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SYSTEMS ANALYSIS AND DESIGN INNOVATIONS: A REVIEW OF RELEVANT RESEARCH 1990-2001

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Abstract

The current state of research in the area of systems analysis and design is examined from academic and practitioner perspectives. We survey relevant literature by identifying articles published from 1990 to 2001 in academic and practitioner journals concerning innovations in systems analysis and design methods and techniques. Our findings indicate a divide in the coverage of this topic in that practitioner-oriented literature has contributed more frequently to this topic area. We discuss possible reasons for this finding and call for increased research into systems analysis and design.

Introduction

The area of systems analysis and design (SA&D) is an integral part of the MIS curriculum in most universities and colleges. Though topic coverage may differ somewhat in content or length, an examination of textbooks (Hoffer et al. 2001, Kendall & Kendall 2001, and Whitten et al. 2001) reflects a consistent goal of teaching structured development. Though the topic of systems analysis is a key component of most MIS programs, our review finds that research and advancement in the area by academicians has been scant. The lack of advancement is reflected in current SA&D textbooks in that an examination of current editions of the above texts with their earlier edition counterparts reveals minor changes in coverage.

While the academic world appears stable, the practitioner world seems to be changing. The once dominant structured development methods have been found to be unsuitable for all circumstances. In the last 5-10 years, firms have experimented with techniques such as object-oriented development (Fayad & Marshall 1996, Fichman & Kemerer 1992), extreme programming (Beck 1999), and aspect-oriented programming (Elrad et al. 2001).

It appeared that textbooks were not keeping pace with trends in SA&D, but we were curious if journals also lagged, which we perceived as a deeper issue. Specifically, are MIS academics failing to consider the implications of SA&D trends, not just in teaching, but also in our research and understanding of systems development? With this study we examine the state of SA&D research and offer perspectives for future research.

Procedures and Methods

We conducted a comprehensive review of academic and practitioner journals to identify articles addressing new SA&D methods and techniques. We selected eight major academic and practitioner journals. We examined academic journals (*MISQ, ISR, JMIS, IEEE Transactions on Computers and IEEE Transactions on Software Engineering)* for the time frame of January 1994 thru October 2001. We anticipated that these journals would focus on examinations of new SA&D techniques, while practitioner journals would focus on presenting new techniques. As such, a topic could appear in a practitioner journal prior to empirical evaluation in an academic journal. Therefore, the practitioner journals (*IEEE Software, IEEE Computer* and *CACM)* were examined for January 1990 thru October 2001. We identified 127 articles concerning innovations in SA&D (see Table 1).

Table 1. Articles Concerning Innovations in SA&D

Source	Number of Articles
MIS Quarterly	2
Information Systems Research	10
Journal of MIS	10
IEEE Transactions on Computers	4
IEEE Transactions on Software Engineering	20
IEEE Software	32
IEEE Computer	12
Communications of the ACM	<u>37</u>
Total Atticles	127

Analysis of Research Trends

To identify trends in topics within the general area of SA&D, we classified the 127 articles by adopting the portion of Barki, Rivard, and Talbot's scheme (1993) that relates to SA&D. Our study deviates from earlier examinations (cf. Dickson & DeSanctis 1989) as we include non-empirical work. We include non-empirical work for two reasons. First, we were interested in identifying innovations in the area of SA&D, which may appear initially in non-empirical form (e.g., presentation of the technique or method). Second, although not necessarily distinct from the first, was a desire to include practitioner journals, may not follow the empirical format prevalent in academic literature. The Barki et al. (1993) scheme was modified to include three categories relevant to object-oriented development: OO analysis, OO development & design, and OO programming. The category key classifies the articles in 12 categories (Table 2).

Overall Trends

Upon sorting the articles according to the classification scheme, we clearly see that the majority of the work in SA&D falls within the practitioner literature. Only one-third (46) of the total articles (127) identified appear in the academic journals, the remaining two-thirds (81) are accounted for by the practitioner journals (refer to Table 3.). This majority in practitioner work occurs even though most of the journals come from the academic arena (5 academic journals to 3 practitioner). Further, limiting the time frame for the practitioner journals to include only 1994 to 2001 (consistent with the academic journals) reveals a 46 (43%) to 61 (57%) split, favoring the practitioner-based literature. Further isolation of the journals to the three key academic IS journals, *MISQ, ISR,* and *JMIS,* (Saunders 2001), identifies only 22 (17%) articles addressing innovations in SA&D. From Table 3, research into new SA&D techniques or concepts has not attracted much academic effort.

The reasons that the majority of SA&D publications appear in practitioner journals may be twofold. The first is the nature of the publication process within the two perspectives. Academic journals are refereed and generally require empirical work for support, a lengthy process. Practitioner journals may not require peer-review and empirical validation; an innovative approach and demonstration may be published. Second, academic journals also address broader MIS issues such as management and control. SA&D, a more technical area, appears to fall on the border of the issues covered by academic MIS journals, despite the inclusion of SA&D in MIS foundation articles (Barki et al. 1988, Dickson & DeSanctis 1993). *IEEE Transactions on Software Engineering* accounts for half of the academic articles.

