ORGANIZATION RESEARCH AND ORGANIZATIONAL LEARNING: TOWARDS A DESIGN SCIENCE

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Abstract

Research into organizational learning and knowledge management tends to be based on science and the humanities. Science helps to understand organized systems by uncovering laws and forces that determine their characteristics, functioning and outcomes. Research drawing on the humanities helps to understand, and critically reflect on, the human experience of actors inside organized systems. This paper argues that scholars operating in this field should adopt design as one of their primary modes of engaging in research. Design is characterized by its emphasis on solution finding, guided by broader purposes and ideal target systems. Moreover, design develops, and draws on, propositions that are tested in pragmatic experiments and grounded in organization and management science. Drawing on Herbert Simon's work, the development of a design science is therefore advocated.

"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: 111).

1. INTRODUCTION

Research into organizational learning and knowledge management tends to be based on science and the humanities. Science helps to understand organized systems by uncovering laws and forces that determine their characteristics, functioning and outcomes. Research drawing on the humanities helps to understand, and critically reflect on, the human experience of actors inside organized systems. This paper argues that scholars operating in this field should adopt design as one of the primary modes of engaging in research. State-of-the-art design research is characterized by its emphasis on solution finding, guided by broader purposes and ideal target systems. Moreover, design develops, and draws on, design propositions that are tested in pragmatic experiments and grounded in organization and management science. Elsewhere I have provided an overview of science, humanities and design as different but complementary modes of engaging in research (Romme 2003b). Table 1 summarizes this overview.

This paper explores the main differences and synergies between science and design in the context of researching organizational learning and knowledge management. Illustrations of the pragmatic focus on actionable knowledge as well as the key role of ideal target systems in design processes are taken from the design and development of circular infrastructures. Finally, a framework is proposed for creating synergy and collaboration between the science and design mode in researching organizational learning, knowledge management and related organizational phenomena and artifacts. This framework may also help to reduce the so-called 'relevance gap' between academic research and the work being done by practitioners. In sum, the development of a *design science* is advocated.

See Table 1
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2. "SCIENCE" IN ORGANIZATION RESEARCH

Organization science thus assumes organizational order to be empirically manifested as a set of stable regularities that can be expressed in the form of hypothetical statements. These statements have usually been conceived as revealing the nature of organizations, namely as a set of objective mechanisms underlying diverse organizational realities (Donaldson 1985; 1996). In addition, what a system consists of, and the objectives it aims to achieve, are either taken for granted or regarded as being externally imposed (Tsoukas 1998).

Drawing on the humanities, some writers have been explicitly criticizing the representational nature, and thus findings, of science-based inquiry (e.g. Gergen 1992; Tsoukas 1998). Others have expressed severe doubts about whether or not the representational and constructivist view are really incompatible (Czarniawska 1998; Elsbach et al. 1999; Tsoukas 2000; Weiss 2000). This debate on the nature of knowledge has primarily addressed epistemological issues and has turned attention away from the issue of research objectives, that is, our commitments as organization researchers (Wicks and Freeman 1998).

More in particular, organization science tends to focus on the discovery of general causal relationships among variables. Causal propositions or inferences can be rather simple ("if x and y, then z"). However, because variations in effects may be due to other causes than those expressed in a given proposition, causal inferences are usually expressed in probabilistic equations or expressions (e.g. "x is negatively related to y"). This concept of causality helps to explain and understand any observable organizational phenomenon, but in itself cannot account for qualitative novelty (Bunge 1979; Ziman 2000). As such, organization scientists typically employ the following research methods: the controlled experiment, field study, simulation model, and case study. In controlled experiments, the research setting is safeguarded from the constraints and disturbances of the practice setting, and thus a limited number of conditions can be varied in order to discover how these variations affect dependent variables (e.g. Sarbaugh-Thompson and Feldman 1998). In the field study, also known as the natural experiment, the researcher gathers observations regarding a number of practice settings, measuring in each case the values of relevant (quantitative or qualitative) variables; subsequently the data are analyzed to test whether the values of certain variables are determined by the values of other variables (e.g. Eisenhardt and Schoonhoven 1996; Kraatz and Zajac 2001; Wageman 2001). Mathematical simulation modelling involves the study of complex cause-effect relationships over time; this requires the translation of narrative theory to a mathematical model, to enable the researcher to develop a deep understanding of complex interactions among many variables over time (e.g. Rudolph and Repenning 2002). Finally, the single or comparative case study helps researchers to grasp holistic patterns of organizational phenomena in real settings (Numagami 1998).

