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Supplementing Ron Weber's view on a theory building

DEPARTMENT OF COMPUTER SCIENCES
UNIVERSITY OF TAMPERE

D-2004-8

TAMPERE 2004

UNIVERSITY OF TAMPERE
DEPARTMENT OF COMPUTER SCIENCES
SERIES OF PUBLICATIONS D – NET PUBLICATIONS
D-2004-8, DECEMBER 2004

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Appeared earlier as the plenary paper in

the CD Proceedings of IRIS27, Falkenberg, 14-17.08.2004

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ISBN 951-44-6199-1
ISSN 1795-4274

Supplementing Ron Weber's view on a theory building

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Abstract*: The information systems science needs its own theories. To this end, the method to develop a new theory which Ron Weber, Editor-in-Chief of MIS Quarterly, recently presented is very welcome. The method with the four steps is not, however, universal, i.e. it cannot be applied to every case. We shall show three different exceptions. First, based on the analysis of the lawful states of the novel system we shall demonstrate that the innovative system building task must be excluded from the application domain of that method. Secondly, by using different categories of dynamic systems we show that the method can be applied to the nilpotent systems with the rest point, but the method cannot be applied to the self-steering systems. The latter is pity, because the self-steering system is the most natural model of the total intellectual process of human being, i.e. the consciously controlled human tasks cannot be theorized by using the method presented by Ron Weber. Thirdly, because of social construction of reality and the fact that constructs are grounded in common understanding rather than physical reality so the possibilities for differing interpretations are great. Further, they may become out dated as common understanding can change.*

Keywords*: Theory, systems development, human being, dynamic systems, method*

1. Introduction

"Nothing is as practical as a good theory" is a phrase we sometimes hear. Interaction between theory and practice is two-directional. Theoretical constructs guide our acts and our practice shapes our theoretical view on the world. We see our world through our theoretical lenses. Giddens (1984, p. 326) uses an expression a *sensitizing device*, when he means the role of a theory, model or theoretical framework in observing of a part of the world. Orlikowski (2000) developed a new concept a *practice lens*, which posits human as constituting structures in their recurrent use of technology. The practice lens she is proposing focuses on emergent technology structures enacted in practice rather than embodied structures fixed in technologies. This practice lens further recognizes that in both research and practice researchers often conflate two aspects of technology: the technology as artifact (the bundle of material and symbol properties packaged in some socially recognizable form, e.g. hardware, software, techniques); and the use of technology, or what people actually do with the technological artifact in their recurrent, situated practices.

Ron Weber was an invited speaker in the 26th IRIS in Haikko, Finland. He presented the ideas which he was included into his own column MIS Quarterly (2003, pp. iii – xii). In these editorial comments, Ron Weber addressed the topic of theory building. His motivation is fourfold. First, he believes that, as members of a discipline, we still need to improve our theory-building skills. In his view, we still rely too much on theories borrowed and adapted from other disciplines – perhaps a manifestation of our need to build theories in domains where no prior theory exists. Second, much more has been written about theory testing than theory building. He hopes these editorial comments might help by providing some useful pointers on how to build high-quality theory. Third, he wants to reiterate Bob Zmud's call for more theory-only submissions to the MIS Quarterly (June 1998). Via these editorial comments, he hopes to illustrate the ways in which such submissions might be crafted and the types of contributions to knowledge that theory-only submissions might seek to make. Finally, he wants to canvass briefly some controversial issues relating to theory building – for example, whether theory building is even a meaningful activity to undertake within our discipline and, if so, what forms it should take. His hope is that his comments will motivate more discussion and debate on these issues – issues that perhaps some of us would prefer to shun because of the challenges they present to our long-held beliefs about theory.

In their survey article Lee et al. (2003) support the Ron Weber's arguments by claiming that the technology acceptance model (TAM) is almost the only own theory which information systems science has. We really need new own theories for phenomena under our studies, especially in our core area independent on is it narrower (Benbasat & Zmud, 2003) or broader (Alter, 2003).

