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Linking Theory and Practice

Reinventing the future: adding design science to the repertoire of organization and management studies

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Abstract
Mainstream research on organization and management is largely modeled after the natural sciences and the humanities. It aims at understanding social systems and, as such, has produced a vast knowledge base. However, this knowledge base has been criticized as fragmented and lacking relevance for practice. Two recent developments have produced the possibility of reinventing the future of organization and management studies: the increasing interest in design science research and in evidence-based management. First, we discuss how the actor perspective and solution-orientation of design science research can lead to more relevant research output. Second, we explore how the use of this research output in evidence-based management – typically via a design-oriented research synthesis – can decrease fragmentation by drawing together various strands of research and, moreover, lead to more relevant and interesting research questions, aiming at understanding as well as solution design Adding design science research to the repertoire of organization and management studies can create a virtuous cycle toward a future in which these studies matter more than they do now.
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Organizations are pervasive, important and highly interesting social systems, worth studying for knowledge's sake (Huff, 2000). Mainstream organization research strategies, aimed at understanding organizations and explaining their behavior, are largely based on the approaches of the natural sciences and, more recently, also the humanities (Banathy, 1996; Romme, 2003). The science approach deals with organizational phenomena as empirical objects, whose properties and behavior can be explained on the basis of objective variables (Mohr, 1982; Donaldson, 1985, 1996). The typical science-based research strategy is quantitative. The humanities approach studies organizational phenomena in terms of what actors think and say. The aim is to understand, interpret and portray the human experience in and around organizations (Zald, 1993). The typical research strategy here is qualitative.

Organization and management research, based on these two archetypical approaches, has produced a vast knowledge base. However, this knowledge base has been criticized as having too little relevance for practice (see e.g., Beyer and Trice, 1982; Daft and

Lewin, 1990; Hambrick, 1994; Tranfield and Starkey, 1998; Rynes *et al.*, 2001) and for being too fragmented (see e.g., Koontz, 1980; Whitley, 1984; Pfeffer 1993; Van Maanen 1995; Whitley 2000). Banathy (1996) presents a third archetypical approach for studying organizations, which can be a promising addition to these first two approaches. This is the design science approach. Both the science and the humanities approach help to understand organizations as natural systems that are "out there waiting to be studied." However, organizations are also artifacts, shaped through design-based interventions by their founders and other change agents, as well as action systems created and sustained by their stakeholders to combine and coordinate actions to further common goals. Therefore, it is important to complement research into organizations-as-natural systems with studies of organizations-as-artifacts. These latter will provide additional understanding of organizational phenomena, following the adage "if you want to understand a system, try to change it" (Kurt Lewin, cited in Starbuck and Nyström, 1981). Moreover, this research approach may provide the various stakeholders of organizations with the kind of knowledge that is instrumental in designing, changing and redirecting their organizations.

Two recent developments have increased the potential of extending the repertoire of organization and management studies with design science research. First, there is an increasing interest in design and design science research itself (e.g., Romme, 2003; Van Aken, 2004; Huff *et al.*, 2006; Bate, 2007). Second, evidence-based management (EBM) is becoming increasingly popular in organization and management studies (e.g., Tranfield *et al.*, 2003; Pfeffer and Sutton, 2006; Rousseau, 2006). Relevant input for EBM can be produced by design science research and by design-oriented research synthesis. The combination of these two may reinvent the future of organization and management studies: the relevance problem of organization and management studies can be mitigated by using the actor perspective and solution orientation of the design science research approach, and the fragmentation problem can be addressed by design-oriented research synthesis, drawing together various research streams in order to develop design propositions to be used in EBM. Both developments can lead to research that matters more.

The argument is organized as follows. The first section will provide a general definition of the three archetypical approaches to organization studies previously mentioned: the sciences, humanities, and the design sciences. We then develop the design science research approach, by articulating its main product (namely field-tested and grounded design propositions), by analyzing the use of such design knowledge in designing or improving organization structures or management systems. Subsequently we turn to EBM and how design-oriented research synthesis is used as input for this. Finally, we discuss how this combination of design science research and EBM can serve to reinvent the future of organization and management studies.

