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A Design Science Approach to Evidence-Based Management

Joan Ernst van Aken and Georges Romme

Eindhoven University of Technology

"Design is (…) the principal mark that distinguishes the professions from the sciences. Schools of engineering, as well as schools of architecture, business, education, law, and medicine, are all centrally concerned with the process of design."
Simon (1996, p. 111)

This chapter builds on the idea proposed by Nobel laureate Herbert Simon that organization and management research is a science of design. Evidence-Based Management (EBMgt) as characterized here has as core a design process individuals and teams use to solve real-world organizational problems through the use of scientific evidence, local facts, and experiential learning.

EBMgt itself is a family of approaches to the practice of management, all of which using relevant scientific evidence (Briner et al., 2009). In this chapter, EBMgt is positioned in the context of the design science paradigm in management and organization science (e.g. Boland and Collopy, 2004a; Bate, 2007; Jelinek, Romme and Boland, 2008; Romme, 2003; Van Aken, 2004). As such, EBMgt is much more than rational decision-making; it is about *changing the actual into the preferred, in which research-informed designing is the core activity.* This perspective draws on the conceptualization of EBMgt as research-informed organizational problem-solving (Tranfield et al., 2003) and a design science approach (Romme, 2003; van Aken, 2004).

By positioning EBMgt in the context of management as a design-oriented discipline, we draw in this chapter on Simon's (1996) pioneering work as well as on the seminal book on professional work by Donald Schön (1983). Schön analyzed the more science-based professions like medicine and engineering, as well as the somewhat less science-based professions like architecture, management and psychotherapy. Following Schön, professional work, both in the science-based and in the less science-based disciplines, entails much more than the model of pure technical rationality. In this model professional practice largely boils down to instrumental problem solving on the basis of explicit knowledge, made rigorous by applying scientific theory and technique. The classic example of pure technical rationality is the engineer just using a formula to calculate the maximum load of a certain building construction. Instead, as will be discussed below in more detail, professionals use rich repertoires of explicit and tacit knowledge in a creative process of reflection-in-action. These repertoires contain tacit knowledge, developed through personal experiential learning as well as explicit knowledge, developed by their academic discipline.

This chapter thus develops four key ideas :
- the core process in EBMgt is research-informed designing, which entails a creative process of synthesizing solutions to design issues, combined with a more analytic process of evaluating these solutions
- this core process of designing is integral to changing the actual into the preferred
- the design process draws on multiple forms of knowledge including tacit as well as explicit knowledge, through a creative process of reflection-in-action
- personal and interpersonal experiential learning are central to developing both tacit and explicit knowledge used in designing.

We first describe the design science perspective and then a key component in design: the role of reflection-in-action in the design process. The chapter then describes the general process involved in changing the actual into the preferred and subsequently compares and contrasts designed-based changes in the material world with design-based changes in the social world. We then explore the nature of generic evidence-for-design, and contrast it with the specific nature of evidence in the social world, setting the stage for a discussion of EBMgt from a design science perspective. The chapter concludes by illustrating the EBMgt approach to design in a study on creating university spinoffs.

The Design Science Perspective

Designing a future is fundamentally different from describing and explaining the present. Simon's (1969; 1996) seminal “The Sciences of the Artificial” has played an important role in recognizing the importance of design in applied disciplines, by demonstrating the fundamental differences between describing and explaining ‘what is’ and designing and evaluating ‘what can be’. In many disciplines scholars continue to emphasize ‘describing and explaining the present’ as the core mission of *any* academic discipline. In contrast, designing is a core activity of architecture and the arts and also of research-based engineering design. Yet, an increasing number of disciplines now resonate with Simon’s recognition that the human world is artificial and that design is an essential activity in its making.

Academic disciplines like Medicine and Engineering have the creation of preferred futures as their mission. This mission is in part realized through the knowledge their research produces as well as by the actions of the professionals they train. As design plays a central role in the creation of preferred futures, one may call disciplines where design is central *design sciences*, as opposed to *explanatory sciences.* The mission of an explanatory science, like Physics and Sociology, is to describe and explain the world as it is. Their research is largely driven by a quest for knowledge as an end in itself; students are trained to become scientists. The iconic research product is the causal model. A causal model is valued for how well it accounts for the observed world (descriptive validity).

Research in a design science is driven by field or real-world problems. Field problems are situations in reality that, according to influential stakeholders, can or should be improved. Knowledge is developed to be instrumental in solving field problems; students are trained to become professionals, using the knowledge of their discipline to explore, design and create preferred futures. Explanatory research typically uses an observer perspective, primarily interested in explaining average outcomes. Design science research rather uses a player perspective, needing knowledge on outcome-context combinations to be able to make judgments on the outcome in specific cases.

