Qualitative Research and the Challenges of Complexity

Antonio Dias de Figueiredo(✉)

Departamento de Engenharia Informática, CISUC, Polo II da Universidade de Coimbra, 3030-290 Coimbra, Portugal
adf@dei.uc.pt

Abstract. Will the research agendas of this 21st century be able to handle with rigor the complexity and uncertainty of our world? Will they accommodate the leaps into the unknown of today's creative and innovative processes? Should we care about it? Our answer is yes, because the social, economic, and political problems we confront today are becoming increasingly complex and nondeterministic. As this happens, and even their formulation becomes elusive, our traditional theories, methods, and instruments fail. We argue that the qualitative approaches inspired by the design disciplines are ideal to handle these situations, provided we carefully take into account some principles of the philosophy of science. We believe that the researchers willing to confront the growing complexity of our day, in all its richness and diversity, will have much advantage in following these approaches.

Keywords: Complexity · Creativity · Design · Ethics · Explanatory research · Qualitative research · Projective research · Relevance · Rigor · Wicked problems

1 Introduction

This chapter concentrates on the challenges to scientific research in a world where complexity plays an increasingly predominant role [1]. It starts by debating the extent to which today's uncertainty and sociotechnical strains are changing the nature of the problems we deal with, namely their dependence on multiple social factors and their loss of determinism and linearity [2]. On a different key, it also stresses the changing nature of research in contemporary contexts, where the interests of most stakeholders, and not just a few, must be carefully accounted for [3, 4]. With this background established, the chapter visits Herbert Simon's proposals for the creation, beyond the traditions of the natural sciences, of a new category of sciences, the *design sciences*, or *sciences of the artificial*, devoted to the study of the creations of man [5–7]. This distinction is then used to argue in favor of the distinction between two kinds of research: *explanatory research* and *projective research*.

Recognizing the close relationship between Simon's proposals and the traditions of the design discipline, the chapter recalls a debate occurred some decades ago in the designers' community, where a vision of design as a science-based discipline was opposed to a vision of design as a independent discipline, distinct from science and capable of solving problems that traditional science was unable to tackle [8–10]. This latter vision, which now

A.P. Costa et al. (eds.), *Computer Supported Qualitative Research*,
Advances in Intelligent Systems and Computing 621, DOI 10.1007/978-3-319-61121-1_2

prevails in the designers' community, has been retained in this chapter. To explore further the role of design in research, the chapter inquires into the nature of the design *process*, in its cyclical and evolutionary fashion, which is so radically distinct from the chains of reasoning that characterize the traditional science process [7, 11]. Then, to highlight the apparently overlooked relationship between research and the design process, it stresses that Kurt Lewin's proposal of action-research as a form of qualitative research, in the mid 1940s [12], was based on the adoption of an identical cyclical process, which points to Lewin as the probable pioneer of the use of the traditions of design in scientific research.

To inquire more deeply into the epistemological strengths of the design process, when put at the service of research, the chapter then delves into the principles of the philosophy of science [7, 11, 13] and analyzes the potential value of their exploration in connection with Popper's critical rationalism [14, 15]. Drawing on the abductive nature of design, which facilitates the incorporation of intuitive hunches, creative leaps and accidental discoveries into the design process [16–19], the chapter explores this analogy to bring identical features to the research process.

The chapter then proposes a two-dimensional complexity space [20] where the opportunities for research inspired in the traditional sciences and of research inspired in the design process can be placed, where quantitative and qualitative research can be positioned in regions of this space, and where one can gain insight on when to handle a problematic situation as a problem or when to pursue it, instead, as an investigation of possible outcomes or emergent solutions.

The chapter continues with an analysis of the rigor, relevance and validity of the research carried out using the proposed design-inspired approaches. It discusses the rigor *vs* relevance debate [21] in the context of this kind of research, addresses the issues of error elimination through criticism [14], proposes eight tactics to harness rigor, stresses the critical importance of the ethical dimension, and closes with some general considerations about validity. The chapter concludes with a summary of its main arguments and claims.

2 New Problems, New Knowledge, New Research

Just before the turn of the century, leading physicist Stephen Hawking predicted that the 21st century would be the century of complexity [1]. Globalization, the increasing power of computers, the exploding number of human and technological systems, the rising dependence between such systems, the escalating speed of communications, the changing competitive environments and organizational needs, and, above all, the human and social dimensions of all these issues, are generating, indeed, an explosion of independent variables that interact in unpredictable ways, sometimes on the verge of chaos. This reality has dramatic implications on the nature of the problems we must deal with, on the core of the knowledge we must create, and on the essence of the scientific research we must develop.