2.1 Science in and for practice

Studies of how research is actually done in the natural sciences have been undermining the ideal-typical image of science (e.g. Latour and Woolgar 1979; Knorr-Cetina 1981). More recently, work by Gibbons et al. (1994) has motivated a number of authors to advocate that organization and management studies should be repositioned from research that is discipline based, university centered and focused on abstract knowledge towards so-called Mode 2 research (Huff 2000; Tranfield and Starkey 1998; Starkey and Madan 2001). Mode 2 research, which appears to be characteristic to a number of disciplines in the applied sciences and engineering, focuses on producing knowledge in the context of application and is transdisciplinary: potential solutions arise from the integration of different skills in a framework of application and action, which normally goes beyond that of any single contributing discipline (Gibbons et al. 1994; Tranfield and Starkey 1998). As such, Mode 2 research is heterogeneous in terms of the skills and experience people bring to it. In addition, accountability and sensitivity to the impact of the research is built in from the start (Ziman 2000). In this respect, Mode 2 research draws on the humanities to built reflexivity into the research process (Gibbons et al. 1994; Nowotny et al. 2001).

The proposal for Mode 2 research has been debated in a special issue of the *British Journal of Management* (e.g. Grey 2001; Hatchuel 2001; Huff and Huff 2001; Hodgkinson et al. 2001; Weick 2001). For example, Hatchuel (2001) suggests that Mode 2 research requires two essential conditions: a clarification of the scientific object of management research and the design of research-oriented partnerships of academics and practitioners. Weick (2001) argues that the 'relevance' gap is as much a product of practitioners being wedded to gurus and fads as it is the result of academics being wedded to science. He suggests that this gap persists because practitioners forget that the world is idiosyncratic, egocentric and unique to each person and organization.

These ideas suggest that organization research is better captured and guided by more pluralistic and sensitive methodologies than by exclusive images of how science should be done or is actually practised. In this respect, there appears to be no unique or exclusive methodology for any of the (social) sciences, because there is no way to determine what constitutes 'better' forms of meaning creation, in either epistemological or moral sense (Fabian 2000; Wicks and Freeman 1998; Ziman 2000). Thus, the epistemological core of organization studies are here assumed to include at least three different ideal-typical modes of research (see Table 1) that cannot readily be reduced to a single methodology, or more broadly, privileged culture of scientific inquiry.[1]

3. EMERGENCE OF A DESIGN APPROACH

In *The Sciences of the Artificial*, Herbert Simon distinguished between science and design. According to Simon, science is organized in disciplines, such as physics, chemistry and biology. These disciplines are interested in what natural objects are and how they work. Thus, science develops knowledge about what already is, and it aims at discovering and analysing these existing systems and things (Simon 1996). By contrast, design involves human beings using knowledge to create what should be, things that do not yet exist. Design is the core of all professional activities: the activity of changing existing situations into desired ones (Simon 1996).

Historically and traditionally, says Simon (1996), the sciences research and teach about natural things: how they are and how they work. The engineering disciplines have been teaching about artificial things: how to design for a specified purpose and how to create artifacts that have the desired properties (see also: Baldwin and Clark 2000). The social sciences have traditionally viewed the natural sciences to be their main reference point. However, Simon argues that engineers are not the only professional designers, because "everyone designs who devises courses of action aimed at changing existing situations into preferred ones. The intellectual activity that produces material artifacts is no different fundamentally from the one that prescribes remedies for a sick patient or the one that devises a new sales plan for a company or a social welfare policy for a state" (Simon 1996: 111).

Thus, the design approach is what distinguishes the professions from the sciences, and "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: 111). Subsequently, Simon describes how the natural sciences almost drove the sciences of the artificial from professional school curricula – particularly in engineering, business and medicine - in the first twenty to thirty years after the second World War. An important factor driving this process was that professional schools in business and other fields hankered after academic respectability, when design

[1] Moreover, Nowotny et al. (2001) argue that too much focus on its epistemological core is likely to constrain the potential of science and "could be taken to imply that ultimate and absolute truth is still attainable" (Nowotny 2001: 200). The position of 'paradigm incommensurability' (cf. Czarniawska 1998; Donaldson 1998) is also avoided here. In this respect, Hacking (1986) and Wilber (1998) suggest the thesis of 'paradigm incommensurability' stems from a misreading of Thomas Kuhn's (1962) *The Structure of Scientific Revolutions*.