I shall in this paper participate in discussion and debate on theory building as Ron Weber wishes. To develop a necessary basis for discussion I have in Section 2 repeated his mean message, i.e. his four major steps associated with theory-building which I call the RW method. My threefold criticism concerns applicability of the RW method. I shall show that the RW method cannot be applied to the systems development process

(Section 3), to a certain kind of dynamic system (Section 4) and to social sciences (Section 5).

2. Ron Weber's view on theory building

In this section we shall present Ron Weber's (2003) own method for theory building. Because the method plays an important role, we described it in detail. A theory is an *account* that is intended to explain or predict some *phenomena* that we perceive in the world. The terms *account* and *phenomena*, however, have particular meanings. Weber will explain the latter first and then the former.

To understand the meaning of the term phenomena, Weber first needs to cover some basic ontology. For him, the two fundamental (atomic) constructs the researcher needs to be able to describe anything shee perceive in the world are *things* and *properties of things*. The values of the properties of some thing at a point of space-time are its *state*. Changes of state (changes that occur in the values of properties) are *events* that occur to a thing. Perhaps a counterintuitive idea, however, is that the states of and events that occur to a thing are also properties of the *thing*. States and events do not exist in the ether. They "belong to" some thing. Thus, they are properties of the thing.

Phenomena are the states of things or events that occur to things. When the researcher builds a theory, therefore, she is seeking to account for the state(s) of some thing (or things) or an event(s) that occurs to some thing (or things). … The theory she seeks to build in essence is an attempt to articulate a *law* (or less formally an association or statement) that relates the value of two components of the user's state. … She might have articulated the theory at the outset of her research on the basis of prior research and her own knowledge and experience. Alternatively, she might have articulated it only in light of insights she has obtained after long period of intensive data gathering in the field. Whatever the scenario, the phenomenon she is seeking to explain or predict is the relationship among values of various components of the state of a particular thing. … Weber finally defines that the *account* of the phenomena is the explanation of the laws that are hypothesized to relate them – laws that specify the relationships between the values of different properties of a single thing, or laws that specify the relationships between the values of properties of different things. Often an account is couched using the terms *construct* and *association* among constructs. A construct is simply a property of a thing (either a simple thing or a composite thing). An association is simply a law (formal statement of some kind) that is hypothesized to govern the values of different properties (properties of the same thing or different things) or changes to the value of properties of a thing.

Weber (2003) writes that "building good theories is in part an art – an activity that requires creative insights on the part of the theory builder. Broadly, however, there are procedures we can follow. Below Weber have provided a brief description of four major steps associated with theory-building endeavors. For each step, he has also indicated how as scholars we might make theoretical contributions to our discipline. Also while his comments below imply that scholars follow the steps sequentially, clearly the process of building theory is iterative.

Step 1: Articulate the constructs of a theory

The most fundamental components of a theory are its constructs. Recall, the constructs represent properties of things. A theory seeks to explain or predict the values of or changes in the values of these properties. Often some subset of these properties is likely to have a special status in her theory building. They represent the so-called dependent variable (or variables) that the researcher is seeking to explain or predict. They are the focal construct (or constructs) in her theory. The other properties are of interest to the researcher because she believes they are associated in some way with changes in the value of her dependent variable(s). They are the ancillary constructs in her theory. In some cases, however, there is no focal construct *per se*.

Her choice of the constructs to include in a theory is a critical decision. The focal constructs she "sees" in the world and the ways she conceptualizes them are likely to have an important impact on the contribution to knowledge she makes via her theory. Furthermore, in her choice of ancillary constructs, she has to make important trade-offs between richness and parsimony in her theory.

Step 2: Articulate the laws of interaction (relationships) among the constructs of a theory

Once she has chosen her constructs, she then needs to explain how they are related to one another – in other words, how their values change in concert according to some sort of *law*.

Her laws of interaction can be specified with varying levels of precision.

Step 3: Articulate the lawful state space of a theory

The lawful state space is the set of combinations of construct values for which the theory is expected to hold. It is one element of the *boundary conditions* of a theory.