The classic research product in the design sciences is a well-tested *solution concept*, i.e. a generic intervention to solve a generic field problem, tested in the laboratory and in its intended field of application. For example, in Medicine solution concepts for a certain dysfunction (the field problem) can include types of drugs or of types of surgery. In Engineering, solution concepts for designing certain electronic equipment with a higher performance can include types of electrical circuits or types of programmable logic for their operation. In Management, solution concepts for creating performing cooperative arrangements can include types of contracts and procedures for assessing the fit between the prospective partners. A solution concept is valued for its practical use in the real world, that is, pragmatic validity (Romme and Endenburg, 2006; Worren et al., 2002). For example, two solution concepts for organization design problems are: ‘hierarchy’ as an unambiguous sequence of accountability levels and ‘circularity’ for organizing the flow of power and information (Romme and Endenburg, 2006).

The logic of applying the solution concept is the *design proposition* (also called technological rule). The design proposition puts the solution concept into its application context. It runs like: "if you want to achieve a given outcome for this generic problem-in-context, then use this generic intervention". For example: "if you want to achieve a successful entry in a rather inaccessible foreign market through a cooperative arrangement with a local company, then use this type of contract". The most powerful design proposition is the field-tested and grounded one: the intervention is tested in its intended field of application and is supported by an understanding of the generic mechanisms that produce the outcome (van Aken, 2004). Therefore, in the example of the proposition on the type of contract (given above) one would like to have it tested through actual applications in its intended field of application, and grounded in a theoretical explanation of why in this type of context this type of contract is superior.

In a design science, research aiming to develop knowledge-for-design, is by definition firmly positioned in its mainstream. This is the case in fields like architecture and engineering. But the importance of design has also been acknowledged in, for example, IT (March and Smith, 1995; Hevner et al., 2004), accounting (Kasanen et al., 1993; Labro and Tuomela, 2003) and education (Kelly, 2003; Collins et al., 2004). Moreover, a growing interest in developing knowledge-for-design is also developing among management researchers. Inspired by architect Frank Gehry’s approach to design, Boland and Collopy (2004a) brought together a group of people from very different backgrounds to explore the potential of design for management studies. The design science perspective to organization and management studies was initially developed by, among others, Romme (2003) and Van Aken (2004) and later also in special issues of the *Journal of Applied Social Science* (Bate, 2007) and *Organization Studies* (Jelinek, Romme and Boland, 2008).

Like EBMgt, design science can be regarded as a family of approaches. All members of this family share an interest in research-informed designing – that is, an interest in creating preferred futures, an orientation toward solutions, pragmatic validity, and, especially, an interest in making full use of knowledge produced by rigorous research in designing and evaluating solutions to field problems.

Research-Based Designing and Reflection-in-Action

The core activity of designing consists of synthesis-evaluation iterations. A possible solution to the design problem is created or synthesized, typically by contextualizing a well-suited solution concept. Then the designed solution is evaluated 'on paper' to determine how well the problem is solved. Evaluation ‘on paper’ means judging the extent to which a design meets the desired specifications for the design, before that design is actually realized. Evcaluation may also take place by engaging in small experiments or pilot studies to try out one or more alternative designs. If the result is unsatisfactory, the solution is re-designed and evaluated again, an interative process that continues until a satisfactory design is obtained.

In their design processes, professionals use their creativity, skills and *repertoires* of tacit and explicit knowledge. They engage with a specific situation and treat their case as a unique one. At the same time, in a creative process of *reflection-in-action* they draw on an extensive repertoire of, among others, examples, models, theories and solution concepts in order to make sense of their case and to design alternative solutions (Schön, 1983). In this respect, a repertoire operates as a kind of 'grab bag' of knowledge from which the designer, sometimes consciously but more often largely unconsciously, selects elements to synthesize and evaluate alternative designs.

The repertoires of junior professionals largely are the result of their initial training. These initial repertoires consist of internalized formal theory and of tacit 'clinical experience', obtained through personal experiential learning. Subsequently, professionals continually enrich their repertoires with further personal experiential learning, usually combined with activities to keep their formal disciplinary knowledge up-to-date.

The use of explicit disciplinary knowledge demands creativity and considerable expertise: design science research is not really meant to be used by the layperson but rather by experienced and well-educated professionals. That is, design science results are best used by professionals, having mastered the body-of-knowledge of their discipline, having the ability to locate and obtain (new) knowledge that is relevant in their work setting, the ability to contextualize explicit knowledge, and the ability to develop intimate knowledge on the case under consideration and its context.

The degree to which explicit knowledge can support the designing and realizing of preferred realities varies from profession to profession. In engineering, this role is so important and self-evident that evidence-based engineering is a non-issue. Engineers do not want to reinvent the wheel. In medicine the role of explicit knowledge is also important, but compared to engineering, more professional judgment is needed to contextualize generic knowledge in designing and choosing interventions. In some cases this need for contextualization is fairly low, allowing for the crisp definition of best practices. In others this need is so high that it is impossible to define unambiguous best practices, and the role of the practitioner's judgment thus becomes more pervasive (Goodman, 2010). Both engineering and medicine (largely) operate in the material world, although laws in physics are more general and less contingent than those in biology (Mitchell, 2000). This allows engineering to evaluate designs more unambiguously than medicine (e.g. evaluating the maximum load of alternative constructions in designing a building versus evaluating alternative interventions in case of a brain tumor).

