Editorial: Design Science, Grand Challenges, and Societal Impacts

HSINCHUN CHEN, Editor in Chief TMIS, University of Arizona

It has been a great relief and pleasure for me to finally see the inaugural issue of the much-anticipated ACM *Transactions on Management Information Systems* (ACM TMIS) in print and distributed at the recent ICIS meeting in St. Louis, Missouri on December 12–15, 2010. Many thanks to those AEs, advisors, authors, colleagues, and friends who attended our little celebration party at the beautiful conference site, Hyatt Regency St. Louis at the Arch. In total, we had close to 80 guests who attended the party and I signed many copies of the "collector's edition" of this exciting inaugural issue! With this great beginning, I hope to see the continuous growth and success of this important ACM journal for the MIS community.

Inaugural Issue and WITS Participation. In addition to the ACM TMIS Inaugural Issue Party, I was also invited to present in a Meet-the-Editor panel organized by WITS (Workshop on Information Technologies and Systems). Other panelists included: Dr. Varghese Jacob of *Information Technology and Management*, Dr. Kalle Lyytinen of the *Journal of AIS*, Dr. Sandra Slaughter of *Management Science*, and Dr. Asoo Vakharia of *Decision Sciences*, all senior and distinguished colleagues who have done much for the MIS community. I was able to get very enthusiastic responses from the packed audiences by introducing ACM TMIS and distributing our very "fresh" first issue (and I autographed a few more copies)! As the WITS community represents much of the active technical research in MIS, it has always been a target community for ACM TMIS, which, by design, favors high-impact and relevant design-science-oriented research. At WITS 2009 in Phoenix, Arizona I was invited by Dr. Paulo Goes to introduce the new ACM TMIS journal at the WITS luncheon. Subsequently we were able to make arrangements with the help of Drs. Daniel Zeng, Paulo Goes, and Steve Miller to invite three highly ranked papers from WITS and two best-paper nominees from ICIS 2009. I am glad to report that these papers have all appeared in either the first or second (current) issue of ACM TMIS. With the continued support of the WITS community and the help of Dr. Ray Patterson, for WITS 2010 we will invite 3–4 papers from some of the highly rated WITS design science papers. In addition to ACM TMIS, the *Journal of AIS* will invite methodological papers from WITS 2010 and the *Information*

Technology and Management journal will invite papers of relevance to management of IT. For WITS 2011 in Shanghai, China, I am glad to report that the Program cochair Drs. Roger Chiang and Andrew Gemino have tentatively agreed to create a larger pool of best WITS papers for ACM TMIS. Overall I am truly thankful and appreciative of the overwhelming support from the WITS and MIS community over the past year.

Design Science and the AIS Basket of 6+2. Over the past two months I have also participated in some interesting discussions of relevance to the "AIS Senior Scholars." As some of you might already know, the AIS/ICIS Senior Scholars include (http://home .aisnet.org/displaycommon.cfm?an=1&subarticlenbr=866):

—All Leo and AIS Fellow Awards winners,
—All current and former Presidents of AIS,
—All current and former Editors-in-Chief of the journals listed in the AIS basket of six
  journals, plus *Journal of Strategic Information Systems* and *Journal of Information
  Technology*, and
—All current and former Conference Chairs and Program Chairs of ICIS

In the past the list was even more exclusive, including only ICIS conference and program chairs and EICs of MISQ and ISR. The invitation-only Senior Scholars Consortium (SSC) was formed and has been held at ICIS since 2004. The intention for forming this group is good, as stated at the AIS Web site.

> "The main purpose of the SSC is to provide a forum for senior scholars to discuss important issues that are (or will) affect the IS discipline. Topics for discussion have included the domain of the IS discipline, how the number of A* (high quality) publications published by the IS community as a whole might be increased, and the current state of IS departments around the world. As many of the senior scholars have the ability to influence deans, promotion committees and other colleagues, the SSC hopes that it can play a positive role both within and beyond the IS field."

The definition of the AIS Senior Scholars clearly is more restricted than our typical notion of senior scholars in academia and has thus caused some tension in the community. Due to my capacity as the ICIS 2009 Program Co-Chair, I have become an AIS Senior Scholar recently (after receiving an unexpected email invitation). However, because of the past history of our discipline and the composition of the existing AIS Senior Scholars, I have to admit that I am one of the very few design science researchers among the predominantly behavioral AIS Senior Scholars. (I learned that quickly from the email communications and debates in the AIS Senior Scholars listserv.)