She begins to specify the lawful state space of her theory when she selects the constructs to include in her theory. The choice of constructs dictates the *things* in the world to which her theory applies. … Given her choice of constructs, her theory might apply only for certain values of each of her constructs. … In principle, she also needs to consider all combinations of values of her constructs.

Step 4: Articulate the lawful event space of a theory

The lawful event space is a set of changes of state of the constructs for which the theory is expected to hold. As with the lawful state space, the lawful event space is an important element of the boundary conditions of a theory.

In some cases, an event is unlawful because either the prior state or the subsequent state is unlawful. In some circumstances, however, both the prior state and the subsequent state are lawful but the transition between them is unlawful.

3. The systems development process

In this section we shall analyze the systems development, its lawful states and transitions between states. The systems development can be described as follows: According to March and Smith (1995) design science products are of four types of artifacts: constructs, models, methods, and instantiations. We use their definitions. *Constructs* or concepts form the vocabulary of a domain. A *model* is a set of propositions or statements expressing relationships among constructs. A *method* is a set of steps (an algorithm or guideline) used to perform a task. An *instantiation* is the realization of an artifact in its environment.

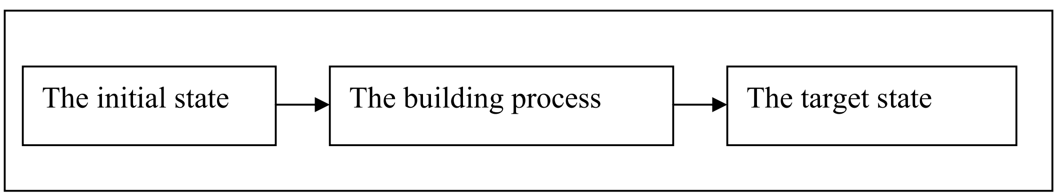


Figure 1. The building process

We would like to enlarge the artifact concept to the innovation concept. Instantiations operationalize constructs, models and methods. The motivation behind the building a new innovation is either lacking of that innovation or low quality of the outcomes achieved by old innovation. It is almost always possible to identify the starting point of an effort to construct something new and also the contemporary view on the desired state, e.g. the functioning artifact. The purpose of the construction process is to achieve a movement from the initial state to the target state (Figure 1).

In Figure 1 there normally are two states and one process, i.e. a transition from the initial state to the target state. According to the RW method, our state space consists of two (initial and target) states and our event space of one transition.

In few cases the initial state can be lacking, i.e. we do not have any earlier innovation, in other words the building process of the new innovation will be started from scratch. A developer/researcher may have her own ideas about the desired state. But it cannot be based on the business need as Hevner et al. (2004) require, because the innovation to be built is totally new and anybody does not know whether the new innovation will be a success in business sense before it will enter to the market. In this situation we have difficulties to apply the RW method.

In the normal case, some of the interested parties have perhaps considered the initial state to be problematic. The performance criteria of the old version of artifact or innovation may be below the stated goals. Some party can also have an idea or a concept to apply or to use some resources (technological, human, data/ information/ knowledge, financial resources) in a new way in order to solve the problem. This concept resembles a business concept or business idea. In practice it can be a new theoretical or practical, e.g. technical invention.

March and Smith (1995) connect two models to two states, the first one to the initial state and the second one to the target state, in such a way that the models represent situations as problem and solution statements. It means how things are at the beginning and how they ought to be at the target state (a normative model). The (positive) model of the initial state may need to capture the structure of reality in order to be a useful representation. The positive model or theory of the initial state of the old information system describes both the structure and behavior of the system. The normative model of theory of the target state describes which kinds should be both the structure and behavior of the new system. To our mind, at least the positive model (but maybe the normative one, too) can be built by following the RW method. But we see some problems with the development process for the new system. - As we earlier said the reason for building the new innovation is "either lacking of that innovation or low quality of the outcomes achieved by old innovation", but Ron Weber does not speak anything about, for example, "quality of outcomes". Before discussing this important theme, we would like to slightly elaborate our simple Figure 1.

