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Some Information Systems Research Trends over the Past Decade

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ABSTRACT

In order to gain an understanding of the recent evolution and the current state of information systems (IS) development research, three sub-topic areas within IS development, were examined: IS development methodology, IS architecture, and IS design and modeling. Relevant papers were selected from the *Association for Information Systems* (AIS) "basket of eight" journals. Using these articles, an empirical method based on author keywords was used to identify categorical research trends in each of the three areas. Research trends observed in each of the categories over the past decade are discussed.

Keywords

Research trends, systems development, IS architecture, IS development methodology, IS design, IS modeling

INTRODUCTION

Assessing prior research in a topic area is useful to gain an understanding of the relevant epistemology, the topics that researchers are investigating, and potential topics for future research that would expand our knowledge on an existing research topic or lead into a previously unexplored territory. While the area of information systems research is vast, this analysis investigates three specific areas:

1. systems architecture
2. systems design and modeling
3. systems development methodology

Each of these areas is briefly defined below.

Systems Architecture

While the basic concept of software or systems architecture seems to be universally understood, there is no consensus on its exact meaning. The word *architect* is derived from the Greek word *arkhitekton*, meaning *chief builder* or *master builder*, and thus architecture is something produced by a master builder. Contemporary dictionaries extend this meaning to both, the process of constructing as well as the resultant artifact, i.e. the structure. Clements, Bachmann, Bass, Garlan, Ivers, Little, Merson, Nord and Stafford (2010) state that the emerging concept of software architecture "takes a largely structural perspective." For our purposes, we define systems architecture as the overall structure, arrangement, or organization of a system, and we include research related to the definition, differences, and processes relevant to such in this trend analysis.

Systems Design and Modeling

Unlike science, which seeks to understand natural phenomena, design pertains to man-made phenomena. According to the Oxford English Dictionary, design is "a plan or scheme conceived in the mind and intended for subsequent execution" (1989). The objective of research is "to investigate or study closely" (2010) to increase knowledge. For information systems, this knowledge consists of artifacts, which can be constructs, models, methods, or instantiations (Hevner, March, Park and Ram, 2004; March and Smith, 1995). In our trend analysis we focus on design research and research related to design theory, with an emphasis on modeling.

Systems Development Methodology

The term *methodology* refers to the branch of knowledge that deals with method in general or with the methods of a particular discipline or field of study. For the field of information systems, Avison and Fitzgerald (1995) define a *systems development methodology* as "a system of procedures, techniques, tools and documentation aids, usually based on some philosophical view, which help system developers." As information systems encompass software (but may also include other components), systems development methodology encompasses software development methodology.

For the purposes of this trend analysis, we distinguish between methodologies, which take a high-level view at how to develop systems, from *methods*, which are ways of performing more specific tasks during the development of systems. Thus for this section of the analysis, we specifically consider research on evaluating, adopting, and comparing methodologies, rather than research on specific methods within methodologies.

METHODOLOGY

To find relevant papers to include in the trend analysis, we began searching the tables of contents in issues from the last ten years of the AIS "basket of eight" journals for articles related to each of the three sub-topic areas. Next, the cited and citing papers for each selected paper were searched for additional relevant papers, i.e. we searched the results of a paper's one-generation forward and backward citation map in the Web of Science. Though we focused on papers published over the past ten years, older seminal works, i.e., a paper with a very large number of citations, were also included. These older articles may help in resolving if an identified trend is a continuation of previous research or if it is a new, emergent area.

To determine a research trend empirically, a method to code each article without bias is needed. The Web of Science's taxonomy contains elements that can be used for this purpose, viz. *KeyWords Plus*® and author keywords. The Web of Science uses both of these when performing a topic search. However, a limitation of both elements is that the Web of Science only contains this information for articles published since 1991. According to the Web of Science, "*KeyWords Plus*® are unique to Web of Science and consist of words and phrases harvested from the titles of the cited articles." Examining the coding used for the *KeyWords Plus*® found higher-level categories. Therefore, using these categories does not reveal specific research topics.

Author keywords are assigned to an article by its authors. Unfortunately, there is no predefined research topic ontology to assist authors with their keyword selection; thus, the keywords may not be consistent in either typology or semantics. Yet, authors are motivated to code their articles so that other researchers will easily locate their contributions amongst the Web of Science's library of articles from 11,400 journals. To partially address the problem of consistency, categories were corrected were they disagreed in form or word order, e.g., methodology vs. methodologies, science of design vs. design science, etc. No attempt was made to resolve overlapping meaning. Finally, semantically similar keywords were combined into a single category.