One of the activities sponsored by the AIS/ICIS Senior Scholars has caused significant discussions recently – the AIS Senior Scholars' Basket of Journals. According to the official Web site:[1] "This list was adopted from a formal statement by the Senior Scholars Forum as of 23 April 2007 and is intended to provide more consistency and meaningfulness to tenure and promotion cases." It is the hope of the AIS Senior Scholars that by including more high-quality journals, some schools will be more inclusive in their P&T evaluation instead of counting only the top-two MIS journals (MISQ and ISR). These are the original six journals in the list, in alphabetical order.

—*European Journal of Information Systems* (EJIS)
—*Information Systems Journal* (ISJ)
—*Information Systems Research* (ISR)
—*Journal of AIS* (JAIS)
—*Journal of MIS* (JMIS)
—*MIS Quarterly* (MISQ)

---

[1]http://home.aisnet.org/displaycommon.cfm?an=1&subarticlenbr=346.

Recently two more journals were added (but with a lower and fuzzier designation), thus the AIS Basket of 6+2 Journals.

—*Journal of Strategic Information Systems* (JSIS)
—*Journal of Information Technology* (JIT)

In a recent survey of AIS members (I believe more detailed survey results will be reported by AIS shortly), there is a general positive sentiment towards the AIS Basket of Journals. The Basket has appeared to save more jobs than it has destroyed. North American and Australian respondents have expressed important benefits. Seventy-two percent of respondents are in favor of the Basket. However, some negative comments have also been expressed, for example:

—Inclusion of two surprise journals reduces credibility.
—The list was biased by the makeup of the Senior Scholars. The few should not decide for the many.
—The Basket is the worst of all worlds; not strong enough to elevate journals and disadvantages those journals not making the list.

While the discussions and debates about the Basket will continue in the future, I do sense potential division among the MIS community due to our respective academic disciplines and inherent biases.

Although I am considered an AIS Senior Scholar now, my opinion of the list is very different (so you can consider this my Minority Report, following the P&T tradition in some schools). Among the eight journals in the list, three are well known and well regarded, that is, MISQ, ISR, and JMIS. However, the other five journals are not as well recognized as the first three, thus reducing credibility for the entire Basket. What is perhaps much more important is that the Basket may reflect a long-standing bias of considering behavior research as "mainstream MIS," as stated in the official AIS Senior Scholars' Basket of Journals Web site:[2]

> "The Senior Scholars *focused on behavioral, business-oriented IS research, which might reflect a majority*, but is not a universal model that fits (or even should fit) all schools. It strengthens our discipline to integrate our knowledge with other fields, and provides more choices for students, so interdisciplinary work should be encouraged."

This statement of behavior research being a majority doesn't reflect the current composition of MIS scholars from the behavioral (organization, strategy, social), mathematical modeling (management science, economics), and design science (computer science, HCI) communities in different parts of the world. Some have also questioned the reason for omitting the well-regarded design-science-oriented journals including several IEEE and ACM Transactions, as well as *Decision Support Systems* journal, which has been managed by one of our most respected community founding fathers, Dr. Andrew Whinston, for years.

Take DSS as an example. As shown in Table I, DSS has consistently been ranked high among MIS journals as shown by its ISI Impact Factors (IF). In 2009, DSS had the second highest IF (2.622), after the leading MISQ (4.485), and higher than *Management Science* (2.227), JMIS (2.098), ISR (1.792), and the *INFORMS Journal on Computing* (1.318). (I thank Dr. Asoo Vakharia for providing these statistics based on his briefing at the WITS panel.) The significant rise in IF may be partly due to the high-quality design-oriented research that DSS has favored, encouraged, and published over the past few years. Conversely, we have not seen significant design-oriented research published in other major MIS journals, although progress has been made in recent years.

_____

[2]http://home.aisnet.org/displaycommon.cfm?an=1&subarticlenbr=346.