Three archetypical approaches to organization studies

Banathy distinguishes three archetypical approaches to organization studies: the sciences, the humanities, and the design sciences (Banathy, 1996; Romme, 2003). In the approach of the sciences one tries to understand social phenomena on the basis of consensual objectivity, by uncovering general patterns and forces that explain and predict these phenomena. Exemplars are not only the natural sciences like physics, but also other disciplines that have adopted the approach of the natural sciences, for example economics. The approach of the sciences draws on a representational view of knowledge (Banathy, 1996).

Scholars adopting research strategies based on the approach of the humanities intend to portray, understand and critically reflect on the human experience of actors inside social practices. Their role models are diverse disciplines such as aesthetics, ethics, hermeneutics, history, cultural studies, literature studies and philosophy. The predominant notion of knowledge development is a constructivist and narrative one: all knowledge arises from what actors think and say about the world (Zald, 1993; Romme, 2003). Research strategies based on the approaches of the natural sciences and the humanities deal with *pure knowledge problems*, such as the explanation of the degree of concentration in a certain industry. The resulting research products add to our knowledge of organizations-as-natural-systems.

On the other hand, research strategies based on the approach of the design sciences such as medicine and engineering are driven by *field problems*. A field problem is a problematic state in social or material reality. In medicine, these concern *improvement problems* with respect to the well-being or performance of existing entities.

(In organizations one also has improvement problems, for example, improving the delivery reliability of existing production systems). Engineering is typically concerned with *construction problems* with respect to not yet existing entities. (An example of a corresponding construction problem in organizations is the design and implementation of new account management systems in a sales department.) Design science research is interested in systems that do not yet exist or in improved performance of given systems. These systems or performance improvements come into being by creating new practices from scratch or by changing present social practices and situations into desired ones (Simon, 1969, 1996). Design science research extends the body of knowledge on organizations-as-artifacts. Other, more mature, design sciences – that is, disciplines in which design science research constitutes the mainstream – can serve as exemplars. These exemplars include medical science and engineering disciplines such as architecture, aeronautical engineering and computer science. These disciplines draw on a pragmatic view of knowledge, implying knowledge is developed in the service of action and is prescriptive and synthetic in nature – but not at the cost of the science mode of research (Simon, 1969; 1996; Banathy, 1996). Following Simon, artificial systems "have no dispensation to ignore or violate natural laws" (Simon, 1969: 6).

As in many other social sciences, the approach of the sciences has thus far prevailed in organization studies, with the humanities approach as an emerging antithesis and critical opponent (Zald, 1993). See also Shrivastava (1987) on the "sociological forces" privileging quantitative research. Most disciplines within the social sciences have in the past few decades been pre-occupied with the epistemological debate between the quantitative, neo-positivistic science and the qualitative, interpretative humanities approach. This debate appears to have turned attention away from the important issue of research objectives and our commitments as scholars (Wicks and Freeman, 1998). As a result, design thinking is largely absent in the social sciences. Design science research in the social sciences, if any, has thus largely moved to other sites in society (e.g., management consulting and applied research agencies). This strongly differs from the situation in the natural sciences and engineering, where the partnership between design and explanatory science research has been the main force behind the development of numerous modern technologies (Banathy, 1996).

Design science research on organizations

Simon's seminal book "*The Sciences of the Artificial*" (Simon, 1969; 1996) showed the fundamental differences between research in the service of the design of artifacts and research aiming at analyzing and explaining the behavior of (given) natural systems. Simon dealt with construction problems, that is, problems concerning the design of artifacts according to certain specifications, such as in engineering design. We can extend this approach by including improvement problems concerning the design of interventions to improve the functioning of existing entities, such as in medicine. Disciplines, engaged in the analysis and design of artifacts are called the sciences of the artificial by Simon. In this paper, we refer to "design sciences" because their mission is to develop *general knowledge* to support the *design* of solutions to field problems (not the art of the actual solving of specific field problems, which is the domain of the professionals of the discipline in question).

Design science research can be defined as research, based on the approach of the design sciences, that is, research that develops valid general knowledge to solve field problems. Design science research has the following characteristics:

- research questions are driven by field problems (as opposed to pure knowledge problems);
- there is an emphasis on solution-oriented knowledge, linking interventions or systems to outcomes, as the key to solve field problems;
- the justification of research products is largely based on pragmatic validity (do the actions, based on this knowledge indeed produce the intended outcomes?).

