating the bridge between TRIZ and Frame Creation. A critical review of the psychology literature surrounding Latent Thematic Analysis (Braun and Clarke, 2006) reveals that while this methodology is predominately used in areas relating to socio-cultural research [psychology, sociology, anthropology, hermeneutics, etc…] it may be utilised to shed light on the nature of the Themes emerging from the TRIZ methodology, as well as with the socio-cultural Themes that emerge in applying the Frame Creation methodology.

Braun and Clarke (2006) advocate Latent Thematic Analysis as a useful and flexible method for qualitative research beyond its source discipline, psychology. They also suggest there are six basic and core phases in thematic analysis, as indicated in Figure 4 below:

Familiarizing yourself with your data
Transcribing data, reading and re-reading the data, noting down initial ideas
V
Generating initial codes
Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code
V
Searching for themes
Collating codes into potential themes, gathering all data relevant to each potential theme
V
Reviewing themes
Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis
V
Defining and naming themes
Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme
V
Producing the report
The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis

Figure 4 The Six basic phases typical of Latent Thematic Analysis

Some may argue semantic analysis may be appropriate as a bridging tool. However, when comparing and contrasting semantic analysis and latent thematic analysis, in general the semantic approach relates to a specific question or area of interest within the data, whereas latent thematic analysis seeks to identify particular 'latent' themes across the whole or majority of the data set. Moreover, with a semantic approach themes are identified at a rather superficial level. It is argued this is of little help to the design thinking process as the themes are identified within the explicit or surface meanings of the data. Fundamentally, as designers move towards an ever increasingly complex future, with the semantic approach they would not be looking for anything beyond what is explicit in the data set, be it the technical aspects of the data or socio-cultural aspects. Accordingly Patton (1990) indicates ideally, the analytic process should involve a progression from description. That is to say the data should not simply be organized to show patterns in semantic content, and summarized.

It is argued semantic analysis is of little help to the design thinking process as the themes are identified within the explicit or surface meanings of the data. In using latent thematic analysis, the development of the themes themselves involve interpretative work, and the analysis that is produced is not just a description, but is theorized and extends the ideas inherent in the data. There is a need to move to interpretation, endeavouring to theorize the significance of the patterns and their broader meanings and implications. As latent thematic analysis moves beyond the semantic content of the data, it starts to identify or examine the underlying ideas, assumptions, and conceptualizations / and ideologies / that are theorized as shaping or informing the simplistic semantic content of the data. Hence, we contend that latent thematic analysis as a design tool brings depth and indeed rigour to the design process as we confront technological change. Latent Thematic analysis starts to identify or examine the underlying ideas, assumptions, and conceptualizations that are theorized. It

shapes the simplistic semantic content of the data/information. Thus future designers are able to capture and map the more nuanced possibilities spanning both the socio-cultural and techno-physical issues while moving through the design process.

In order to express how we may adopt, adapt, and extend the six phases above to seven phases, they may be envisaged in a design context. We propose the following very simplistic exemplar: 3D printing and Additive Manufacturing [AM] in emerging nations.

> Let us say we are given the task of assisting a developing country in evolving their capacity to leverage their workforce in taking advantage of the growth in 3D printing and additive manufacturing. As they do not have a large technically skilled workforce they need to rely on the project team to creatively address the large number of interrelated systemic issues/problems associated with this problem task. In phase 1.), we may generate and code topic titles/issues/nodes emerging from this problem space. We could start to do things like list varieties of additive manufacturing technologies, lists of surrounding technologies involved, various human resources involved, industries, products and services [direct and indirect], educational requirements, power requirements, costs of start-up, physical and environmental issues, legal issues, the politics of local infrastructure issues, materials for manufacture, skill levels of existing workforce, natural resources available, etc… etc…. Once we have done this we turn our attention to phase 2.) Generating and coding Creative linkages / connections /relationships between topic nodes, ensuring both socio-cultural and techno-physical topics are linked and cross linked. Given some of the nodes listed in phase 1, we may make some links as follows: we may make a connection/relationship between the skill level and the local workforce developing surrounding technologies may or may not easily adapt to the technologies in relation to additive manufacturing [techno-physical link]. Hence the politics of local infrastructure may or may not need to reshape local educational curricula to prepare a new workforce [socio-cultural link]. Additionally, additive manufacturing requires various technical materials which have a relationship/link to the different specific technical manufacturing processes [techno-physical link]. Moreover, we may link materials for manufacture with both natural resources available in the local area and physical environmental issues. Etcetera… Given this illustrated network of links and nodal connections, we may move to phase 3.) Identifying, clustering, and codifying related latent thematic linkages and cross linkages. We may group the relationships and technical issues surrounding old manufacturing available with the new technologies. The nature of the necessary mergers force new local educational strategies to emerge. Once we have related latent thematic linkages and cross linkages, we may move on to phase 4.) Identify, frame, and name large and small latent thematic clusters - generating clear definitions and names for each cluster / theme [Themes such as: technology education; merging existing and new technologies; environmentally sustainable material issues, etc…]. Then we may move to phase 5.) Explore and Reshape large and small latent thematic clusters – actively seeking different stories and frames. This phase offers the opportunity to find common aspects both between and among themes and clusters of "mapped" issues. Given some of the themes will converge and others will diverge in phase 6.), the ordering, listing, and ranking of the different thematic briefing directions and potential new project directions offers an opportunity to better structure the themes for the purposes of clarity. This in turn assists in the progression to phase 7.), formally

> reporting different briefing and project directions. This is a final opportunity for analysis while presenting a wide selection of vivid, compelling extracted examples. Additionally, the report offers an opportunity for a final analysis of selected extracts, and innovative well considered projects / briefs and directions.