Table I. Recent Impacts Factors of Major MIS Journals

Journal (alphabetical order)	2009 IF	2008 IF	2007 IF
Decision Support Systems	2.622	1.873	1.119
Information Systems Research	1.792	2.261	2.682
INFORMS Journal on Computing	1.318	1.041	0.907
Journal of MIS	2.098	2.358	1.867
Management Science	2.227	2.354	1.931
MIS Quarterly	4.485	5.183	5.826

In an interesting recent bibliometric analysis paper by Holsapple and O'Leary [2009], the authors analyzed the actual published papers of tenured professors in 31 top private and 31 top public universities in the USA (a total of 171 IS faculty members). Their approach relied on analysis of the actual publishing behaviors of successful IS scholars over a long period of time (1980–2006), instead of gathering the opinions and perceptions of a small group of scholars (such as the AIS Basket). The following journals are consistently ranked in the top six using various publication metrics (intensity and breadth) among both private and public universities: JMIS, *Management Science*, *Communications of the ACM*, DSS, MISQ, and ISR. None of the other AIS Basket Journals is ranked in the top 15 of the list, possibly because they are either too new or too narrow. The MIS field is clearly more diverse and balanced (behavior, design, and modeling) than what the Basket suggests.

Design Science and A Response from our German Colleagues. Such discipline tension has also risen to the surface recently in the European MIS community. In the Österle et al.'s "Memorandum on Design-Oriented Information Systems Research" in EJIS (2010), 10 prominent scholars argued convincingly the importance of design-oriented research (in addition to behavior research) and proposed principles of design-oriented IS research, similar to those proposed in the seminal design science article of Hevner et al. [2004], published in MISQ in 2004. The memorandum was also supported by 111 full professors from the German-speaking scientific community. One of the comments made in the memorandum has stirred up much interest and debate:

> "The [English IS] journals most relevant are based in the Anglo-Saxon scientific community, predominantly following behaviorism as the guiding research paradigm."

Many of my respected MIS colleagues in Asia have expressed similar sentiments to me in person; however, they have not been as direct or open as our esteemed German colleagues. In Asia and possibly in Europe, design and engineering are highly valued (more so than "explanation" research); however, the respect and recognition for such design-oriented research has not been found in abundance in major MIS publications until now.

In an opinion piece that shortly followed in EJIS, Baskerville et al. countered in "A Response to the Design-Oriented Information Systems Research Memorandum" by presenting examples of highly regarded design science research in major MIS journals (including those of Hevner and Nunamaker) and arguing that:

> "This is simply not the case in the actual review practices of the journals we represent, namely EJIS, JAIS, ISR, and MISQ."

The authors (editors of four major MIS journals) also included a table with information about design science expertise in their respective editorial boards, from 20% to 37% (statistics that are somewhat hard to verify). The authors also defended the fact

that some behavioral IS researchers publish regularly in top journals and explained that the reason was because they are "innovative, and pointedly, resilient." Despite some truth in these statements, I am afraid that the perception and reality remain the same: there is a strong bias towards the behavioral paradigm in MIS that has developed over the years. I don't believe there is purposeful manipulation. It reflects mostly the historically larger composition of behavioral scholars in the MIS field at the early stage of our discipline. However, the IT and MIS landscape has changed dramatically over the past decade. There have been tremendous developments and opportunities for performing high-impact, macro-level (more on this shortly) design-oriented research. Our community has seen a great infusion of scholars working in many exciting Web-based, e-commerce-relevant, and data-intensive design science applications. Similarly, the market place, the MIS curriculum, and the student population (in particular, BS and MS) have also demanded hands-on, technically solid, business-relevant education and training for our students. For example, most of the BS and MS students at the University of Arizona are learning through design/system/information-centric courses such as Database, Data Mining, Web Computing, Business Intelligence, System Analysis and Design, Project Management, Security Informatics, etc., as they prepare for their careers as IT and e-commerce system developers, project managers, and business consultants for many different organizations.

Despite these debates, we have seen positive developments in the MIS community in recent years. The need for diversity and inclusion in the MIS community has long been recognized [Dennis et al. 2006]. In Dr. Detmar Straub's MISQ Editor's Comments in 2008 he explained clearly his effort to expand from the longstanding MISQ policy for explanation research paradigm to include design science research favored by the WITS community and the IS economics work advanced by the WISE community. Some tangible steps have been taken. Two new Senior Editors (out of 19 SEs) were added to the MISQ Board: Dr. Alan Hevner representing design science and Dr. Chris Kemerer representing IS economics (who has since stepped down). Several new special issues with a design science orientation have been promoted actively by MISQ, including: "Design Science in the Information Systems Discipline" by March and Storey [2008] and "Business Intelligence Research" by myself along with Chiang, and Storey (forthcoming). We wholeheartedly applaud such efforts and wish to see these kinds of developments accelerate.

