Activity Cycles in Design Research: A Pragmatic Conceptualisation of Inter-related Practices

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Abstract. There has been a great interest among scholars to identify and conceptualise activities and processes of information systems design research. Based on a paradigmatic foundation in pragmatism, this paper furthers these earlier works on activities and processes. It identifies three main sub-practices of design research; theorize, build and evaluate. It also identifies three external practices/communities: research community, general practice and local use practice. The different practices are related to each other through the construct of an activity cycle. Seven different activity cycles are specified in the paper: Theorize – Build cycle, Theorize – Evaluate cycle, Build – Evaluate cycle, Theorize – Research community cycle, Design research – General practice cycle, Build – Use cycle and Evaluate – Use cycle.

Keywords: Design research, information system, practice, pragmatism.

1 Introduction

The interest in design research (DR) within the information systems (IS) community has been growing over the last decade. It has been seen as a research approach that encourages an interest in practical outcomes and improved practice, and thus for enhanced practical relevance. There are many attempts to conceptualise DR, e.g. [1], [2], [3], [4], [5], [6], [7] and [8], showing great diversity. This diversity may be explained that the paradigmatic foundations for design research have not yet settled. There have been suggestions to position DR within interpretivism [9] and critical realism [10]. There have been several attempts to position DR within pragmatism [11], [12], [13], [14], [15], [16], [34]. Pragmatism emphasises action, change and practical use, which makes it an appropriate paradigm candidate. There are valid arguments to position design research within pragmatism since DR:

- Addresses real life problems.
- Attempts to create artefacts of practical value (utility).
- Contributes to practice improvement.
- Is engaged in interaction between academia and practice.

This paper takes pragmatism as a suitable research paradigm for design research for reasons mentioned above and following the suggestions of [11], [12], [13], [14].

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The intention is to try to create a meaningful conceptualisation of DR based on pragmatic perspectives and constructs. The main idea is to identify sub-practices of design research and try to relate them to each other. In doing so, the paper uses the idea of activity cycles borrowed from [11].

The main purpose of this paper is thus to contribute to the conceptualisation of design research based on pragmatic foundations. It can be characterised as a conceptual inquiry and is driven by a problematic situation that needs resolving [17].

There is still confusion and conflict concerning how to view design research; e.g. the processes and outcomes of DR [3], [4]; the role of theory and theorizing [18], [19]; the relation between design research and design practice [20], [21]; the role and character of evaluation and validation [8], [23], [24]; the relation between DR and intervention [5], [24]; what is included DR and not [20]. There is also confusion with regard to what to call this research approach: design research, design science research or design science. I will use the term design research throughout this paper.

Part of this conceptual diversity of DR will be investigated in section 2 below as a basis for the conceptualisation made in section 3. This paper represents an initial step of practice conceptualisation and it should be followed up by more empirically-focussed research. In proposing this DR conceptualisation, the author is influenced by several years of empirically oriented DR. However, these empirics are not brought explicitly into the paper, but form a tacit background. As stated, the next step of this research is to conduct empirical grounding for this practice conceptualisation.

2 Attempts to Conceptualise Design Research

There have been many attempts to conceptualise design research. One salient contribution is the division of DR into two main activities: build and evaluate [2], [3], [11]. There are several proposals of extensions of this basic DR division. Offerman et al [6] have added problem identification to the build and evaluate activities. Sein et al [5] have made another expansion of build and evaluate. In an attempt to integrate DR with action research, they have added intervention as a third core activity, although these three activities are kept together in an integrated way in “BIE cycles”. They also include problem formulation as well as reflection and learning in DR. There are also further expansions of DR activities into prescriptions of DR processes. Peffers et al [4] describe a six step DR process consisting of problem identification, objective definition, design, demonstration, evaluation and communication. The classical paper by Nunamaker et al [1] also contains a process description consisting of five steps; three design steps in the middle are surrounded by an initial conceptualisation and a concluding evaluation. Another proposal for the DR process can be found in [7] where the DR process consists of five steps: problem awareness, suggestion, development, evaluation and conclusion. There are already integrative approaches that try to combine and condensate previous process proposals, e.g. [6], [8]. However, in these detailed process descriptions, the different activities are grouped together mainly using the build – evaluate division. This means that the original build – evaluate dichotomy seems valid and useful for describing DR, although there will of

course exist many identifiable and related activities. Several of these other identified DR activities can thus be seen as sub-activities of build or evaluate.

