Mapping Research Questions to Research Methods

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Abstract: In Information Systems (IS) research, there is a wide range of research methods available. Yet the selection of a suitable research method remains a problem. March and Smith (1995) proposed a classification of research methods. Instead of their great merits, for example, differentiation between design science and natural science, we would here like to supplement them with some important amendments like mathematical approaches, theoretical studies and the dissensus and consensus views. In particular, we demonstrate how to select a suitable research approach in light of the research question.

1. Introduction

In this paper we prepare the taxonomy of research approaches in such a way that a junior researcher can find a suitable research approach to her research question. Sometimes the selection of a proper research method is simple, but sometimes the junior researcher at least may find it difficult. At the beginning of the research process the formulation of the research problem may well undergo a slight change, likewise the research method. Junior researchers may then utilize the taxonomy of research methods, if it is properly constructed.

Galliers and Land (1987) proposed the first taxonomy of information systems (IS) research taxonomy. It was based on "the *object* of which the research effort is focused and the *mode* by which the research is carried out are differentiated" (p. 901). They identified the following object categories: Society, organization (group), individual, technology, and methodology. The latter refers to the IS development approaches (Galliers 1985). The research approaches were divided into two classes: Modes for traditional empirical approaches (observations) consisting of theorem proof, laboratory experiment, field experiment, case study, survey, forecasting and simulation; and modes of newer approaches (interpretations) consisting of game/role playing, subjective/ argumentative, descriptive/interpretive and action research. Galliers and Land used the expressions: yes, possibly, and no, when they evaluated whether a certain mode was suitable for a particular object. We give two examples of research modes. First, according to their recommendation, theorem proof is suitable for research on technology, but not for research on society, organization, individual or methodology. Secondly, laboratory experiment is suitable for individual, technology, and possibly for small groups, but not for society, methodology or organization. Galliers and Land's taxonomy shows that organization and individual as research foci can be approached by all the other modes but theorem proof. Hence, we conclude that the object categories do not efficiently guide a researcher in the choice of mode of research approach.

Next, we turn to consider whether the form of research question could help. In his case study textbook Yin (1989) gives a proposal for how some determinants (Table 1) could be used to select a suitable research strategy.

Table 1: Relevant situations for different research strategies (Yin (1989, p.17)

Strategy	Form of research question	Requires control over behavioral events?	Focuses on contemporary events?
Experiment	how, why	yes	yes
Survey	who, what*, where, how many, how much	no	yes
Archival analysis (e.g. economic study)	who, what*, where, how many, how much	no	yes
History	how, why	no	no
Case study	how, why	no	yes

* "What" questions, when asked as part of an exploratory study, pertain to all five strategies

The table above shows that survey and archival analysis rows are identical, i.e. Table 1 cannot give instructions when we should use survey or archival analysis as a research strategy. The other three research strategies have the same forms of research question, but they can be distinguished by using the required control over behavioral events and whether we are concerned with contemporary or past events. Yin does not include such research strategies as theorem proof, grounded theory, ethnography, action research, and design research in his classification. Hence, it is reasonable to seek a better taxonomy.

According to March and Smith (1995), "scientific interest in IT reflects assumptions that these phenomena can be explained by scientific theories and that scientific research can improve IT practice. Note, however, that there are two kinds of scientific interest in IT, descriptive and prescriptive. Descriptive research aims at understanding the nature of IT. It is knowledge-producing activity corresponding to natural science. Prescriptive research aims at improving IT performance. It is a knowledge-using activity corresponding to design science." (p. 252)

March and Smith (p. 253) continue that "IT research studies artificial as opposed to natural phenomena. It deals with human creations such as organizations and information systems. This has significant implications for IT research which is discussed later. Of immediate interest is that fact that artificial phenomena can be both created and studied, and that scientists can contribute to each of these activities. This underlies the dual nature of IT research. Rather than being in conflict, however, both activities can be encompassed under broad notion of science that includes two distinct species, termed natural and design science. Natural science is concerned with explaining how and why things are. Design science is concerned with 'devising artifacts to attain goals' (Simon 1981, p. 133)."

Our main purpose is to help a junior scientist to find the most suitable research method by analyzing the research question. The distinction between natural and design sciences may be based either on the object under study (the use of an IT system vs. the construction of a new IT artifact) or on the form of the research question (how and why things are vs. devise an artifact) or on the verb used in the formulation (understand vs. improve) of the question. March and Smith clearly concentrate on research problems in the real world, and they propose that we should distinguish between natural science and design science studies.

