A Design Science Approach to Evidence-Based Management

Joan Ernst van Aken, Eindhoven University of Technology
Georges L. Romme, Eindhoven University of Technology

Abstract

In this chapter we adopt a Design Science approach to demonstrate how Evidence-Based Management can extend experience-based management by judiciously gathering, validating, selecting and using knowledge. The creative processes in which valid knowledge is used in designing and creating preferred futures are discussed, as well as the nature of the design knowledge needed for this. This includes knowledge on possible interventions with expected outcomes and on the mechanisms producing these outcomes.

Keywords: Design science
Collaboration between scientists and practitioners
Design propositions
Spin-offs
Preferred future
Professional practice
Technical rationality
“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. In keeping this idea, Evidence-Based Management (EBMgt) is a design process individuals and teams use to solve real-life organizational problems through the use of scientific evidence and validated local facts.

EBMgt itself is a family of approaches to the practice of management, all of which use 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. Bate, 2007; Boland & Collopy, 2004a; Jelinek, Romme & Boland, 2008; Romme, 2003; Van Aken, 2004). As such, we argue EBMgt is much more than rational decision-making; it is about changing the actual into the preferred, with research-informed designing as the core activity. This perspective draws on the conceptualization of EBMgt as research-informed, organizational problem solving (Tranfield, Denyer & Smart, 2003) and a design science approach (Romme, 2003; van Aken, 2004).

A Design Science approach to EBMgt has the following three key features:

- Design Science Research produces a critical part of the evidence to be used in EBMgt.
• This evidence is not to be used as a set of instructions or fixed protocols, but as input to the creative and innovative process of designing structures, processes or interventions.

• Research-informed designing is the core activity in a complex process of changing the actual into the preferred: EBMgt involves acting, rather than (only) decision-making, on the basis of evidence.

By positioning EBMgt in the context of Management as a design-oriented discipline, this chapter draws on two seminal books, namely Herbert Simon’s (1969, 1996) The Sciences of the Artificial and Donald Schöll’s (1983) The Reflective Practitioner, both building on the work of James (1907), Dewey (1929) and Pierce (1955) on pragmatism. Schöll 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 Schöll, professional work in all these disciplines entails much more than the model of pure technical rationality implies. In the latter 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 who uses a formula to calculate the maximum load for a building’s construction. By contrast, 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, derived from their academic discipline.

This chapter thus develops the following key ideas:

- The core process in EBMgt is research-informed designing of structures, processes or interventions, which entails a creative process of developing situation-specific solutions to design issues, combined with a more analytic process of evaluating these solutions.

- This process of designing “on paper” is an essential part of the very complex and challenging process of changing the current (organizational) world into a preferred one.

- The design process draws on multiple forms of knowledge, including tacit as well as explicit knowledge, through a creative process of reflection-in-action.

- Design science research produces a critical part of this explicit knowledge.

- Personal and interpersonal experiential learning are central to developing both tacit and explicit knowledge for use in designing.

We first describe the design science perspective and then discuss a key component in the design process: the role of reflection-in-action. The chapter then describes the general process of changing the actual into the preferred, and subsequently compares and contrasts designed-based changes in the material and social worlds. We then explore the nature of generic evidence-for-design, and
contrast it with the nature of evidence in the social world, setting the stage for a
discussion of EBMgt from a design science perspective. The chapter subsequently
illustrates the EBMgt approach to design in a study of creating university
spinoffs. Finally, we give recommendations for both practitioners and
organizational researchers in advancing EBMgt as a design process.

The Design Science Perspective

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

The primary mission of academic disciplines like Medicine and
Engineering is the creation of preferred futures -- for example, restoring health in
case of pneumonia or creating a more fuel-efficient car. This mission is realized
through knowledge produced by research as well as through the actions of the
professionals trained in these disciplines. As design plays a central role in the
creation of preferred futures, one may call disciplines for which 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. Explanatory research is largely driven by a quest for knowledge as an end in itself. The iconic research product here is the causal model. A causal model is assessed in terms of descriptive validity, that is, how well it accounts for the observed world.