To emphasize the utility aspect motivating construction the (problematic) initial state is evaluated by using a certain utility metrics (or many), and the target state is estimated to be better, more valuable, more desired with the same metrics. The model of the initial and/or target state can (but need not) contain one or more new constructs.

To think the building task, the target state can be known or unknown. If it is known, the task of researchers as builders is to try to implement the desired change from the initial state to the target one. If the target state is unknown, we have at least two alternatives. We can firstly specify the target state and then try to implement measures to achieve that state or we can in parallel realize both target-seeking and implementation. Instead of implementing the totally new version of artifact by ourselves, we can also purchase a ready-made artifact, if such one exists and is for sale at a competitive price. The good hopes of builders will not always materialize, but the final state may differ from the target state (Figure 2).

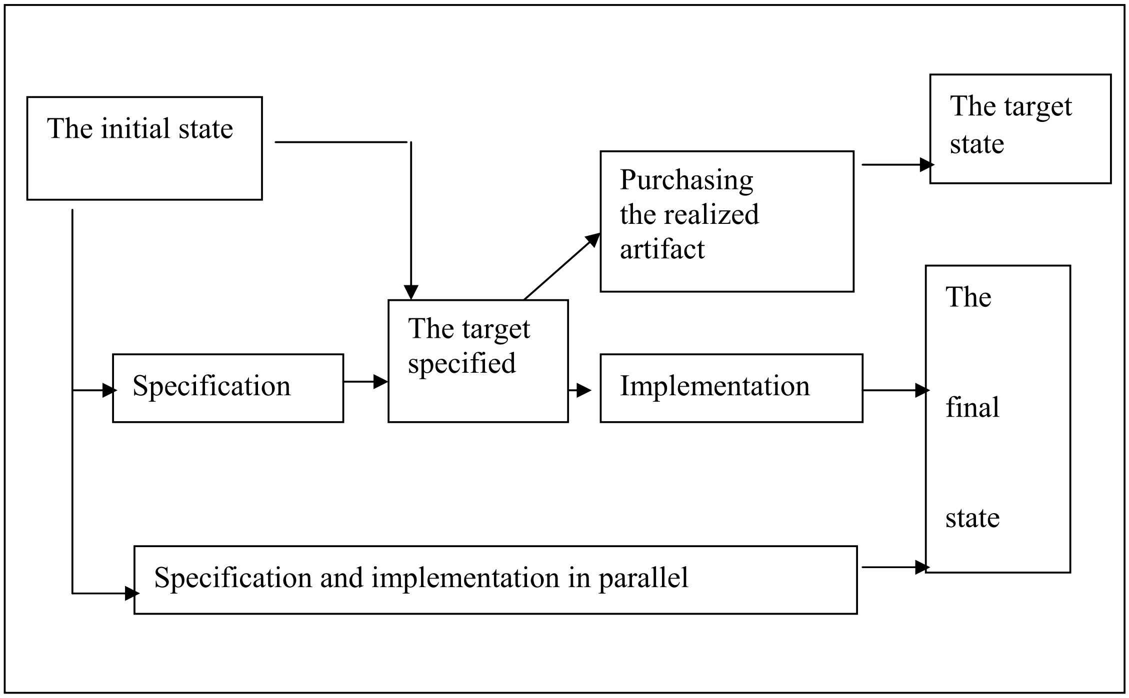


Figure 2. Different alternatives concerning the building process and its outcomes

Our aim is to develop some criteria and measures to estimate the building methods, too. We therefore return to the views on methods taken by March and Smith who assume a well-structured building task and therefore emphasize the implementation process only. We cannot totally agree with them, because at the beginning of the specification and parallel processes there does not necessarily be any model representing the solution space (i.e. the building task is ill-defined). The task of the specification process is to find that model. The other path from the initial state to the final state goes via the parallel process, and its idea is to define the solution space model in the course of the process from the initial state to the final one.