March and Smith (1995) describe these two sciences as follows: "Research activities in natural science are parallel: discover and justify. Discover, or more appropriately for IT research, theorize, refers to the constructions of theories that explain how and why something happens. In the case of IT research this is primarily an explanation of how or why an artifact works within its environment. Justify refers to theory proving. It requires scientific evidence that supports or refutes the theory.

Research activities in design science are twofold: build and evaluate. Build refers to the construction of the artifact, demonstrating that such an artifact *can* be constructed. Evaluate refers to the development of criteria and the assessment of artifact performance against those criteria.

We *build* an artifact to perform a specific task. The basic question is, does it work? Building an artifact demonstrates feasibility. These artifacts then become the object of study. We build constructs, models, methods, and instantiations. Each is a technology that, once built, must be evaluated scientifically.

We *evaluate* artifacts to determine if we have made any progress. The basic question is, how well does it work? Recall that progress is achieved when a technology is replaced by more effective one. Evaluation requires the development of metrics and the measurement of artifacts according to those metrics. Metrics define what we are trying to accomplish. They are used to assess the performance of an artifact. Lack of metrics and failure to measure artifact performance according to established criteria result in an inability to effectively judge research efforts." (p. 258)

These descriptions of natural sciences and design sciences provide a preliminary taxonomy of different studies (Figure 1).

A junior IS researcher can use Figure 1 in such a way that she first tries to distinguish whether she seeks to understand the nature of IT or to improve IT performance, i.e., to distinguish between natural sciences and design sciences. In the latter case she wants to ascertain whether she is building a new IT artifact or evaluating an existing one, i.e. measuring how good a new artifact is or if it is better than the best of all possible artifacts for a given task. For the natural science case, a junior scientist can discover whether or not there is in the literature prior knowledge about her research topic (cf. Edmondson and McManus 2007). If the prior knowledge exists, she can develop a theoretical framework to be justified, and if it does not exist, she must herself theorize this new topic.

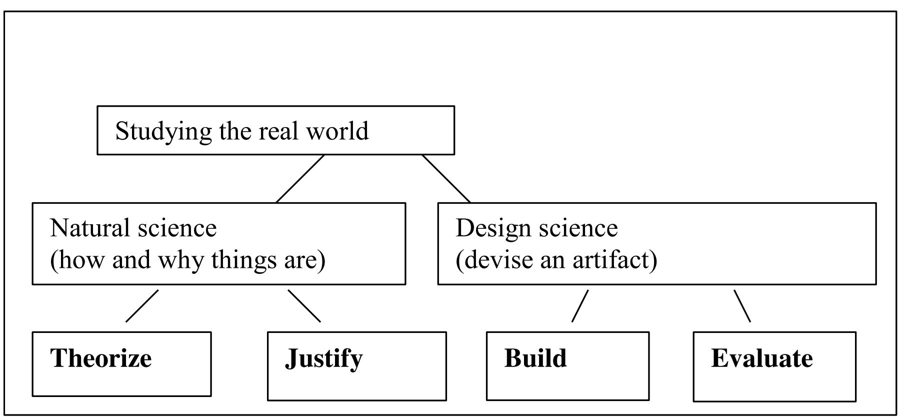

Figure 1. Preliminary taxonomy of different studies (cf. March and Smith 1995)

Figure 1 describing the broad structure and classification of the most commonly occurring studies does not, however, include all the studies and research methods needed. For example, critical studies are lacking. Further, I should like to point out that such abstract research objects as formal languages and general systems having no reference to the real world are also lacking. March and Smith (1995) do not pay much attention to purely conceptual studies, although in the classic survey by Ives et al. (1980) the second common research strategy was already "non-data" studies (30.5 %). For these reasons we can state our research problem in this paper: *How can we develop such a taxonomy of studies that is as exhaustive as possible*?

In the rest of the paper we first develop a more exhaustive taxonomy. Thereafter we propose which research methods are suitable for each class of studies, and how a junior scientist could find the correct class by analyzing her research question. Finally we discuss various implications of our study.

