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# On mechanistic vs. self-steering views of human being in information systems theory vs. practice

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**Abstract.** Two views, mechanistic and organic, are normally taken on organizations. Relating those views to people, the organic view will reach the physiological and biological side of human beings. To this end we take a self-steering view emphasizing the intellectual processes of people. The new typology of information systems (IS) typology is recently presented. We shall in this paper analytically test that typology by relating both the mechanistic and self-steering views on people to the types of IS theories. The mechanistic view seems to be applicable to every type of theories but the self-steering view is not applicable to theory for design and action. These findings will shed a new light for some IS design theories and premises concerning IT artifacts.

## Introduction

Software engineers are often astonished when their systems are not accepted by users, although they have designed them as good as possible. One potential reason could be the view of human being which engineers have taken. People are not behaving deterministically as assumed by engineers, but people have their own will and habits.

In information systems Benbasat and Zmud (2003) initiated a discussion about the core properties of this discipline. They emphasized the key role of IT artifact in information systems, and they did not include people into the IT artifact. They conceptualized "the IT artifact as the application of IT to enable or support some task(s) embedded within a structure(s) that itself is embedded within a context(s)." Alter (2003) took part in wide discussion with his work system. "The concept of work system is useful in trying to interpret Benbasat and Zmud's definition of IT artifact. A *work system* can be defined as a system in which human participants and/or machines perform work using information, technology, and other resources to produce products and/or services for internal or external customers. A rudimentary understanding of a work system requires a basic description of those six underlined elements in the definition plus some understanding of three additional elements: the relevant environment, infrastructure, and strategies." In discussing information systems design theories (ISDT) Gregor and Jones (2004) claim that we should first consider the nature of the artifacts about which we are theorizing. They are considering systems that involve humans, technology, organizations and society. The essence of these artifacts is that they are systems in which there is human use of information and communication technologies. It is this property that distinguishes ISDTs from other types of design theory: for example, in architecture, medicine, or management. Hevner et al. (2004, p. 82) indirectly define IT artifact: "We include not only instantiations in our definition of the IT artifact but also the constructs, models, and methods applied in the development and use of information systems. We do not include people or elements of organizations in our definition nor do we explicitly include the process by which such artifacts evolve over time." I would like to pay attention to the fact that the authors exclude people from their IT artifact. Hence, we have the dilemma: either people are included into IT artifact or not.

Aulin (1989) have studied dynamic systems and developed an exhaustive classification for them. In that connection he found that one type of systems, namely self-steering ones, seem to best fit with the total human intellectual process. The simplest type of systems is rather mechanistic one. Aulin's classification gives two extremes, self-steering and mechanistic, to us.

In information systems there are a strong need of own theories. Lee et al (2003) say that the technology acceptance model seems to be the most influential theory of the few ones in information systems. To this end, Gregor's (2002, and in press) articles are important, because she defines five types of theories in information systems. Her typology is based on differentiation whether a theory allows analyzing, describing, understanding, explaining, predicting or prescribing a certain phenomenon.

Our purpose in this paper is to study which types of theories are valid for the mechanistic view on human being on the one hand and for the self-steering view on the other hand. We also consider some experiences on people and premises presented concerning IT artifacts.

The rest of this paper is divided into sections as follows: First, we refer to Aulin's classification of dynamic systems. Second, we refer to Gregor's five types of theories in information systems. Third, we relate those two classifications and analyze our main research question on the mechanistic and self-steering views and their relations to potential theories. Fourth, we present empirical evidence supporting the self-steering view and theoretically based premises on IT artifacts. Finally, we discuss about merits of our study and its implications.

# Classification of dynamic systems

We consider information systems as dynamic systems and we use the Aulin's (1989) classification of those systems.