Mainstream 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 development here is instrumental in solving field problems; students are thus trained to become professionals, using the knowledge of their discipline to explore, design and create preferred futures. Whereas explanatory research typically uses an “independent observer” perspective, Design Science Research draws on a participant-observer perspective that requires knowledge on intervention-outcome-context combinations to be able to make judgments on the (likely) outcomes of interventions in specific cases.

With disciplines like Medicine and Engineering as inspiration one can define Design Science Research (DSR) as a family of approaches to research that are driven by field problems, use a participant-observer instead of the independent observer perspective, and pursue a solution orientation. This implies design science researchers are not satisfied with describing field problems and analyzing their causes, but also develop alternative general solution concepts for these field problems. In Medicine and Engineering the participant-observer perspective does not pose specific problems because most researchers in these disciplines are, or
have been, practicing professionals. In Management research this is typically not the case. Therefore DSR in this discipline often draws on research strategies like collaborative or interventionist research (e.g. Romme and Endenburg, 2006).

The iconic research product of DSR is a well-tested solution concept, i.e. a generic intervention to solve a generic field problem, tested in the laboratory and in the field of its intended use. In Medicine, for example, solution concepts for a certain dysfunction (the field problem) can include types of drugs or surgery. In Engineering, solution concepts to design a particular electronic equipment can include types of electrical circuits or programmable logic for their operation. In Management, for example, solution concepts for creating cooperative arrangements can include types of contracts and procedures for assessing the fit between the prospective parties. A solution concept is assessed in terms of its real-world practical use, that is, pragmatic validity (Worren, N., Moore, K. & Elliott, R., 2002). For example, 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 & 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 by way of a cooperative arrangement with a local company, then use this
particular 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 grounded in an understanding of the generic mechanisms -- that is the cause-effect relations -- that produce the outcome (van Aken, 2004). Therefore, in the example of the proposition regarding the type of contract (given above), one would like to have it tested through actual applications and grounded in a theoretical explanation of why this type of contract is superior in this particular context. The logic of the field-tested and grounded solution concept is called the CIMO-logic (Denyer, D., Tranfield, D. & Van Aken, J.E., 2008), a combination of problem-in-Context, Intervention, generative Mechanisms producing the outcome, and Outcome.

A discipline is called a Design Science if DSR-approaches are firmly positioned in its mainstream. This is the case in fields like Medicine, Architecture and Engineering. But the importance of design has also been acknowledged in other fields, for example, IT (March & Smith, 1995; Hevner, A.R., March, S.T. & Park, J., 2004), accounting (Kasanen, E, Lukka, K. & Siitonen, A., 1993; Labro & Tuomela, 2003) and education (Kelly, 2003; Collins, A., Joseph, D. & Bielaczyc, K., 2004). Moreover, there is a growing interest in developing knowledge-for-design among management researchers. For example, inspired by architect Frank Gehry’s approach to design, Boland & 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 Behavioral Science (Bate, 2007) and Organization Studies (Jelinek, Romme & Boland, 2008).

Like EBMgt, Design Science Research can thus be regarded as a family of approaches: driven by field problems, using a participant-observer perspective, and pursuing a solution orientation.

**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 an appropriate solution concept. The designed solution is then evaluated “on paper” to determine how well it solves the problem. Evaluation is the basis for choosing among alternative solutions to a design issue; evaluation “on paper” means judging the extent to which a design meets its desired specifications, before that design is actually implemented. Evaluation may also take place by engaging in small experiments or pilot studies to try out one or more alternative designs. If the result is not satisfactory, the solution is re-designed and evaluated again, an iterative process that continues until a satisfactory design is obtained.

Engineers, psychotherapists, managers and other design professionals draw on 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, the designer draws on a repertoire as a kind of “grab bag” of knowledge, sometimes consciously but more often largely unconsciously, to synthesize and evaluate alternative designs.

