Eindhoven Centre for Innovation Studies

The Field-tested and Grounded Technological Rule as Product of Mode 2 Management Research

J.E. van Aken

Eindhoven Centre for Innovation Studies, The Netherlands

Working Paper 03.14

Department of Technology Management

Technische Universiteit Eindhoven, The Netherlands

July 2003

version 4 June 2003

The Field-tested and Grounded Technological Rule as Product of Mode 2 Management Research

Joan E. van Aken
Eindhoven Centre for Innovation Studies
Eindhoven University of Technology

The relevance problem in academic management research is an old and thorny one. Recent discussions on this issue have resulted in proposals to use more Mode 2 knowledge production in our field. In these discussions the focus has been largely on the process of research and less on the products produced by that process. In this article the focus is on the so-called field-tested and grounded technological rule as a product of Mode 2 research with the potential to help to remedy the relevance problem. The nature of such technological rules is discussed as well as their actual use in management practice.

Introduction

A respectable objective for academic research is the development of knowledge for knowledge sake (Huff, 2000). The key quality criterion for such knowledge is validity, i.e. that it is deemed valid by an informed audience – the relevant scientific community – on the basis of the arguments and empirical proof given (Peirce, 1960). However, for research at professional schools like Business Schools, one may want to add a second criterion, viz. relevance. A significant part of the knowledge produced by research at Business Schools should not only take the hurdle of academic rigour but also the one of relevance (to use the double hurdles metaphor of Pettigrew, 2001). It should be relevant for the world of management and business, as the majority of their students may expect that they can use their Business School knowledge in their careers outside academia.

Yet, that relevance of academic research products in the field of Organisation and Management is problematic. And it is a fairly old problem. Already in 1978 Susman and Evered remark "There is a crisis in the field of organisational science. The principal symptom of this crisis is that as our research methods and techniques have become more sophisticated, they have also become increasing less useful for solving the practical problems that members of organisations face" (Susman and Evered, 1978, p.582). In 1982 as well as in 1983 the *Administrative Science Quarterly* devoted Special Issues on this problem. Several presidents of the American Academy of Management addressed the issue, including Hambrick, who bemoaned the very limited role of academic research in most major debates on business and management (Hambrick, 1994).

Recently the relevance problem has received again more attention. The *Academy of Management Journal* published a Special Issue on collaborative research, prompted by this problem (Rynes, Bartunek and Daft, 2001). And in the UK, the *British Academy of Management* and this Journal play a major role in drawing attention to the relevance gap, starting with Tranfield and Starkey (1998), followed by the Starkey-Madan Report (an abridged version of that report is given in Starkey and Madan, 2001a) and subsequently by a Special Issue of this Journal (Hodgekinson, 2001). In the UK this debate is strongly inspired by the seminal work of Gibbons et al. (1994) on the distinction between Mode 1 knowledge production, purely academic and mono-disciplinary, and Mode 2 knowledge production, multidisciplinary and aimed at solving complex and relevant field problems.

However, as will be discussed below in some more detail, these discussions on collaborative research and Mode 2 Knowledge production tend to focus on the research process and less on the nature of the knowledge produced by that process. One may expect that the intense interactions between researchers and practitioners in collaborative or Mode 2 research will enhance the relevance of the resulting research products. Nevertheless it seems also to be worthwhile to give a hard look at the products from such research processes. The present article intends to contribute to the Mode 2 discussion by discussing a possible research product from collaborative or Mode 2 research, viz. the *"field-tested and grounded technological rule"*. This approach has been inspired by what can be called the "design sciences" (like Medicine and Engineering), so this background will be discussed as well. The technological rule is a chunk of solution-focused knowledge, intended to be used in an instrumental way, as opposed to descriptive knowledge, which usually will be used in a more conceptual way, i.e. for general enlightenment of the issue at hand. Instrumental use of knowledge, however, is often seen as problematic. Therefore also the use of the technical rule in an instrumental way will be discussed: in actual management practice the rule is not to be applied as an instruction, spelling out a certain course of action, but rather as a "design exemplar", a well-tested and documented starting point to design one's own context-specific intervention or system.

Improving the relevance of the products of academic management research

There is a long-standing debate on the relevance of academic research products in the field of Organisation and Management. As remarked above, a leading academic journal, *Administration Science Quarterly*, devoted special issues on it in 1982 and in 1983. Beyer and Trice remarked in the first one, "Recently (...) scholars have expressed concern about why organisational research is not more widely used (Beyer and Trice, 1982, p.591). Thomas and Tymon (1982) cite an impressive list of criticisms with respect to the relevance of academic organisational research, while, according to a survey at that time, academics considered only some 20% of well-established academic organisational theories as having a better than questionable usefulness (Miner, 1984). In launching their new academic journal, *Organization Science,* Daft and Lewin also expressed concern about the relevance of received academic organisational theories (Daft and Lewin, 1990).

Hambrick (1994) in his Presidential Address to the Academy showed grave concern with the external relevance of the field. In 2001 the *Academy of Management Journal* published a special issue on the interaction between academics and practitioners, also prompted by the problem of external relevance (Rynes, et al., 2001). And, as mentioned, in the same year the *British Journal of Management* published a Special Issue on the relevance gap in academic management research and on the ways to bridge this gap (Hodgkinson, 2001).

Among the possible approaches to improve the use of the products from academic management research one can mention three. The first one is to improve the communication on these products with practitioners, based on the idea that they are valid and relevant, but that they are not well presented to the world of business and management. This is the solution Hambrick (1994) proposes and which still gets – rightly so – much attention, see e.g. Wilmott (1994) and Kelemen and Bansal (2002).