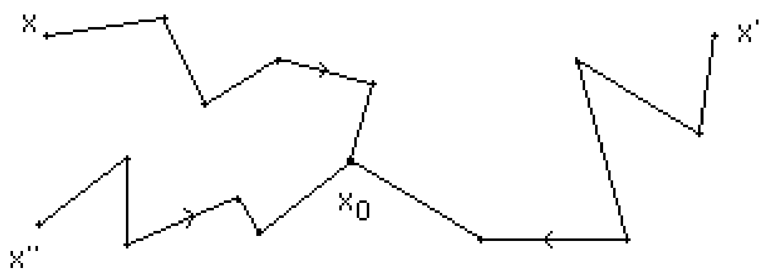


Figure I. A nilpotent dynamic system

Aulin (1989) defines that 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. 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 (Figure I) and systems with a full causal recursion.

```
causal systems
  |
  |--- nilpotent systems
  |
  |--- systems with a full causal recursion
```

The causal systems with full causal recursion can be divided into four classes depending on whether the system will *disintegrate* after a certain disturbance and its trajectory disassociate from the path of its old goal function, or the system is *steerable from outside* and its path goes in the constant distance of the path of its old goal function or it comes closer to the path of its old goal function in time. The latter can be either finite (*self-regulating systems*) or infinite (*self-steering systems*).

```
causal systems
  |
  |--- nilpotent systems
  |
  |--- systems with a full causal recursion
         |
         |--- self-steering systems
         |
         |--- self-regulating systems
         |
         |--- systems steerable from outside
         |
         |--- disintegrating 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. According to Aulin (1989, 173) 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 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*.

In this paper, two categories are considered as views of human being. The simplest causal dynamic systems are the nilpotent systems, which are here called as *mechanistic* ones, because they behave regularly. The same cause always creates the same effect. In a certain sense, the most complex causal dynamic systems are the *self-steering* systems, which is another view of human being. The typical characteristic for the self-steering systems is that the same state never returns but the self-steering system always moves to the new state in the course of time. We shall later consider how these two views of human being are related to different theories in information systems.

# Classification of theories in information systems

The method for classifying theory for IS proposed by Gregor (in press) begins with the **primary goals** of the theory. Research begins with a problem that is to be solved or some question of interest. The theory that is developed should depend on the nature of this problem and the generalizability questions that are addressed. Whether the questions themselves are worth asking should be considered against the state of knowledge in the area at the time. The four primary goals of theory discerned are:

*Analysis and description*. The theory provides a description of the phenomena of interest, analysis of relationships among those constructs, the degree of in constructs and relationships and the boundaries within which relationships and observations hold.

*Explanation.* The theory provides an explanation of how, why and when things happened, relying on varying views of causality and methods for argumentation. This explanation will usually be intended to promote greater understanding or insights by others into the phenomena of interest.

*Prediction.* The theory states what will happen in the future if certain pre-conditions hold. The degree of certainty in the prediction is expected to be only approximate or probabilistic in IS.

*Prescription.* A special case of prediction exists where the theory provides a description of the method or structure or both for the construction of an artifact (akin to a “recipe”). The provision of the recipe implies that the recipe, if acted upon, will cause an artifact of a certain type to come into being.

Combinations of these goals lead to the five types of theory shown in the left-hand column of Table 2. The distinguishing features of each theory type are shown in the right-hand column. It should be noted that the decision to allocate a theory to one class might not be straightforward. A theory that is primarily analytic, describing a classification system, can have implications of causality. For example, a framework that classifies the important factors in information systems development can imply that these factors are causally connected with successful systems development. Some judgement may be needed to determine what the primary goals of a theory are and to which theory type it belongs.

Table I. A taxonomy of theory types in IS research

| *Theory type* | *Distinguishing attributes* |
|---|---|
| I. Analysis | Says "what is". The theory does not extend beyond analysis and description. No causal relationships among phenomena are specified and no predictions are made. |
| II. Explanation | Says "what is", "how", "why", "when", "where". The theory provides explanations but does not aim to predict with any precision. There are no testable propositions. |
| III. Prediction | Says "what is" and "what will be". The theory provides predictions and has testable propositions but does not have well-developed justificatory causal explanations. |
| IV. Explanation and prediction (EP) | Says "what is", "how", "why", "when", "where" and "what will be". Provides predictions and has both testable propositions and causal explanations. |
| V. Design and action | Says "how to do something". The theory gives explicit prescriptions (e.g., methods, techniques, principles of form and function) for constructing an artifact. |

Gregor (2002) in the following sections describes five different types of theory that are seen as relevant to information systems. These five different categories of theory are not regarded as mutually exclusive, but are inter-related.

Type I: Theory for Analyzing and Describing

Descriptive theory says "what is". Descriptive theories are the most basic type of theory. They describe or classify specific dimensions or characteristics of individuals, groups, situations, or events by summarizing the commonalities found in discrete observations.