approaches were still largely "intuitive, informal and cookbooky" (Simon 1996: 112). In addition, the enormous growth of the higher education industry after the second World War created large populations of scientists and engineers who spread out through the economy and took over jobs formerly held by technicians and others without academic degrees (Gibbons et al. 1994). This implied the number of sites where competent work in the area of design and engineering was being performed increased enormously, which in turn has undermined the exclusive position of universities as knowledge producers in this area (Gibbons et al. 1994). Another force that contributed to design being (almost) removed from professional school curricula was the development of capital markets that offered large, direct rewards to value-creating enterprises, and as such, large incentives for human beings to cooperate for the purpose of creating economic value (Baldwin and Clark 2000). In other words, design in the technical as well as managerial and social domain moved from professional schools to a growing number of sites in the economy where it was viewed as more respectable and could expect larger direct economic rewards.

Since the mid-1970s design methodologies have nevertheless been developed. The first edition of *The Sciences of the Artificial*, published in 1969, was particularly influential in the development of systematic and formalized design methodologies in architecture, engineering, urban planning, medicine and computer science (e.g., Baldwin and Clark 2000; Cross 1984; Jackson & Keys 1984; Klir 1981; Long and Dowell 1989; Warfield 1990).

3.1 Design methodologies for organization and management

Although design is not a key notion in the current state of the art of organization research (incl. knowledge management), it does have a long history in this field. In this respect, three generations of design methodologies can be distinguished. The first generation developed in the late 1800s and early 1900s and culminated in the work of the engineer Frederick Taylor (1911), whose work was initially published and discussed only in engineering journals (Barley and Kunda 1992). Known as the 'scientific management' movement, these design approaches arose from attempts by managers with engineering backgrounds to apply the principles of their discipline to the organization of production. The core of these approaches involved specific schemes and practices for improving managerial control and coordination, particularly in the area of cost accounting systems, production control systems and wage payment plans (Barley and Kunda 1992).

The second generation of design methodologies in organization and management focused on regulatory approaches such as socio-technical systems, functionalist systems theory and human relations (Checkland 1981; Drucker 1954; Emery and Trist 1972; Jaques 1962). Like the first generation of design approaches, the primary concern of the second generation was to seek universal dictums that managers could employ in the course of their work (Burrell and Morgan 1979). However, unlike their predecessors, the new design approaches described and codified general processes rather than specific practices – for example, in the area of setting objectives, planning, and forecasting (Barley and Kunda 1992).

More recently, a third generation of design thinking appears to be emerging. This category of design approaches is grounded in explicitly stated philosophical and theoretical positions, characterized by a co-evolutionary, value-laden and ethics-based systems approach. Examples include design methodologies for organizing education (Banathy 1996 and 1999; Romme 2003a; Schön 1987), for group model building (Vennix 1996), and for teamwork in business organizations (Tranfield et al. 1998;

Tranfield et al. 2000). Well-known contributions are those by Argyris and co-authors in the area of organizational learning and defensive behaviour (e.g., Argyris et al. 1985; Argyris and Schön 1978). In Europe, Endenburg has pioneered the development of a system's design methodology for organizations (Endenburg 1998; Romme 1999). The design work of Endenburg will be explored in more detail in the next section.

Particularly as a result of the first generation of design methodologies, the concept of design is easily misinterpreted as being a technical, instrumental concept used by managers trying to bring their organizations under rational control. This older notion of design is no longer useful and relevant. In the second and particularly the third generation of design thinking, managers are not viewed as all-powerful architects of organizations: their influence on organizational processes is assumed to be limited, because they are not the only participants in the discursive and collaborative processes that shape organizational systems (cf. Banathy 1996).