A second approach that gets much attention nowadays, is to look at the process producing these research products, and, more particularly, to intensify during that process the researcher-practitioner interaction in order that the researcher gets a better understanding of field-problems, of their possible solutions, of the needs of practitioners and of the intricacies of effective communication with practitioners. This is the case in the already mentioned collaborative or Mode 2 research. Of course, in our field this is not really new, as researcher-practitioner collaboration has already been practised in various forms under the umbrella label of Action Research (see e.g. Clark, 1972; Argyris, Putnam and McLain Smith, 1985; Eden and Huxham, 1996; Reason and Bradbury, 2001).

Both better communication and research-practitioner collaboration may well contribute to an improvement of the use of academic research products in management. Still, a third approach can be to give a hard look at the nature of these products themselves. Gibbons et al. (1994) don't give much attention to this issue, as can also be seen in the analysis of Mode 2 management research by MacLean, MacIntosh and Grant (2002) and by Kelemen and Bansal (2002). The emphasis Gibbons et al. put on the contextual nature of the knowledge produced, suggests that their main ambition is knowledge production in the context of their immediate application, rather than the production of knowledge that may be transferred to other contexts. The same applies to a significant segment of the Action Research approaches, see e.g. Reason and Bradbury (2001). However, on this issue I will follow Eden and Huxham (1996), who contend that, in order to label a certain collaborative problem-solving activity as research, it should produce knowledge that can be transferred to contexts, other than the one in which it has been produced.

In the present article this third approach to the improvement of the relevance of research products in Management will be taken by looking at the nature of these products.

The nature of the products of academic management research

Knowledge produced by academic management research can be of a descriptive or a prescriptive nature. In the first case a given organisational phenomenon is described and possibly explained in terms of some independent variables. Generally such knowledge is problem-focused. Prescriptive knowledge, on the other hand, is rather solution-focused and describes some course of action to deal with a certain organisational problem.

The classics of our field like Taylor, Fayol and Barnard did not shrink from prescription, but the subsequent scientisation of our field has greatly diminished its academic respectability. Many researchers feel that the mission of *all* academic research is limited to understanding, i.e. its mission is to describe, explain and possibly predict (see e.g. Nagel, 1979, and Emory, 1985); developing prescriptive knowledge is seen as rather un-academic. Prescriptive literature still abounds, but now mainly in the form of "management literature", dubbed "Heathrow literature" by Burrell (1989) or "Literature on Principles" (of management) by Whitley (1988). This type of literature generally is weak in justification and tends to oversell its contribution to problem-solving. It is widely sold, but – understandably so – abhorred by academics.

Research products can be used in a conceptual or in a more instrumental way (Pelz, 1978). In the first case they give a general enlightenment of the issue at hand: knowledge for understanding. In the second case they are used in a more specific and direct way in problem solving or decision making: knowledge for action. Descriptive knowledge will largely be used by practitioners in a conceptual way. The thesis of this article is that the relevance of the products of academic management research may be improved if they would also include prescriptive, or solution-focused knowledge to be used in a more instrumental way. In the following the term "prescriptive" will be avoided, because of its connotations with the medical doctor, prescribing a certain medicine to his/her layman patient, who has in principle no other choice than to obey the prescription. For similar reasons also the term "normative" will be avoided. Rather the term "solution-focused" will be used, more in line with the nature of the researcher-practitioner relationship and with the idea of using solution-focused knowledge as design exemplars rather than as instructions.

In order to get more insight in the nature of such research products we may turn to disciplines like Medicine and Engineering, for which the production of solution-focused, instrumental knowledge is a natural objective of academic research. As will be explained, such disciplines may be called "design sciences".

Research objectives in the design sciences

One can make a distinction between "explanatory sciences", like Physics, Biology, Economics and Sociology, and "design sciences", like Medicine and Engineering (Van Aken, 1994; forthcoming). The core mission of an explanatory science is to develop valid knowledge to understand the natural or social world, or – more specific – to describe, explain and possibly predict. The core mission of a design science, on the other hand, is to develop knowledge which can be used to design solutions to problems in the field in question. Understanding the nature and causes of problems can be a great help in designing solutions. However, a design science does not limit itself to understanding, but also develops knowledge on the advantages and disadvantages of alternative solutions.

This distinction between explanatory and design sciences is, of course, similar to the one between the so-called "basic" and "applied" sciences. However, I prefer to avoid these terms as they suggest that sciences as Medicine and Engineering just apply the results of the true "basic" sciences, thus negating the extensive and significant scientific knowledge that those sciences developed themselves. The term "design science" is chosen to underline the orientation on knowledge-for-design (of solutions for real world problems), and not on action itself and the skills necessary for adequate action, which is the domain of practitioners.

Research in the Explanatory Sciences

In the explanatory sciences academic research can be seen as a quest for truth. It is description-oriented and it aims at shared understanding. The typical research product is the causal model, with the laws of nature of Physics as the example to follow. If such laws are beyond reach, as in most issues in the social sciences, the aim is to reach at least shared understanding of causal patterns, shared between the researcher and an informed audience (Peirce, 1960). The students in these disciplines are trained to be researchers in order to be able to contribute to the collective understanding of their field.

Research in the Design Sciences

In the design sciences academic research objectives have a more pragmatic nature. Research in these disciplines can be seen as a quest for understanding and improving human performance. It is solution-focused, using the results of description-oriented research from supporting (explanatory) disciplines as well as from own efforts, but the ultimate objective of academic research in these disciplines is to produce knowledge that can instrumentally be used in designing solutions to problems. Their students are trained in Professional Schools to be professionals, able to use the general knowledge of their discipline to design specific solutions for specific problems. The training of researchers is largely seen as a by-product and the professionals are supposed to contribute to their disciplines by reflecting on their cases and publishing their insights to be used in handling similar cases. Many academic researchers in these fields started their careers as professionals.