Next to the generic knowledge of the professional repertoire, the core process of designing requires case-specific inputs: the formulation of the design problem, the specifications the design has to satisfy, (likely) root causes of the problem, and an analysis of the problem context. But designs cannot be logically derived from these inputs. Designing typically entails a creative leap from inputs to design; this maybe a small leap, but more often it is a large one (cf. Peirce, 1955). For example, new product development teams draw on a lot of knowledge from the past, but only to use this as a jumping board for radically innovative products. Designing is thus creatively exploring possible futures. It deploys accumulated knowledge and experience without becoming locked into the past.

Changing the Actual into the Preferred in the Material World

The core process of designing (above discussed) is embedded in an overall process of changing the actual into the desired. In the present section, we explore this overall process in a setting in the material world, namely engineering design. In this way, key elements of design and change processes can be identified, but this discussion will later also be used to understand what makes design processes in the social world different from those in the material world.

Prior to the core process of designing, designers engage with principals and users to formulate the design problem and to establish the design's specifications. These specifications can change during the design process based on increased understanding of the problem and its changing circumstances; moreover, time and cost constraints may make it impossible to meet specifications. These may be adjusted (downward). Alternatively, developments in technology or competitive conditions may lead specifications to be adjusted upward. If the design problem and specifications can be well defined, developing specifications can be clearly separated from the core process of designing. If design problem and specifications cannot yet be defined unambiguously, both problem formulation and design specification are strongly intertwined with designing; designing then involves exploring alternative futures in close collaboration with various stakeholders.

Designing often also involves an intense dialogue with those that will produce and implement the design, in order to produce designs that are easy or inexpensive to realize. In a wide range of routine settings (e.g. designing and producing shoes), design-for-manufacturing can be readily accomplished using explicit knowledge about manufacturing requirements. Otherwise, the intense communication between designers and producers mentioned above is necessary.

In other words, changing the actual into the preferred involves the creation of an *action net* (Lindberg and Czarniawska, 2006), a network of actors – individuals, groups, organizations – working together to create something new. This action net can be emergent, but for effective design processes it can have significant advantages to deliberately design and create this action net.

A design can be defined as a model to be realized. In engineering design, evaluating alternative designs 'on paper' is typically done with help of mathematics (e.g. analytically or through simulation modeling). As will be further discussed later, this is enabled by the fact that key mechanisms in the material world can be described in terms of universal, invariant and determining laws. However, even in the material world it is not always possible to develop models of future entities that can be analyzed mathematically. If the entity being designed is too complex to be adequately modeled in mathematical terms, case-based reasoning is useful (e.g. Leake, 1996; Watson, 1997). In case-based reasoning, the design is evaluated by comparing it with similar, previously realized designs – just as lawyers assess their cases on the basis of case law. If even case-based reasoning cannot be used, small-scale pilot implementations might be used to evaluate alternative designs.

Evidence-for-Design in the Social World

A design science approach is a pragmatic one. It is not about developing 'true' propositions about reality. Rather, it develops propositions that inform people about how to create preferred realities. This does not imply that design science approaches merely aim at 'instrumentalistic' propositions (Archer, 1995: 153), informing agents about interventions producing preferred realities without informing them on *why* these interventions would produce these . On the contrary, including the answer on the why-question is essential for effective and competent usage of a design proposition. Nevertheless, the pragmatism of design science deeply influences the kind of evidence used for designing in the social world.

Design science research produces knowledge on solution concepts to be used to solve practical problems. The key scientific claim with respect to a design proposition is that it predicts the outcomes of the use of the solution concept in question (in the given context). In applied research in the material world this prediction is enabled by general, invariant mechanisms governing the behavior of matter – even if these are contingent on this world (Mitchell, 2000). An electron does not have the freedom today to behave differently from yesterday, nor can it act differently in Amsterdam than in New York. A machine tested in Barcelona will perform similarly in Buenos Aires (assuming that the human operator cannot significantly influence the machine's performance). Because of these universal, invariant and determining mechanisms, behaviors identified in past/current tests can reliably be used to predict behavior in the future.

Human agency creates the social world. Thus, no invariant mechanisms exist in the social world. However, human behavior has patterns and regularities as a result of human nature and nurture. These patterns and regularities can be uncovered and then used in predicting – within certain ranges – the outcomes of interventions in the social world. In fact, predicting human behavior is an almost universal human competence (*almost* universal; autistic people lack this competence, showing how important and rather generic it is). Starting from the day we are born, we learn over the years what we can do to get what we want from others: experiential learning (Kolb, 1984).