2. Towards a more exhaustive taxonomy of studies

In order to emphasize the exhaustiveness of our taxonomy (Bunge 1967) we select the top-down approach. We first consider all the studies and distinguish such research objects as formal languages, algebraic units etc., in other words, symbol systems having no direct reference to the real world. Gregor (2006) developed the taxonomy of 5 types of theory in IS. She poses the question and giver her own answer (p. 631): “Do some theory types belong to particular paradigms? An unequivocal ‘no’ is the answer to this question. … Theory Types II to V require some form of realist ontology, as constructs in theoretical statements can refer to entities in the real world. Type I theory does not necessitate reference to real-world entities, but could be purely analytic, as in mathematics and logic”

From the remaining studies concerning reality, we pay attention to the use of values in differenting between natural and design science studies. March and Smith (1995, p. 260) already write that “research in the build activity should be judged based on *value* or utility to a community of users”. In the build and evaluation activities the utility of an innovation (IT artifact) is most often stressed, but van der Heijden (2004), studying hedonic (pleasure-oriented) systems, and Iivari (2007) paying attention to entertaining, artisticizing and accompanying IT systems, demonstrated other values in IT studies (“value-laden”). In addition to technical artefacts or innovations, we also accept that there may also be social and informational innovations. Therefore we use the term innovation instead of artefact.

Those studies that do not emphasize values (“value-free”), i.e., studies that are interested in “how and why things are” in understanding the phenomenon under study may be either theoretical or empirical. Empirical studies may be concerned with either theorizing (theory-developing studies) or justifying (theory-testing studies). In theory-testing studies we can a priori assume either dissensus or consensus (Burrel and Morgan 1979; Deetz 1996). In theory-creating studies we recognize whether dissensus or consensus holds at the research site. We adopt Deetz’s (1996) taxonomy of discourses and cite Sanford and Rose (2007, p. 408): “Although developed in the context of organizational science, it provides a well-known and reasonably transferable account of different research styles suitable for use in most socially oriented literatures.”

To summarize earlier distinctions we present Figure 2 below. To give a more concrete view of our classes we enumerate research approaches in mathematical, theoretical, theory-testing and theory-developing, innovation-building and innovation-evaluation studies.

3. Research methods are suitable for each class of studies

We use the term ‘research approach’ as an umbrella expression to refer to similar research methods. *Mathematical* studies, e.g., general systems theory, can also be utilized in some IS studies. For example, Aulin (1989) mathematically developed the classification of dynamic systems that can help IS researchers to differentiate IT artifacts from the information systems where people play a central role.

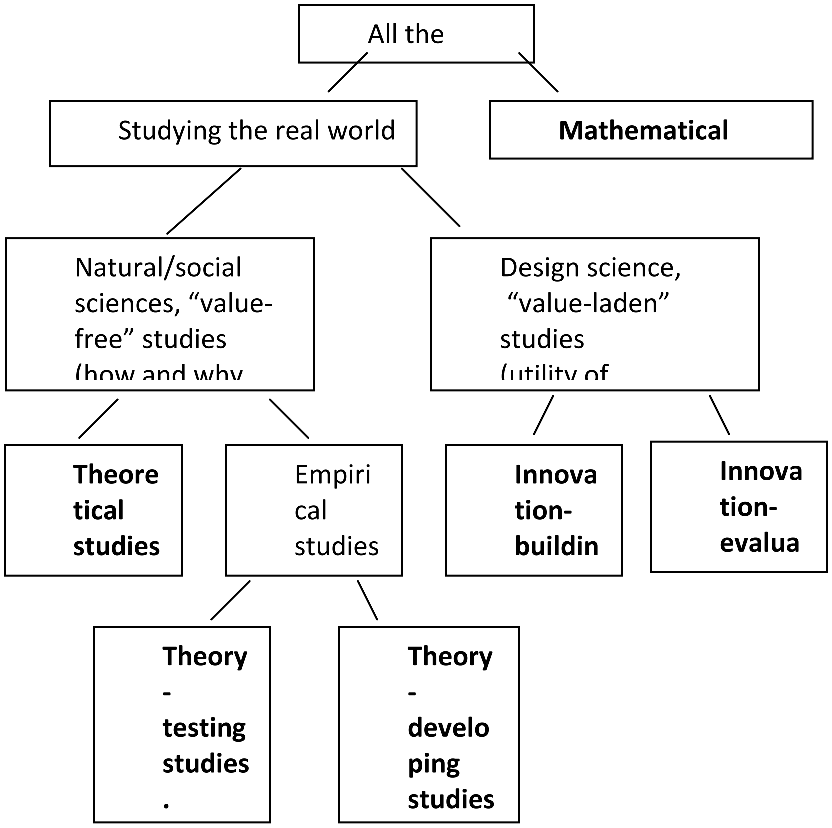

Figure 2. Our taxonomy of different studies

By using set theory Aulin (1982) also developed an actor model where three constructs (beliefs, values and procedural norms) can to a great extent explain human behavior. He argued that, if something (for example, self-steering) cannot be directly observed, it can sometimes be studied indirectly, mathematically. In mathematical studies a certain theorem, lemma or assertion is proved to be true.