Hence, our Figure 2 represents a wider and realistic view on the processes where the building methods are needed. We can here conclude that the views of March and Smith concerning a method are rather restricted and only applicable to the implementation process where the models of the initial state and the target one exist by definition.

Our ‘theory’ of the systems development in Figure 2 seems to have four states (initial, specified, target and final states) in the lawful state space of the theory and four transitions (specification, implementation, purchasing and parallel processes) in the lawful event space of the theory. At beginning of the building process all the stakeholders wish that the final state were the target state, but it does not always take place. Is the target state lawful, if the final state after the development effort does not coincide with the target one, i.e. there is no transition from other states to the target one? We claim that our view in Figure 2 corresponds to reality, i.e. in practice it often takes place that the systems development project does not always achieve the target state. The final information system can be better or worse than planned. Our reasoning above shows that we cannot follow the RW method.

In our description above we use ‘a certain utility metrics’ in evaluating the problematic initial state and the desired target and final states. But the RW method does not have any such metrics. The reason for that can be the difference between the design science and the natural science. March and Smith (1995) and recently Hevner et al. (2004) carefully describe that difference. Hence, we propose that some additional boundary conditions (cf. Mathiassen, 1981; Mathiassen & Munk-Madsen, 1986) are needed in the RW method: The four steps method is not valid for the research problems in the design science.

4. On dynamic systems

In this section we shall use mathematical notions for very strict description. A reader who does not like those notions can read the verbal text and examples only, and she can get an overview of our message. Aulin (1989) differentiates three primary types of causality: causal relation, causal law and causal recursion, from weakest to strongest one. Causal recursion is the type of causality required at the fundamental level of physical theory, and thus at that of natural science generally. It implies a complete state-description of the dynamical system concerned, given by a total state x, as a function of which any property x of the system at any moment t can be expressed: z(t)=z(x(t)). *Causal recursion* is defined for the total state x if there is a transitive recursion of x(t) to any past state x(τ), i.e. if

$x(t) = \varphi^{t\tau}(x(\tau)),\ \ \varphi^{tt'}\cdot\varphi^{t'\tau} = \varphi^{t\tau}$ for $t > t' > \tau$

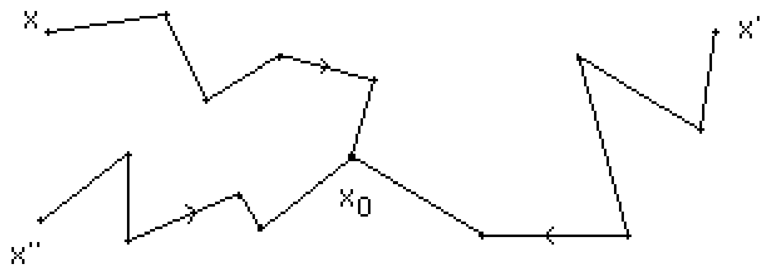
Thus a system having causal recursion is what Ashby (1972) called "state-determined system".

Causal recursion is *nilpotent*, if there is such a positive integer s and state x_0 that

$\varphi^{s}(x) = x_0$ V x ϵ X (E

$\varphi(x_0) = x_0$,

where E is an Euclidean space and X is a set of states of the system.



The initial state x_0 is called the rest state and the nilpotent dynamical system has the property that it comes back to its initial state after the finite number (s) of units of time. We can say that an external disturbance (or stimulus) occurring at the moment t=0 throws the system out of its rest state x_0 to a perturbed state x, after which the nilpotent causal recursion conducts the total state xt=u along the half-trajectory uT^+ until, at the moment t=s, the system is back in the rest state x_0. During its return journey the system gives response to the stimulus. If the same stimulus is offered again, the system gives the same finite total response. Thus it is a memoryless system that does not learn from experience.

If the nilpotent system contains feedback, it is called a cybernetic nilpotent system. If a computer is programmed to solve a finite problem, i.e. a problem that can be solved in a finite number of steps of computation in the machine, it is the cybernetic nilpotent system. (But computers can also be programmed to simulate systems that have a full causal recursion.)