The repertoires of professionals (both in the material and in the social world) contain the explicit knowledge of their discipline and the results of their *personal* experiential learning in 'clinical' settings. For applied disciplines in de social world, we argue that, because universal, invariant and determining laws are absent, knowledge production in these disciplines should also be largely based on the strategy of experiential learning. However, in this case knowledge production should be the result of *objectified* experiential learning, based among other things on controlled observations (following protocols and using methods like triangulation), critical cross-case analyses and validation of designed interventions by alpha- and beta-testing in the intended field of application. Objectified experiential learning in academic research can, for instance, be done through the multiple case study, resulting in a rich understanding of context, intervention and outcome.

According to Bhaskar (1998) it is the nature of the object that determines the form of its possible science. In engineering design the available science is such that one often can evaluate alternative designs through *calculations* of their expected performance. But in social system design, the nature of the designed system implies that the evaluation of alternative designs proceeds rather through experience-based *judgment* of expected performance. To support this judgment, objectified experiential learning is a powerful knowledge production strategy.

Problems arising in organizations are not limited to purely social dimensions. They can also refer to socio-technical systems (like e.g. in operations management). The smaller the social component in such a system, the stronger the universal, invariant and determining mechanisms governing system behavior are and thus the stronger the potential for adequate mathematical modeling of the system (of both an existing and a newly designed one). Designing socio-technical systems with a small social component is more similar to engineering design than to social system design, making math-based evaluation tools more useful. For instance, the design and evaluation of a scheduling or inventory control system can be largely based on mathematical modeling and analysis if the human operator can be expected to follow the instructions from the information system quite closely. However, if the operator has to make frequent and significant adaptations to the schedules calculated by the system (e.g. because the dynamic complexity of the context leads the operator to make frequent exceptions to the built-in rules), in any evaluation effort mathematical modeling has to be supplemented with experiential learning. So, if the social component of the system is large, one has to rely to a large extent on experience-based prediction of the performance of the designed system; if the social component is small, one may fairly predict this performance on the basis of calculations.

EBMgt from a Design Science Perspective: Operating in the Swamp of Practice

Schön (1983) argued there is the high ground of theory and there is the lowly swamp of practice. The ambition of the design science approach toward EBMgt is to provide some firm ground in the swamp, but without draining it.

The context: dealing with major managerial challenges

Managers deal with most problems 'on the fly'. However, this chapter discusses a way of dealing with major managerial challenges in a more or less organized way, thus allowing for the deliberate use of EBMgt. An 'organized way' is an approach giving sufficient attention to following various process steps, to relevant stakeholders, as well as to the information needed and its quality. This can result in a formally organized project with a principal, a project team, a project leader, a project assignment and a project plan. Major challenges can also be engaged within the framework of a series of regular management meetings in which the incumbent issue is part of the normal agenda – possibly supplemented with assignments on sub-issues to members or non-members of the team between these meetings and one or more 'break-out sessions' to get more focused discussions on the issue.

In the following we give a generic process model of formal or informal solution design projects (for more details: van Aken et al., 2007). These projects deal with a significant issue, like a revision of strategy, a merger, a reorganization, or starting a large, high-risk product development project. Typically, the project is preceded by a fuzzy front end, in which some stakeholders start to recognize the issue and try to obtain support for addressing it. Weick (2004) characterizes the experience of entering and engaging a new project as 'being thrown' into a continuously evolving and ambiguous context. This fuzzy stage may result in an explicit acknowledgement of the issue by major stakeholders and the decision to start a major effort to deal with it. If one decides to follow an organized process, then a project definition step is initiated. The products of this step should include:

- the problem definition
- the project assignment, among other things giving the specifications for the intended outcomes of the project
- the project plan that outlines the approach to analysis, design and realization, and provides a time line for these activities
- the project team, project leader, and reporting structure.

If a less organized approach is chosen, a sound problem definition is critical and its importance cannot be overstated. The rest of the project brief may be less detailed and formalized, but one still needs agreements on what will be done, by whom and when. If using EBMgt, an important part of these agreements refers to the gathering of explicit (scientific) knowledge on the issue.

Another key issue is the intended realization. If it is a really significant issue, already at the project definition step one should develop rough ideas on the possible change recipients and their involvement in the design and realization processes. The whole process should lead to the development of a strong action net (Lindberg and Czarniawska, 2006), as previously discussed, to realize the designed solution.

The process steps following project definition generally are:

- problem analysis (elaborating the initial problem analysis, made at the problem definition step), which involves a process of naming and framing (Schön, 1983); this naming and framing will give pointers to relevant scientific literatures; the analysis will include a diagnosis of the causes of the problem and the background of the issue
- context analysis, both internal and external to the organization
- the core process of designing the solution and the change plan
- realization, that is the actual change of roles, role structures and activities in reality
- learning for performance by the change recipients
- reflection on results, the design process and the change process, all with the goal of capturing learnings to be used next time.