The build – evaluate descriptions of DR seem to have a focus on the generation of the design artefact. This is, however, interpreted as a limited view of DR. The prevailing view [3], that the main result of DR is the designed artefact, has been questioned by several scholars. The importance of creating abstract knowledge besides concrete artefacts is contended by [20], [21], [25], [26]. The DR process models accounted for above can be said to be linear, one-level process models, e.g. [1], [4]. Alternatives are formulated with two interacting levels; one concrete design level and one abstraction level [21], [25], [26], [27]. This is fully in line with the suggestions made by many advocates of design theory in DR, e.g. [7], [18], [19], [28], [29]. If one scrutinizes the process models mentioned above, in some there are elements that point to abstraction and theorizing and not to concrete design. Examples of this are: learning and reflection [5], conclusion [7] and communication [4].

Some part of the diversity of DR activities and processes has been mentioned briefly above. They all give their valuable fragments to our required understanding of what we, as researchers, do when we conduct design research. The DR process models have been put forth with the ambition to be comprehensive; e.g. [4], [5], [6], [7], [8]. However, these models do not fully take into account the interaction between concrete design and abstraction/theorizing. We still need a DR conceptualisation that acknowledges, in a clear way, the dual DR purposes of contributing to 1) practical problem solving through design of artefacts and 2) the knowledge goals of a scientific community [21] in a clear way.

3 A Pragmatic Conceptualisation of Design Research

The selected way to move forward in conceptualising design research is not to make a comprehensive listing of possible DR activities in order to arrive at a complete DR process. The approach taken is to identify core sub-practices of DR and to clarify relations between these sub-practices and also relations to surrounding practices. This approach follows a general practice-orientation of this research. Design research is in itself considered a practice; a research practice [30]. A practice is considered to be "embodied, materially mediated arrays of human activity centrally organized around shared practical understanding" [35, p 2]. Even if a practice sometimes can be performed by one human actor at a time, these activities and their results should be seen as based in a shared inter-subjective understanding. A practice is a social phenomenon. A practice consists usually of constellations of actors, actions and objects [36]. Important to add is that a practice produces results that is considered valuable to some actors. A practice means doing something in favor of some people [36].

3.1 Meaningful Sub-practices of Design Research

The current ambition is thus to have a small set of sub-practice and find a few main sub-practices of DR. Since design research is in itself an artificial workpractice, there

is no right division of sub-practices. There is no possibility to find the correct delineation of practices. We must instead find a suitable and adequate division and delimitation. In the search for primary sub-practices, the well-known divisions of build and evaluate seems to be proper candidates. There are many DR references that either argue for these two as core DR activities or simply take them for granted. A design/build activity is obvious in DR since the whole idea is to design artefacts. However, there almost seems to be a consensus among DR scholars that a build activity should be supplemented by evaluation activities. Most scholars claim evaluation to be a clearly identifiable and separate activity (e.g. [3], [22]). There are however, some scholars [5] who see evaluation as an integrated part of building artefacts. I can agree that there should be a continual assessment of design proposals which should be conducted directly related to the design situation. However, there seem also to be obvious needs for separate and distinct evaluation activities; confer figure 1.

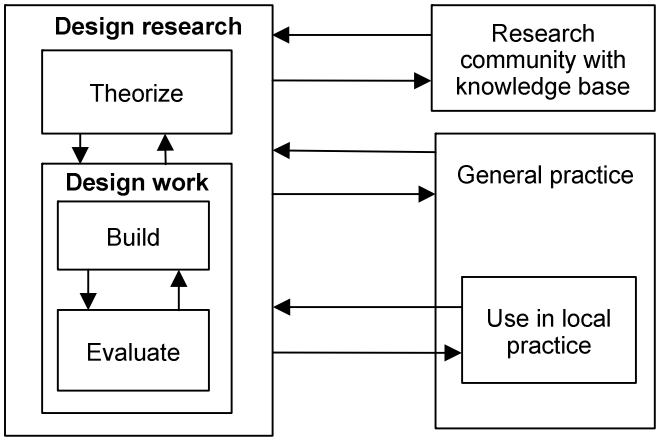

Fig. 1. Sub-practices of design research and relations to surrounding practices/communities (with inspiration from [3], [21], [30])