While MISQ passed its 30-year milestone in 2008, ISR has also recently reached the 20-year milestone [Sambamurphy 2010; Swanson et al. 2010]. An excellent recollection article was written by the past Editors, including Drs. Burton Swanson, John King, Izak Benbasat, and Chris Kemerer, all well-known and respected scholars in MIS. While the journal has successfully created another quality outlet for the MIS community and has strived to be inclusive of all research approaches, it still remains to be seen whether the journal can truly attract high-quality, innovative design science research (like DSS), instead of favoring traditional (high-quality, but similar and less impactful) explanation-based research. Despite the INFORMS (modeling) root for ISR, most of the past and current ISR Editors over the past two decades have been behavior researchers in the North American universities. The perception for potential behavioral favoritism has only been amplified by the traditionally behavioral EIC for MISQ and the recent biased effort in the creation of the AIS Senior Scholars' Basket of 6+2 Journals, as discussed earlier.

Clearly, Rome was not built in a day. Much effort is still needed to change some outdated MIS perceptions and begin to foster a vibrant and diverse MIS community. With the new ACM TMIS journal, we hope to add another quality publication outlet to the MIS community (but only time will tell whether we will be successful or not). As stated in the ACM TMIS Charter & Scope:

> "The journal welcomes innovative, high-impact papers on a full range of MIS and information technology (IT)-related research areas. . . Design science and system-oriented papers are especially welcome."

Considering the abundance of high-quality MIS publication outlets for behavior research, the ACM TMIS will favor design-oriented research at the early stage of our journal development. I hope that in the not-so-distant future such an emphasis will not be needed. I also hope to see other top MIS journals continue to break down the discipline barriers by encouraging fair and equal representation (in terms of SEs, AEs, and accepted papers) of the three MIS approaches: behavior, design, and modeling.

MIS Grand Challenges and Societal Impacts. Another interesting item that has received attention among the AIS Senior Scholars recently concerns the MIS Grand Challenges. This discussion is critical and timely as Grand Challenges can often help define a discipline and its existing knowledge and help identify research directions that can make long-lasting societal impacts. Some of the most notable scientific Grand Challenges accomplished over the past four decades have included, for example, landing a man on the moon (1969–1972) and mapping the human genome (1985–2006). In a more recent announcement by the prestigious National Academy of Engineering [2008], the following fourteen Grand Challenges for Engineering have been identified.[3]

—Make solar energy economical
—Provide energy from fusion
—Develop carbon sequestration methods
—Manage the nitrogen cycle
—Provide access to clean water
—Restore and improve urban infrastructure
—Advance health informatics
—Engineer better medicines
—Reverse-engineer the brain
—Prevent nuclear terror
—Secure cyberspace
—Enhance virtual reality
—Advance personalized learning
—Engineer the tools of scientific discovery

Clearly, most of these areas are highly relevant to the future of society and the world. Some areas will also rely heavily upon advances in Information Technology (IT). In a recent email discussion and brainstorming session among the AIS Senior Scholars, after looking at many Grand Challenge examples in other fields, the following areas have been suggested (a more detailed report may follow shortly).

—IT/MIS construct and theory development
—IT value and societal impact
—IT employment
—IT outsourcing and supply-chain
—IT and education
—Health informatics
—Security informatics
—Business intelligence and analytics
—Green IT

This list is not exhaustive and careful thought needs to be put in to articulate the vision. However, these potential MIS Grand Challenges help illustrate the need for diverse

---

[3]http://www.engineeringchallenges.org/cms/challenges.aspx.

and balanced MIS methodologies and approaches, from behavior (e.g., for IT theory, value, education) to design and modeling (e.g., for IT supply-chain, health informatics, security informatics, business intelligence). Ultimately our discipline will be judged based on the tangible societal impacts that we have made, not the number of citations generated or the number of MIS faculty tenured.