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

The use of explicit disciplinary knowledge demands creativity and considerable expertise: general knowledge has to be translated towards the specific context in question. DSR is not really intended for use 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. For example, physicians adapt their use of patient care protocols to individual circumstances and needs, and professional experience and judgment are key elements in designing context-specific solutions.

The degree to which explicit knowledge can support the design and realization of preferred realities varies by profession. In Engineering, this role is
so inherent 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 a crisp definition of best practices. In other instances, 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 (Groopman, 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 derived from these inputs in a number of logical steps. Designing typically entails a creative leap from inputs to design; this maybe a small leap, but more often it is a large one (cf. logic of abduction; Peirce, 1955). For example, new product development teams draw extensively on past knowledge, but only as a jumping board for creating radically new 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, as previously described, is a key part of the overall process of changing the actual into the desired. This section explores this process in the material world, using engineering design as an exemplar. As such, this serves to identify key elements of design and change processes, whereas this discussion will later also be used to understand how design processes in the social world differ from those in the material world.

Prior to starting the core process of designing, designers engage with principals and users to formulate the design problem and its specifications. These specifications can change during the design process, as the understanding of the problem and its setting deepens; moreover, time and cost constraints may make it impossible to meet initial specifications (which may then be adjusted downward). Alternatively, developments in technology or competitive conditions may lead to specifications being adjusted upward. If the design problem and specifications can be well defined, the development of specifications can be readily separated from the core process of designing. If design problem and specifications cannot 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. For instance, many people find it rather difficult to unambiguously specify the home furnishing they
want, so interior decorators have to design interiors in close interaction with their principals.

An intense dialogue may be needed with those that will produce and implement the design, 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, a focused dialogue between designers and producers is necessary.

Changing the actual into the preferred involves creating an action net (Lindberg & Czarniawska, 2006), a network of actors -- individuals, groups, organizations -- working together to create something new. This action net can be emergent in nature, occurring in an ad hoc, as-needed fashion. However, if an action net does not emerge spontaneously, design professionals need to deliberately develop it.

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 discussed below, using mathematical models for evaluation purposes is enabled by the fact that key mechanisms in the material world can be described in terms of universal and invariant 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 the entity involves such a high level of complexity that even case-based reasoning cannot be applied, small-scale pilot experiments with the alternative designs might be used to test and evaluate them.

**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 about why these interventions would work. On the contrary, the answer to the why question is essential for effective and thoughtful usage of a design proposition. As discussed, in the implementation stage a design proposition always has to be adapted to the specific context of application; in designing the adapted version, one has to know why the intervention works in order not to lose its power in the adaptation process. Nevertheless, the pragmatism of design science deeply influences the kind of evidence used for designing in the social world: evidence is needed on how, when and why the particular intervention works.

Design Science Research produces knowledge on solution concepts for solving field 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 universal and 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 and invariant mechanisms, responses identified in past/current tests can reliably be used to predict responses in the future.

Human agency creates the social world and is subject to interactions with the behavior of others. People do have the freedom to act on the basis of anticipated effects of their actions. Thus, no universal and 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 (see 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 real world settings. We argue that for applied
disciplines in the social world, given the absence of universal and invariant laws, knowledge production should be largely based on the strategy of experiential learning. However, knowledge production in this case should result from objectified experiential learning, based among other things on controlled observations (following protocols and using methods like triangulation), comparative case analyses, and validation of designed interventions by alpha-and beta-testing (van Aken, 2004) in the intended field of application. Objectified experiential learning in academic research can, for instance, be done through the comparative case study, resulting in a rich understanding of context, intervention and outcome. But other approaches to objectified experiential learning can also be of value.

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 by means of calculations of their expected performance. But in social system design, the nature of the designed system implies that the evaluation of alternative designs proceeds 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, as in operations management. The smaller the social component in such a system, the stronger are the universal and invariant mechanisms governing system behavior, and thus the
stronger the potential for adequate mathematical modeling of the system (of an
existing as well as 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 quite closely follow the instructions from the information system.
However, if the operator must make frequent, 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), any
evaluation effort has to draw on experiential learning as well as mathematical
modeling. Thus, if the social component of the system is large, one has to largely
rely 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 in Action: 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 EBMgt is to provide some firm ground in the
swamp through the use of valid evidence. This will not drain the swamp: The use
of this evidence still needs a substantial level of competence, experience and
creativity.