As discussed in section 2 above, there are many scholars who claim that there should be a clear theoretical output from DR which means that there should be clearly distinguishable theoretical activities within DR. There are several scholars who describe DR in two layers [21], [25], [26]; one design-oriented and one oriented towards theorizing and abstraction. This differentiation into theorizing and concrete design is important when clarifying DR practices. In [26] the two realms are called "abstraction domain" vs. "instance domain". In [21] the two realms are called "meta-design practice" vs. "design practice". In order to be explicit about its theory generating purpose I will call this sub-practice theorize below. The two other activities of build and evaluate can be grouped under the label design work corresponding to "instance domain" [26] and "design practice" [21]. However, in the following, build and evaluate will constitute two sub-practices, and theorize will thus be the third sub-practice of DR; confer figure 1.

These three sub-practices will be based on different *cognitive orientations*. The build practice will be based on a *design orientation*; the creation of tangible artefacts that are intended to be practical and useful. The evaluate practice will be based on an *inquiry orientation*; i.e. investigating something and stating something about it. Evaluate takes an artefact as an input and based on some investigation and assessment it produces statements concerning this artefact. Theorize will be based on an *abstraction orientation*. Abstract knowledge is created concerning some phenomenon. Each of these sub-practices produces results that should be valuable to other practices.

3.2 External Practices to Design Research

The next question to deal with is what type of external practices exist and are related to design research and its three sub-practices. Hevner et al [3] distinguish two realms that IS design research relates to; the knowledge base and environment (consisting of people, organizations and technology). This means that the research activities of DR interact with a business environment and a science environment. In [21] a differentiation into three related practices/communities are made: 1) Research community, 2) practice community and 3) use situation. Compared with [3] and its business environment, a differentiation is here made between the general practice level and the actual use situations. General practice is defined in the following way: "It is important to note that 'general practice' should be interpreted as a special kind of abstraction. It is not one particular practice. When talking about general practice we mean a set of different practices with relevant similarities." [30, p 10]. This division into the general vs. the local is an important distinction for the continued discussion. In figure 1, these three practices/communities are called 1) research community, 2) general practice and 3) use in local practice. Figure 1 thus includes a division of DR into three sub-practices (theorize, build and evaluate) and defines that DR has relations to three external realms (communities/practices). This is one step towards a pragmatic conceptualisation of DR. The next step will be to define the relations between these different practices.

3.3 The Use of Activity Cycles in Design Research

Hevner [11] uses the view of activity cycles to clarify DR. He speaks of three cycles: The design cycle that iterates between build and evaluate; the relevance cycle that iterates between the DR activities and the practice environment; the rigor cycle that contains the utilisation of extant knowledge in DR and the addition of new knowledge from DR to the knowledge base. This cycle construct states that interaction occurs between two types of activities/practices. There is an exchange of knowledge between the two mentioned activities. However, in [11], or in [3], there is no systematic specification of the knowledge exchange between the two mentioned activities. Some parts of the knowledge exchange are mentioned in running text. As identified above (section 3.1-2) the Hevner DR framework, [3] and [11], operates with fewer practices than the one articulated in this paper. In [3] there is no clear differentiation between

general practice and local use practice, and the theorizing sub-practice of DR is not included either.

Earlier attempts to use and develop the cycles of the Hevner framework have been made in different directions. An expansion of the three cycles to four has been made by [27], when adding an abstract knowledge activity within DR that has cycle relations to the design activity; confer similar conceptualisations in [21]. There is a discussion [31] regarding which part (in a DR sub-practice) informs which part (in another DR sub-practice). As concluded, there can be mutual informing processes. Confer also related discussions on inductive vs. abductive approaches in DR [26], [32]. Evaluation will play pivotal roles in DR. As noted by several scholars, e.g. [8], [21], evaluation will interact with both build/design and use and will thus have different functions in relation to these activities. Evaluation will also have an important impact on theorizing [21], [26], [31].