3.2 Key values in design

The normative core of the design approach that has emerged in professions such as architecture, organization development and community development can be described in terms of an underlying philosophy. This design philosophy involves the values and normative ideas that guide design as creative disciplined inquiry. These values and ideas are explored here in terms of eight principles; five principles have been suggested by Nadler and Hibino (1990), and have been adapted and extended on the basis of the work of others; three additional principles – regarding participation, discourse and pragmatic experimentation – have been defined with reference to other sources, including my own work. These principles describe the main values and normative ideas that have been guiding, as well as arising from, actual design projects conducted over the last twenty years in organizational development, education and related fields. The first four principles define the content dimension of design thinking:

Uniqueness principle. This principle implies that no two situations are alike; each problem situation is unique and is embedded in a unique context of related problems, requiring a unique approach (Checkland and Scholes 1990; Nadler and Hibino 1990). The unique and embedded nature of problem situations makes them ill-defined or 'wicked', which means that there is no sufficient information available to enable the designer to arrive at solutions "simply by transforming, reducing, optimising, or superimposing the given information alone" (Archer 1984: 348).

Purposes principle. Focusing on purposes helps 'strip away' nonessential aspects of the problem situation. It opens the door to the creative emergence of larger purposes and expanded thinking. It also leads to an increase in considering possible solutions, and guides long-term development and evolution (Banathy 1996; Nadler and Hibino 1990; Tranfield et al. 2000).

Ideal solution principle. Having an ideal target solution puts a time frame on the ideal system to be developed, guides near-term solutions, and infuses them with larger purposes. "Even if the ideal long-term solution cannot be implemented immediately, certain elements are usable today" (Nadler and Hibino 1990: 140).

Systems principle. Systems thinking helps designers to understand that every unique problem is embedded in a larger system of problems (Argyris et al. 1985; Checkland and Scholes 1990; Vennix 1996). It helps them to see "not only relationships of elements and their interdependencies, but, most importantly, provides the best assurance of including all necessary elements, that is, not overlooking some essentials" (Nadler and Hibino 1990: 168).

The following four principles define the values and ideas regarding the process of design:

Limited information principle. This principle guards designers against excessive data gathering that may make them an expert with regard to the existing artifacts, whereas they should become experts in designing new ones. Too much focus on the existing situation prevents people from recognizing new ideas and seeing new ways (Nadler and Hibino 1990).

Participation principle. Those who carry out the solution should be immediately involved in its development. Involvement in making decisions about solutions and their implementation leads to acceptance and commitment (Vennix 1996). Moreover, getting everybody involved is the best strategy if one wants long-term dignity, meaning and community (Endenburg 1998; Weisbord 1989). In some cases, the benefits of participation in creating solutions can be more important than the solution itself (Romme 1995).

Discourse principle. For design professionals, language is not a medium for representing the world, but for intervening in it (Argyris et al. 1985). Thus, the design process should initiate and involve dialogue and discourse aimed at defining and assessing changes in organizational systems and practices (Checkland and Scholes 1990; Warfield and Cardenas 1994).

Pragmatic experimentation principle. Finally, pragmatic experimentation is essential for designing and developing new artifacts, but also for preserving the vitality of artifacts developed and implemented earlier (Argyris 1993; Banathy 1996). Pragmatic experimentation emphasizes the importance of experimenting with new ways of organizing and searching for alternative and more liberating forms of discourse (Argyris et al. 1985; Wicks and Freeman 1998). This approach is necessary to "challenge conventional wisdom and ask questions about 'what if?' but it is tempered by the pragmatist's own commitment to finding alternatives which are useful" (Wicks and Freeman 1998: 130).

Some of these principles are familiar to other approaches. For example, the discourse principle is shared with postmodernists (Gergen 1992), although the latter may not share the underlying notion of pragmatism (see Table 1). The notion of experimentation is also central to laboratory experiments in the natural sciences and (some parts of the) social sciences; however, experiments by designers in organizational settings are best understood as action experiments (Argyris et al 1985) rather than controlled experiments in laboratory settings.

In response to the need for more relevant and actionable knowledge, organization researchers tend to adopt action research methods to justify a range of research methods and outputs. Action research has been, and still is, finding difficulty in acceptance on the grounds that it is not normal science (Bartunek and Louis 1996; Eden and Huxham 1996; Heron and Reason 1997; Tranfield and Starkey 1998). As such, action researchers have been greatly concerned with methods to improve the rigor and validity of their research, in order to gain academic credibility. Moreover, action researchers in this area have emphasized retrospective problem diagnosis more than finding and creating solutions (e.g. Eden and Huxham 1996). Design research incorporates several key ideas from action research, but is also fundamentally different in its future-oriented focus on solution finding.