The typical research product in a design science is not the causal model, but the technological rule (Bunge, 1967).

Field-tested and grounded technological rules

A technological rule is defined by Bunge (1967, p.132) as "an instruction to perform a finite number of acts in a given order and with a given aim". I use this powerful concept in a somewhat more general way. A technological rule, then, is "*a chunk of general knowledge linking an intervention or artefact with an expected outcome or performance in a certain field of application*". "General" in this definition means that it is not a specific solution for a specific situation, but a general solution for a type of problem. (On the other hand a technological rule is a mid-range theory, its validity being limited to a certain application domain). If the rule is “field-tested”, this means that it is tested in its intended field of application, and if it is “grounded”, this means that it is known why the intervention or artefact gives the desired performance.

A technological rule follows the logic of “if you want to achieve Y in situation Z, then perform action X”. That action can be an act, a sequence of acts, but also the design and implementation of some process or system. There are *algorithmic* rules which can be used as *instructions*, which have typically a quantitative format and whose effects can be conclusively proven on the basis of observations through deterministic or statistical generalisation. But there are also rules with a more *heuristic* nature, which can be described as “if you want to achieve Y in situation Z, then perform something like action X”. A heuristic rule has a more abstract nature and is to be used by the practitioner as a *design exemplar*, a tested and well-documented general solution serving as basis for the design a specific variant of it for application to a specific case. It has typically a qualitative format.

An example of an algorithmic technological rule is: in order to cure disorder Y in adult males, you follow a treatment consisting of taking 0.3 milligram of medicine X during 14 days. An example of a heuristic rule is: in order to cure disorder Y in adult males, you follow for some weeks a course of treatment of rest, some exercise and a low fat diet. Using this heuristic rule implies that you still have to design your specific course of action. The more indeterminate nature of the heuristic rule makes it impossible to prove its effects conclusively, but it can be tested in context which can produce sufficient supporting evidence.

Technological rules don’t have to be formulated in the format given above; that format is only given to describe the *intervention-outcome logic* of a technological rule. For instance, in mechanical engineering a set of drawings of a certain transmission system with a description of its application domain and its advantages and disadvantages can be seen as a technological rule: use this system if you want to achieve in that application those advantages. In this article the term “technological rule” is used to designate the knowledge one may use to design an intervention (or series of interventions or artefact) to produce in a given setting a certain desired outcome.

Finally one may remark that the application of a technological rule presumes competence on the part of the practitioner: in Medicine and Engineering technological rules are not developed for laymen, but for competent professionals.

Breakthrough by Testing and Grounding

Mankind has a long tradition in developing technological rules. Early man developed rules to produce artefacts like bow and arrow, and more advanced societies developed rules for e.g building the complex irrigation systems along the Tigris and Euphrates and the medical insights of Hippocrates.

Over the centuries Engineering and Medicine made significant progress, but their real break-through came through their scientisation after the Enlightenment. This transformed those fields from practice-based crafts into research-based disciplines. They used the research methods and products of the natural sciences to develop – in terms of Bunge’s (1967) philosophy of science – field-tested and grounded technological rules. Their rules were *tested*, using the methods of the natural sciences and *grounded* on the laws of nature and other insights produced by those sciences. It is, for instance, possible to design a successful aeroplane by trial and error, like the brothers Wright proved, but the design of further improvements is much more effective and faster if that can be grounded on the research results from fields like aerodynamics and material knowledge. At first the actual development of technological rules in these design sciences was done predominantly by professionals, but later on increasingly also by academic researchers (to which one may add that academic recognition for the design sciences took quite some time and struggle, see e.g. Noble, 1977, for the example of Engineering in the US).

Medicine deals predominantly with *improvement problems*, i.e. with designing treatments to improve the well-being of patients, and Engineering predominantly with *construction problems*, i.e. with designing artefacts to certain specifications. I will now turn to Management, which deals with both types of problems.

Field tested and grounded technological rules in Management

A technological rule can be seen as a general solution to a type of field-problem. A general solution in the form of a certain intervention, or series of interventions, or a management system, to be used if one wants to achieve in a given setting certain desired results. For example, to increase customer satisfaction, use account management if you have a limited number of large and important customers, each with a variety of needs. Or, to decrease the throughput time of new product development, use concurrent engineering. Or, to achieve close co-operation between the partners of a strategic alliance, invest time and effort during the first phases of the alliance in building sound social relations and trust among the key players in the partner organisations. Technological rules in Management can be related with improvement problems, like a desired increase in sales or a desired reduction of costs, as well as with construction problems, like the design and implementation of a new organisation structure or management system.

Such rules are typically developed through multiple case studies (see Eisenhardt, 1989 and 1991, and Parkhe, 1993, on the power of the multiple case study, and Brown and Eisenhardt, 1997, for a good example of a multiple case-study). There are two types of multiple case study. In the *developing* multiple case study a series of problems of a certain type is solved in collaboration between the researcher(s) and the local people (in a kind of Action Research, see e.g. Eden and Huxham, 1996). In the *extracting* multiple case study best practices in solving problems of a certain type are analysed. After the initial series of cases technological rules are developed by reflection and induction and subsequently tested and further refined through still other cases (Van Aken, forthcoming). The multiple case study operates as a learning system: step by step one learns how to produce certain desired outcomes. Learning to deal with a certain type of management problems can further be enhanced by not only using a single multiple case-study but several studies and by using systematic review in drawing conclusions from them (see e.g. Pettigrew, 2001, and Pawson, 2002, on the idea of systematic review).