Trends in Topics

An examination of the research topics addressed in the studies indicates broad coverage by both academic and practitioner based journals in the areas of "Information Requirements," "Data Modeling," and "Process Modeling". In contrast, the topic "Risk, Time, & Cost Estimate" appear exclusively in academic journals (3 articles). This could be attributed to the empirical nature of the topic, which lends to academic inquiry. On the other end of the spectrum, OO techniques and innovations appear primarily in the practitioner-based journals. These publications reflect the broad interest in OO development as evidenced by 28 articles devoted to the topic However, only 2 article addresses OO developing in the academic journals. This gap may be due to the

evolving nature of OO approaches. However, many firms are currently developing OO capabilities and it seems appropriate for academics to play a role in the evaluation, if not development, of such approaches. The topic of "New Design Concepts" has received little interest (4 articles) from either set of research. While new data modeling and process modeling techniques have been proposed from an academic and practitioner basis (40 articles).

Table 2. Category Key

Categories	Definition
Determination of Information Requirements	New techniques or methods of gathering information requirements from users, management, the environment, etc.
Software Testing & Evaluation	Methods of testing new software for bugs and design problems. Also evaluation issues associated with software design.
Risk, Cost, & Time Estimates	Methods and frameworks that can be used to estimate the risks & thus the cost & time elements associated with software development.
New Design Concepts	Software design concepts and issues. ("design reuse", "design methods")
New Conceptual Modeling Issues (Data Modeling)	Frameworks or schemes for areas not being considered in the current design process.
New Development Models or Frameworks (Process Modeling)	'New' development models or modifications to existing models (SDLC, Waterfall, etc.). Contrast existing models to find best practices.
Hardware & Software Design Linkages	Co-design between hardware and software, how to improve both hardware and software designs by simultaneously working on both.
Software Implementation Issues	Problems/solution associated with transitioning from design to actual implementation.
Object-Oriented Analysis Issues (OOA)	Issues related to analysis via OO techniques.
Object-Oriented Development & Design Issues (OODev)	Issues related to OO design & development. (examples: transitions from analysis to design, new development methods, software design techniques)
Object-Oriented Programming Issues (OOP)	OO programming methods and their effects on software development.
New Programming Methods	New programming methods that may affect the future of software design, includes "Extreme Programming", "Scripting", OO Programming (106)

Conclusions and Directions for Future Research

The trends indicate many research opportunities for both academics and practitioners. Academically, the area of OO development appears to be a fruitful area for future research. Given the lag with practitioner researcher, it seems imperative for academic research to address o OO development. Even now, OO design has begun to morph into the area of aspect-oriented programming and design (Elrad et al. 2001, and Netinant et al. 2001). "New Design Concepts and Techniques" received the least amount of interest from either group. As design is integral to SA&D, advances in this area could be beneficial.

Our study was motivated by a desire to examine how well academic research reflected or better yet, led the way, in the development of new approaches to SA&D. Unfortunately, examinations of new approaches to SA&D are rarely found in the academic journals. Instead, new concepts and techniques in SA&D have been promoted by the practitioner-based journals. Our review supports the criticisms that MIS research lags practice (Benbasat & Zmud 1999). However, redirecting research efforts into under-researched areas could remove some of the criticisms regarding the relevance of MIS research.

Table 3a. Systems Analysis Design Literature Sorted by Journal and Topic Content

Numbers refer to sources cited in the reference section, Table 3b. IEEE TC = IEEE Transactions on Computing, IEEE TSE = IEEE Transactions on Software Engineering, IEEE C = IEEE Computer, IEEE S = IEEE Software

Journal	Type	TOPICS					
		Determination of Information Requirements	Software Testing & Evaluation	Risk, Cost, & Time Estimates	New Design Concepts	New Conceptual Modeling Issues (Data Modeling)	New Models or Frameworks (Process Model)
		15	13	10	4	18	23
2	A			*2*			
MISQ				1, 7			
10	A	*1*		*1*		*3*	*5*
ISR		73		46		4, 66, 122	8, 23, 55, 68, 104
10	A	*4*		*1*			*1*
JMIS		2, 75, 78, 88		114			22
4	A		*3*				*1*
IEEE TC			21, 38, 115				37
20	A		*3*	*5*	*2*		*4*
IEEE TSE			16, 24, 70	12, 46, 74, 94, 110	76, 107		17, 51, 81, 96
32	P	*4*	*5*		*2*	*5*	*9*
IEEE S		43, 54, 72, 95	14, 34 ,59, 118, 123		30, 111	19, 63 ,65, 71, 113	3, 20, 77, 87, 98, 99, 103, 112, 127
12	P	*2*				*3*	*1*
IEEE C		6, 42				39, 48, 97	85
37	P	*4*	*2*	*1*		*7*	*2*
CACM		50, 62, 117, 119	40, 109	64		18, 36, 49, 56, 57, 101, 116	13, 126

Journal	Type	TOPICS					
		Hardware & Software Design Linkages	Software Implementation Issues	New Programming Methods	Object-Oriented Development Issues (OODev)	Object-Oriented Analysis Issues (OOA)	Object-Oriented Programming Issues (OOP)
		2	3	15	14	7	3
0	A						
MISQ							
0	A						
ISR							
4	A			*2*		*1*	*1*
JMIS				27, 67		120	108
0	A						
IEEE TC							
6	A		*3*	*1*	*2*		
IEEE TSE			26, 79, 100	52	15, 93		
7	P			*1*	*1*	*3*	*2*
IEEE S				124	61	44, 53, 60	11, 45
6	P	*2*		*3*	*1*		
IEEE C		69, 106		9, 25, 90	121		
21	P			*8*	*10*	*3*	
CACM				5, 28, 41, 58, 80, 84, 89, 91	10, 31, 32, 33, 35, 47, 86, 102, 105, 125	29, 82, 92	

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