As a design science scholar and a seasoned PI of many National Science Foundation grants (40 NSF grants totaling $15M over the past twenty years), I have always been impressed with a diagram that is frequently used in important government policy assessment meetings. In the National Research Council report, entitled "Assessing the Impacts of Changes in the Information Technology R&D Ecosystem: Retaining Leadership in an Increasingly Global Environment" [2009], the IT R&D Ecosystem diagram (shown in Figure 1) includes many successful examples of government-sponsored IT (i.e., Computer Science) R&D in the creation of commercial products and industries, from the earlier years of timesharing, client/server computing, and workstations, to the more recent successes in data mining, WWW, and broadband technologies. Each success case is illustrated in the timeline with the major initiating universities (with government funding in basic research), subsequent industry R&D and products, and the resulting final $1 billion market (a very significant and tangible outcome). For example, the success of the WWW was attributed to research at CERN (European Organization for Nuclear Research) and the UIUC (University of Illinois at Urbana-Champaign). Subsequently successful companies such as Alta Vista, Netscape, Yahoo, and Google were created. The Google research was also credited to the NSF Digital Library Initiative (DLI) program, which I was also personally involved in as a co-PI of the UIUC DLI project from 1994–1998. My personal design science research at the University of Arizona has also resulted in the successful adoption, commercialization, and exit of the COPLINK law enforcement information sharing and crime mining system, which has revolutionized public safety IT, and is often quoted as "the Google for Cops."[4] The many successful and tangible examples included in the diagram have clearly given the Computer Science discipline much respect and recognition in academia, industry, and society. Despite some recent critiques associated with Computer Science (e.g., overproduction of graduates, overemphasis on short-term research and conference publications, lack of new and critical fundamental breakthroughs in light of the heavy amount of recent IT funding, etc.), the discipline has demonstrated its ability to produce high-visibility and high-impact research that influences all facets of society.

I often fear that there is not much tangible societal impact that our MIS community has collectively made over the past 30 years. Although many attempts have been made that call for high-visibility and high-impact MIS research [Agarwal and Lucas 2005; Chen et al. 2011], the results have been less than stellar. As Agarwal and Lucas cautioned [2005]:

> "The impact of IS research has arguably been relatively small, especially compared with research in fields like finance with its capital assets pricing model, efficient market hypothesis, and options pricing model. Our fear is that the information systems discipline may not survive in academia."

A few examples have been quoted as unique MIS contributions, including: Dr. Jay Nunamaker's Group Decision Support Systems (GDSS) research and the well-known Technology Acceptance Models (TAM) [Agarwal and Lucas 2005; Baskerville et al. 2010]. Although impressive, these works clearly have not had the same impact as any that are listed in the IT R&D ecosystem diagram. I am afraid that MIS research has contributed mostly to the successful P&T of professors, instead of making a substantive and measurable impact on the society as a whole.

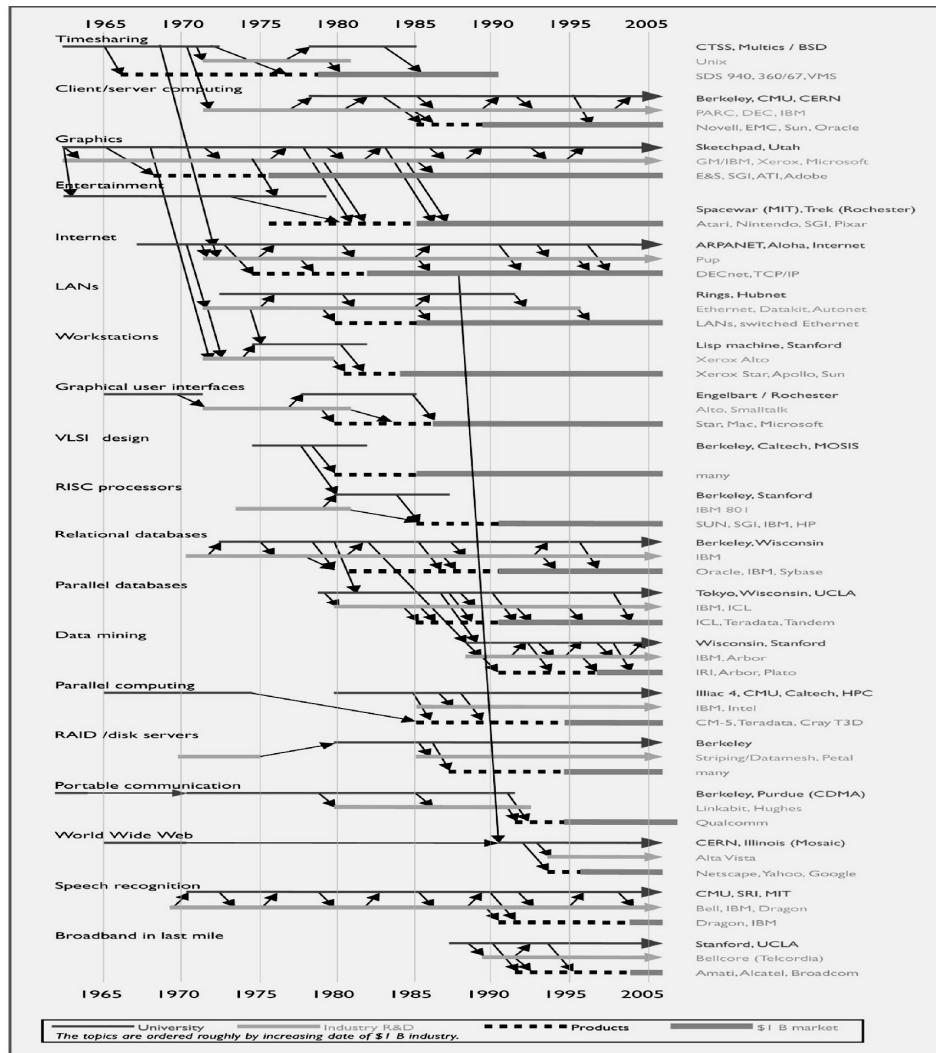[4]http://en.wikipedia.org/wiki/Hsinchun_Chen.