A dynamical system with a full causal recursion does not have any rest state to be reached in a finite number of steps (in a finite time). The causal systems can be classified to two categories: nilpotent systems and systems with a full causal recursion.

causal systems

|

|--- nilpotent systems

|

|--- systems with a full causal recursion

The mathematical definition of "goal" is based on an infinite process, and thus on a full causal recursion (Aulin 1989). To define exactly the difference between a goal and a task, Aulin assumes that an external disturbance throws the system at the moment t=0 from an unperturbed state x to a perturbed state p. Corresponding to the alternative cases, related to the behavior of the Euclidean distance $\rho(pt, xR^+)$ of the point pt from the half-trajectory xR^+ and to the boundedness or unboundedness of xR^+ we have the following four types of systems with full causal recursion:

1. If, for a small enough δ-neighbourhood $S(x,\delta)$ of x, the Euclidean distance $\rho(pt,xR^+)$ -> 0 with t -> +∞ for all $p\epsilon(x,\delta)$, and if the positive half-trajectory xR^+ is unbounded, the system is called *self-steering in state* x.

2. If the convergence of $\rho(pt,xR^+)$ is as above, but the half-trajectory xR^+ is bounded, the system is called *self-regulating in state* x.

3. If, for a small enough δ-neighbourhood $S(x,\delta)$ of x, the Euclidean distance $\rho(pt,xR^+)$ remains finite for all $p\epsilon(x,\delta)$, but does not for all $p\epsilon(x,\delta)$ converge to zero with t -> +∞ , the system is called *steerable from outside in state* x.

4. If in any δ-neighbourhood $S(x,\delta)$ of x there is a point p for which $\rho(pt,xR^+)$ -> ∞ with t -> +∞, the system is called *disintegrating in state* x.