Typically, the project does not follow a linear process, but one of iterations and explorations, while there may be also slowing-downs and accelerations in the process, as it always is embedded in the stream of the daily operations of the organization. These may demand temporary urgent attention for other issues or, on the other hand, sudden increases in the urgency of the issue in question. In the iterations one goes back to a previous step, because increased insight has shown that more information is needed on certain issues; there may even be a need to change the project brief at such an iteration. In the explorations one goes forward in the process to explore possible solutions in order to know what information is needed to design and evaluate alternative solutions.

The core process: designing

In this chapter, we focus on the core process of *solution design and change planning*. In this core process the basic process steps are

- sketching, by informally and creatively exploring possible solutions
- actual designing alternative solutions through a process of synthesis-evaluation iterations, resulting in the outline design and in a change plan to realize it
- detailing the outline design and change plan.

In organizational solution design, there can be many people involved. There may be a lead designer or main sponsor (e.g. the CEO or his/her delegate), but in all cases a group of people will be working together on the issue. This group may involve and activate others in the organization in various ways and degrees and at various times. In the remainder of this section, we will call this system of tightly and loosely coupled people the *design group*.

For major issues this design group generally should be multidisciplinary. The quality of the designed solutions strongly depends on the extent to which this group is able to use effectively and efficiency the expertise of the various members of this group. In other words, the quality of the designed solution strongly depends on the performance of the Transactive Memory System (TSM) of this group (Wegner, 1986; Peltokorpi, 2008). That is, in terms of the repertoire concept, the quality of the design depends on the quality of the design group's *shared repertoire*.

With respect to the actual designing (i.e., the synthesis-evaluation iterations), we can distinguish a decision mode and a design mode (cf. Boland and Collopy, 2004b). In the more common decision mode the emphasis is on the evaluation part of the iterations, fairly tangible, allowing the use of familiar analytic scientific methods. In the design mode, on the other hand, the emphasis is on the much less tangible synthesis part.

Boland and Collopy give a telling illustration of working in design mode (Boland and Collopy, 2004b). This illustration concerns the design of the Lewis building for the Weatherhead Business School, by the architectural firm of Frank Gehry. Toward the end of the design process the floor space had to be reduced by 4,500 square feet, a really major change. At that point, the project architect Matt Fineout took two days to discuss this design problem with a representative of the client, going into many details and into many alternative detail solutions, making a lot of drawings. But to the complete astonishment of the client, at the end of the second day, as the client thought the problem had largely been solved, the architect tore these drawings up and threw them in the trashcan. The client had expected that the design would emerge through a process of successive detailing, each intermediate design coming closer to the eventual design. But Matt Fineout demonstrated by his behavior two key principles of designing

- designing is playing with alternatives (don't marry your first design idea)
- assign the main effort to the outline design (only start the time and resources consuming detailing after all the key design dilemma's have been solved in this outline design).

The architect needed the discussions with the client to become familiar with the design dilemmas he faced. But he was not yet ready to resolve these dilemmas in an outline design, being still in the phase of creatively synthesizing alternative solutions to deal with this new design problem. In organizational problem solving *in the design mode* one has a similar emphasis on taking one's time for *playing with alternatives,* and putting much effort in making a *sound outline design*. Too often the design group gets entrapped in the first feasible solution found and then spends all effort in its detailing.

As said previously, one cannot deduce the design from the inputs; there always is a creative jump from input to design. But, of course the inputs to the design process are of critical importance to the quality of the design. The explicit inputs include:

- the problem analysis and diagnosis;
- the context analysis;
- solution concepts and ways to evaluate them.

In the synthesis steps these explicit inputs are merged with the tacit and explicit knowledge of the design group and used by them to synthesize alternative solutions to design issues in a process of reflection-in-action. In the same way tacit and explicit knowledge is used to evaluate the alternative designs against the specifications, the most important being that the solution should solve the problem. Like in particular situations in engineering design that are more difficult to model, case-based reasoning is an important approach to evaluate organizational designs 'on paper'.

The contribution of Evidence-Based Management

As in any design process the members of the design group use their repertoires of tacit and explicit knowledge in designing through a process of reflection-in-action. EBMgt can make significant contributions to this, including:

- improving the process of information gathering
- enhancing the Transactive Memory System, or shared repertoire the design group possesses regarding the issues in question
- providing significant content to the design process (see below).

In the course of problem and context analysis a lot of case-specific information is gathered within the organization. An EBMgt approach promotes a rigorous approach to this information gathering and a critical attitude towards accumulated information. EBMgt thus contributes significantly to the quality of inputs to the design process.

An EBMgt approach also aims at making full use of the explicit knowledge of the members of the design group and at making explicit, as far as possible, their tacit knowledge (see e.g. the example in the next section), thus creating a shared repertoire for the design group. This is an important issue, especially because design groups for significant organizational issues often represent many different disciplines. Making knowledge explicit and critically assessing its quality can significantly enhance the design group's performance by promoting knowledge sharing and deepening understanding.