3.3 Ill- and well-defined problems

The focus on solution finding rather than problem diagnosis makes design highly different from science. In science the representation of the problem is the result of an in-depth analysis and structuring of the problem, and any solutions brought to the problem stay within the boundaries of the problem definition and analysis. Such an approach is appropriate and effective in dealing with well-defined and well-structured problems, such as determining the optimal inventory level or selecting the 'best' candidate from a pool of applicants on the basis of explicit requirements (Newell and Simon 1972).

However, in case of an ill-defined problem, an approach is required that cannot and should not stay within the boundaries of the given problem definition. Archer (1984: 348) describes an ill-defined problem as "one in which the requirements, as given, do not contain sufficient information to enable the designer to arrive at a means of meeting those requirements simply by transforming, reducing, optimising, or superimposing the given information alone." Typical ill-defined problems include, for example, lack of communication and collaboration between team members or different organizational units; non-participation as the typical response of employees to a variety of development programs initiated by management; and the security of commercial airline flights with regard to 'new' forms of terrorism.

Facing ill-defined problems and challenges, designers employ a solution-focused approach. They begin generating solution concepts very early in the design process, because an ill-defined problem is never going to be completely understood without relating it to an ideal target solution that brings novel values and purposes into the design process (Banathy 1996; Cross 1984). According to Banathy (1996), focusing on the system in which the problem situation is embedded tends to lock designers into the current system, although design solutions lie outside of the existing system: "If solutions could be offered within the existing system, there would be no need to design. Thus designers have to transcend the existing system. Their task is to create a different system or devise a new one. That is why designers say they can truly define the problem only in light of the solution. The solution informs them as to what the real problem is" (Banathy 1996: 20).

4. EXAMPLE: DESIGNING CIRCULAR ORGANIZATIONS

This section describes a specific design project in the area of organizational learning. I have selected this example because it is grounded in explicitly stated philosophical and theoretical positions and has been tested in a large number of applications. Another excellent example of design science is the work of Argyris and others on designing and creating effective learning by individuals and groups (e.g. Argyris 1993; Argyris et al. 1985).

The circular organization design, pioneered by Gerard Endenburg, aims at the creation of learning ability by active participation at the organizational level as well as the group and individual level. Endenburg started to develop this design approach in the early 1970s, as CEO of an electro-technical company in the Netherlands. In this company he was confronted with problems such as the functioning of the works council that did not appear to provide any opportunities for effective consultation between management and employees, but instead, frequently generated conflicts. Inspired by the notion of circularity from systems theory as well as the idea of consensus decision-making practised in Quaker organizations, Endenburg started experimenting with a so-called circular design to solve the problem of employee participation and involvement (Endenburg 1998; Romme 1999).

Initially, he started doing this in collaboration with managers and employees within the company; later also outsiders started participating in the further development of the design and its implementation process. This has led to a well-developed approach, which essentially implies that the organization's ability for effective learning and decision-making at all levels is increased by adding a so-called circular structure to the existing (usually) hierarchical structure (Romme 1999).

This design approach involves a number of design rules, defining how decisions should be made, how different decision-making units are to be linked, and so forth. These rules are formulated in terms of: *In condition C, do D.* For example, one of the rules is as follows: in case of policy making in a group of people authorized to do so, decision-making must be done on the basis of consent (or 'no argued objection'); that is, a decision is made if and only if all participants give consent (Endenburg 1998).

These rules are laid down in the company's statutes, as a set of permanent rules safeguarding the participation of all stakeholders and shareholders at the board level and managers and employees at other levels in the organization. The circular design method also includes tools in the area of setting objectives, organizing and managing work, performance assessment, and performance-based compensation at the individual, group and organizational level (Endenburg 1998). Case studies of several firms that have redesigned their organization on the basis of the circular model suggest that decision-making and learning proceeds more easily and effectively than without this redesign (Van Vlissingen 1991; Romme 1999).

Since the first experiments in Endenburg's own company in the early 1970s, the circular model now appears to have progressed beyond the experimental stage. It is currently being used in about thirty organizations throughout the world including Brazil, Canada, the USA and the Netherlands (Romme and Reijmer 1997; Romme 1999; Van Vlissingen 1991). For Dutch firms, by law required to install one or more work councils, implementation of the circular model implies they are exempted from this requirement (Romme 1999). Thus, the circular design as an ideal target solution has been tested in an increasing number of organizational practices. Elsewhere, the details of the circular design approach have been described and grounded in systems theory (Endenburg 1998; Romme 1995) and organization theory (Romme 1997; 1999).