Given the above it makes sense to turn our attention to comparing and contrasting what is considered the "Typical" six Latent Thematic phases with proposed "Design" Latent Thematic Phases. In reviewing the example above it should be noted we have both added an additional phase and brought forward the "naming" phase in the process. That is to say the typical phase 5 is brought up to phase 4 in the design context. Additionally, when reviewing the similarities and differences, data and design problem information flows are acquired, generated, and then "mapped" in the case of design. Conversely, "typical" latent thematic phases rely on transcribing data. By using latent thematic analysis, the development of the themes, technology education; merging existing and new technologies; environmentally sustainable material issues involves interpretative work, and the analysis that is produced is not just a description, but is theorized and extends the ideas inherent in the problem space. Latent Thematic analysis starts to identify or examine the underlying ideas, assumptions, and conceptualizations that are theorized in a designerly way. It both informs and indeed shapes the simplistic semantic content of the data/information. We see the adapted latent thematic phases as a starting point to evolve a more considered and developed methodology in the future. It is anticipated this more evolved methodology will span both the socio-cultural and techno-physical issues while moving through the design process in the future.

5. Conclusion

Here we are advocating that latent thematic analysis will be a useful and flexible method for helping future designers learn to cope with looming technological change issues facing them. We argue the synergies in these methodologies will assist in developing an underlying structure in the complexity of problems. In brief, thematic analysis involves searching across information, data, ideas, contexts, and creative concepts to find what is embedded / hidden in the repeated patterns of meaning. In essence it is the search for what lies beneath the surface. It is imperative future designers be able to step outside of the ways of thinking embodied in their original value systems and nuanced technical details in order to frame the design situation in a new way, moving away from the manner it was initially phrased and presented.

A review of the literature surrounding latent thematic analysis revealed it could bridge the gap, and we see our next steps are to research and test the utility of using latent thematic analysis as a tool to bridge the techno-physical and the socio-cultural aspects [TRIZ and Frame Creation] of technological change. This is an important step toward the creation of a methodology that is both theoretically and empirically grounded.

6. References

Altshuller, G. (1997) *40 Principles – TRIZ Keys to Technical Innovation*. Technical Innovation Center, Worcester, MA.

Altshuller, G., B. Zlotin, A. Zusman, & V. Philatov, (1999) *Tools of Classical TRIZ*, Ideation International Inc.

Altshuller, G. & Vertkin, I., (1994) *How to Become a Genius: A Life Strategy of a Creative Person*, Minsk, Belarus, (in Russian).

Braun, V., Clarke,V., (2006) Using thematic analysis in psychology, *Qualitative Research in Psychology*, 3:2, 77-101.

Buchanan, R. (1995) Wicked problems in design thinking in V Margolin and R Buchanan (eds) *The idea of design*, Cambridge MA: MIT Press, 3-20.

Checkland, P., (2000) Soft Systems Methodology: A Thirty Year Retrospective, *Systems Research and Behavioral Science* ,17, S11–S58.

Dorst, K., (2015) *Frame Innovation – create new thinking by design*, Cambridge, MA: MIT Press.

Girifalco, L.A. (1991) *Dynamics of technological change*, New York : Van Nostrand Reinhold.

Karamchedu, V. R., (2005) *It's not about the technology : developing the craft of thinking for a high technology corporation*, New York : Springer.

Kunz, W and Rittel, H W J (1970) Information science: on the structure of its problems. *Information Storage and Retrieval*, 8, 95-98.

Kurzweil, R., (2005) *The singularity is near: when humans transcend biology*, New York : Viking.

Lawson, B., (2006) *How Designers Think: The design process demystified*, London: Architectural Press.

Orloff, M., (2006) *Inventive Thinking Through TRIZ: A Practical Guide*, Springer-Verlag, Berlin.

Patton, M.Q. (1990) *Qualitative evaluation and research methods*, second edition, Sage.

Porter, A. L. [et al.], (1980) *A Guidebook for technology assessment and impact analysis*, New York: North Holland.

Rantanen, K. and Domb, E. (2002) *Simplified TRIZ- New Problem Solving Applications for Engineers, and Manufacturing Professionals*, S. Lucie Press, NY.

Rittel, H. and Weber, M. (1973) Dilemmas in a general theory of planning, *Policy Sciences*, 4, 155-169.

Savransky S.D., (2000) *Engineering Creativity Introduction to TRIZ Methodology of Inventive Problem Solving*, (CRC Press, Boca Raton).

Schmidt, S., (2008) *The coming convergence: surprising ways diverse technologies interact to shape our world and change the future*, Amherst, N.Y. : Prometheus Books.

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