2.1 Extending Research to Problem Spaces of Complexity

All scientific research occurs in a problem space, a space of possibility where the problems are experienced and research is carried out to solve them. Most of the problem spaces of our time are populated: they are inhabited by people whose life is affected either by the problems being researched or by the results of that research. In the past, the role played by people in research processes was negligible. Today, as pointed out by the science and technology studies movements since the early 1970s [3, 4], most research projects must include representatives of the stakeholders affected. This is prominent in the environmental sciences and biotechnology, and slightly less obvious in the social sciences, but even in technology research the interests of politics and the games of power play a critical, albeit invisible, role on the definition and unfolding of the research projects.

Besides the disagreement between the people involved, the problem spaces of research can also be characterized by uncertainty, either for natural reasons, or for reasons relating to the growing complexity and unpredictability of the social, economic, and political worlds we live in. A typical situation of uncertainty is illustrated by the so-called *wicked problems*, or problems that, because of their complexity and close dependence of multiple social factors, cannot be formulated [2]. The problem of the refugees is an example of a wicked problem. The process of solving wicked problems, which are increasingly common in contemporary organizations and societies, coincides with the process of understanding their nature: problem understanding and problem resolution are concomitant, with the information needed to understand a problem depending on the ideas that emerge for solving it. In this chapter, we will concentrate on complex problem spaces characterized by these two variables: disagreement and uncertainty.

2.2 From Explanatory Research to Projective Research

The acceptance of the distinction between the natural sciences and the design sciences, originally proposed by Simon in *The Sciences of the Artificial* [5], led to a distinction between two opposed, though complementary, kinds of research: explanations-oriented research and solutions-oriented research. For Simon, just as the natural sciences have been created to study nature, a new category of sciences, which he described as the *design sciences*, was needed to study the creations of man. In his elaborations on Simon's proposals, Jean-Louis LeMoine gave the name of 'projective knowledge' to the knowledge obtained through the design sciences [22]. He did so to stress the teleological character of this knowledge, which, unlike the 'objective knowledge' of traditional science, is better characterized by its 'project' than by its 'object'. The carved flint attributed to the prehistoric man had received its sharp contour 'in order to' cut or slice, and the computer was designed by contemporary man 'in order to' manipulate symbol systems [22]. To incorporate this dimension of meaning in our reasonings, we will refer to the two above kinds of research as *explanatory research* and *projective research*.

Explanatory research is the traditional kind of research. It produces laws, models, and theories that explain the world [6]. It has the aim of finding out why things are as they are and of predicting how things will be. Quite differently, the aim of projective research is to produce artifacts to serve human needs and to find out how things ought to be [5]. Thanks to projective research, the process of developing a new – physical, intellectual, or institutional – artifact can be, today, a rigorous research project. The artifact may be anything that can be imagined and implemented by man: a curriculum model, a teaching approach, a medical practice, a healthcare system, a new device, a piece of software, an information system, an organization, a methodology. Projective research not only produces artifacts, but also advances knowledge and empowers its actors to intervene in contexts identical to those where the artifacts are developed.

The importance of the design sciences and of projective research has increased dramatically in the last decades, thanks to the pressure of agendas that are now driven, not just by the search of first principles, but also by economic and social needs [7, 23]. In traditional explanatory research, the criterion to assess the quality of research was scientific excellence, as judged by disciplinary peers. In solutions-oriented research, besides the inescapable requirement of scientific excellence, other criteria are taken into account, such as efficiency, usefulness, and the ability to fulfill the expectations of multiple stakeholders [7, 23]. This is particularly visible today in a substantial proportion of the public funding systems, which, besides the criterion of scientific excellence, impose several additional criteria that reflect social and economic priorities.

2.3 From Science-Generated Knowledge to Design-Generated Knowledge

In the 1970s, a vigorous debate on the nature of research broke out in the design professionals and researchers community. Since the 'modern movement of design' of the early 1920s, the design discipline had been converging towards the values of objectivity and rationality that characterized science. It was within this spirit that Le Corbusier declared in his 1923 manifesto *Vers Une Architecture* that "a house is a machine for living in" [24]. This aspiration to 'scientize' design was further strengthened in the 1960s, with the emergence of the 'design methods movement', which extended from products to methods the convergence between design and science [10]. Then, in the 1970s, a sudden backlash emerged, in what J. C. Jones described as a reaction to "the machine language, the behaviorism, the continual attempt to fix the whole of life into a logical framework" [9]. In 1981, some of the participants in this debate declared an open rupture with the traditions of science, stating that "the epistemology of science was (…) in disarray and (…) had little to offer an epistemology of design" [10].