Technological rules can also be developed on the basis of large scale quantitative studies, like the rule that one should use related, rather than unrelated diversification in designing and implementing growth strategies (Rumelt, 1972). But also in this instance it would be very interesting to do case-studies and to make cross-case analyses to get a real understanding what goes wrong and why, if one tries to set up unrelated diversification and, furthermore, to get more general understanding of the indications and contra-indications for diversification (see e.g. Bettis, 1981).

Justification through Field-Testing

A key element of a technological rule resulting from academic research is justification. This is obtained through testing the rule in its intended context. At first during the above-described development of the rule by the researchers themselves through a series of cases and subsequently by third parties to get more objective evidence. Third party-testing counteracts the “unrecognized defenses” of the researchers (Argyris, 1996), which may blind them for flaws or limitations of their rules. This idea is borrowed from software development, where third-party testing is called beta-testing - see e.g. Dolan and Matthews (1993) - and testing by the software developers themselves alpha-testing. Such beta-testing can be seen as a kind of replication research (see e.g. Tsang and Kwan, 1999), but its design-orientation makes that it has more in common with evaluation research of social programmes (see e.g. Guba and Lincoln, 1989, and especially Pawson and Tilley, 1997).

The alpha- and beta-testing of technological rules can give further insight in the intended as well as the unintended consequences of their application, in their indications and contra-indications, and in the scope of their possible application, their application domain. For algorithmic rules testing can lead to conclusive proof, or at least to conclusive internal validity. The more indeterminate nature of heuristic rules – and in Management technological rules will often be heuristic - makes such proof impossible, but alpha- and beta-testing can lead to “theoretically saturated” *supporting evidence* (Eisenhardt, 1989).

Grounding on generative mechanisms

Without grounding the use of technological rules degenerates to mere instrumentalism, i.e. to a working with theoretically ungrounded rules of the thumb (Archer, 1995, p 153). In Engineering and in Medicine grounding of technological rules can be done with the laws of nature and other insights from the natural sciences. In Management grounding can be done with insights from the social sciences. Normally, these are not given in the form of laws. Here one can use the concept of *generative mechanisms,* a concept taken from Pawson and Tilley (1997). They developed this concept in their evaluation research of social programmes, like educational programmes and rehabilitation programmes.

Pawson and Tilley use as starting point what they call the basic realist formula *mechanism + context = outcome.* Any social programme can be seen as a coherent set of interventions, applied in some context by some body of actors in order to produce certain desired outcomes. The generative mechanism is the answer on the question “why does this intervention produce (in that context) that outcome?” Pawson and Tilley discuss the example of a programme to improve the safety of a car park. The proposed measures include the closing of the car park for non-parking public and the introduction of close-circuit TV-camera’s. The generative mechanism, then, for the first measure is that it will become more difficult for potential wrongdoers to enter the car park, while for the second one the possible generative mechanisms include that it will deter potential wrongdoers because they will believe that this will increase the chance that they will be apprehended. Insight in the generative mechanisms can help to design improved interventions. In the case of the closed circuit TV-camera's it is important that the camera's are very visible and that there are conspicuous signs in the car park, drawing attention their presence. Evaluation research is subsequently used to verify the putative generative mechanisms and to supply insight on possible additional mechanisms.

The generative mechanisms can have a "structure-" or an "agency-nature". The mechanisms produced by the controlled entrance measure given above, is an example of a "structure-mechanism", a "structure" external to the target group constraining or directing its behaviour. The mechanisms produced by the closed-circuit TV-camera's measure is rather an "agency-mechanism", relying on influencing certain intentional behaviour of the target group.

Grounding technological rules in Management

Likewise one can ground technological rules in Management on the generative mechanisms that will produce the desired outcomes. Again these mechanisms are the answers to the question: "Why will this intervention produce in that context that outcome?". This "why-question", of course, strongly resembles the key-question in description-oriented research, leading to some kind of causal model. One difference is the nature of the independent variable. In description-oriented research this often is a characteristic that is already present in the organisation, while in solution-focused research it is a carefully designed intervention, which, furthermore, may be redesigned on the basis of lessons learnt from testing and grounding (then to be tested again). In description-oriented research the dependent variable is often some operationalisation of overall organisational effectiveness (which is notoriously different to explain in terms of a limited number of independent variables, see e.g. Lewin and Milton, 1986 and March and Sutton, 1997). In solution-focused research the dependent variable is rather related to some more operational objectives, like an increase in brand recognition or a reduction of overall inventory.
Like in evaluation research on social programmes, discussed above, in the field of Management the answers on the "why-question" may be given both in terms of "structure" generative mechanisms and in "agency" generative mechanisms. An example of the use of a "structure-mechanism" as generative mechanism is Goldratt's Theory-of-Constraints (Goldratt and Cox, 1986). The rule is that in managing a factory one should focus on optimising the use of the constraining capacity group. The generative mechanism is that it is this group that determines the output of the factory as a whole. An example of the use of an "agency-mechanism" can be found in Tichy's TPC-model (Tichy, 1983). One rule is that if a given strategic change hurts the real interests of a certain subgroup, one should use political interventions rather than technical or cultural ones. The generative mechanism is that technical, i.e. content-oriented interventions will demonstrate even more clearly to that group that their interests will be hurt, which will not help to overcome their resistance to the change, that cultural interventions, i.e. inviting participation, will give them the opportunity to organise coalitions against the change, while political, i.e. power interventions can be accepted as being the duty of top management to act in the interests of the organisation as a whole.

Testing a rule can provide both driving and blocking generative mechanisms. Cases were the rule works less well can be at least as interesting as successful ones, as they give insight in those blocking mechanisms or in limitations of the application domain of the rule.