The way in which the circular model serves as an ideal target system in the design process can be illustrated as follows. Very early in the design process, typically with help of external consultants, the circular design rules are used to define the nature of problems and challenges the organization is facing (Romme and Reijmer 1997). For example, in a first session with the executive team of a large catering services firm the imperatives for and direction of organizational change were explored. The executives initially defined these imperatives in terms of low commitment to and involvement of their employees and middle management in service quality programs, set up to improve the firm's competitive position. The consultant then introduced the circular system as an ideal target solution, and invited the executives to frame and understand the problems they were facing in terms of this ideal-typical system. The executives subsequently reframed the existing situation in their organization in terms of a lack of sustained opportunities for participation as well as their own mistrust in delegating authority to local managers. In this respect, their initial problem definition was perceived to be not 'wrong', but merely "incomplete and somewhat superficial". The executive team subsequently started a long-term effort to develop a tailor-made solution, drawing on the design rules that constitute circular organizing as an ideal target system, to decentralize decision-making to the people closest to the customer and at the lowest level possible in view of the decision issue (Romme and Reijmer 1997).

These and other cases suggest that the circular model as an ideal target system serves to define and understand the existing organizational situation from a more systemic point of view, and as such broaden and deepen the managerial focus on behavioural patterns and (financial) results (Romme and Reijmer 1997; Van Vlissingen 1991; Romme 1999).

5. TOWARDS A METHODOLOGY OF DESIGN SCIENCE

The circular design methodology appears to acknowledge the ill-defined and embedded nature of organizational problems, and emphasizes broader purposes and ideal target solutions to guide long-term organizational development. Moreover, it also has a strong focus on designing solutions, rather than extensive analysis of problems. This design approach also emphasizes and intends to enable participation by people involved, and uses models for intervening in organizational systems and practices. Moreover, the participants try to build the potential of continual change into the new system. In this paper, I will not deal with the (scientific) question whether or not this design approach performs 'better' than others. At this point it is sufficient to observe that they appear to 'work', that is, produce satisfactory outcomes for a certain population of professionals other than the pioneer (e.g. Romme and Reijmer 1997; Van Vlissingen 1991; Romme, 2003a).

The focus on solutions, envisioned with help of broader purposes and ideal target systems, characterizes this design approach. Mainstream science in the area of management and organization suggests we focus on analyzing and understanding the existing situation, which in it self would not lead to any changes in the direction of a novel situation or system. As such, the design mode of engaging research shares its pragmatic focus on solutions with the so-called Mode 2 research discussed earlier. The main difference between Mode 2 and design research appears to be that the latter involves the development and application of broader purposes and ideal target systems.

5.1 Testing and grounding design propositions

A design methodology for organization research should focus on developing design propositions or rules. In the remainder of this paper, I will use the notion of a design *proposition* to refer to preliminary design 'rules', and design *rules* for propositions that have been tested in practice as well as grounded in empirical evidence.

The form of design propositions or rules – as the core of design knowledge – is highly similar to the basic form of knowledge claims in science-based research, irrespective of differences in ontological and epistemological assumptions. These design propositions can provide a shared focus for dialogue and collaboration between design and science. In this respect, Van Aken (2001a) argues that a design science for management research should focus on the development of tested and grounded 'technological' rules. Drawing on Bunge (1967), he argues that effective partnerships between science and design in the technical domain lead to tested technological rules grounded in scientific knowledge – for example, the design rules for aeroplane wings being tested in engineering practice as well as grounded in the laws and empirical findings of aerodynamics and mechanics (Van Aken 2001a). Van Aken (2001b) recommends a similar approach to testing and grounding design rules in management research. He argues that testing should involve both alpha and beta testing, notions adopted from software development. Alpha testing involves the initial development of a design rule, and is done by the researchers themselves through a series of cases. Subsequently, beta testing is a kind of replication research done by third parties to get more objective evidence as well as to counteract any blind spots or flaws in the design rules not acknowledged by the researchers (Van Aken 2001b).

Testing design rules by means of pragmatic experiments is highly similar to the replication logic recommended for comparative case studies (Numagami 1998; Yin 1984). The difference between case studies and pragmatic experimentation is that case studies are usually conducted in order to explain and understand a certain phenomenon, whereas pragmatic experiments are set up to test, develop and apply design propositions.