Bruce Archer, a leading voice in this debate, stressed the differences between science and design. In the sciences, he pointed out, "there is no insistent demand that subjects for scientific enquiry should be confined to particular categories or that findings should be useful" [8]. On the contrary, "Design is directed towards meeting a particular need, producing a practicable result and embodying a set of technological, economic, marketing, aesthetic, ecological, cultural and ethical values determined by its functional, commercial and social context" [8]. And he added: "In contrast to the overriding importance of orthodox methodology in the conduct of science, the conduct of design is validated by its efficacy rather than the rigor of its methods" [8]. In the same text, Archer favored "a designerly approach, rather than a scientific approach" [8], in what marked the distinction between two rigorous ways of knowing: *scientific knowing* and *designerly knowing*. In subsequent years, this distinction would be further stressed and clarified by other authors, namely Nigel Cross, who published in 2007 a whole book devoted to the subject [25].

This consolidation of an alternative way of building knowledge, besides the traditional ways of science, converges with the distinction between explanatory research and projective research. As will become evident throughout this chapter, designerly research, or design-generated research, is synonymous with projective research.

2.4 From Chains of Reasoning to Spirals of Evolutionary Learning

When we consider the design disciplines in the sense attached to the word *disegno* in the Italian Renaissance, from the Latin verb *designare* (to designate, assign a meaning to, destine, imagine a destiny for), we may describe them, historically and linguistically, as the disciplines of the conception of new systems, artifacts and solutions [11]. Unlike the traditional scientific disciplines, which rely heavily on the assumptions of certainty and determinism, the design disciplines, in their tradition of creating the future through tentative approximations, are particularly appropriate to handle ill-defined problems in situations characterized by high levels of uncertainty and disagreement. This is the reason why ‘design thinking’ is today so popular in organizational management and politics to handle problems of great complexity and uncertainty.

The aptitude of the design disciplines to reformulate problems adaptively, taking into account the tentative results obtained, was strongly present in the act of sketching that characterized the design activities in the early Renaissance days. The sketch, drawn at hand, was then the first outline of a world being imagined and created, which could, through a process of successive improvements, become a masterpiece. This spiral process of improvement in successive cycles is in sharp contrast with the linear, or chain process, of positivist science, where all realities, even the most complex, can be decomposed in “long chains of reasons, all simple and easy”, so that, provided “one always kept to the order necessary to deduce one thing from another, there would not be anything so far distant that one could not finally reach it, nor so hidden that one could not discover it” [26].

The likely first connection between spiral processes and qualitative research was established by Kurt Lewin in the seminal paper that marked the foundation of action-research, which he described as “proceeding in a spiral of steps, each of which is composed of planning, action and the evaluation of the result of action” [12]. The epistemological richness of Lewin’s action research spiral is that it breaks with the linear chains of reasoning typical of traditional science to embrace the recurrent dynamics of the design disciplines, where the construction of knowledge emerges as a form of emergent evolutionary learning [27].

3 The Philosophical Implications of Design-Generated Research

Since Kurt Lewin’s adoption of a design-generated, interactive, multiple-cycle research approach [12], many other scientists have followed him, not only in connection with the practice of action-research [11, 28, 29], but also by creating and putting into practice additional qualitative approaches to research, such as design science research [30–32], design research [33], design-based research [34], design experiments research [35], and other variations of these approaches. In order to explore further the innovative value of the combination between design and research, we will now analyze it from the point of view of the philosophy of science and inquire into the epistemological opportunities offered by exploring its layered structure in association with Karl Popper's critical rationalism.

3.1 The Four Key Questions of the Philosophy of Science

The epistemological strength of design-generated research can be better appreciated if we watch it in light of the four key questions of the philosophy of science [7, 13]: the ontological, epistemological, methodological, and axiological questions. The ontological question inquires into *what reality can be known* when we carry out research in this alternative way. The epistemological question looks into *what is knowledge* or *what knowledge we can get* in this way. The methodological question inquires into *how we can build that knowledge*. The axiological question asks *what is the worth, or value, of the knowledge we build* in this way.

From the ontological point of view, a design-generated approach fulfills the phenomenological hypothesis, according to which "we know the world by interacting with it in an emergent process that changes knowledge as we keep interacting" [7, 22]. This is radically different from the realist hypothesis that supports traditional science, which sates that "the reality we deal with is external to us, independent from us, and driven by immutable laws" [7, 22]. In other words, in traditional science, reality is out there waiting for us to uncover it. In design-generated approaches, we build reality as we progress.