The technological rule as design exemplar

The technological rule in management is meant to be used in an instrumental way. It is often assumed - explicitly or only implicitly - that instrumental use of knowledge means that it is to be used as a kind of *instruction*, spelling out how to act in a given situation to achieve a certain objective. As effective management action is strongly context dependent, the use of research products as instructions is regarded as problematic by many, because it involves the transfer of knowledge from the context in which it has been produced to another context, the context of application. The instruction cannot possibly take into account all the intricacies of the specific local context.

However, the use of technological rules in management as instructions is rare. It may be to some extent the case in the use of algorithmic rules, like in inventory control possibly the use of some reordering rule (reorder stock level plus reorder quantity). But most technical rules in management will be of a heuristic nature and such rules are to be used as *design exemplars*. The rule is a well-tested and well-documented solution to some type of management problem and the practitioner designs his/her own *specific variant* of that solution for his/her specific situation (see e.g. Fowler, 1996, for the use of variant design in another discipline, i.e. Engineering). Like in the application of heuristic rules in Medicine and Engineering, variant design presumes competence on the part of the practitioner. In such problem solving the practitioner has to use this competence, his/her experience and creativity and a deep understanding of the local context to design his/her specific solution to the problem on the basis of the technological rule. This translation from the general to the specific necessitates a thorough understanding of the rule and of the mechanisms driving or blocking its effects and hence it needs thick descriptions (Geertz, 1973) and the rich evidence from testing it under various circumstances.

The transfer of knowledge incorporated in an algorithmic technological rule can follow a linear view of knowledge transfer. The instrumental use of heuristic technological rules as design exemplars, however, rather follows a constructionist view of knowledge transfer (see e.g. Gergen, 1982, and Gibson, 1999). Knowledge is produced by the practitioner in the context of his/her problem solving, but in doing so he/she does not start as a tabula rasa but uses prior knowledge, which is produced in solving similar problems in similar contexts. In that view management research products are to be used to inform the *self-design* (Mohrman, Gibson and Mohrman, 2001) by the practitioner.

Description-oriented research compared to solution-focused research

More emphasis on solution-focused research, as discussed above, does not mean that the results from classical description-oriented research have no relevance. On the contrary, such results may be used for developing hypotheses on generative mechanisms producing desired outcomes. For instance, motivation theory can be a great help in understanding the above-discussed "agency-mechanisms".

Furthermore, description-oriented research results often can be reformulated in terms of technological rules, like

- if you want to realise a large-scale, complex strategic change, use a process of logical incrementalism (Quinn, 1980)
- if you want effective realisation of the outcomes of strategic decision-making, promote perceived procedural fairness (Korsgaard, Schweiger and Sapienza, 1995) and active participation of middle management (Woolridge and Floyd, 1990)
- if you want to manage the activities within the operational core of a professional organisation, use standardisation of skills rather than direct supervision (Mintzberg, 1979).

Compared to sound design-oriented research, however, a major difference is testing. In descriptive academic articles possible "rules" are often formulated as managerial implications in their last pages and these are not tested as such by the authors and even less so by third parties, the above-discussed beta-testing. Another difference is that testing and grounding can make the rules much more sophisticated. It is one thing to suggest that active participation of middle management in strategic decision-making is important (Woolridge and Floyd, 1990), but quite another to set up an effective participation programme and that is not just an issue of filling in some practicalities. For design-oriented management research this means among other things the development of alternative designs for the set-up and main elements of such participation programmes and in particular an analysis of the generative mechanisms that make those programmes effective. It is especially the insight in those generative mechanisms that makes it possible for the user of the rule to design a specific variant of the general technological rule for a specific situation.

Still another difference is that design-oriented research is solution-focused, aiming at developing and testing solutions, while description-oriented research usually is rather problem-focused, aiming at understanding the problem and detecting its causes. As said, understanding can be a great help in developing solutions but full understanding is not always necessary. Traditional Chinese medicine developed, for instance, powerful drugs for many diseases without knowing their causes and man was able to design and fly an aeroplane, before the laws of aerodynamics were formulated. And – more importantly – understanding a problem is usually only halfway in solving it. Understanding the sources of resistance to certain organisational changes, still leaves undone the task of developing sound change programmes. Understanding the changes on certain markets still leaves undone the task of developing successful strategies.

Furthermore, in description-oriented research the analysis may be partial. One can limit descriptive research to a specific aspect or component of a complex system. In solution-focused research the testing of a rule is in principle holistic: it is tested in context and both known and unknown factors contribute to its effects. Which also means that even with solid grounding there will always be factors present which remain wholly or partially unknown. Or, in other words, even grounded technological rules usually retain to some extent a black box character.

Finally one may remark that in Management some technological rules have already been developed. An early example is the work of Halman on the development of a risk management system in New Product Development. He first developed a version in a series of developing case-studies and had that version subsequently beta-tested and further developed under his supervision by students in various settings. This work has been published in his doctoral thesis (Halman, 1994) and subsequent work in Keizer, Halman and Song (2002).

Discussion

The instrumental use of technological rules in management may raise a number of issues, two of which will be discussed briefly here, viz. the limitations of human agency and the political implications of improving management effectiveness.

Academics in the social sciences give much attention to the limitations of human agency in the context of social structure (Giddens, 1984; Archer, 1995), but in Management the general public, (top)managers themselves and academic authors of textbooks on management tend to strongly overrate the potential of managerial agency. Almost all textbooks use – in most cases only implicitly- a design approach, giving the message "use this theory to design your interventions and you will be successful", illustrating this message by many examples of (top) managers, who in hindsight proved to be successful. Everyone knows that there may be some "implementation-problems", but if a manager is unsuccessful he/she must have picked the wrong theory or is not a good manager in the first place. Alfa- and beta-testing of technological rules will show both the potential and the limitations of human agency. Even with a solid grounding of the rule, its working will not be fully understood and in any case there are many factors influencing the outcome of an intervention, which are beyond the control of the manager. So testing of technological rules will also give insight in the distinction between a *good* decision (based on state-of-the-art management knowledge and all available local knowledge), and a *successful* one, a decision through which relevant objectives have been realised. On the average good decisions should prove to be more successful than bad ones and technological rules should help managers to make more often good decisions. However good decisions will not always be successful.