In *theoretical* studies on reality the basic assumptions (for example, Wand and Wang 1996) underlying constructs are first analyzed; theories, models and frameworks used in previous empirical studies are identified, and logical reasoning is thereafter applied.

When we empirically study the past and present, we can use theory-testing or theory-developing methods depending on whether we have a theory, model or theoretical framework guiding our research or whether we are developing a new theory grounded on the raw data gathered.

In *theory-testing* studies such methods as laboratory experiment, survey, field study, field test etc. are used. Lee (1989) presented a particular version of the case study, which should be classified as a theory testing approach, but has had a marginal effect so far. Some longitudinal study methods belong to this category. In a study using the theory-testing method the theory, model or framework is either selected from the literature after a comparison of those available or developed or refined for the study at hand. In many IS studies, consensus is tacitly assumed. But if dissensus is assumed, as in an activity theory (Kuutti 1991), a critical study is then performed (cf. Richardson and also Robinson 2007).

Among the *theory-developing* studies we include "normal" case study (Yin 1989, Eisenhardt 1989), multiple case study (Eisenhardt and Graebner 2007), content analysis, ethnographic method, grounded theory (Glaser and Strauss 1967; Strauss and Corbin 1990; Suddaby 2006)), phenomenography, contextualism (Pettigrew 1985), discourse analysis, some longitudinal study methods, phenomenological study, hermeneutics etc. In the theory-developing study, an attempt is made to create one story or tentative theory and the consensus is then implicitly presupposed. But if the case cannot be described with one story only, and two, three, even four stories are needed as in Buchanan (2003), then dissensus holds.

In *building* an innovation the utility or other aspects (that can be collected into a goal function (Järvinen 2007b)) are pursued and a particular (information systems) development method and/or the design theory is applied or developed (Gregor and Jones 2007). In the *evaluation* of the innovation, e.g. an information system, some criteria or a certain goal function are applied and some measurements performed.

4. From research question to research methods

To demonstrate how from the research question we can arrive at a suitable research approach in mathematical, theoretical, theory-testing and theory-developing, innovation-building and -evaluation studies we present some examples. Aulin (1989) could state his research question as follows: What is an exhaustive classification of general systems theories? The latter as research objects do not refer to real world entities. Hence *mathematical* approaches can be recommended.

Albert et al. (2004, p. 163) state that “our goal is to propose an operational framework for continuous redesign, especially for non-transactional sites”. The verb ‘redesign’ refers to innovation-*building* studies. Gregor (2006) also assigned the paper by Albert et al. to her Type V theory (design and action). Albert et al. (p. 164) continue that “as suggested in Hevner et al. (2004), we use an observational *evaluation* method to evaluate the design”. In this class [design research] we try to answer the questions: Can we build a certain innovation and how useful will it be? We may also ask what a certain innovation ought to be like, and how we could build it? For example, how could we improve our human-computer interface so as to reduce the number of errors? If our research question contains the following verbs: build, change, improve, enhance, maintain, extend, correct, adjust, introduce, etc., our study might belong to design science research.

Gefen et al. (2003, p. 53) have two objectives in their study. “The first objective of this study is *to integrate trust-based antecedents and the technological attribute-based antecedents found in TAM into a theoretical model*. … *Examining how customer trust can be maintained in an e-vendor* is accordingly, the second objective of this study.” Gefen et al. clearly study a part of the real world. Their first objective concerns *theoretical* part of their study. The second objective emphasizes their empirical part of the study where their theoretical model is *tested*. In this class [theory-testing studies] we try to answer the question: Does a particular theory, model or framework aptly describe a certain part of reality? In a more detail, do our experiments, field or case studies confirm or refute our theory, model or framework?