From the epistemological point of view, a design-generated approach follows the teleological hypothesis, according to which "knowledge is what gets us to an intended result" [7, 22]. Again, this is very different from the deterministic hypothesis that supports traditional science, for which "knowledge is what we learn by exploring the causes of the problems we face" [7, 22]. In other words, in traditional science, knowledge clarifies the relationships between causes and effects and formulates them as theories and general principles. In design-generated research, knowledge materializes in the creation of physical, intellectual, or institutional artifacts.

From the methodological point of view, a design-generated approach follows two principles [7]: the principle of complexity and the principle of intelligent action. The principle of complexity states that "we build knowledge by recognizing the world as complex and in constant flux, embodying stability, change, chaos, and order, the whole exceeding the sum of the parts and the parts interacting in the shared, emergent and largely unpredictable construction of reality" [7]. The principle of intelligent action states that "human reason can transform intelligible representations of the dissonances to which it is confronted by creating responses in the form of 'intelligent actions' adapted to reduce these dissonances" [7, 22]. These two methodological principles differ radically from the two methodological principles of traditional science: the principle of analytical modeling and the principle of sufficient reason [7, 22]. The principle of analytical modeling states that "to explain reality we must divide each difficulty into as many parts as possible and necessary to resolve it better" [7, 22]. The principle of sufficient reason asserts that "there is no effect without a cause and no change without a reason for change" [7, 22].

From the axiological point of view, a design-generated approach follows the principle of value inclusion and the principle of intrinsic ethics [7]. The principle of value inclusion states that "values have an essential role to play in the emergent process of knowledge construction" [7, 36]. The principle of intrinsic ethics asserts that "ethical behavior is constructed by each researcher in the persistent search for the collective good" [7]. Contrariwise, traditional science does not attach specific attention to the axiological dimension. As affirmed by Guba and Lincoln, traditional science sees ethical considerations as "confounding variables that cannot be allowed a role in putatively objective inquiry" [36], on the assumption that "ethical behavior is formally policed by external mechanisms, such as professional codes of conduct and human subjects committees" [36], so it does not need to be accounted for.

3.2 How Layered Research Accommodates Creativity and Accidental Discovery

The layered nature of design-generated research, where problem and solution are revisited recurrently, in successive approximations, offers a wealth of opportunities for research when combined with Karl Popper's critical rationalism [15], which rests on the recognition that "the growth of knowledge always consists in correcting earlier knowledge" and that the only one way of learning to unravel a problem "is to try to solve it and to fail" [14]. This means that, unlike the chains of strict cause and consequence of traditional science, that require every step of the chain to be exhaustively confirmed as correct before proceeding to the subsequent steps, the recurrent visitations of problem and solution in design-generated research tolerate the occurrence of failures in some of its intermediate steps. In fact, they assume them as natural ways of generating the divergence that sparks creativity and makes innovative solutions possible.

This tolerance of unexpected events and failure throughout the layered process is something designers have been valuing for ages: "to indulge in, or even provoke, opportunities for creative leaps that have little to do with rigor, only to recover at subsequent stages the rigor that had temporarily been broken" [7]. The implications of this fact are paramount, because they offer, apparently for the first time, a systematic way of accommodating into the research process concepts of critical importance for the progress of knowledge, which the traditional science has been unable to handle up to now: creative leaps, accidental discoveries, and bursts of intuition.

The concept of abduction, as proposed by Charles Peirce, is a key notion to understand the relationship between creativity and scientific discovery. Peirce saw abduction as one of the possible ways of dealing with scientific hypotheses, which he found to be, in many cases, a better alternative to induction and deduction. To abduct was, for him, to formulate hypotheses in exploratory ways, on the basis of incomplete evidence, before moving on to the scrupulous confirmation of these hypotheses [16]. He used the term 'hypothesis' in a broad sense, essentially to mean a 'guess' [15], or, using Popper's terminology, a 'conjecture' that waited to be confirmed or refuted.

Design is considered today an eminently abductive discipline. As put by Nigel Cross, "The more useful concept that has been used by design researchers in explaining the reasoning process of designers is that design is abductive" [17]. By resorting to abductive reasoning, the designer, or anyone reasoning as a designer, can do without the traditional inductive and deductive chains of reasoning and use abduction instead to enable the exploration of creative leaps and intuition. In principle, the exploratory hypotheses – or guesses, or conjectures – put forward by the researchers are likely to originate in solid evidence. However, since their scientific soundness is only to be verified at later stages, the researchers can freely incorporate insights induced by chance events, gut feelings, and creative leaps and explore them without any risk of blotting scientific rigor, provided they scrupulously attempt to refute them in subsequent stages.