The second issue is connected with the fact that virtually every human action has political implications, i.e. the material or immaterial interests of some are promoted and possibly those of some others are harmed. Critical management writers (see e.g. Grey and Mitev, 1995, and Alvesson and Deetz, 2001) give much attention to the fact that organisations have multiple stakeholders and that it may not be the mission of academic management research to promote the interests of only one group of stakeholders, i.e. managers. The aim of this article is to advocate the development of technological rules in management with the idea that their use will lead to more effective management action and hence to more successful organisations. The underlying rationale is that managers and managed (and other organisational stakeholders) do not play a zero-sum game, in that the interests of managers are contrary to those of the managed, but that the success of an organisation is in principle in the interest of all stakeholders, even if some get a larger part of the pie than others: in a successful organisation the pie is larger. This is not a plea to close ones eyes for e.g. the gross misuse of organisational power by some topmanagers for personal gain, as we have recently seen. However, the solution of that problem falls outside the scope of an article, intending to help organisations to become more successful.

Conclusion

In order to improve the use of products from academic research in Management more researcher-practitioner communication has been advocated (see e.g. Hambrick, 1994; Kelemen and Bansal, 2002), as well as researcher-practitioner partnerships in research (see e.g. Rynes, Bartunek and Daft, 2001, and Starkey and Madan, 2001b). This article supports this plea and would like to add that one should also look at the nature of the products produced by academic research in Management. The field should aim to develop, next to descriptive knowledge, also solution-oriented knowledge. The field-tested and grounded technological rule is an example of such a research product. It is solution-focused, based on intervention-outcome logic and meant to be used in an instrumental way and has as such the potential to be relevant for practitioners. Description-oriented research will remain relevant to understand management problems and to provide insights for the grounding of technological rules, but it should be complemented with solution-oriented research, producing research products for instrumental use by practitioners.

References

Alvesson, M. and Deetz, S. (2000). *Doing critical management research.* London: Sage.

Archer, M.S. (1995). *Realist Social Theory: the Morphogenetic Approach.* Cambridge, Cambridge University Press

Argyris, C. (1996). Unrecognized Defenses of Scholars: Impact on Theory and Research. *Organization Science,* 7, pp 79-87.

Argyris, C., Putnam, R. and McLain Smith, D. (1985). *Action Science, Concepts, Methods, and Skills for Research and Intervention*. San Francisco: Jossey-Bass Publishers.

Beyer, J.M. and Trice, H.M. (1982). The Utilisation Process: a Conceptual Framework and Synthesis of Empirical Findings. *Administrative Science Quarterly,* 27, pp 591-622.

Bettis, R.A. (1981). Performance Differences in Related and Unrelated Diversified Forms. *Strategic Management Journal,* 12, pp 379-383.

Brown, S.L. and Eisenhardt, K.M. (1997). ‘The Art of Continuous Change: Linking Complexity Theory and Time-paced Evolution in Relentlessly Shifting Organizations’. *Administrative Science Quarterly* 42, pp 1-34

Bunge, M. (1967). *Scientific Research II: The Search for Truth*, Springer Verlag, Berlin.

Burrell, G. (1989). The absent centre: The neglect of Philosophy in Anglo-American Management Theory. *Human Systems Management*, 8, pp 307-312.

Clark, P.A.(1972). *Action Research and Organisational Change.* London: Harper and Row.

Daft, R.L. and Lewin, A.Y. (1990). Can Organizational Studies Begin to Break Out of the Normal Science Straitjacket? An editorial Essay. *Organization Science,* 1, pp 1-9.

Dolan, R.J. and Matthews, J.M. (1993). Maximizing the Utility of Customer Product Testing: Beta Test Design and Management. *Journal of Product Innovation Management*, 10, pp 318-330.

Eden, C. and Huxham, Chr. (1996). Action Research for the Study of Organizations, in Clegg, S.R., Hardy, C. and Nord, W.R. (eds). *Handbook of Organization Studies*, pp 526-542. Sage, London.

Eisenhardt, K.M. (1989). ‘Building Theories from case study Research’. *Academy of Management Review,* 14, pp 532-550.

Eisenhardt, K.M. (1991). ‘Better Stories and Better Constructs: the Case for Rigor and Comparative Logic’. *Academy of Management Review*, 16, pp 620-627.

Emory, W.C. (1985). *Business Research Methods*.: Irwin, Homewood(Ill).

Fowler, J.E. (1996) ‘Variant design for Mechanical Artifacts: A State-of-the-Art Survey’. *Engineering with Computers* 12, pp 1-15

Geertz, C. (1973). *The interpretation of culture.* Basic Books, New York

Gergen, K.J. (1982). *Toward transformation in social knowledge.* New York: Springer-Verlag

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P. and Trow, M. (1994) *The New Production of Knowledge: the Dynamics of Science and Research in Contemporary Societies.* London: Sage

Gibson, C.B. (1999). ‘Do they do what they believe they can ? Group efficacy and effectiveness across task and culture’. *Academy of Management Journal*, 42, pp 1-15

Giddens, A. (1984). *The constitution of Society*. Cambridge: Polity Press

Goldratt, E.M. and Cox, J. (1986). *The Goal, a Process of Ongoing Improvement.* Croton-on-Hudson, North River Press.

Grey, C. (2001). Re-imagining Relevance. A response to Starkey and Madan. *British Journal of Management,*12 pp S27-S32

Grey, C. and Mitev, N. (1995). 'Management Education, A Polemic'. *Management Education* **26**(1), 73-90.