The number of categories was initially kept within reasonable bounds by selecting only those categories within the author keywords that were used by at least two articles. Next, the number of categories was further reduced by selecting only those categories that were common to at least two articles in a single year or to at least twenty-five percent of the years in which all of the articles were published.

TRENDS AND CURRENT STATE OF RESEARCH

Systems Architecture

Twenty-four systems papers were selected for the trend analysis. These articles were coded with ninety-five unique categories (keywords). As Figure 1 shows, three of these categories were found to be significant: Design Science, Design Theory, and Software Architecture. However, due to the small number of papers analyzed, none of these categories shows a significant trend beyond being used consistently over the decade. Therefore, no conclusions can be obtained from this technique. However, a subjective review of these papers provides insight into the research trends over the decade.

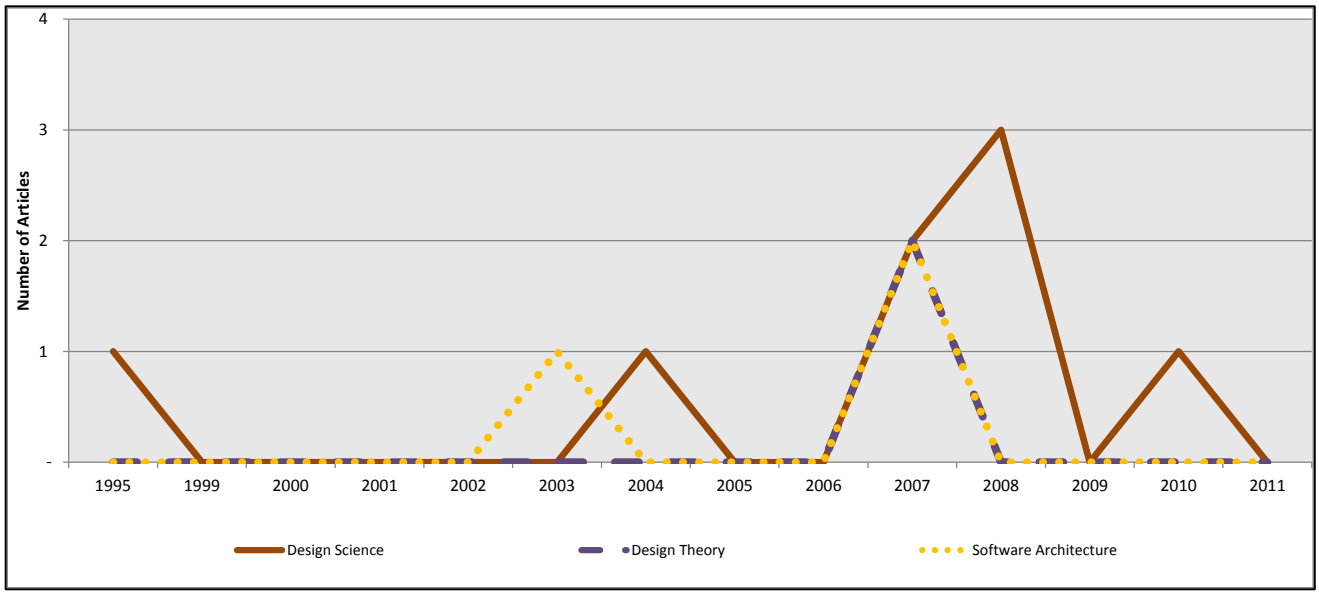

Figure 1. Systems Architecture Trend Analysis

Earlier research focused on the development of frameworks that represent and communicate design information. As illustrated by Kruchten (1995), these frameworks concentrated on the needs of technical users of the information. Hevner et al. (2004) proposed a common framework to design, evaluate, and present design research for both academics and practitioners. This article begins the growing trend that architecture artifacts must be communicated to non-technical stakeholders, e.g. managers. Following this trend, Medividovic, Dashofy and Taylor (2007) updated their earlier work on architectural description language, which addressed technical concerns, to extol that architecture artifacts must also address business concerns. This idea was extended by Smolander, Rossi and Purao (2008) in a case study. They suggest that it is no longer sufficient for architecture to only be used as a specification, but rather, research is required that will yield a broader view of architecture that explains the use of the system (language), communicates decisions and trade-offs (decision), and transfers knowledge over time (literature).

Systems Design and Modeling

The search for systems design and modeling related research found 65 articles, which the respective authors coded with 241 unique categories. Figure 2 shows the significant categories. The apparent outlier in 2008 was the result of an issue dedicated to design science by two journals, the *European Journal of Information Systems* and *MIS Quarterly*. Several of the categories have been consistently investigated over the decade including ontology, conceptual model, and method. These categories are the foundations of system design.