5.2 Design causality

This suggests that design research should focus on design propositions developed through testing in practical contexts as well as grounding in the empirical findings of organization science. In this respect, testing design rules in a practical context appears to be different from hypothesis testing and tinkering in science. This difference arises from the notion of causality underlying design.

Design draws on what Argyris (1993: 266) has called ‘design causality’ to produce knowledge that is both actionable and open to validation. This notion of design causality appears to be less transparent and straightforward than the concept of causality underpinning science – involving the study of variance among variables. This is due to two characteristics of design causality. First, design causality explains *how patterns of variance among variables arise* in the first place, and in addition, why changes within the pattern are not likely to lead to any fundamental changes (Argyris 1993). Argyris’ (1993) model I and Endenburg’s hierarchical structure are examples of a model of a certain category of structures in which organizational processes are embedded. They each define a relatively invariant pattern of certain values, action strategies, group dynamics and their outcomes.

Second, when awareness of another design program as an ideal target system – such as Argyris’ (1993) Model II respectively the circular structure – is created, design causality *implies ways to change the causal patterns*. That is, ideal target systems can inspire, motivate and enable agents to develop new organizational processes and systems. Both Argyris (1993) and Endenburg (1998) emphasize that the causality of the old and the new structure will co-exist, also long after a new program or structure has been introduced.

These two characteristics of design causality tend to complicate and undermine the development and testing of design propositions (and the ideal target systems they are linked to).

5.3 Towards a framework for synergy between science and design

With a few exceptions, design inquiry into organization is currently largely left to practitioners such as organization development professionals and management consultants. As such, the body of design knowledge is rather fragmented and dispersed, in any case more so than science- and humanities-based knowledge on organization. Design research must therefore be redirected towards more rigorous research to produce *design propositions* that can be grounded in empirical research as well as tested, learned and applied by ‘reflective practitioners’ (Schön 1987) in organization and management. The form of such propositions and rules – as the core of design knowledge – is highly similar to knowledge claims in science. This similarity is an important condition for dialogue and collaboration between design and science, to the extent that these design propositions can provide a shared focal point. As such, a more rigorous approach to design inquiry will facilitate collaboration and dialogue with organization science.

In sum, the potential synergy between science and design can be summarized as follows. First, the body of knowledge and research methods of organization science can serve to ground preliminary design propositions in empirical findings, suggest ill-defined areas where the design mode can effectively contribute, and help build a cumulative body of knowledge about organization and organizational learning from a design perspective. In turn, the design mode serves to translate empirical findings into design propositions for further development and testing, suggest research areas (e.g. with design propositions that lack empirical grounding) where science can effectively contribute, and help bridge the relevance gap between science and the world of practice. Table 2 provides an overview of the main differences and potential synergies between design and science to facilitate collaboration and dialogue between these two modes of engaging in research.

Insert Table 2 about here

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6. CONCLUDING REMARKS

After enjoying a certain degree of paradigmatic consistency and unity in the first half of the 20th century, research into management and organization (and particularly organizational learning) has become increasingly pluralistic in nature (Pfeffer 1993; Weiss 2000). In the years since Burrell and Morgan's (1979) presentation of multiple approaches, the attention of the community of organization scholars has been turning away from the important issue of research objectives and our commitments as researchers.

In this respect, science and the humanities help to understand existing organizational systems, rather than to actually help create new organizational artifacts. This suggests that organization studies must be reconfigured as an enterprise that is explicitly based on science, humanities *and* design. With a few exceptions in the academic community, design inquiry into organization and organizing is currently largely left to practitioners such as organization development professionals and management consultants. As such, the body of design knowledge appears to be fragmented and dispersed, in any case more so than science- and humanities-based knowledge of organization. Design research must therefore be redirected towards more rigorous research, to produce outcomes that are characterized by high external validity but also are teachable, learnable and usable by practitioners. Collaboration and exchange between science and design can only be effective if a common framework is available that facilitates interaction and communication between the two. The argument in this paper involved a modest attempt to define the main conditions, differences and synergies of three modes of engaging in organization research (see Table 1); subsequently, the nature and contribution of the design mode was explored in relation to the science mode (see Table 2).