But the primary contribution of EBMgt is to produce valid generic knowledge on the issue in question based on rigorous scientific research. This explicit knowledge can support problem analysis and diagnosis, context analysis and especially design, both for synthesis and for evaluation. Naming and framing at the problem definition step gives pointers to the literatures to be searched. The synthesis step of the design process proper can be supported by identifying a range of generic solution concepts along with their indications and contra-indications. The subsequent evaluation step can be supported by evidence from the literature arising from testing the solution concepts in various settings. As in the more difficult-to-model solutions described in engineering design, designs in management and organization make use of case-based reasoning to their evaluation and justification.

The process of producing this knowledge is systematic research synthesis (Denyer and Tranfield, 2006; Denyer et al., 2008). Quantitative meta-analysis may be a powerful way to synthesize quantitative research outcomes in the material world. In the social world, however, a highly effective knowledge production strategy is to synthesize research outcomes on the basis of an objectified experiential learning approach. At each new item of the literature review the basic question is: what do we learn from this item to understand our problem and to synthesize alternative solutions, and what evidence does it give to enable us to judge what the outcomes of these solutions would be in our specific context.

As discussed in the section on evidence-for-design in the social world, if the system to be designed has a significant material component, designing is more like engineering design. In that case the knowledge production strategy can make more use of quantitative approaches to research synthesis.

The results of the systematic research synthesis are shared within the design group, thus further adding to its shared repertoire. These results can also be shared with the prospective change recipients. In this way an even broader shared repertoire is created, which can be of great value in the eventual realization of the design as will be discussed below.

Design-based change in the social world

The overall process of changing the actual into the preferred in organizations has similarities to engineering design: the problem analysis, the development of specifications, the interactions with the various stakeholders, the building of an action net to realize the solution in reality. Fundamental differences also exist.

Foremost is the significant need to contextualize generic knowledge. For this, descriptions are needed that are thick, detailed and rich. This refers to the various solution concepts, the contexts in which these concepts have been tested and the nature of the outcomes, both intended and unintended ones. Further, the evaluation of alternative designs is of a very different nature. Many engineering designs can be adequately mathematically modeled, so engineers can use their impressive array of engineering mathematics to evaluate their designs on paper. This typically is not the case in the social world, because of the non existence of universal, invariant and determining laws. Therefore, rather an experiential learning approach, like case-based reasoning, has to be used as strategy to evaluate designs.

Finally, a fundamental difference exists in realizing the design. In engineering, the design determines the realized entity and thus also its behavior. In management and organizational settings, the realization of a design always involves a redesign of this design by the change recipients: their behavior is based on their interpretation of the design. The collective interpretation of the design by these change recipients can produce social realities at odds with the design group's intentions, and thus different outcomes. In engineering design this is the issue of design-for-manufacturing, which can be dealt with during the core process of designing. In management and organization, however, the design group needs to support the interpretation and enactment of their design by the change recipients by interacting with them during the design process, possibly designing in a participative mode, and by staying involved in the entire subsequent process of change and learning for performance.

In this process of participation in the designing by the change recipients and of their interpretation the eventual design, EBMgt can also provide an important contribution by not only informing the design group but also the broader audience of all stakeholders in the design and change, thus supporting interpretation, giving it additional credibility and giving confidence in the successful eventual outcome of the endeavor.

EBMgt in Developing University Spin-offs

To illustrate designing in the context of organization and management, we draw on a study of university spin-off creation by Van Burg, Romme, Gilsing and Reymen (2008) to illustrate our argument on evidence-based solution design. This study provides an example of designing and developing policies, informed by a systematic research synthesis that draws on an extensive literature review as well as on externalized practitioners' experience.

The problem addressed was how to create university spin-offs (i.e. business start-ups that commercialize technologies developed at a given university). Its particular context is the common case where the incumbent university resists attempts to deviate from its core processes in teaching and research. The assignment to develop evidence-based guidelines for spin-off creation was given to a research team by a Dutch university - Eindhoven University of Technology (TU/e). The actual design effort was already underway when this assignment was given. Three years earlier TU/e had started the development of a new venturing incubation unit. This meant that the research team (in which one of the authors of this chapter participated) could benefit from the initial learning outcomes and experiences (cf. reflection-in-action) of the practitioners involved. On the other hand, arriving in the middle of the project meant that the design group, the group of people actually involved in designing, consisted not only of the research team, but included also the practitioners already engaged in developing university spin-offs. Thus the research team faced the challenge of transforming an ongoing, largely emergent design process into a more deliberate one. A further challenge was, as always in evidence-based solution design, the need to contextualize any generic findings derived from a systematic literature review toward the specific TU/e setting.

In view of these challenges, a design science-driven EBMgt approach was adopted in which two key notions connected professional practices and research findings (cf. Romme and Endenburg, 2006): design propositions and solution concepts (as discussed in the section on the design science perspective). *Design propositions* can be based on research, but can also be derived from successful professional practice. The research-based propositions serve as tangible artifacts that allow different groups of people to focus upon and create shared understandings (Romme and Endenburg, 2006). That is, these explicit propositions allowed participants from diverse backgrounds to focus on a common set of issues in the design process.