In the present section we discuss EBMgt in the swamp of organizational
change, particularly in design-based organizational change. This discussion will
highlight several important aspects of EBMgt that draws on a Design Science perspective.

**EBMgt: Dealing with Major Managerial Challenges**

Managers deal with most problems “on the fly.” However, in this chapter we discuss ways of dealing with major managerial challenges in a more or less organized way, allowing for the deliberate use of EBMgt. An “organized way” implies 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 by assignments on aspects of these issues completed between meetings or by “break-out sessions” for more focused discussions.

In the following we give a generic process model of formal or informal solution design projects (for more details: Van Aken, J. E., Van der Bij, H. & Berends, H., 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 adopt 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 agreement is still needed on what will be done, by whom and when. If using EBMgt, an essential part of these agreements refers to the efforts to be spent on collecting validated local knowledge as well as explicit scientific knowledge on the issue in question through systematic review and research synthesis.

Another key issue is the intended realization. If it is a significant issue, already at the project definition step one needs to develop a rough idea of who the possible change recipients are as well as their involvement in the design and realization processes. The entire process should lead to the development of a strong action net (Lindberg & 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, involving both the internal and external organizational context
• The core process of designing the solution and the change plan
• Realization, that is, the actual changes in roles, role structures and activities
• Learning for performance by the change recipients
• Interpretation of and reflection on the results, design process and change process -- with the intent to capture the main lessons learned, to be used next time

Typically, the project will not follow such an undisturbed process, because of delays or accelerations in the process, resulting from the interactions with the daily operations in the organization. Other urgent issues may demand attention, or the issue itself suddenly may increase in urgency.

The Core Process: Designing

The basic process steps for solution design and change planning are:

• Sketching, by informally and creatively exploring possible solutions
• Actually 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

Usually the actual design process is not a linear one. Rather, the design process will use iterations and explorations. In an iteration one may return to a previous step, because new insight reveals that more information is needed. There may even be a need to change the project objectives at such an iteration. In an exploration, one jumps to a step further in the process, for example to understand what information is needed to design and evaluate alternative solutions.

In organizational solution design, many people may be 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 work together on the issue. The composition of this group may change over time. In the remainder of this section, we will call this group of tightly or loosely coupled people the design group.

For major issues, this design group generally should be multidisciplinary. The quality of the designed solutions depends on the extent to which this group uses its members’ expertise effectively and efficiently. 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 Schön’s repertoire notion: the quality of the design depends to a large extent on the quality of the design group’s shared repertoire.
With respect to the actual designing (i.e., the synthesis-evaluation iterations), we distinguish between a decision mode and a design mode (cf. Boland & 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 creative but much less tangible synthesis part is emphasized.

Boland and Collopy give an interesting illustration of the “working in design” mode (Boland & 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 the architect’s behavior in this case demonstrated two key principles of designing:

• Designing is playing with alternatives (don’t marry the first design idea)
• Assign the main effort to the outline design (start the time-and resource-consuming detailing only after the key design dilemmas are solved)

The architect needed 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. In organizational problem solving in the design mode, participants therefore need to take time to play with alternatives, and put a lot of effort into making a sound outline design. In managerial settings, too often the design group becomes entrapped in the first feasible solution found, and then shifts all its effort in detailing it.

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

• The problem analysis and diagnosis
• The context analysis
• Solution concepts and ways to evaluate them

In the synthesis steps, the design group merges these explicit inputs with their tacit and explicit knowledge, to subsequently 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 very complex situations in engineering design that are rather
difficult to model, case-based reasoning is an important alternative approach to
evaluate organizational designs “on paper.”