Fig. 1. The IT R&D ecosystem: Examples of government-sponsored IT R&D in the creation of commercial products and industries (source: reprinted from National Research Council, *Innovation in Information Technology,* The National Academies Press, Washington, D.C., 2003. Updated and adapted from figure originally published in National Research Council, *Evolving the High Performance Computing and Communications Initiative to Support the Nation's Information Infrastructure,* National Academy Press, Washington, D.C., 1995).

Agarwal and Lucas [2005] argued that instead of the microfocus for IS research (e.g., adding one more variable to a popular model like TAM), a significant portion of our research should be macrostudies of the impact of IT (focusing on organizations, environments, and strategy). Although I agree with the general assessment of the state of the MIS community (five years have passed since the publication of the paper and we have seen even more MIS department closures and enrollment and faculty positions decline) and the opportunities for conducting macro-level MIS research, I believe the direction for studying only the impact of IT is misplaced. Such an explanation and behavior-based perspective will significantly hamper the potential impacts that the MIS community

can collectively make in the future. Design-oriented MIS research targeting actual high-visibility, high-impact macro-IT applications (i.e., "macrodesign science") would bring significant attention and rewards to our community, from healthcare informatics to security applications, and from business intelligence to global supply-chain. Instead of adopting the micro approach (focusing on specific techniques and algorithms) often used by the Computer Science community, the MIS community can potentially offer more holistic, multidisciplinary, application-driven, and business-centric approaches and solutions for many emerging, high-impact organizational and societal problems. This kind of research calls for collaborative, multidisciplinary teams of design, modeling, and behavior researchers. Instead of studying only what other IT researchers and practitioners have designed and developed (a traditional behavioral paradigm), we should become a leading force in bringing unique innovations, solutions, and knowledge to society. As echoed by our German colleagues in their "Memorandum on Design-Oriented Information Systems Research" [Österle et al. 2010]:

> "...German speaking countries and Scandinavia, who were proud to graduate students with fundamental knowledge concerning the design and implementation of innovative business solutions that both business and public administration demanded. Also, these researchers could cite numerous examples where scientific results produced in their field had successfully been transferred to various areas in society and business. These examples are founded in the close collaboration between scientists and business, as well as in the unity of research and teaching... In the Anglo-Saxon world, the corresponding research area to the German term 'Wirtschaftsinformatik' (recently translated as 'business and information systems engineering') is IS research. Rooted in the business school culture, it is based on a behaviorist approach. Rather than aiming at the design of innovative IS, it focuses more on observing IS characteristics and user behavior..."