The research team developed design propositions for university spin-off creation by separately developing propositions based on practice (practice-based propositions) and propositions based on scholarly knowledge (research-based propositions). The synthesis of these propositions subsequently resulted in design propositions, which thus provides a body of knowledge that is grounded in research as well as tested in practice (cf. Van Aken, 2004). Thus, the key steps in developing design propositions were as follows (Van Burg et al., 2008):

- first, so-called *practice-based propositions* are developed by converting the largely tacit knowledge of key actors in university spin-off creation into explicit propositions;
- second, propositions are derived from a review of the literature; these *research-based propositions* then serve to understand (and possibly improve) practices and solutions already in place as well as create entirely new solutions;
- third, the practice-based and research-based propositions are *synthesized* in a set of design propositions – defined as propositions that are tested in practice as well as grounded in the existing body of research.

The practice-based propositions were derived from the data by means of a careful coding and reduction process (Strauss and Corbin, 1990). First, the research team coded all different practices and experiences reported by starters and support advisors as well as described in key documents. Next, the coded practices were clustered and reduced to a small number of categories. For each category, crucial elements of the solutions and any common denominators were identified. Finally, for each practice-based proposition the different experiences of support staff and entrepreneurs were listed. For example, Van Burg et al. (2008: 122) identified the following practice-based propositions: "Create arrangements for starters to use university labs and other resources; provide office space with the possibility to use different services; (…); enable starters to use the academic network of the university; establish a network around the support organization of investors, industry contacts and financers."

The research team derived research-based propositions by means of a systematic literature review using a qualitative meta-synthesis approach (Denyer and Tranfield, 2006). The domain of this review was defined in terms of all research in the area of university spin-offs. The purpose of the review was to derive normative (generic) propositions rather than to provide a comprehensive overview. The findings from the review were synthesized in a number of key concepts and a preliminary set of propositions. Subsequently, this set of research-based propositions was linked to general theories, to explain the key mechanisms addressed by these propositions (according to the CIMO logic, advocated by Denyer, Tranfield and Van Aken, 2008).

Finally, Van Burg et al. (2008) composed a set of design propositions by confronting and comparing the list of practice-based propositions with the list of research-based propositions. This resulted in the following set of design propositions for building and increasing capacity for creating spin-offs; in this respect, a (European) university should design and implement practices that:

1. Create university-wide awareness of entrepreneurship opportunities, stimulate the development of entrepreneurial ideas, and subsequently screen entrepreneurs and ideas by programs targeted at students and academic staff.
2. Support start-up teams in composing and learning the right mix of venturing skills and knowledge by providing access to advice, coaching and training.
3. Help starters in obtaining access to resources and developing their social capital by creating a collaborative network organization of investors, managers and advisors.

4. Set clear and supportive rules and procedures that regulate the university spin-off process, enhance fair treatment of involved parties, and separate spin-off processes from academic research and teaching.
5. Shape a university culture that reinforces academic entrepreneurship by creating norms and exemplars that motivate entrepreneurial behavior" (Van Burg et al., 2008: 123).

This set of (emerging) design propositions was shared with the design group as a whole. They were discussed repeatedly with startup advisors, the incubation unit manager, entrepreneurship professors and other stakeholders at the TU/e. This ongoing dialogue also served to reposition and fine-tune two specific incubation practices at the TU/e. The first one involved a program in which MSc students work in teams to develop value propositions and business models for a particular technology developed in the university's labs. The second practice was a regional incubator network in which investors, banks, incubators of local companies (including Philips Electronics), applied research institutes and regional developments agencies collaborate with the startup advisors of the TU/e to provide access to resources, network contacts and other facilities to entrepreneurs engaging in spin-off projects. The design propositions developed by Van Burg et al. (2008) served to create awareness and understanding of each of the elements of the TU/e approach to spin-off creation, by placing these in a broader framework.

Moreover, the set of design propositions exposed blind spots and major opportunities for improvement and development. In fact they helped to create a shared repertoire of knowledge on university spin-offs for the various parties concerned. Thus, the EBMgt project by Van Burg and co-authors served to define the lack of an entrepreneurial university culture (cf. design proposition 5) at the TU/e as the main weakness of its spin-off creation capability. Throughout the university, the awareness of this deficiency grew and several new initiatives and projects were used to expose the TU/e community to role models (e.g. successful entrepreneurs among the TU/e alumni) and to motivate entrepreneurial behavior (e.g. by creating attractive financial benefits for scholars whose patented technologies are used in successful spin-offs). The university's senior management and other key stakeholders are well aware of the long-term effort required here, because universities tend to be rather conservative organizations with a strong historical commitment to academic research and education.