**Design-Based Change in the Social World**

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

Foremost among the differences is the need to contextualize generic
knowledge. How teams, meetings, or policies are thought of and operate in one
firm differs from those in another. Thick, rich and detailed descriptions are
therefore needed for the various solution concepts, the contexts in which these
concepts have been tested, and the nature of the (intended and unintended)
outcomes. Furthermore, the evaluation of alternative designs is done differently.
Many engineering designs can be adequately 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. An experiential learning
approach, like case-based reasoning, therefore has to be used to evaluate designs.
For instance, to evaluate the design for an account management system in a sales
department, the design group can draw on data on the performance of
implemented account management systems in other sales departments (within or
outside the same company).
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, realizing any design always involves the ultimate redesign and adaptation of the initial design by the change recipients: their behavior depends on how they interpret the design. Their collective interpretation can produce social realities at odds with the design group’s intentions, and thus different outcomes. A nursing group implementing a new self-managing team approach, developed at the level of the hospital at large, may distrust the given protocol and still appoint a group leader. In engineering design, this dilemma is solved in the design-for-manufacturing approach. In management and organization, however, the design group needs to facilitate the interpretation and enactment of their design by frequently interacting with change recipients during the design process as well as by staying involved in the entire subsequent process of change and learning for performance.

In this process of participation by the change recipients, EBMgt can make another contribution by informing the design group as well as the broader stakeholder audience of the design and change -- thus supporting interpretation, enhancing credibility, and generating confidence in the endeavor’s future outcomes.

Other Contexts of EBMgt

Above we discussed EBMgt in design-based organizational change. EBMgt can also be of great value in issues not necessarily involving major organizational change, like in decision-making on large investments or technology-driven
innovations. Moreover, in organizational change there are important alternatives to design-based change. In some situations, one cannot design a preferred end state, for instance because the available knowledge is insufficient or because organizational politics make it ill-advised. In such cases one may prefer to adopt a step by step approach, each step based on the results of the previous one. In other cases, change objectives are difficult to realize by designing preferred end states (e.g. in cultural change). In each of these alternative settings, however, there still is a lot of design to do -- for example, defining the objectives and set-up of the next step of the change process or the type of intervention to be used.

The Contribution of Evidence-Based Management

EBMgt intends to extend and build on intuitive, experience-based managerial problem solving. It does so by:

- Giving attention to the informational inputs to the problem-solving process
- Enhancing the shared repertoire (or Transactive Memory System) of the design group
- Providing significant content to the design process.

In the course of problem and context analysis, the design group gathers a lot of case-specific information, with respect to both the organization and its environment. EBMgt promotes a rigorous approach to collecting information, calling attention to scientific evidence as well as local facts and experiences, and adopting a critical attitude toward the information collected. EBMgt thus
enhances the quality of the inputs to the process of designing solutions to organizational problems.

An EBMgt approach emphasizes not just the solution to a single problem, but also enhances the organization’s readiness to address issues in future. Thus, it also aims to make full use of the explicit knowledge of the members of the design group and at making their tacit knowledge as explicit as possible (e.g. see the case 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 deeper understanding.

The primary contribution of EBMgt, however, is to produce valid generic knowledge on a particular issue, based on rigorous scientific research, including the outcomes of Design Science 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. Evidence from the literature arising from testing the solution concepts in various settings can support the subsequent evaluation step. As in engineering design, the evaluation and justification of designs in management and organization may draw on case-based reasoning.
The process of producing this valid generic knowledge is systematic research synthesis (Denyer & Tranfield, 2006; Denyer et al., 2008; Briner & Denyer, this Handbook). 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 step of the literature review, the basic question is: what have we learned until now to understand our problem and to synthesize alternative solutions, and what evidence have we generated 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. This serves to create an even broader shared repertoire, which can be of great value in realizing the design -- as will be discussed below.

**EBMgt in Developing University Spin-offs**

To illustrate evidence-based solution design in the context of organization and management, we draw on a study of university spin-off creation by Van Burg, Romme, Gilsing & Reymen (2008). This study provides an example of designing
and developing policies, informed by codifying and synthesizing practitioners’ experiences and the academic body of knowledge inferred from an extensive literature review.