The human race has been profoundly changing the parameters of the evolutionary process, particularly as a result of the collaboration between the natural sciences and the design and engineering disciplines. Our capacity for learning, producing knowledge, and designing and organizing complex systems has an extraordinary, although often unintended, impact on societal evolution. The key question for scholars in our field therefore is: for what purposes are we going to use our scholarly capacity for learning and creating? I have argued that this capacity can be used to guide human beings in the process of designing and developing their organizations towards more humane, participative and productive futures. This is a complex and challenging task that requires intensive collaboration between organization science and design.

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Table 1: Three Ideal-Typical Modes of Engaging in Research

	Science	Humanities	Design
Contribution & Purpose:	Helping understand the organized world, by uncovering the laws and forces that determine its characteristics, functioning and outcomes	Helping understand (and critically reflect on) the human experience of actors inside organized practices	Helping shape organizational systems by developing (and drawing on) a vision of what those systems could and should be
Role Model:	Natural sciences (e.g. physics) and other disciplines which have adopted the science approach (e.g. economics)	Humanities (e.g. aesthetics, ethics, history, cultural studies, literature, philosophy)	Design and engineering (e.g. architecture, aeronautical engineering, computer science)
View of Knowledge:	Representational: our knowledge represents the world as it is	Constructivist and narrative: all knowledge arises from what actors think and say about the world	Pragmatic: knowledge in the service of design action
Object:	Organizational phenomena as *empirical objects* with descriptive properties	*Discourse* that actors and researchers engage in	Organizational systems as artificial objects (*organizational artifacts*) with descriptive as well as imperative properties
Nature of Thinking:	Descriptive and analytic (drawing on the concept of variance among variables)	Critical and reflexive	Normative and synthetic; producing knowledge that is actionable as well as open to validation
Focus on:	Explaining currently existing or emerging organizational phenomena; key question is whether or not a knowledge claim ("if x, then y" or "x is neg/pos related to y") is valid for a certain population of organized practices	Understanding, interpreting and portraying the human experience using a variety of metaphors and narratives: key question is whether the experience is "good", "fair", etc.	Producing systems that do not yet exist, with help of ideal target solutions bringing novel values and purposes into the design process; key question is whether an integrated set of design propositions (e.g. "in S, to achieve C, do A") 'works' in a certain practical context

Table 2: Framework for Creating Synergy and Collaboration between Science and Design in Researching Organizational Learning and Knowledge Management

	Science Mode	**Design Mode**
Context	Relatively well-defined organizational problems, processes and practices that can be effectively studied from an outsider position (e.g. which information technology applications and systems are used in a certain population of organizations?).	Relatively ill-defined problems, processes and practices that people encounter (e.g. creating and sharing knowledge) with regard to their organizational artifacts (e.g. information and other organizational systems).
Key Values	Basic *attitude* of scientists is characterized by disinterestedness and intersubjectivity and additional (domain-specific) espoused values such as observational reliability, external validity, and generalizability. Actual *process* of science is characterized by "tinkering": encountering and exploiting opportunities that arise; recognizing what is feasible, and adjusting projects accordingly; etc.	*Content* dimension of design is characterized by uniqueness of problem situation, focus on purposes, focus on ideal solutions, and systems thinking. *Process* dimension is characterized by limited information, emphasis on participation, language and discourse as medium for intervention, and pragmatic experimentation.
Nature of Research	Existing or emerging organizational systems are analyzed in-depth; any recommendations or proposed solutions stay within the boundaries of the analysis.	New (states of existing) artifacts are designed by developing and drawing on broader purposes and ideal target systems; design process thus tends to move outside boundaries of initial problem definition.
Causality Concept	*Variance causality:* study of cause-effect relationships by analyzing variance among variables across time and/or space.	*Design causality:* study of how relatively invariant patterns arise, and of ways to change these patterns, to produce knowledge that is actionable as well as open to validation.
Research Methods	Controlled experiment, field study, mathematical simulation, and descriptive case study	Testing design propositions by way of pragmatic experimentation (action experiments)
Potential Synergy	Science … a) grounds design propositions, initially developed and tested in design inquiry, in empirical findings; b) suggests ill-defined areas (e.g. with ambiguous empirical findings) where the design mode can effectively contribute; c) helps to build a cumulative body of knowledge about organization and organizing as design.	Design … a) translates empirical findings into design propositions for further development and testing; b) suggests research areas (e.g. design propositions that lack empirical grounding) where science can effectively contribute; c) helps to bridge the relevance gap between science and the world of practice.