There are two categories of descriptive theory – naming and classification. A naming theory is a description of the dimensions or characteristics of some phenomenon. A classification theory is more elaborate in that it states that the dimensions or characteristics of a given phenomena are structurally interrelated. The dimensions may be mutually exclusive, overlapping, hierarchical, or sequential. Classification theories are frequently referred to as typologies, taxonomies or frameworks.

Research approaches for building descriptive theory include analysis of existing evidence or data, philosophical and historic enquiry and empirical observation.

Type II: Theory for Understanding

This type of theory explains “how” and “why” something occurred. It is not formulated in such a way, however, that predictions about the future are made so that they can be tested.

At least two types of work may be distinguished here. In the first, theory is used as a “sensitizing device” to view the world in a certain way. The point of theory, in this view, is not to generalize, because many generalizations are widely known and rather dull. Instead, theory is a ‘surprise machine’ .., a set of categories and domain assumptions aimed at clearing away conventional notions to make room for artful and exciting insights. - Examples of theory used in this way in information systems are structuration theory and actor-network theory.

In a second type of theory for understanding, “conjectures” are drawn from a study of how and why things happened in some particular real world situation. These conjectures could form the basis of subsequent theory development, or be used to inform practice.

Research approaches that can be used to develop this type of theory include case studies, surveys, ethnographic, phenomenological and hermeneutic approaches and interpretive field studies.

Type III: Theory for Predicting

Theories aiming at prediction say “what will be”. These theories are able to predict outcomes from a set of explanatory factors, without necessarily understanding or explaining the causal connections between the dependent and independent variables.

Associated research approaches include statistical techniques such as correlational or regression analysis. Correlational work can be longitudinal, that is, we can show how Y varies with a number of independent variables ($X_1$, $X_2$, …) over a time period. Correlation studies can also be multi-directional, that is we can say larger values of X are related to larger values of Y, and also larger values of Y are related to larger values of X (as in height and weight of the population).

Type IV: Theory for Explaining and Predicting

This type of theory says “what is”, “how”, “why” and “what will be”. To many it is the **real** view of theory (the traditional view).

A theory is a set of interrelated constructs (concepts), definitions, and propositions that presents a systematic view of phenomena by specifying relations among variables, with the purpose of explaining and predicting the phenomena.
This theory type implies both prediction **and** understanding of underlying causes, as well as good description of theoretical constructs. Authorities can be found for the dimensions and specification of theories of this type.

In the social sciences the predictions made are not expected to take the form of universal or covering laws, but rather to be probabilistic-type propositions.
Almost all research methods can be used to investigate aspects of theory of this type, including case studies, surveys, experiments, statistical analysis, field studies, and also interpretive methods if they are used to build theory with predictive power. The grounded theory approach can be used to develop theory, which is at some point capable of prediction, and thus being tested.

Type V: Theory for Design and Action

This type of theory has two aspects. First, it can concern the methodologies and tools used in the development of information systems. Second, it can be about "design principles", which are design decisions and design knowledge that are intended to be manifested or encapsulated in an artifact, method, process or system. In both cases it must be possible to articulate the principles instantiated in the method, tool, process, or design.  It is this articulation, whether in natural language, diagrams or similar, that constitutes the design theory.

# Two views of human being and the five types theories in information systems

In this section we shall analyze how the mechanistic and self-steering views of human being will be suitable for those five types of theories. We shall consider whether we can analyze, describe, understand, explain, predict and prescribe mechanistic and self-steering beings.

According to the mechanistic view of human being, the same cause always creates the same effect. When the mechanistic view of human being is taken, the behavior of human being is assumed to be regular. A human being is performing a certain task in the same way, and after that s/he will return to the same rest state. According to mechanistic view, the human being will not learn at work. That kind of human being can be included as a component of an information system into all the types of five theories. This means that if the mechanistic view of human being is presupposed, we can then analyze, describe, understand, explain, predict and prescribe the behavior of human being. Gregor and Jones (2004) took this kind of presupposition concerning people.