Design science research is not confined to engineering and medicine, but can be found in various other fields. Examples are computer science and information systems (e.g., March and Smith, 1995; Hevner *et al.*, 2004), accounting (e.g., Kasanen *et al.*, 1993; Labro and Tuomela, 2003) and education (e.g., Kelly, 2003; Barab and Squire, 2004; Collins *et al.*, 2004). In a given discipline, design science research can be a minor research stream. If it is mainstream research, as in medicine and engineering, that discipline can be called a design science. A discipline such as physics or economics, which involve little or no design orientation, is called an explanatory science. The mission of an explanatory science is to explain the behavior of existing entities in a quest for truth, whereas the mission of a design science is to develop knowledge to support the solving of improvement of construction problems in a quest for improving the human condition.

The intended product of design science research is a major issue. A *specific* design, tested in a *specific* setting constitutes empirical data rather than a main research product. Design science research should aim at developing *general design propositions* to be used in designing solutions to field problems. Input to the design of solutions for field problems includes descriptive knowledge, providing understanding of these problems. However, a key input to solution design concerns solution-oriented or prescriptive knowledge. Prescriptive knowledge follows the logic of the technological rule, a concept adopted from Bunge's philosophy of technology (Bunge, 1967). He defines such a rule as "an instruction to perform a finite number of acts in a given order and with a given aim" (Bunge, 1967: 132). We use this concept in a more general way and prefer for various reasons to use the term "design proposition": a design proposition is "a chunk of general knowledge, linking an intervention or artifact with an expected outcome or performance in a certain field of application" (Van Aken, 2004: 228). "General" here means that it is not a specific solution for a specific situation, but a general solution for a type of problem. (On the other hand, a design proposition is a mid-range theory, whose validity is limited to a certain application domain.)

Formulated in another way, the logic of the design proposition is, "if you want to achieve Y in situation Z, then apply intervention X." The core of the design proposition is X, a general *solution concept* for a certain type of field problem. The remainder of the proposition is a kind of user instruction connecting the solution concept with the field problem, including indications and contra-indications, that is, knowledge on when to use the solution concept and when not to. The solution concept can be an act, a sequence of acts, but also some process or system. Prescriptive knowledge follows this simple intervention-outcome *logic*, but its *form* may range from a brief recommendation to an article, a report or a whole book.

The most informative type of design proposition is the field-tested and grounded one. A design proposition is "field-tested" if it is tested in its intended field of application. Van Burg *et al.* (2008) provide examples of such design propositions. A design proposition is "grounded" if it is known why, through what mechanisms, its application produces the predicted outcomes. In engineering and medicine, grounding can be based on natural laws and other objective and universally valid cause and effect knowledge. In organization science, grounding can be achieved on the basis of "generative mechanisms," mechanisms linking management interventions with outcomes (Pawson and Tilley, 1997; Van Aken, 2005). In the social world, there are no invariant and universal mechanisms, as there are in the physical world. Nevertheless, following Numagami (1998), there are observable stable patterns in social phenomena, which are reproduced by human conduct, consciously or unconsciously, and supported by stable shared knowledge and beliefs. Generative mechanisms are such stable patterns of thinking and acting, triggered by intervention or by system, and producing outcomes. See also Pajunen (2008) on explanations of outcomes in terms of social mechanisms. Humanities-inspired research can be a powerful approach to uncover generative mechanisms. For instance, humanities-inspired, interpretative research may uncover the generative mechanisms, triggered by certain management interventions, producing resistance to organizational change in given contexts. Similarly, the same kind of research may uncover the mechanisms, triggered by other interventions, producing support for change.

Design propositions involve general knowledge on general solution concepts for types of field problems. In actual solution design, a practitioner has to choose a fitting solution concept and has to contextualize it for the specific setting. This demands considerable expertise, including in-depth knowledge of alternative solution concepts, of their properties and their potential for various settings, and of the local situation. Design propositions are not developed for the layman but for the professional.