3.4 Design Research Internal Cycles

The governing idea in this pragmatic conceptualisation of DR is to clarify the primary knowledge exchange that may occur between the different sub-practices. Activity cycles between sub-practices will be specified. In a pragmatist spirit, the different sub-practices are conceived as functional in relation to each other. This means that the starting-point in the analysis below is that there is a mutual interchange and serving. Practice A serves practice B with some knowledge and practice B serves practice A with some knowledge. These mutual serving processes are conducted through the activity cycles. The interaction within the activity cycles can in several cases be seen as initiatives and subsequent responses to these, following the well-known construct of adjacency pair from conversation analysis [33]. The three sub-practices of design research give rise to three activity cycles (figure 2):

- Theorize – Build cycle (T-B)
- Theorize – Evaluate cycle (T-E)
- Build – Evaluate cycle (B-E)

Design research can be performed in a theory-informed way. Fischer et al [32] describes this as one possible option, in DR, as an abductive approach; confer also [26]. Sein et al [5] emphasize that the designed artefact should be a theory-ingrained artefact. This means that theories can be used actively in DR governing both build and evaluate. This is called theory as guidance in figure 2. The theory as guidance covers both descriptive-explanatory “kernel” theories [18] and design-oriented theories [18], [19]. It covers also the cases 1) when extant theories from the knowledge base are selected and possibly adapted to the DR situation and 2) when ideas, observations and reflections from the on-going DR process is abstracted to an emergent theory that can then be fed back to build and evaluate from theorize. Besides such empirical data, the build practice will produce the designed artefact as its main output to theorize. In the view of DR put forth here this is pivotal. It is not the artefact per se that is the scientific contribution from DR. It is abstracted knowledge about artefacts [21], [26]. The artefact from build is an artefact to theorize. The theorize sub-practice will create

abstract knowledge about artefact functions, structure and other properties. These abstractions may be fed back to design work, but they will also be a distinct outcome from DR to practice and research communities (see section 3.5 below).

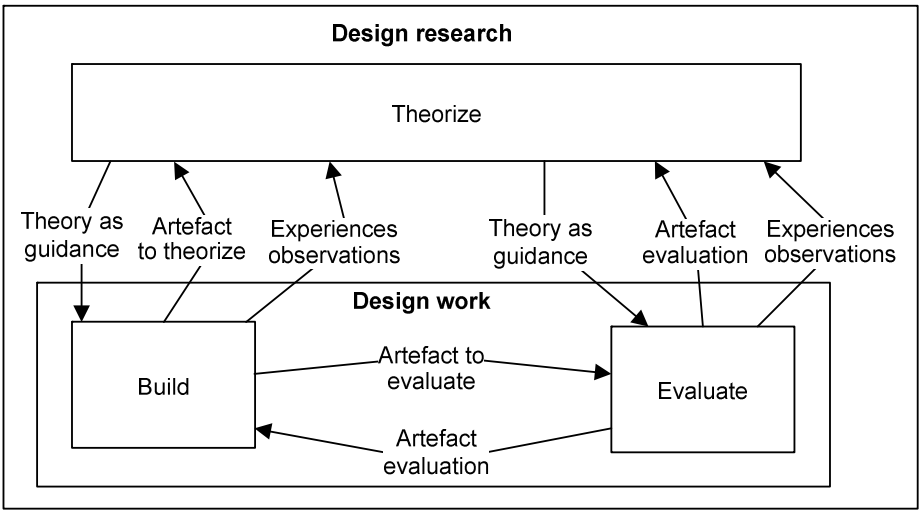

Fig. 2. Activity cycles of design research (internal cycles)

An important input to theorize is the explicit evaluations that will be conducted as part of the design work. There may be different types of evaluations; e.g. an artificial evaluation of a proposed artefact or a naturalistic evaluation of the real use of designed artefacts [8], [22]. Such evaluations will have an important function in empirical grounding of the abstract design knowledge in the theorizing practice [21].

The main input from theorize to build and evaluate is said above to be theory as guidance. Theory is here used in a generic sense. It should not be interpreted literally as only *one* theory. There can of course be different theories; both extant and emergent theories and both kernel theories and design theories, as indicated above. One important basis for further theorizing and justification of these theories is the experiences of theory use in build and evaluate. Were these theories applicable in building and evaluating? How useful were they in these activities?