This approach also lets us explain how serendipity, the faculty of making fortunate and unexpected discoveries by accident, described as one of the strongest contributions to the progress of science [18, 19, 37], can be rigorously incorporated in the research processes. It can also explain how incorrect knowledge can play a role in the development of science, as described by Umberto Eco in one of his essays on "the force of falsity" [38], where he shows how a number of ideas that today we consider false actually changed the world. Amongst those, he recalls that the misunderstanding of Chinese writing by Leibnitz, when looking for the mathematical awareness of Fu-hsi, led him to contribute to the development of modern logic. What Leibnitz did, we can now say, was to abduct from an inspiring piece of incorrect information and work on it so meticulously that he ended up discovering new and reliable knowledge that might have been unattainable in the absence of the incorrect detour that led to it.

The combination between Popper's critical rationalism, the layered nature of design-generated research, and the abductive nature of the design discipline offers us, in this way, a valuable path towards the incorporation of creative insights and accidental discovery into the research process.

4 Mapping the Space of Complexity in Research

The debate of the relationship between complexity and research processes may be easily approached if we recall Ralph Stacey's certainty/agreement matrix [20]. According to Stacey, the degree of contingency of a social system can be easily understood if we place it on a two-dimensional map that displays *certainty* against *agreement* (Fig. 1). The origin of the axis corresponds to maximum certainty about the issues at stake and maximum agreement between the stakeholders who run the system. The horizontal axis points from maximum certainty to maximum uncertainty. The vertical axis points from maximum agreement to maximum disagreement. Maximum certainty is seen as occurring when all the causal relationships in the social system can be known. Uncertainty occurs when the causal relationships cannot be known and the situations to be handled are unique or even unimaginable. The so-called *wicked problems*, mentioned earlier in this chapter, are examples of problems involving a high degree of uncertainty.

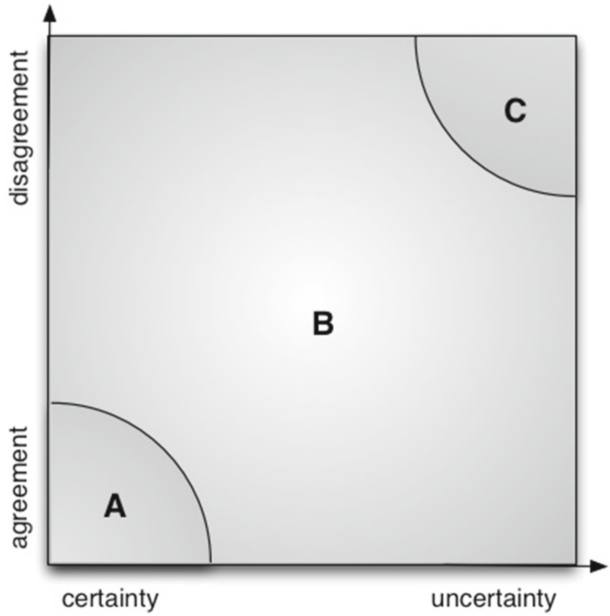

Fig. 1. Stacey's certainty/agreement matrix

In the matrix of Fig. 1, zone A, the zone close to certainty and agreement, corresponds to most of traditional research: causal relationships can be known, first principles can be established and confidently applied, and results can be safely predicted. Zone C, at the top right corner of Fig. 1, is a zone of maximum uncertainty and disagreement. It is the zone of absolute *chaos*, *anarchy*, and *breakdown*, which every organization and social system should avoid [20]. Zone B, the zone of intermediate certainty and agreement, the larger area in Fig. 1, is called the *zone of complexity* or *edge of chaos*. It is a zone where the causal principles of traditional research fail and intuition, creativity, idea sharing, and collaborative learning become essential to explore, discover, transform, co-create, and innovate. It is a zone where most of the problems are wicked, and where the search for solutions, outcomes, and opportunities requires concomitant cycles of problem solving and problem setting.

With this model in mind, we can now say that zone A, which is safely anchored in assumptions of certainty and agreement, is a domain of excellence for *quantitative research*. The uncertainty and disagreement of Zone B leaves little room for causality and uniformity, so it calls for research approaches more appropriate to complex environments, namely kinds of *qualitative research* that enable exploratory progress. This does not exclude, of course, the use of qualitative research in zone A, when the research questions at stake justify it, nor the use of quantitative research in minute neighborhoods of zone B where uncertainty and disagreement can be disregarded.