Guba, Y. and Lincoln, E. (1989). *Fourth Generation Evaluation*. Sage, London.

Halman, J.I.M. (1994). *Risicodiagnose in Produktinnovatie* (Risk diagnosis in Product Innovation, in Dutch). Eindhoven: doctoral dissertation

Hambrick, D.C. (1984). 'What if the Academy Actually Mattered?' *Academy of Management Review*, 19, pp 11-16.

Hodgkinson, G.P. (2001). 'Editorial to the Special Issue'. *British Journal of Management* 12, pp S1-S2.

Huff, A.S. (2000). 'Changes in Organisational Knowledge Production: 1999 Presidential Address'. *Academy of Management Review* 25, pp 288-293

Keizer, J., Halman, J.I.M. and Song, X. (2002). 'From Experience: Applying the Risk Diagnosing Methodology'. *Journal Product Innovation Management* 19(3), pp 213-232

Kelemen, M. and Bansal, P. (2002). 'The Conventions of Management Research and their Relevance to management practice'. *British Journal of Management*, 13, p97-108

Kilduff, M. and Kelemen, M. (2001). 'The Consolations of Organization Theory, . *British Journal of Management,* 12, pp S55-S59

Korsgaard, M.A., Schweiger, D.M. and Sapienza, H.J. (1995). 'Building commitment, attachment, and trust in strategic decision making teams: the role of procedural justice'. *Academy of Management Journal*, 38, pp 60-84.

Lewin, A.Y. and Milton, J.W. (1986). 'Determining Organizational Effectiveness: Another look, and an Agenda for Research'. *Management Science,* 32, pp 514-539.

MacLean,, D., MacIntosh, R. and Grant, S. (2002). 'Mode 2 Management Research'. *British Journal of Management*, 13, p189-207

March, J.G. and Sutton, R.I. (1997). 'Organisational Performance as a Dependent Variable'. *Organisation Science*, 8, pp 698-706.

Miner, J.B. (1984). ‘The Validity and Usefulness of Theories in an Emerging Organizational Science’. *Academy of Management Review*, 9, pp 296-306.

Mintzberg, H.(1979). *The Structuring of Organizations.* Prentice Hall, Englewood Cliffs.

Mohrman, S.A., Gibson, C.B., and Mohrman, A.M. (2001). ‘Doing research that is useful for practice: a model and empirical exploration’. *Academy of Management Journal*, 44, pp 357-375

Nagel, E. (1979). *The Structure of Science.* Hackett, Indianapolis.

Noble, D. (1977). *America by Design. Science, Technology and the Rise of Corporate Capitalism.* Knopf, New York.

Parkhe, A. (1993). ‘Messy Research, Methodological Predispositions and Theory Development in International Joint Ventures’. *Academy of Management Review*, 18, pp 227-268.

Pawson, R.and Tilley, N. (1997). *Realistic Evaluation.* Sage, London.

Pawson, R. (2002). ‘Evidence and Policy and Naming and Shaming’. *Policy Studies,* 23(3/4), pp 211-230

Peirce, C.S. (1960). ‘The Rules of Philosophy’. In Konvitz, M. and Kennedy, G. (Eds) *The American Pragmatists*, New American Library, New York (originally published in 1868).

Pelz, D.S.(1978). ‘Some expanded perspectives on the use of social science in public policy’. In Yinger, M. and Cutler, S.J. (Eds.) *Major Social Issues: A Multidisciplinary view*: 346-357. New York: Free Press.

Pettigrew, A.M. (2001). ‘Management Research after Modernism’. *British Journal of Management* 12, pp S61-S70.

Pettigrew, M. (2001). ‘Systematic review from astronomy to zoology: myths and misconceptions’. *British Medical Journal,* 322, pp 98-101 (also available at http://www.bmj.com/cgi/content/full/322/7278/98)

Pierson, F.C. and Others. (1959). *The education of American business men. A study of university-college programs in business administration*. New York.

Quinn, J.B. (1980). *Strategies for Change, Logical Incrementalism*. Irwin, Homewood (Ill).

Reason, P. and Bradbury, eds (2001). *Handbook of Action Research: Participative Inquiry and Practice*. London: Sage.

Rumelt, R.P. (1972). 'Diversification Strategy and profitability'. *Strategic Management Journal*, 3, pp 359-370.

Rynes, S.L., Bartunek, J.M. and Daft, R.L. (2001). 'Across the Great Divide: Knowledge Creation and Transfer between Practitioners and Academics'. *Academy of Management Journal*, 44, pp 340-355.

Starkey, K. and Madan, P. (2001a). Bridging the Relevance Gap: Aligning Stakeholders in the Future of Management Research. *British Journal of Management*, 12, pp S3-S26.

Starkey, K. and Madan, P. (2001b). In defense of modes One, Two and Three: A Response. *British Journal of Management*, 12, pp S77-S80.

Susman, G.I. and Evered, R.D. (1978). 'An Assessment of the Scientific Merits of Action Research'. *Administrative Science Quarterly*, 23, pp 582-603.

Thomas, K.W. and Tymon, W.G. (1992). 'Necessary Properties of Relevant Research: Lessons from Recent Criticisms of the Organizational Sciences'. *Academy of Management Review*, 17, pp 345-352.

Tichy, N.M. (1983). *Managing Strategic Change, Technical, Political and Cultural Dynamics.* Wiley, Chichester.

Tranfield, D. and Starkey, K. (1998). 'The nature, social organisation and promotion of management research: Towards policy'. *British Journal of Management*, 9, pp 341-353.