3.5 Design Research External Cycles

Design research interacts also with external practices (figure 1). The three DR practices and the three external practices make it possible to distinguish nine cycles (3*3) if all internal practices are seen as having relations to all external practices. However, it is not considered meaningful to make this kind of elementary division. Instead four main activity cycles are distinguished (figure 3):

- Theorize – Research community cycle (T-RC)
- Design research – General practice cycle (DR-GP)

- Build – Use cycle (B-U)
- Evaluate – Use cycle (E-U)

The main activity cycle relation of the research community to the design research practice is to its sub-practice theorize. Theories from the knowledge base can be selected in the theorize sub-practice and furnished to build and evaluate in the T-B and T-E cycles described above (section 3.4). Theories from the knowledge base can be used as basis for developing new theories in theorize or used for theoretical grounding of developed theories [7], [21].

The abstracted result from design research/theorize is in figure 3 expressed as design theory. It is far from always that DR scholars codify their abstract results as explicit design theories according to well-known design theory templates [18], [19]. However, proper DR should abstract results in terms of prescriptions or design principles that may be useful for other design endeavours. Even if not all abstracted results from DR can be seen as full-blown design theories, they should at least contain design-theoretical fragments, like e.g. desirable properties of artefacts, principles and prescriptions for design processes.

The DR contribution to general practice is design-theoretical knowledge. This includes knowledge about artefact properties that are deemed valuable for use-situations. This may also include knowledge about appropriate procedures to conduct development of proposed artefacts. Design research requires knowledge about general practical needs. This is background knowledge that is considered valuable to all three DR practices. Therefore this activity cycle is defined as design research - general practice. In order to create an artefact solution that is not limited to studied local practices, it is important to be aware of needs that relate to the problem class situation [27]. It is not only in the build practice that it is valuable to be knowledgeable about general practical needs and problems. The artefact evaluation can also take into account general demands on the artefact solution. Theorizing should apply to abstracted/general problems, needs and artefact properties.

Through activity cycles, the practice of local use is related to build and evaluate. The build practice delivers an artefact to use. This is partially based on local practical needs, which include problems, goals, opportunities and other relevant practical knowledge. Directly observable use effects and communicated use-experiences may be fed back to build practice for revised design. In-depth studies of artefact use and different effects will be conducted through the evaluate practice. The evaluate practice studies artefact use-situations in different ways. In figure 3 this is called arrangements for capture and evaluation. There will be some intervention into local use practices by actors conducting evaluation. There may be some arranged observations. Questions can be posed to artefact users in different ways and there might be other ways of capturing data. The local use-situation will be exposed to the evaluative practice as a data source arranged according to the stated objectives of the evaluation and the design research endeavour. As described above (section 3.4), artefact evaluations should be used as basis for revised design (in the build practice) and for theory development and for empirical grounding of theories (in the theorize practice). The artefact evaluations can also be a basis for the local use-situations. Think of a

situation where the evaluation does not give rise to any artefact redesign. The artefact evaluation can still be used to improve the use-situation. This can be characterised as an improvement of an artefact-given use. The intervention of a new artefact (from the build practice) implies an improvement of the local work situation. It is the artefact in itself that is a basis for improvement. An artefact evaluation can improve the local practice through evaluative knowledge about artefact use.