We also notice that zone A is ideal for focusing on *problems* that can be clearly formulated, while zone B is more appropriate for people to converge on *outcomes* or to discover or create *emergent solutions*. This orientation towards outcomes and solutions rather than problems stresses the *projective* nature of the research approaches required for zone B. We can wrap-up by saying that zone A is ideal for traditional *science-generated research*, whereas zone B, as a zone of complex realities that must be grasped in their entirety rather than simplified, is more appropriate for *design-generated research*. Region C, as a zone of absolute chaos, is useless for research.

5 Rigor, Relevance and Validity in Projective Research

As the mission of traditional researchers became more and more centered on their contribution to the bodies of knowledge of their domains, their concern about the practical relevance of the knowledge they produced tended to weaken. Recognizing this paradox, Donald Schön initiated in the early 1980s a strong debate on the lack of practical relevance of much of the knowledge produced and published at the time [21]. This debate, which keeps being reignited from time to time, came to be known as the 'rigor *vs* relevance debate'.

5.1 Resolving the Rigor *vs* Relevance Dilemma

One of the interesting aspects of projective research, which results from the foundational philosophical principles described earlier, namely the principle of intrinsic ethics, is that *rigor without relevance is meaningless*. As explained before, most research projects are seen today as partnerships between scientists and stakeholders. For a partnership to be sustainable, it must lastingly fulfill the interests and motivations of all the parts [7]. With this in mind, we may define the relevance of a project as the value the project holds for its stakeholders. The key issue thus becomes, not that of deciding between rigor and relevance, but that of *making sure that all the relevance we create is created with rigor* [7].

5.2 Error Elimination Through Criticism

The rigor of projective research rests on the association between the philosophical principles stated earlier, the proposed design-inspired layered approach, and Popper's *critical rationalism*, which he synthesized in his Harvard lecture of February 1963 [14] in the following terms: "My whole view of the scientific method may be summed up by saying that it consists of these steps:

1. We select some problem – perhaps by stumbling over it.
2. We try to solve it by proposing a theory as a tentative solution.
3. Through the critical discussion of our theories our knowledge grows by the elimination of some of our errors, and in this way we learn to understand our problems, and our theories, and the need for new solutions.
4. The critical discussion of even the best theories always reveals new problems."

Of these four steps, Popper stresses that the most characteristic of science is the third one, *error-elimination through criticism* [14]. In projective research, as described in this chapter, this requirement legitimates the adoption of emergent, cyclical, developments that combine safe steps with less rigorous abductive leaps and bonds. The only condition to be met is to make sure that error-elimination is exhaustively carried out after the less safe steps are taken [7].

Bearing in mind Popper's critical rationalism and the philosophical framework presented earlier, we may say that the eight tactics we have compiled elsewhere [7] to ensure rigor in layered research projects still hold. We reproduce them here, with adjustments for easier understanding:

1. A theoretical framework must be set at the beginning of the process. It is in light of this framework that new knowledge arising from the research will be identified.
2. The use of cycles is essential. In each cycle we should try to refute the emerging interpretation. Using several short cycles allows more opportunities for criticism. Cycles can be used within cycles, with larger ones spanning whole phases of the research program.
3. Research methodology, as well as the research questions, should be critically analyzed and refined in each cycle.
4. Data collection and interpretation should be a part of each cycle. This allows both to be challenged in latter cycles.
5. In each cycle, the researcher should focus only on agreements and disagreements, ignoring the idiosyncratic data. Apparent agreements should be tested and apparent disagreements explained.
6. Divergent data should be deliberately sought. This increases the chances that any piece of data or interpretation be challenged. Existing literature can also play an important role in this effort.
7. Multiple sources of information should be sought (or different perspectives concerning the same source) in order to create a dialectical process.
8. Results from changes introduced into the research situation should be used as additional sources of information for challenging emerging theories.

5.3 The Ethics of Obstinate Rigor

The principle of intrinsic ethics, in spite of its irrelevance for explanatory research, is crucial to safeguard the rigor of projective research. A main reason for this is that it becomes unethical not to pursue rigor to its highest standards. When writing about wicked problems, Rittel and Webber put it this way: "the planner has no right to be wrong" [2]. And they add: "(…) every implemented solution is consequential. It leaves 'traces' that cannot be undone. One cannot build a freeway to see how it works, and then easily correct it after unsatisfactory performance (…). The effects of an experimental curriculum will follow the pupils into their adult lives" [2]. It is probably no accident that the motto of Leonardo da Vinci, the greatest master of *disegno* (design) of all times, was: 'ostinato rigore' (obstinate rigor) [7].