Tsang, E.W.K. and Kwan, K.M. (1999). 'Replication and Theory Development in Organizational Science: a Critical Realist Perspective'. *Academy of Management Review*, 24, pp 759-780.

Van Aken, J.E. (1994). 'Bedrijfskunde als Ontwerpwetenschap' (Business Administration as a Design Science, in Dutch). *Bedrijfskunde*, pp 66, 16-22.

Van Aken, J.E. (forthcoming). 'Management Research Based on the Paradigm of the Design Sciences: the Quest for Tested and Grounded Technological Rules'. *Journal of Management Studies*

Weick, K.E. (2001). 'Gapping the Relevance Bridge: Fashions Meet Fundamentals in Management Research'. *British Journal of Management*, 12, pp S71-S75.

Whitley, R. (1988). 'The Management Sciences and Managerial Skills'. *Organization Studies*, 9(1), pp 47-68.

Wilmott, H. (1994). ‘Management Education: Provocations to a debate’. *Management Learning*, 25(1), pp 105-136

Woolridge, B. and Floyd, S.W. (1990). ‘The strategy process, middle management involvement, and organizational performance’. *Strategic Management Journal*, 11, pp 231-241.

version 4 June 2003

Eindhoven Centre for Innovation Studies

W O R K I N G   P A P E R S

Ecis working papers 2002-2003 (July 2003):

02.01 M. van Dijk
The Determinants of Export Performance in Developing countries: The Case of Indonesian manufacturing

02.02 M. Caniëls & H. Romijn
Firm-level knowledge accumulation and regional dynamics

02.03 F. van Echtelt & F. Wynstra
Managing Supplier Integration into Product Development: A Literature Review and Conceptual Model

02.04 H. Romijn & J. Brenters
A sub-sector approach to cost-benefit analysis: Small-scale sisal processing in Tanzania

02.05 K. Heimeriks
Alliance Capability, Collaboration Quality, and Alliance Performance: An Integrated Framework.

02.06 G. Duysters, J. Hagedoorn & C. Lemmens
The Effect of Alliance Block Membership on Innovative Performance

02.07 G. Duysters & C. Lemmens
Cohesive subgroup formation: Enabling and constraining effects of social capital in strategic technology alliance networks

02.08 G. Duysters & K. Heimeriks
The influence of alliance capabilities on alliance performance: an empirical investigation.

02.09 J. Ulijn, D. Vogel & T. Bemelmans
ICT Study implications for human interaction and culture: Intro to a special issue

02.10 A. van Luxemburg, J. Ulijn & N. Amare
The Contribution of Electronic Communication Media to the Design Process: Communicative and Cultural Implications

02.11 B. Verspagen & W. Schoenmakers
The Spatial Dimension of Patenting by Multinational Firms in Europe

02.12 G. Silverberg & B. Verspagen
A Percolation Model of Innovation in Complex Technology Spaces

02.13 B. Verspagen
Structural Change and Technology. A Long View

02.14 A. Cappelen, F. Castellacci, J. Fagerberg and B. Verspagen
The Impact of Regional Support on Growth and Convergence in the European Union

02.15 K. Frenken & A. Nuvolari
Entropy Statistics as a Framework to Analyse Technological Evolution

02.16 J. Ulijn & A. Fayolle
Towards cooperation between European start ups: The position of the French, Dutch, and German entrepreneurial and innovative engineer

02.17 B. Sadowski & C. van Beers
The Innovation Performance of Foreign Affiliates: Evidence from Dutch Manufacturing Firms

02.18 J. Ulijn, A. Lincke & F. Wynstra
The effect of Dutch and German cultures on negotiation strategy comparing operations and innovation management in the supply chain

02.19 A. Lim
Standards Setting Processes in ICT: The Negotiations Approach

02.20 Paola Criscuolo, Rajneesh Narula & Bart Verspagen
The relative importance of home and host innovation systems in the internationalisation of MNE R&D: a patent citation analysis

02.21 Francis K. Yamfwa, Adam Szirmai and Chibwe Lwamba
Zambian Manufacturing Performance in Comparative Perspective

03.01 A. Nuvolari
Open source software development: some historical perspectives

03.02 M. van Dijk
Industry Evolution in Developing Countries: the Indonesian Pulp and Paper Industry

03.03 A.S. Lim
Inter-firm Alliances during Pre-standardization in ICT

03.04 M.C.J. Caniëls & H.A. Romijn
What drives innovativeness in industrial clusters? Transcending the debate

03.05 J. Ulijn, G. Duysters, R. Schaetzlein & S. Remer
Culture and its perception in strategic alliances, does it affect the performance? An exploratory study into Dutch-German ventures

03.06 G. Silverberg & B. Verspagen
Brewing the future: stylized facts about innovation and their confrontation with a percolation model

03.07 M.C. Caniëls, H.A. Romijn & M. de Ruijter-De Wildt
Can Business Development Services practitioners learn from theories on innovation and services marketing?

03.08 J.E. van Aken
On the design of design processes in architecture and engineering: technological rules and the principle of minimal specification

03.09 J.P. Vos
Observing Suppliers observing Early Supplier Involvement: An Empirical Research based upon the Social Systems Theory of Niklas Luhmann

03.10 J.P. Vos
Making Sense of Strategy: A Social Systems Perspective

03.11 J.A. Keizer & J.P. Vos
Diagnosing risks in new product development

03.12 J.M. Ulijn , A. Fayolle & A. Groen
European educational diversity in technology entrepreneurship: A dialogue about a culture or a knowledge management class?

03.13 J.M. Ulijn, S.A. Robertson, M. O'Duill
Teaching business plan negotiation: How to foster entrepreneurship with engineering students

03.14 J.E. van Aken
The Field-tested and Grounded Technological Rule as Product of Mode 2 Management Research