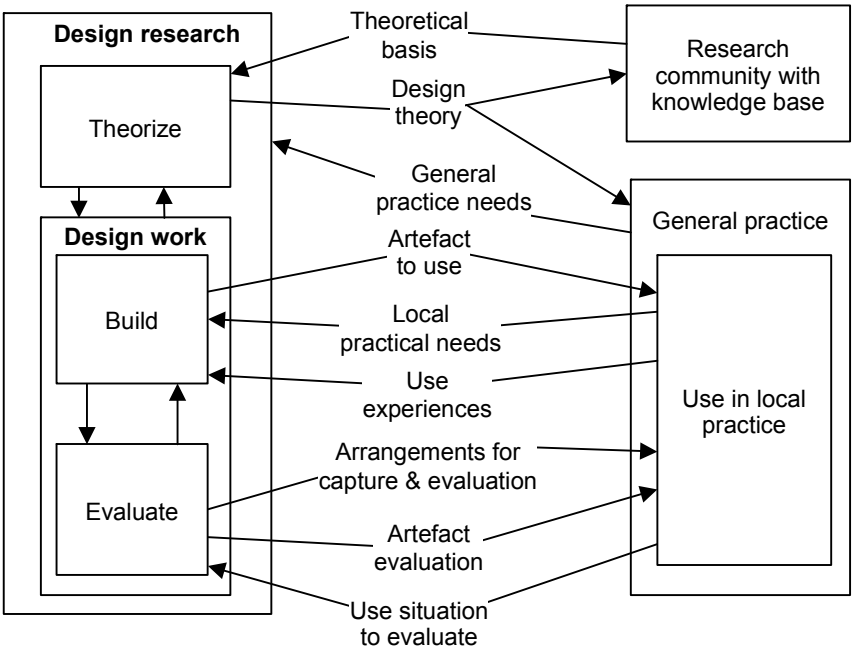

Fig. 3. Activity cycles of design research (focus on external cycles)

3.6 Multi-functionality of Practices

The pragmatic starting-point for this study has been the view that practices are *functional* in relation to each other. This also means that practices are *multi-functional*. For example, the theorize practice produces theories that should be valuable as guidance for the DR practices of build and evaluate, be a proper addition to the knowledge base of the IS research community and also a valuable contribution to general practice in activities of procurement, development and use. The designed artefact is of course primarily aimed for use in local practices. It should, however also be a basis for evaluation and theorizing. The artefact evaluation is also multi-functional. Evaluations can be a modifying basis for redesign of artefacts and they may also have a justificatory role for the conducted design. Evaluation plays a pivotal part in theorizing since it contributes with adapted and generated empirical data. It may also support an adaptation of artefact use in local practices.

It is also important to note the *amalgamation of input* in the sub-practices. For example, the build practice will blend different kinds of input (local practice needs, general practice needs, theoretical guidance of diverse kinds, use experiences and different types of evaluations) in the generation of an artefact.

4 Conclusions

After the explicit introduction of design research as an important research approach in IS, through the landmarks of [1], [2], and [3], there has been an abundance of papers attempting to conceptualise design research or parts of it. These contributions have been important since the traditional explanatory research approach has influenced our thinking to such an extent that it has been hard to imagine other ways of conducting science. This paper has also contributed with an attempt to conceptualise design research. Why yet one more? Do we need any more conceptualisations? Is it not time to say that it suffices?

The presented DR conceptualisations show great diversity even though some convergence is discernible. This diversity, fragmentation and sometimes confusion calls for an elaboration of the conceptual foundations for conducting design research within information systems. The missing theoretical dimension in the seminal work of [3] is probably a major reason for the inadequacies of several of the subsequent conceptual works. The need to integrate theorizing into DR has been acknowledged by several scholars and has also been an impetus for this paper.

This paper tries to take an explicit pragmatist stand in elaborating DR. It has investigated activities and process descriptions of DR and through this investigation it has pointed out three main sub-practices of design research and how these are related; the practices of theorize, build and evaluate. It has also identified three external practices/communities related to DR: research community, general practice and local use practice. DR relations with these external practices have been analysed and described.

The relations between the practices have been described as activity cycles following [11]. The three cycles in the Hevner framework [11] has been expanded to six activity cycles which have been described and depicted in models:

- Theorize – Build cycle
- Theorize – Evaluate cycle
- Build – Evaluate cycle
- Theorize – Research community cycle
- Design research – General practice cycle
- Build – Use cycle
- Evaluate – Use cycle

In the Hevner framework [11], the activity cycle between design research and the knowledge base (research community) is called rigor cycle. However, there must of course be rigor inside design research and its internal cycles. Rigor is rather

something that is created through a proper combined execution of the different activity cycles, both internal and external cycles.

The research presented here has been conceptual. Although not explicitly referred to, due to the stated scope and aim of the paper, the author's extensive experience of DR has had a certain influence on the content of this paper. In future research the presented conceptualisation needs to be more sharply applied and related to concrete examples of design research as empirical sources.

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