Here $S(x,\delta)$ is the open sphere with centre x and radius δ. The four definitions obviously exclude one another, and together exhaust the class of all the dynamical systems having a full (i.e. non-nilpotent) causal recursion.

```
causal systems
  |
  |--- nilpotent systems
  |
  |--- systems with a full causal recursion
          |
          |--- self-steering systems
          |
          |--- self-regulating systems
          |
          |--- systems steerable from outside
          |
          |--- disintegrating systems
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We can ask: Can we find any real system in every category, for example, which real system belongs to the category of *self-steering systems*? If the uniqueness of the states of mind, along with the goal-oriented nature of thought processes, is typical of human consciousness, the only thinkable causal representation of what takes place in human mind in an alert state is the self-steering process. It is, however, necessary to limit the interpretation so that what is self-steering in human mind is the *total* intellectual process. All the partial processes needn't be self-steering.

Real-world examples of *self-regulating systems* are: a ball in a cup that has the form of a half-sphere, a room equipped with a good thermostat (self-regulating equilibrium systems); some living organisms like a heart (periodically pulsating self-regulating systems); etc.

A flying ball (the resistance of the air is negligible), a frictionless oscillator and a robot are examples of *systems steerable from outside*.

A radioactive atom and a dead organism are *disintegrating systems*.

I repeat that for the *nilpotent systems* "an external disturbance throws the system at the moment t=0 from an unperturbed state x to a perturbed state p." By using Ron Weber's terminology this means: A certain event moves the system from state x to state p. If state x is the rest state the system always returns from state p to state x via the same path and in the finite number of transitions. It seems to me that the RW method is suitable for the nilpotent systems.

But do the other categories of dynamic systems obey the rules of the RW method? We above cited Aulin, that the self-steering system is the best model of the total intellectual process of human mind. The self-steering system has a special feature: The same state never returns, i.e. it always moves to the new state. The number of new states of the self-steering system is continuously increasing. Ron Weber in his four steps method implicitly assumed that the number of states in a theory is finite, because the lawful states and lawful transitions are enumerated beforehand. But the self-steering system does not obey those requirements. Hence, the Ron Weber's theory-building method does not contain self-steering systems. If the property of human being, that she never returns to the same state, is essential in some human task, the theory containing such kind of tasks cannot be built by using the RW method. Hence we can conclude that the RW method is not applicable to all kinds of dynamic systems.

5. On social sciences

Hevner et al. (2004, p. 76) write: "The behavioral-science paradigm has its roots in natural science research methods". The assertion is not necessarily exact, because Lee and Baskerville (2003) show that "… interpretivism acknowledges the existence of a phenomenon that is not present in the subject matter studied by the natural sciences. People, who are integral to the subject matter that a social scientist observes, develop and use their own subjective understandings of themselves, their setting, and their history. Therefore, already present in the subject matter of the social sciences are the meanings that people create and that they attach to the world around them. In this sense, subjective meaning is objective reality: The meanings that human subjects create, communicate, and hold are part and parcel of the world that a social scientist receives as the subject matter under investigation. The presence of humanly created, and therefore sometimes contradictory, meanings and socially constructed realities in the subject matter of the social sciences has no counterpart in the subject matter of the natural sciences: 'The world of nature, as explored by the natural scientist, does not 'mean' anything to molecules, atoms, and electrons' (Schutz 1962-66, p. 59)."

For theory-creation the phenomena existing in the social world must have shared constructs with shared meanings. Those constructs are grounded in common understanding rather than physical reality so the possibilities for differing interpretations are great. Further, they may become out dated as common understanding can change. Hence, we can conclude that the lawful state space of a theory or the lawful event space of a theory or both will change as common understanding will change. To this end the RW methods is not applicable with social sciences.

Our conclusion will get support from Orlikowski (2000) who differentiates technologies and technologies-in-practice. "The latter can be and are changed as actors experience changes in awareness, knowledge, power, motivations, time, circumstances, and the technology. They are changed through the same process that all social structures are changed – through human action. People may change their technologies-in-practice by deliberately modifying the properties of their technology and thus how they interact with it."

6. Discussion

In Section 3 we achieved the result that the RW method is not valid for the research problems in the design science problems. It is mainly based on the differences between design and behavioral sciences, which Hevner et al. (2004) describe nicely. The utility aspect emphasized in the design science problems may be the central reason.

In Section 4 we demonstrated that concerning dynamic systems the applicability of the RW method varies. The RW method seems to be suitable for the nilpotent systems, but it is not applicable to self-steering systems, which in the best way model a human being. It is indicative that Hevner et al. (2004) in their article on design science in Information Systems research exclude people from IT artifacts. They write "we do not include people or elements of organizations in our definition [of the IT artifact] nor do we explicitly include the process by which such artifacts evolve over time". They do not give any evidence nor reason for their exclusion, but they may, at least implicitly, guess or know that people as a research object much differ from data and material.

In Section 5 we found that the shared understandings which people have may change in the course of time. To this end the lawful state space of a theory or the lawful event space of a theory or both must be changed, accordingly.

In sum, our main result is that the RW method is not universal but only applicable to some research problems in information systems research, to such phenomena where the objects under study behave regularly. If a researcher wants to apply the RW method in her theory building and also wants to include people into her theory of a certain phenomenon, she must assume that people behave as machines. Otherwise she must select some other approach than the RW method in her theory building.

Aulin (1989) applied mathematics to study different dynamic systems. He writes that if we cannot directly measure something, we could try to use indirect ways. When we cannot directly study free will and human self-steering, we can use, as he demonstrates, for example, mathematics to build the model is close enough to human being with free will. To slightly generalize the basic notions or constructs Ron Weber (2003) used do not have a sufficient expressing power, but Aulin's constructs seem to give some new results. We conclude that the constructs used in the theory building can either inhibit or make the theory building possible.

We have some problems to be studied in the future in our mind. First, the parallel IS system building, i.e. to realize both the specification and implementation process together by using, for example, prototyping, much resembles the trajectory of human being, the tentative candidate of the new system always moves into the new state. This process does not seem to follow the RW method, but it should be demonstrated. Secondly, the other categories than nilpotent and self-steering ones of dynamic systems, although not so important for IS knowledge building, must also be studied.

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