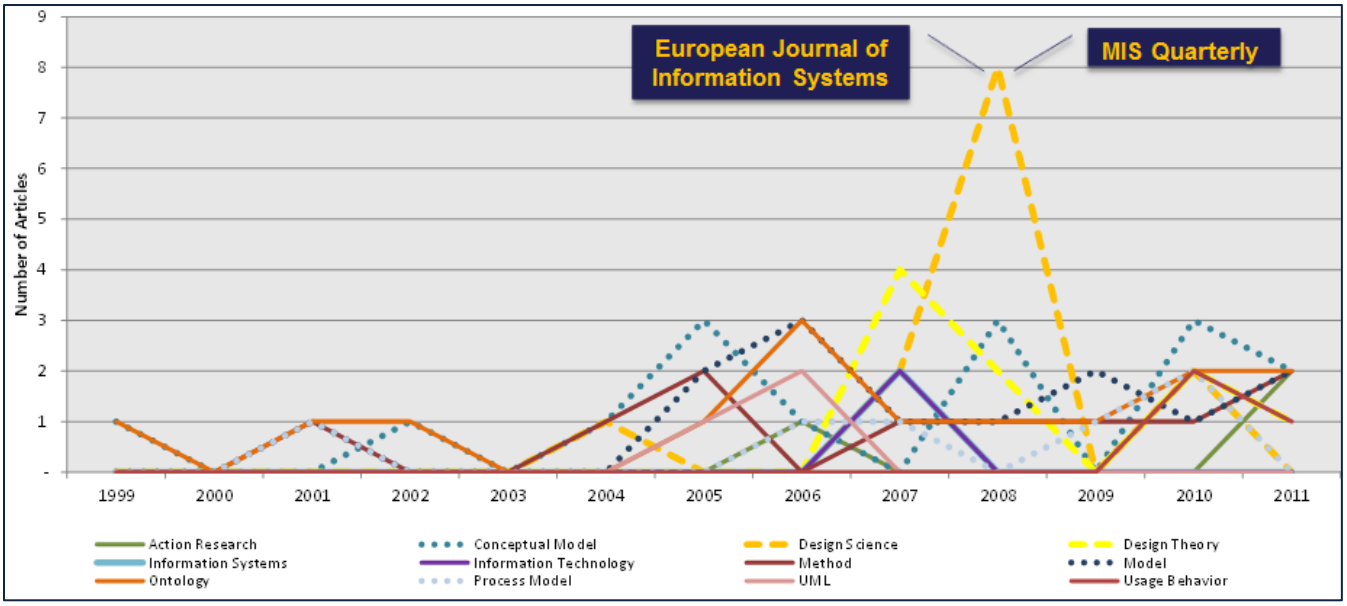

Figure 2. Systems Design and Modeling Trend Analysis

Models are used to express designers understanding of the domain that a system is intended to support. As the analysis shows, researchers have been applying the concept of ontology to "design and evaluate modeling grammars and conceptual models" (Recker, Rosemann, Green and Indulska, 2011). There are two approaches to conceptual modeling research. In the first, researchers investigate the process of modeling, as for example Gemino and Wand (2005), Shanks, Moody, Nuredini, Tobin and Weber (2010), Siau and Tan (2005). Other researchers focus on the theory of conceptual models. For example, Gemino and Wand (2004) propose a framework to empirically evaluate conceptual modeling techniques. Similarly, Thalheim (2010) argues that most research focuses on the results of conceptual modeling, and proposes a framework that encompasses the three dimensions of conceptual modeling: modeling language constructs, application domain gathering, and engineering.

In the *MIS Quarterly* special issue on design science, March and Storey (March and Storey, 2008) explain that business managers ask the question: "Investing in which IT artifacts will increase our firms value?" To answer this question, according to March and Storey, researchers "build and evaluate IT artifacts that extend the boundaries of known applications of IT." March and Storey conclude that this is the focus of IT design science research. In the *European Journal of Information Systems* special issue, Winter (Winter, 2008) distinguishes between behavioral IS research and IS design science research. The former "aims at 'truth', i.e., at the exploration and validation of generic cause-effect relations," and the later "aims as 'utility', i.e., at the construction and evaluation of generic means-ends relations." Further, Winter distinguishes between IS design science and IS design research. The aim of design research is the creation of generic "solutions to specific classes of relevant problems by using a rigorous construction and evaluation process" (Winter, 2008). It is the purpose of design science to create standards to ensure the rigor of the design research process.

Systems Development Methodology

As shown in Figure 3 the areas that were investigated over the past decade included agile development, information system development, methodology, project management, and software development. These five categories emerged from the 141 unique categories used by the authors of the selected 48 papers. As would be anticipated, the category software development was consistently investigated throughout the period. Early in the period, the more general categories of methodology and project management were of interest. Agile Development begins to gain attention towards the end of the decade.