The self-steering system can change its goal function at any moment of time. When the self-steering view of human being is taken, a human being can change her/his goals whenever s/he wants. This means that we cannot predict the behavior of the self-steering human being. The self-steering human being can change her/his behavior without observable reason. Hence an outsider cannot prescribe her/her behavior. We can afterwards analyze, describe, understand and explain the behavior of a certain human being as strictly as needed. To this end, in information systems type I, II, III and IV theories are applicable to the self-steering human being but theory V is not. The latter can be an important explanation why March and Smith (1995) and Hevner et al. (2004) excluded people outside of IT artefacts.

# Experiences and premises in information systems

In this section we shall consider and evaluate results of two important articles, Markus et al. (2002) and Orlikowski and Iacono (2001). Those articles are widely cited. We are interested in to compare whether their views on human beings are closer to mechanistic or self-steering beings.

The paper written by Markus et al. (2002) "addresses the design problem of providing IT support for emerging knowledge processes (EKPs). EKPs are organizational activity patterns that exhibit three characteristics in combination: an emergent process of deliberations with no best structure or sequence; requirements for knowledge that are complex (both general and situational), distributed across people, and evolving dynamically; and an actor set that is unpredictable in terms of job roles or prior knowledge. Examples of EKPs include basic research, new product development, strategic business planning, and organization design. EKPs differ qualitatively from semi-structured decision making processes; therefore, they have unique requirements that are not all thoroughly supported by familiar classes of systems, such as executive information systems, expert systems, electronic communication systems, organizational memory systems, or repositories. Further, the development literature on familiar classes of systems does not provide adequate guidance on how to build systems that support EKPs. Consequently, EKPs require a new IS design theory, as explicated by Walls et al. (1992)." Markus et al. created such a theory while designing and deploying a system for the EKP of organization design. The system was demonstrated through subsequent empirical analysis to be successful in supporting the process. Abstracting from the experience of building this system, they developed an IS design theory for EKP support systems.

Markus et al. (2002) performed a very ambitious project to build the TOP Modeler system (Technology, Organization and People, TOP) for supporting for

emerging knowledge processes (EKPs). The article gives a rather clear description how building took place (Section 5.1 in Järvinen 2004). In connection with the building process the authors learned many important lessons:
M1) They "needed to model the system on a computer game, with color-coded evaluations of the human side of manufacturing technology, while providing benchmarks to shows about how users' organizations 'measured up' to others". The game type IT application seemed to appeal for voluntary use of a system.
M2) "Users acquired immediate benefits from using the system." This is typical requirement in all the adults' voluntary activities, e.g. in adult education.
M3) "In TOP Modeler, users were encouraged to stay by initializing all system values to 'no'; that is, the default organization was shown to contain none of the required organization features." I really appreciate this idea.
M4) "The team composed of naïve users soon became so knowledgeable about the system that they lost their representativeness as 'naïve users'". Users are learning all the time.
M5) "Expert organization designers did not themselves follow such a road map. Because of the emergent nature of organizational design, expert organization designers need process flexibility." This is typical requirement of the expert work.
M6) "We initially pushed for consensus, as recommended in the 50 IS development textbooks. However, we found that pushing for consensus sharply limited what people would be able to do with the system. We then tried a principle of providing 'both-and capabilities' that gave the appearance of reconciling the conflicting requirements. … In the end, we adopted a dialectical approach of development that enabled a more fundamental resolution of the conflicting requirements." Dissensus seems to more real than consensus.
To summarize, all lessons M1) … M6) seem to in one way or other concern a *self-steering nature of human being*.

In their article Orlikowski and Iacono (2001) wrote that "the field of information systems is premised on the centrality of information technology in everyday socio-economic life. Yet, drawing on a review of the full set of articles published in *Information Systems Research (ISR)* over the past ten years, we argue that the field has not deeply engaged its core subject matter – information technology (IT) artifact. Instead, we find that IS researchers tend to give central theoretical significance to the context (within which some usually unspecified technology is seen to operate), the discrete processing capabilities of the artifact (as separable from its context or use), or the dependent variable (that which is posited to be affected or changed as technology is developed, implemented, and used). The IT artifact itself tends to disappear from view, be taken for granted, or is presumed to be unproblematic once it is built and installed. After discussing the implications of our findings, we propose a research direction for the IS field that begins to take technology as seriously as its effects, context, and capabilities. In particular, we propose that IS researchers begin to theorize specifically about IT artifacts, and then incorporate these theories explicitly into their studies. We believe that such a research direction is critical if IS research is to make a significant contribution to the understanding of a world increasingly suffused with ubiquitous, interdependent, and emergent information technologies."