The problem was how to create university spin-offs, that is, business start-ups that commercialize technologies developed at the incumbent university. Its particular context is the common case where the focal university resists any deviation from its core teaching and research processes. 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 spin-off creation project was already underway when this assignment was given. Three years earlier, TU/e had started the development of a new venturing incubation unit. In a quest to realize some early results, this was done without giving much attention to the literature on the subject. After some time the University Board and the incubator director became interested in how their incubator system compared to those at other (leading) universities and in what the scientific literature ad to say on it. In other words, the incubator was set-up without using EBMgt, but after some time the key players became interested in it. This way of starting EBMgt meant that the research team (in which one of the authors of this chapter participated) could benefit from the initial practitioners’ learning outcomes and experiences (i.e. reflection-in-action). On the other hand, arriving in the middle of the project meant that the design group -- the group actually involved in designing -- consisted not only of the research team, but also included the university staff members 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 of a systematic literature review to take into account the features specific to TU/e.

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 & 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 & Endenburg, 2006). That is, these explicit propositions allowed participants from diverse backgrounds to focus on a common set of issues in the design process (cf. boundary objects).

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):
a) So-called practice-based propositions were developed by converting the largely tacit knowledge of key actors in university spin-off creation into explicit propositions;

b) Propositions were derived from a review of the literature; these research-based propositions then served to understand (and possibly improve) practices and solutions already in place as well as create entirely new solutions;

c) Finally, the research team synthesized the practice-based and research-based propositions 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 & Corbin, 1990). First, the research team coded all different practices and experiences reported by initial design team members 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, some of the practice-based propositions identified by Van Burg et al. (2008: 122) were as follows:

Create arrangements for starters to use university labs and other resources; (…) enable starters to use the academic network of the university; establish a network of investors, industry contacts and financers around the support organization.
The research team derived research-based propositions by means of a systematic literature review using a qualitative meta-synthesis approach (Denyer & 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) developed 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 the parties involved, 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 TU/e stakeholders. This ongoing dialogue also served to reposition and fine tune two specific TU/e incubation practices. The first involved a program in which MSc students work in teams to develop value propositions and business models for a particular university-developed technology. 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.
The set of design propositions exposed blind spots and major opportunities for improvement and development. Moreover, 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 were well aware of the long-term effort required here, because universities tend to be rather conservative in view of their long-standing commitment to academic research and education.

This evidence-based project on spin-off creation, set up in 2005, is still ongoing at this writing. 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 per year around 2005, to the current rate (in 2010-11) 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, motivated the university’s top management to increase its ambitions -- to double the spin-off rate in the next 5 years. Of course, it is not possible to determine precisely to what extent the EBMgt 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 EBMgt project the TU/e would also have increased its performance in creating spin-offs. Moreover, any EBMgt 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, which previously was dealt on the basis of common wisdom and personal experiences.

Another, more academic, upshot of this 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 transparency and fairness in university spin-off formation. Moreover, other research teams have adopted and replicated the design framework developed by Van Burg et al. (2008), for example Barr, Baker, Markham and Kingon (2009) in the context of several US-based universities.

Discussion
The term Evidence-Based Management (EBMgt) may evoke a picture of rational decision-making (like the Rational Manager of Keppner & Tregoe, 1965) with academic research findings as its main input, replacing intuitive, experience-based
management. Instead, this chapter demonstrates and illustrates a design science approach in which EBMgt involves extending intuitive, experience-based management. This extension draws on scientific evidence as a source of design propositions and for creating a design process that effectively makes use of a broad array of knowledge and perspectives. EBMgt itself involves identifying and using those business practices that work, according to the best available evidence.

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 practitioners are facing. In Medicine, the Cochrane database (www.Cochrane.org) provides professionals with the evidence 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 persuasion and incentives to engage in EBMgt, since its added value appears 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 operate as a medical practitioner. The challenge here is to demonstrate the added value of recently developed evidence to medical professionals.