Evidence-based management and design-oriented research synthesis

Knowledge produced by design science research is expected to be used in solving field problems. Thus, the recent call for EBM (Tranfield *et al.*, 2003; Pfeffer and Sutton, 2006; Rousseau, 2006; Rousseau and McCarthy, 2007) complements the increased interest in design science research: design science research can produce important input for EBM.

The call for EBM is based on ideas of evidence-based medicine, a successful practice in medicine (see e.g., Trinder and Reynolds, 2000; Petticrew, 2001). In this approach, protocols (cf. design propositions) are developed for certain types of medical disorders through systematic review of the literature, followed by research synthesis. Although evidence-based practice has branched out to other fields in the meantime (e.g., Davies *et al.*, 2000), some may question whether it is possible and feasible to create evidence-based practices in management (cf. the title of Rousseau, 2006: "is there such a thing as evidence-based management?"). Therefore, Tranfield *et al.* (2003) preferred the term "theory-informed management." The role of formal, explicit knowledge in management may indeed be somewhat more modest than in some other fields, but it is gaining support in the academy of management community (e.g., see http://www.evidence-basedmanagement.com).

Furthermore, its potential can be seen in those MBA course programs, where students engage in theory-informed field problem-solving projects. If the program is based on the paradigm of the design sciences, business problem-solving is the core competence of the MBA. A key element of the development of this competence is field problem-solving. A discussion of the potential and pitfalls of theory-informed business problem-solving by students, based on many years of experience, is given by Van Aken *et al.* (2007). As in evidence-based medicine, problem-solving in these projects is based on a (formal or sometimes less formal) systematic review of the literature on their type of field problem, followed by a synthesis into a number of alternative solution concepts. In the review, students typically use academic literature (typically based on the explanatory paradigm, and therefore rich in evidence but poor in solutions) as well as "practice-based literature" (almost always informally based on the design paradigm that is rich in practical solutions, but currently also poor in evidence). The next step in the process is to discuss the alternative solution concepts with the client, make a choice and then to contextualize the chosen solution.

The research synthesis after systematic review of all the literature on a certain type of organizational problem will typically yield not a single but a set of solution concepts. Some will be alternatives for one another, and in deciding among them the practitioner draws on context and objectives; others may give solutions for more detailed design issues, giving the set a multilevel and possibly a nested structure. For instance, a solution concept for production control of a factory is Goldratt's so-called Theory of Constraints (Goldratt and Cox, 1986). The highest level of his solution theory is to maximize the utilization of the bottleneck, or capacity-constraining group, if you want to maximize the output of the factory as a whole. A next level solution theory would involve a method to determine which group is the bottleneck group. Applying the latter solution theory may necessitate measuring the potential output of a production group, so solution theories on the next level may utilize one or more methods to do so.

Design science research strategies

Design-oriented research synthesis is a key process in EBM, but also in design science research (a further discussion of design-oriented research synthesis in management is given in Denyer *et al.*, 2008). If one is interested in developing design propositions for a given type of field problem, one starts with a systematic review of the existing knowledge-base on that issue, to be followed by a synthesis of design propositions. The review and synthesis can produce design propositions to be developed further, but can also uncover gaps in the existing literature – for example, insufficient explanatory theory on certain aspects, deficient field-testing and/or the absence of any knowledge for grounding the propositions. On the basis of these limitations, research questions or development objectives are defined and further research is initiated. The findings are incorporated in the existing knowledge-base, which in turn may lead to further research questions, and so forth (see Figure 1). In a relatively mature field of research, systematic review in itself can produce field-tested and grounded design propositions. In a new area of research, field research is needed to generate data on the basis of which a first set of initial design propositions can be defined, which then in turn drives further experimentation and development.

The research strategy proposed here, triggered by the knowledge gaps uncovered by systematic review and research synthesis, may consist of any one or a combination of computational, explanatory, mathematical, experimental, interpretive or exploratory methods (Banathy, 1996). Testing a design proposition to find out *whether* it works can be done by means of statistical tests, clinical case studies, pragmatic experimentation and action research (e.g., Argyris *et al.*, 1985; Schein, 1987; MacLean *et al.*, 2002). Research that intends to ground a technological proposition to explain *why and how* it produces certain outcomes will typically have to draw on survey-based field studies,