Orlikowski and Iacono (2001) defined IT artifacts as the “bundles of material and cultural properties packaged in some socially recognizable form such as hardware and/or software”.

Orlikowski and Iacono (2001) found that Information Systems Research (ISR) published 188 articles in the decade beginning in 1990 and ending in 1999. They excluded 11 metaresearch articles from consideration. Their analysis of 177 articles yielded the 14 categories and 5 clusters. They wrote that “our labels for these metacategories signal primary conceptualization of technology that distinguishes each category. … The *tool* view represents the common, received wisdom about what technology is and means. Technology, from this view, is the engineered artifact, expected to do what designers intend it to do. … The conceptualizations of technology that we have clustered under the ‘*proxy*’ label have a focus on one or a few key elements in common that are understood to represent or stand for the essential aspect, property, or value of the information technology.” The *ensemble* view of technology is characterized as follows: “while the technical artifact may be a central element in how we conceive of technology, it is only one element in a ‘package’, which also includes the components required to apply that technical artifact to some socio-economic activity.” The *computational* view is described in the following way: “Some research concentrates expressly on the computational power of information technology. Articles embracing this view are interested primarily in the capabilities of the technology to represent, manipulate, store, retrieve, and transmit information, thereby supporting, processing, modeling, or simulating aspects of the world. … Our label for the *nominal* category is intended to indicate that the articles in this group invoke technology ‘in name only, but not in fact’ (as ‘nominal’ is defined in Webster’s dictionary).”

Orlikowski and Iacono wrote that “theorizing about IT artifacts might take many forms, but as a starting point they offer the following five premises:
O1) IT artifacts, by definition, are not natural, neutral, universal, or given. … Because IT artifacts are designed, constructed, and used by people, they are shaped by the interests, values, and assumptions of a wide variety of communities of developers, investors, users etc.”
O2) IT artifacts are always embedded in some time, place, discourse, and community. As such, their materiality is bound up with the historical and cultural aspects of their ongoing development and use, and these conditions, both material and cultural, cannot be ignored, abstracted, or assumed away. …
O3) IT artifacts are usually made up of a multiplicity of often fragile and fragmentary components, whose interconnections are often partial and provisional and which require bridging, integration, and articulation in order for them to work together. …
O4) IT artifacts are neither fixed nor independent, but they emerge from ongoing social and economic practices. As human inventions, artifacts undergo various transitions over time (from idea to development to use to modification), while

coexisting and coevolving with multiple generations of the same or new technologies at various points in time. …
O5) IT artifacts are not static or unchanging, but dynamic. Even after a technological artifact appears to be fixed and complete, its stability is conditional because new materials are invented, different features are developed, existing functions fail and are corrected, new standards are set, and users adapt the artifact for new and different uses.”

Those five premises O1 … O5 concern IT artifacts, not human beings, but the latter are mentioned in connection with artifact design, construction, use, integration and further development. We can now put the question: Could people with the mechanistic view on human being design, construct, use, integrate and further develop the artifacts which will realize premises O1 … O5 presented above? Our answer is no, because the mechanistic human being could be as a hardware type component of the IT artifact. Instead of that the people with the self-steering view could, for example, further develop a certain IT artifact as premise O4 requires.

# Discussion

Our paper has three contributions. First, it demonstrates different presuppositions concerning people in information systems theory types. Second, it gives a potential reason why people are sometimes included into IT artifacts and why they sometimes are not. Third, our paper gives some new insight why premises on IT artifacts presented by Orlikowski and Iacono (2001) are such as they are.

The first result, there are different presuppositions in the IS theory types, is important, because it means the essential limitations in use of those 5 theory types. It also limits a view of human being into mechanistic one in Gregor and Jones’ (2004) conception of IT artefact.

We have only limited our consideration on two almost opposite conceptions of human being. There can be other types of human images (Isomäki 2002), too, and those types must be carefully studied. Information systems are mostly built to support communication between two persons, two groups of people etc. This pays attention to the larger unit of analysis, social actors (Lamb and Kling 2003), teams, groups, organizations etc, and their premises as social beings, which seem to offer interesting research questions.

This paper is dominantly theoretical, but at least one message to practice can be given. Because people are different, the information systems in practice should be as flexible as possible.

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