5.4 The Issues of Validity

From the issues of rigor and relevance, we might now move to the issues of scientific validity. This is, however, an extensive topic that would not fit the space reserved for this chapter. It is interesting to notice, however, that the validity principles of most of the qualitative research approaches characterized by cyclical and evolutionary paths – such as action-research, design science research, design research, design-based research, and design experiments research – agree with the principles stated in this chapter. If we take, for example, the concept of 'pragmatic validity' asserted by van Aken for design science research [30], we notice that it fully agrees with our principles. This means that, following our principles, design science research can be safely used to address problems with high levels of complexity, unpredictability and disagreement, as well as to incorporate intuitive gut feelings, accidental discovery and creative leaps in the research process.

6 Conclusions

The main objective of this chapter was to contribute to a reflection on the nature of 21st century research that took into account the increasing complexity of our world. The chapter started by stressing the extent to which the consideration of complexity affected the nature of the problems we must deal with, the knowledge we must create, and the essence of the research we must develop. It stressed the attention we must attach today to the stakeholders involved, the growing call for projective visions of research, and the prospects of using the design disciplines as sources of inspiration for the consolidation of the new visions. It then discussed the implications of the philosophy of science on these visions, the key role of Popper's critical rationalism, and the opportunities offered by these visions to incorporate creative leaps and unexpected events in the research process. It went on by proposing a two-dimensional complexity space to help develop insights on the nature of the problems, outcomes and emergent solutions being studied and on the choice of research approaches to tackle them. Finally, it discussed the rigor, relevance and validity of the research carried out using the proposed approaches. The main threads of the arguments produced can be synthetized as follows:

- Explanatory research and projective research are two fundamentally distinct categories of research. Explanatory research explains the past and the present. Projective research creates the future. As the creation of the future invariably rests on the present and the past, explanatory and projective research generally complement each other.
- Explanatory research is limited in its ability to solve the growing number of problems that occur in complex contexts associated to uncertainty and disagreement. Projective research is particularly fit to handle these contexts.
- Explanatory research is limited in its ability to incorporate in the research process the occurrence of accidental discoveries, bursts of intuition and creative leaps. Projective research is particularly fit to explore this neglected dimension of the research process.
- Just as explanatory research is grounded on the traditions of the natural sciences, projective research is grounded on the traditions of the design disciplines.

- The rigor of projective research rests upon the epistemological opportunities offered by exploring its layered structure in association with Karl Popper's critical rationalism.
- When the abductive character of the layered research processes is explored, the advantages of their adoption extend to the incorporation into the research process of accidental discovery, intuition and creative leaps.
- If the degree of uncertainty of the issues at stake is plotted against the disagreement between the stakeholders intervening in the process, we obtain a two-dimensional space where we can gain insight on the nature of the problems, outcomes or emergent solutions under consideration as well as on our choice of research approaches to tackle them.

An overarching conclusion, aligned with this chapter's aim of clarifying how research can flourish in a world of increasing complexity, is that projective research, the design-inspired approach proposed here, is particularly appropriate to address both the ill-defined problems and the startling opportunities this world reserves for us.

References

1. Hawking, S.: What is Complexity? The Washington Center for Complexity. http://www.complexsys.org/downloads/whatiscomplexity.pdf
2. Rittel, H., Webber, M.: Dilemmas in a general theory of planning. Policy Sci. **4**(1), 155–169 (1973)
3. Pickering, A.: Science as Practice and Culture. University of Chicago Press, Chicago (1992)
4. Brey, P.: Philosophy of technology meets social constructivism. J. Soc. Phil. Technol. **2**, 3–4 (1997)
5. Simon, H.A.: The Sciences of the Artificial. MIT Press, Cambridge (1969)
6. March, S.T., Smith, G.F.: Design and natural science research on information technology. Decis. Support Syst. **15**, 251–266 (1995)
7. Figueiredo, A.D., Cunha, P.R.: Action research and design in information systems: two faces of a single coin. In: Kock, N. (ed.) Information Systems Action Research: An Applied View of Emerging Concepts and Methods, pp. 61–96. Springer (2007)
8. Archer, B.: The nature of research in design and design education. In: Archer, B., Baynes, K., Roberts, P. (eds). The Nature of Research into Design and Technology Education. Loughborough University (1992)
9. Jones, J.C.: How my thoughts about design methods have changed during the years. Des. Methods Theor. **11**, 1 (1997)
10. Cross, N.: Designerly ways of knowing: design discipline versus design science. Des. Issues **17**(3), 49–55 (2001). Massachusetts Institute of Technology
11. Figueiredo, A.D.: On the historical nature of engineering practice. In: Williams, B., Figueiredo, J., Trevelyan, J. (eds.) Engineering Practice in a Global Context: Understanding the Technical and the Social, pp. 7–32. CRC Press, Boca Raton (2013)
12. Lewin, K.: Action research and minority problems. J. Soc. Issues **2**, 34–46 (1946)
13. Lincoln, Y.S., Guba, E.G.: Paradigmatic controversies, contradictions, and emerging confluences. In: Denzin, N.K., Lincoln, Y.S. (eds.) Handbook of Qualitative Research, 2nd edn. Sage Publications, Thousand Oaks, CA (2000)
14. Popper, K.: Models, instruments and truth: the status of the rationality principle in the social sciences. In: The Myth of the Framework, pp. 154–184. Routledge, London (1994)