Lamb and Kling (2003, p. 198) regret that “within several research disciplines related to IS studies, there is a growing realization that ICTs, such as online information services, have achieved only limited success as useful information systems, in part because they are based on models that reflect this user concept”. They later (p. 202) continue that “in order to develop a better understanding of ICT use, and to develop an alternative to the user concept, we designed a study to examine online information services from the perspective of the people who were actually using or not using them. Mindful of the main criticism of the user concepts that have informed its critiques, we focused our qualitative research on the organizational contexts of situated use." Lamb and Kling study a part of the real world, and develop a new user concept. Hence, their study belongs to the *theory-developing studies*. They used on-site interviews to assemble their raw data and they mainly followed the rules of grounded theory (Glaser and Strauss 1967) in their analysis. Miles and Huberman (1994) refer to Tesch's (1990) book with 27 research approaches and classify those theory-developing research methods into more detailed classes. In this class [theory-developing studies] we try to answer the question: What kind of theory, model or framework best describes or explains a part of reality? In more detail, what kinds of theories, models or frameworks can we use to describe and explain our observations from case studies, content analyses, ethnographic, phenomenological, hermeneutic, phenomenographic etc. studies?

To summarize, we have given examples and guidelines for how to arrive at a suitable research approach from the research question. My personal experience (Järvinen, 2004) as a supervisor of doctoral students, especially students coming from industry, supports my claim that our taxonomy (Figure 2) can guide junior scientists to choose a suitable research approach for their studies. Next, we move on to consider the implications of our taxonomy for science.

5. Implications

March and Smith (1995) placed much emphasis on design science with two activities, build and evaluate. It is interesting to note that Susman and Evered (1978) described *action research* as a repetitive performance of the following cycle: Diagnose, plan, implement, evaluate and learn. The three first phases in the cycle (diagnose, plan and implement) resemble the information systems development method when the so-called phase approach is applied, i.e. when a new system is built. Hence, action research seems to contain both the build and evaluate activities (cf. Järvinen 2007a). This may resolve the problem of how to categorize action research. Ives et al. (1980) included action research studies in the category of "unknown research strategy", Iivari (1991) assigned action research to idiographic methods, and Orlikowski and Baroudi (1991) had one action research article in their set of 155 article studies, which they classified as either positivist or interpretive but not as critical philosophy. Our result that action research is a combination of the build and evaluation activities, and hence belongs to design science concurs with the fact that in every action research project some utility is emphasized and some improvement is stressed. Our taxonomy seems to evince more evidence for Järvinen's (2007a) tentative consideration.

It is significant that March and Smith (1995) write "natural science uses but does not produce methods. Design science creates the methodological tools that natural science uses." The distinction between natural science and design science concerning method corresponds to the distinction between *positive* and *normative* (prescriptive) views, where the positive view proclaims what reality *is,* and the normative view what reality *ought to be*. The positive methods are included in a certain (positive) theory describing a part of reality, its structure and action. For example, Hann and Weber (1996) assume that the research object (in a part of reality) have reached a stable state. The normative methods demonstrate how to build an IT artifact, for example, and an information system (van Aken 2004; Gregor and Jones 2007).

Concerning instantiations the difference between natural science and design science is that natural science describes why and how a particular instantiation is as it is, its structure and action, and this description is then value-neutral. But at the beginning of the building process design science emphasises the problematic initial situation, i.e. a low utility or a low value of the goal function, and during the building process design science stresses the expected utility of the desired state of the new system. During the evaluation of the ready-made instantiation its final state (or more exactly its goal function) is compared with the expected state (its goal function). Hence, values play a crucial role in design science research.

Deetz (1996) proposed two dimensions to contrast Burrell and Morgan's (1979) dimensions. The first new dimension (local/emergent vs. elite/ a priori) focuses on the origin of concepts and problem statement as part of the constitutive process in research. The second "consensus-dissensus" dimension draws attention to the relation of research to existing social orders. This dimension is similar to Burrell and Morgan's use of the traditional sociological distinctions between an interest in "change" or "regulation", but enables some advantages. The first dimension (local/emergent vs. elite/ a priori) supports March and Smith’s distinction between theory-developing (theorizing) and theory-testing (justifying) activities. Deetz calls the combination of a priori theory and dissensus the discourse of *critical studies,* where some conflicts are pre-supposed in the theoretical framework or theory to be tested. Orlikowski and Baroudi (1991) recommended “ethnographic studies of organizational processes and structures” when the critical philosophy of information systems research will be applied. But in light of the foregoing we cannot agree with them. Their recommendation is rather valid for Deetz’ discourse of dialogic studies, where the local or emergent theory and dissensus were assumed. The class of dialogic studies and its special methods (Buchanan 2003) are new.