A similar problem occurs for experienced managers and management consultants: the added value of research-based knowledge is not always self-evident to them (and experienced managers may also have different views on what counts as evidence; see Green & Potwoworski, this Handbook). The community of management and organization researchers and educators must take charge of this challenge, by building a strong case for EBMgt, by creating attractive conditions for practitioners to join collaborative EBMgt projects and especially by giving much attention to EBMgt in management training.

The term “evidence” suggests a decision mode; that is, the idea that the main challenge is to choose between known alternatives. This implies that 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 major managerial issues. For such issues, we advocate a design mode that puts substantial effort in the design of alternative solutions or arrangements of solutions, thus crafting 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 -- being 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 perceiving EBMgt as a solely technical-rational approach to managerial issues (e.g. Denzin, 2009). Or the criticisms leveled by Morrell (2008) of, among other things, having a commitment to positivism (quod non), having simplistic ideas on the nature of evidence and on accumulation and progress in social science knowledge and of being troubled by “physician envy” (as opposed to the “physics envy” in some other social science arena’s). 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.

One of the characteristics of a Design Science approach to EBMgt is that a significant part of the general evidence to be used is produced by DSR, an approach to research that has three defining characteristics: it is driven by field problems, uses a participant-observer perspective, and adopts a solution orientation. As such, DSR differs from the (in the social sciences) far more common explanatory research. But DSR is not foreign to management research: both observe reality, both analyze observations and both draw grounded conclusions. Explanatory research studies the world as it is, DSR is interested in what the world can be. But knowledge about what comes from experimenting with these future states and observing and learning from these experiments. In its
methods DSR is thus not fundamentally different from explanatory research. Furthermore, almost every actual DSR-project starts with an explanatory part, describing and analyzing the type of field problem at hand and only then starts with developing alternative solutions. If there is a substantial body of knowledge about the field problem in question, the DSR part can be large; if little is known, the explanatory part needs to be larger, leaving much work for DSR in follow-up projects. Finally, DSR is not discipline-specific. In disciplines like Medicine and Engineering it is an important part of mainstream research, but in other disciplines one can do DSR equally well.

**Implications for Practice and Research**

Like Bismarck said: fools learn from their experience, I prefer to learn from the experience of others. EBMgt does not replace intuitive, experience based management, but extends it by judiciously gathering, validating, selecting and using knowledge on the incumbent organization, its environment and the types of issues at stake. In a design science approach to EBMgt, a critical part of the general evidence to be used is produced by DSR. Moreover, one deals with these significant issues in a design rather than decision mode: the emphasis is on designing and creating a preferred future, rather than on using evidence to choose from existing alternatives. EBMgt is not about finding exact interventions in the literature, but about interrogating scientific evidence to obtain valid input for the design of managerial initiatives, interventions and systems.

Next to practitioners, educators and researchers also have an important role in advancing and applying EBMgt. MBA as well as DBA programs should
include rigorous training in EBMgt, including systematic review and research synthesis, preferably also in real life settings. Researchers can support EBMgt by including design science in their repertoire of research strategies, in order to develop field-tested solution concepts for significant managerial issues. In the medical discipline, the Cochrane database does not only give practitioners diagnoses of dysfunctions, but also field-tested alternative treatments. Likewise, EBMgt should (ideally) be able to draw on a body of valid knowledge on alternative solutions to types of field problems.

EBMgt can and should become part of mainstream managerial thinking, just like Total Quality Management became part of this mainstream after the hype surrounding it had abated. For this to become reality a strong partnership between interested practitioners, educators and researchers is needed.
References


Denzin, N.K. (2009). The elephant in the living room; or extending the conversation about the politics of evidence. *Qualitative Research*, 9, 139-160.


*Organization Science, 14*, 558-573.


Rousseau, D. M. (2006). Is there such a thing as evidence-based management?  

*Academy of Management Learning and Education, 31*, 256-269.


*Journal of Management Studies, 41*, 219-246.