15. Popper, K.: Conjectures and Refutations: The Growth of Scientific Knowledge. Routledge, London (2002)
16. Peirce, C.: Collected papers of Charles Sanders Peirce. In: Hartshorne, C., Weiss. P. (eds.), vol. 1–6. Harvard University Press, Cambridge (1931–1958)
17. Cross, N.: Natural intelligence in design. Des. Stud. **20**, 25–39 (1999)
18. Van Andel, P.: Serendipity: expect also the unexpected. Creativity Innov. Manage. **3**, 20–32 (1992)
19. Figueiredo, A.D., Campos, J.: The serendipity equations. In: Proceedings of ICCBR 2001. Naval Research Laboratory, Washington, DC (2001)
20. Stacey, R.: Complexity and Creativity in Organizations. Berrett-Koehler, San Francisco (1996)
21. Schön, D.: The Reflective Practitioner: How Professionals Think in Action. Basic Books, New York (1983)
22. LeMoigne, J.-L.: Les Épistémologies Constructivistes, 2nd edn. Presses Universitaires de France, Paris (1999)
23. Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., Trow, M.: The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies. Sage Publications, London (1994)
24. Corbusier, L.: Vers Une Architecture. Flammarion, Paris (1995)
25. Cross, N.: Designerly Ways of Knowing. Birkauser, Basel (2007)
26. Descartes, R.: Discours de la Méthode. Librarie Philosophique J. Vrin, Paris (1961)
27. Gasson, S.: Emergence in Organizational 'Problem-solving': Theories of Social Cognition' (2006). http://cci.drexel.edu/faculty/gasson/papers/probsolv.pdf
28. Kemmis, S., McTaggart, R.: The Action Research Planner, 3rd edn. Deakin University Press, Geelong (1988)
29. Stringer, E.T.: Action Research, 2nd edn. Sage, Thousand Oaks (1999)
30. Van Aken, J., Chandrasekaran, A., Halman, J.: Conducting and publishing design science research. J. Oper. Manage. **47–48**, 1–8 (2016)
31. Vaishnavi, V.K., Kuechler, W.: Design Science Research Methods and Patterns: Innovating Information and Communication Technology, 2nd edn. CRC Press, Boca Raton (2015)
32. Sein, M., Henfridsson, O., Purao, S., Rossi, M., Lindgren, R.: Action design research. MIS Q. **35**, 37–56 (2011)
33. Edelson, D.C.: Design research: what we learn when we engage in design. J. Learn. Sci. **11**(1), 105–121 (2002)
34. Barab, S., Squire, K.: Design-based research: putting a stake in the ground. J. Learn. Sci. **13**(1), 1–14 (2004)
35. Brown, A.L.: Design experiments: theoretical and methodological challenges in creating complex interventions in classroom settings. J. Learn. Sci. **2**, 141–178 (1992)
36. Guba, E.G., Lincoln, Y.S.: Competing paradigms in qualitative research. In: Denzin, K.D., Lincoln, Y.S. (eds.) Handbook of Qualitative Research. Sage, Thousand Oaks (1994)
37. Roberts, R.M.: Serendipity: Accidental Discoveries in Science. Wiley, New York (1989)
38. Eco, U.: Serendipities: Language and Lunacy. Weidenfeld & Nicolson, London (1999)

http://www.springer.com/978-3-319-61120-4

Computer Supported Qualitative Research
Second International Symposium on Qualitative
Research (ISQR 2017)
Costa, A.P.; Reis, L.P.; Souza, F.N. de; Moreira, A. (Eds.)
2018, X, 436 p. 68 illus., Softcover
ISBN: 978-3-319-61120-4