This evidence-based project on spin-off creation was set up in 2005 and is still ongoing. The preliminary results of the project are as follows. First, the TU/e increased its spin-off rate from zero in the late 1990s and about 5 firms per year around 2005, to the current rate of about 15 new firms exploiting IP of the university per year. The design framework developed by Van Burg et al. (2008), in combination with this boost in the spin-off rate, also informed and motivated the university's top management to raise its ambition level – which amounts to doubling the spin-off rate in the next 5 years. Of course, it is not possible to determine precisely to what extent the EBMngt project of Van Burg et al. (2008) contributed to the increase in the spin-off rate at the TU/e. It is not unlikely that without this EBMngt project the TU/e would also have increased its performance in creating spin-offs. Moreover, any EBMngt project is embedded in a continuously evolving and ambiguous socio-economic system. The spin-off creation project at the TU/e, however, does illustrate that EBMgt serves to build a systematic, theory-driven understanding of a rather complex managerial issue, that previously was dealt on the basis of common wisdom and personal experiences.

Another, more academic, upshot of this EBMngt project is that the design propositions developed by Van Burg et al. (2008) served to reflect on the comprehensiveness of (previous) research and theory development. In this respect, Van Burg et al. (2008) observed that some of their design propositions are not yet (firmly) incorporated in the university spin-off literature. For example, the proposition referring to clear and supportive rules and procedures was not previously identified, and as such not grounded in any theoretical frameworks. In turn, this finding motivated a new study exploring the role of transparancy and fairness in university spin-off formation. Moreover, other research teams have recently adopted and replicated the design framework developed by Van Burg et al. (2008). For example, Barr et al. (2009) have applied and replicated this framework in the context of several US-based universities.

Discussion and Conclusion

The term Evidence-Based Management (EBMgt) may evoke a picture of rational decision-making with academic research findings as its main input *replacing* intuitive, experience-based management. Instead, this chapter demonstrates a design science approach in which EBMgt involves *adding* to intuitive, experience-based management. What is added is both scientific evidence as one source of design propositions and a design process to better deploy a broader array of knowledge and perspectives in this complex professional process.
EBMgt demands a significant effort in gathering valid information for designing solutions for management and organization problems. As yet, research-based information on many managerial and organizational issues is not readily accessible; our academic community thus needs to engage in a systematic literature review and synthesis on each significant managerial challenge that practitioners are facing. In the medical discipline, the Cochrane database (see www.Cochrane.org) provides professionals with the evidence they need to design and optimize their interventions for a broad range of disorders. As long as there is no such equivalent in the field of management and organization, EBMgt in this field needs to focus on major issues and challenges for which it is feasible to invest in an extensive systematic research synthesis.

Even so, practitioners need some persuasion and incentives to engage in EBMgt, because its added value is less obvious than in some other disciplines. We already observed that the value of valid, explicit knowledge is self-evident in engineering. Interestingly, in the social world we have a similar example: law practice. Evidence-based law practice simply is a non-issue: lawyers and judges have to extensively use the law, case-law and all available evidence to get their job done. On the other hand, experienced medical doctors sometimes need to be seduced to acquire and use state-of-the-art explicit knowledge; they may feel that their initial training in the medical discipline, complemented with their rich tacit knowledge gained through experiential learning, is quite sufficient to be a good medical practitioner. The challenge here is to demonstrate the added value of recently developed evidence. A similar problem occurs for experienced managers and management consultants: the added value of research-based knowledge is not always self-evident to them. The community of management and organization researchers needs to take charge of this challenge, by building a strong case for EBMgt as well as creating attractive conditions for practitioners to join collaborative EBMgt projects.

The term ‘evidence’ suggests a decision mode, that is, the view that the main challenge is to choose between known alternatives - which implies the main contribution of evidence-based practice is to produce the evidence for making a rational choice between these alternatives. As previously argued, EBMgt will typically address significant managerial issues. For such issues, we advocate a design mode that puts substantial effort in the design of alternative arrangements of interventions and thus crafts a high-quality outline design before going into details. Academic research can provide significant support for this type of design effort by providing a range of well-tested solution concepts.

A final comment relates to the roots of the Evidence-Based practice movement in medicine - both an asset and a liability. As an asset, it provides a link with a well-respected design science. It is also a liability that evokes criticism, like by those (e.g. Morrell, 2008; Denzin, 2009) perceiving EBMgt as a solely technical-rational approach to managerial issues. This chapter serves to argue that this is not necessarily the case. In this respect, a design science approach suggests that effective EBMgt is *complementary* to experience-based management, by giving research evidence a productive role in management as a complex professional process.

A design science approach to EBMgt implies that significant managerial and organizational issues need to be dealt with in a design rather than decision mode: the emphasis is on designing preferred futures and ways to realize these, rather than on choosing from pre-defined alternatives. EBMgt is not about finding the exact interventions in the literature, but about interrogating scientific evidence to obtain valid input for the design of interventions. Through Evidence-Based Management, especially through systematic research synthesis, one can add to the existing repertoires of the design group and the broader organization, by creating a shared repertoire that enhances the quality and effectiveness of managerial and organizational designs.

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