We totally agree with Lee (1989), who found that his consideration for assessing the analytical rigor of case studies recognized *no differences between quantitative and qualitative approaches*. Lee concluded that any distinctions between quantitative and qualitative approaches are artificial and inconsequential. Neither type of research is inherently more rigorous than the other. In other fields of academic research, the perceived differences between quantitative and qualitative approaches have, unfortunately, become institutionalized into opposing camps. Some of the methodological concepts in Lee’s article may prove helpful in avoiding a similar fate in the academic field of MIS. Deetz’ article (1996) used in our taxonomy also supports the same view.

Concerning *mathematical approaches* we would like to pay attention to Aulin’s (1982, 1989) studies on dynamic systems. Aulin differentiates nilpotent systems with a rest point or equilibrium from four types of dynamic systems with a continuous goal function g(t). Self-steering dynamic systems seem best imitate human behaviour. One of the most interesting features of self-steering systems is that the same state never recurs. This may explain why repetitive studies with people have not been successful. From the continuous goal function in time we can conclude that we are able to change our minds in the course of time. This may explain in part why maintenance activities (especially perfective maintenance) play as a central role as they do in information systems (Lientz et al. 1978). It seems that the self-steering system is a more realistic model of the human being and of an organization than a machine or an organism, which are frequently evinced as metaphors for that purpose, e.g., Huy (2001). A detailed analysis of our class of mathematical approaches provided self-steering systems, the new and more realistic model of human being. Aulin himself argues for his mathematical approach saying that if we cannot directly observe and measure something we could try to model and study it mathematically.

To summarize, mathematical approaches clearly can provide new applications like self-steering systems. Action research is close to design research, where values play a central role. Concerning methods it is reasonable to distinguish between positive and normative methods. A new class of dialogic studies emerged. Instead of quantitative and qualitative studies we should speak about theory-testing and theory-developing studies. Hence, our taxonomy as such or its immediate corollaries really mean progress in IS.

6. Discussion

In supplementing Figure 1 with some amendments like mathematical studies and consensus-dissensus alternatives, we did not stipulate any conditions or restrictions that a certain study must concern information systems. On the contrary, we even extended our innovations from technical ones to social and informational ones. Hence, our taxonomy (Figure 2) is also equally applicable to other disciplines like engineering, education, social work, etc.

Webster and Watson (2002) give advice on how to conduct a literature review. They also describe how fields of inquiry develop. Their theories are often placed on a hierarchy from ad hoc classification systems (in which categories are used to summarize empirical observations), to taxonomies (in which the relationships between the categories can be described). Two higher level constructions are conceptual frameworks (in which propositions summarize explanations and predictions), and theoretical systems (in which laws are contained within axiomatic or formal theories). To our mind, earlier classifications of research methods (Ives et al. 1980, Galliers 1985, Galliers and Land 1987) as linear lists are ad hoc classifications. Figure 1, based on March and Smith (1995), has some relationships between its constituents. Our tree-like structure in Figure 2 better fulfills the requirements of taxonomy than any other classifications of research methods.

March and Smith (1995) provide some universal criteria for every research output type. "Evaluation of constructs tends to involve completeness, simplicity, elegance, understandability, and ease of use." To demonstrate the *completeness* of our taxonomy we refer to pairs: 1. real/abstract, 2. value-free/value-laden (natural-social science/design science), 3. theoretical/empirical, 4. develop/test, 5. dissensus/consensus, 6. build/evaluate. All the six pairs consist of exhaustive classifications. Concerning *simplicity,* the mental capacity of human short-term memory is restricted to 5 ± 2 observational units (von Wright 1979), and those six pairs are within the limits. The *elegance* of our taxonomy is difficult to evaluate, because elegance is normally "in the eye of the beholder". To measure understandability we must consider how easily we can differentiate these six pairs. Most terms in them are fundamental scientific concepts. A person cannot perform any study if she does not *understand* these terms. Ease of use may depend on the complexity of relationships. Our concepts in Figure 2 do not form any network, but rather a tree-structure. The latter is normally *easier to use* than the former. Hence, according to the universal criteria presented by March and Smith our taxonomy (Figure 2) is a 'good' construct.

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