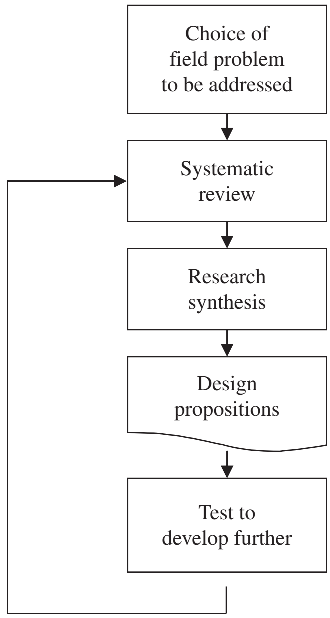

Figure 1 The design science research cycle.

comparative case studies or mathematical simulation (e.g., Eisenhardt, 1989; Oliva and Sterman, 2001; Wageman, 2001). This list of research methods is merely illustrative.

Design science research can, in principle, use all known methods for data gathering and analysis. However, in practice, research strategies tend to be case-based, collaborative and interventionist. Collaborative approaches are used to foster a deeper understanding of the problem, of the actors involved in it, and of the outcomes, intended and unintended, of alternative interventions or systems as well as to gain access to the field problems. Interventionist approaches serve to learn to understand the dynamics of the incumbent systems and to test the various solution concepts. Van Aken (2004) describes a process of developing design propositions for a type of field problem through a series of interventionist and collaborative case studies on the basis of the "reflective cycle." A (collaborative) problem solving project on a specific example of that type of problem is undertaken, followed by reflection on the solution to tease out a general solution theory or concept, which might be used for the same type of problem in another setting. Then another project on the same type of problem is undertaken, after which further refection may lead to an adaptation of the solution concept, and so forth. An essential element of the development is so-called beta-testing, that is, the testing of the design proposition by others than the original developers of the proposition, to eliminate bias and to optimize its ease for use (Van Aken, 2005). This beta-testing is done in the last cases of the series. Examples of research following this reflective cycle include Rozemeijer (2000), developing solution concepts for organizing the purchasing function of an industrial company; Andriessen (2003), developing solution concepts for the valuation of the intangible assets of an organization and Romme and Endenburg (2006), developing solution concepts for re-engineering organizations around the notion of circularity.

It is difficult to overstate the importance of researcher–practitioner collaboration in design science research. Its absence is cited by many as a major cause of the relevance problem (Rynes *et al.*, 2001). The development of design propositions on the basis of systematic review, research synthesis and original research is preferably accomplished in a collaborative mode. But already the choice of which field problems to tackle is an obvious example of joint practitioner–researcher activities. Moreover, literature written by practitioners can be included in the systematic review. The need to acknowledge practitioners as producers of relevant knowledge is advocated by Hoshmand and Polkinghorne (1992) and in a much more recent, powerful call for practice-informing theory by Bartunek (2008). There are often limitations in the literature written by practitioners (such as the possible limited empirical evidence for the propositions given), but this type of literature may contain valuable "nuggets" (to use the words of Pawson, 2006).

Conclusion

The actor perspective and solution orientation of design science research can mitigate the relevance problem of organization and management studies by producing knowledge that is geared toward designing solutions for field problems. It can also serve to develop a more fundamental understanding of organizations by taking into account that they are not only natural systems, but also action systems designed to combine and coordinate human action to realize common objectives.

Explanatory research is a quest for truth. Such a quest can easily lead to competing truths and the use of competing paradigms. Design science research is a quest for improving the human condition. Design propositions are tested on pragmatic validity. Design-oriented research synthesis can draw on a broad variety of inputs (Van Aken *et al.*, 2007; Denyer *et al.*, 2008). Any contribution that can add to our understanding of what works or does not work can be used. This type of research synthesis can therefore decrease the fragmentation of the field.

Including design science strategies in the repertoire of organization and management studies is likely to lead to a greater use of its results in practice. Steam engine development gave a boost to the development of thermodynamics; aero plane engineering boosted aerodynamics. Similarly, using organization research outcomes in practice can help boost further research by formulating more interesting explanatory and design research questions, the field testing of results of these research questions, and formulating new research questions. We hope this process will create a virtuous cycle, reinventing a future in which organization and management studies matter much more to practitioners and their stakeholders.

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