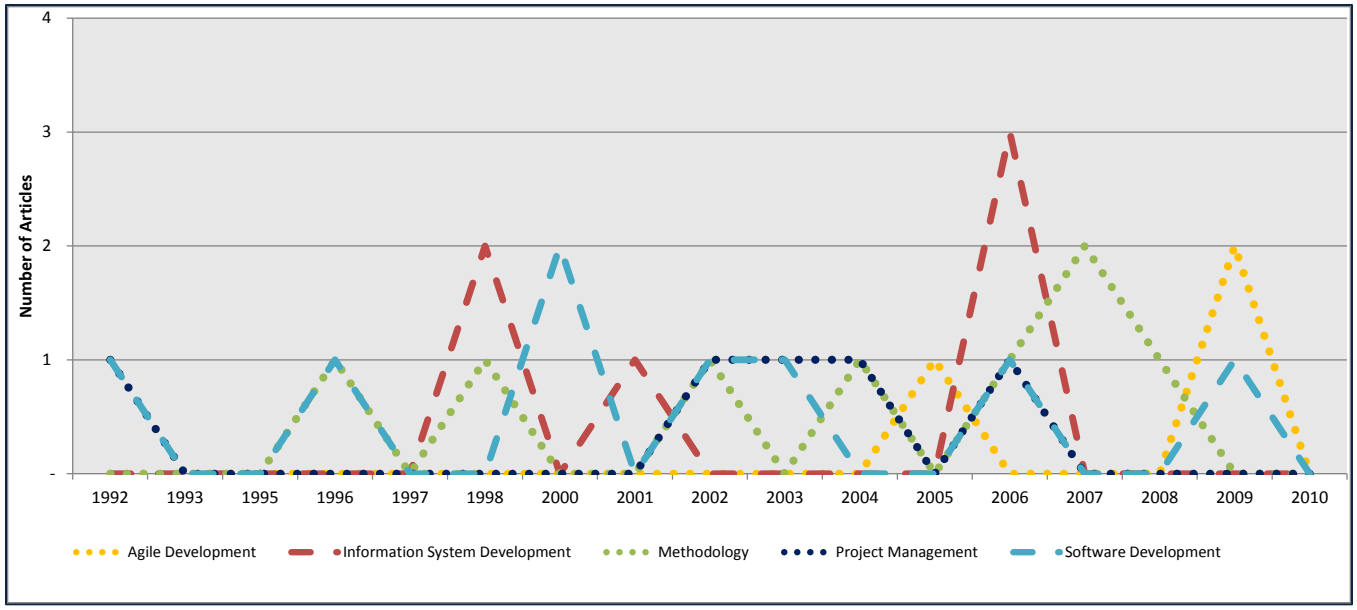

Figure 3. Systems Development Methodology Trend Analysis

While earlier authors such as Hirschheim and Klein (1989) seemed to have assumed universal applicability of methodologies, the earlier research selected for this analysis has focused on the adoption and tailoring of methodologies to meet the needs of a specific organization and/or information system project. This trend was evidenced by Fitzgerald (1998) who found that "Methodology usage is not increasing…" and concluded, "… there is a need to reconsider their [methodology] role in today's environment." Fitzgerald, Russo and O'Kane (2003) followed up with a case study of successful software development at Motorola's Cork Ireland facility, and found macro and project level practices for tailoring the facility's methodology. Madsen, Kautz and Vidgen (2006) continued this trend by examining how a methodology should be used, how it is used, and how it emerges. More recently, de Cesare, Patel, Iacovelli, Merico and Lycett (2008) derived a framework for tailoring a software methodology. Specifically examining the tailoring of the agile methodology family, Cao, Mohan, Xu and Ramesh (2009) contributed a multisite case study in which they conclude that adaptation of an agile methodology must include project and task characteristics, organizational requirements and practices, and the team's internal systems.

CONCLUSION

Overall, the analysis identified the IS research trends as improving the value of IS artifacts for the organization either by tailoring processes or improving communication, e.g. improved conceptual models, broader applicability of architecture artifacts, etc. While the methodology used for the analysis identified general categories, which is useful for exploratory research, it provided limited insight. This limitation is partially due to a lack of semantic understanding of the keywords that the authors self-selected.

Rather than using the author keywords, a semantic method to categorize the articles may be needed. One means to perform such categorization would be to generate ontology from the articles. Therefore, the authors are investigating the use of fuzzy ontology generation. It is postulated that by applying analytic techniques to the generated ontology, meaningful research trends can be revealed.

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