Although explanation-based research has a long history and important role in the MIS community, it is my belief that much of the future high-visibility, high-impact IT research opportunities are surrounding the "design and implementation of innovative business solutions," the essence of "macrodesign science" MIS research. Some of the explanation-based research could also be used to predict or inform better information system design and business solutions. We have already seen many examples of successful high-impact, information-centric companies. While IBM was founded as a hardware company and Microsoft as a software company, new emerging Internet powerhouses such as Google, Yahoo, Amazon, and Facebook are examples of the new "information businesses" that built upon successful business systems/models and valuable information/contents. (I have been teaching a "Web Computing and Mining" graduate-level course at the University of Arizona for the past several years and much of the materials on designing such new-style "information businesses" using Web services, mashups, cloud computing, and data mining technologies can be found at the class Web site.[5] I am afraid that we may be missing a once-in-a-lifetime opportunity for our discipline during this period of "data deluge" (a term coined by *The Economist*) [2010] as businesses, governments, and society begin to explore the potential of business intelligence and advanced analytics. Design-oriented MIS research has much to contribute to society through our current and future research and teaching.

In closing, I present here my New Year's resolutions for 2011. I wish to see a more vibrant and diverse MIS community in the near future. I wish that high-visibility and high-impact macrodesign research and education will continue to prosper in our community. And lastly (and most importantly), I hope you will consider submitting your novel and high-impact research (design, modeling, and behavior) to ACM TMIS,

---

[5]http://ai.eller.arizona.edu/mis510/.

as we work together to build a respected and high-impact MIS community for the next generation.

REFERENCES

ACM Transactions on Management Information Systems (ACM TMIS). 2011. ACM TMIS homepage. http://tmis.acm.org/

AGARWAL, R., H., AND LUCAS, C. J. 2005. The information systems identity crisis: Focusing on high-visibility and high-impact research *MIS Quart.* 29, 3, 381–398.

AIS SENIOR SCHOLARS CONSORTIUM. 2011. AIS senior scholars consortium homepage. http://home.aisnet.org/displaycommon.cfm?an=1&subarticlenbr=866

BASKERVILLE, R., LYYTINEN, K., SAMBAMURTHY, V., AND STRAUB, D. 2010. A response to the design-oriented information systems research memorandum. http://www.palgrave-journals.com/ejis/journal/vaop/ncurrent/full/ejis201056a.html

CHEN, H., CHIANG, R., AND STOREY, V. 2011. Business intelligence research. *MIS Quart.* To appear.

COPLINK. 2011. COPLINK research. http://en.wikipedia.org/wiki/Hsinchun_Chen

DENNIS, A. R., VALACICH, J. S., FULLER, M. A., AND SCHNEIDER, C. 2006. Research standards for promotion and tenure in information systems. *MIS Quart. 30*, 1, 1–12.

HEVNER, A. R., MARCH, S. T., PARK, J. AND RAM, S. 2004. Design science in information systems research. *MIS Quart. 28*, 1, 75–105.

HOLSAPPLE, C. AND O'LEARY, D. 2009. How much and where? Private vs. public universities' publication patterns in the information systems discipline. *J. Amer. Soc. Inf. Sci. Technol. 60*, 2, 318–331.

MARCH, S. T., AND STOREY, V. 2008. Design science in the information systems discipline. *MIS Quart. 32*, 4, 725–730.

NATIONAL ACADEMY OF ENGINEERING GRAND CHALLENGES FOR ENGINEERING. 2008. National academy of engineering grand challenges for engineering homepage. http://www.engineeringchallenges.org/cms/challenges.aspx

NATIONAL RESEARCH COUNCIL OF THE NATIONAL ACADEMIES. 2009. Assessing the impacts of changes in the information technology r&d ecosystem: retaining leadership in an increasingly global environment. http://sites.nationalacademies.org/CSTB/CompletedProjects/CSTB_042215

ÖSTERLE, H., BECKER, J., FRANK, U., HESS, T., KARAGIANNIS, D., KRCMAR, H., LOOS, P., MERTENS, P., OBERWEIS, A., AND SINZ, E. J. 2010. Memorandum on design-oriented information systems research. *Euro. J. Inf. Syst.*, 1–4.

SAMBAMURTHY, V. 2010. Editorial notes. *Inf. Syst. Res. 21,* 4, 661–674.

SENIOR SCHOLARS' BASKET OF JOURNALS. 2011. Senior scholars' basket of journals homepage. http://home.aisnet.org/displaycommon.cfm?an=1&subarticlenbr=346

STRAUB, D. 2008. Thirty years of service to the IS profession: Time for renewal at MISQ? *MIS Quart.* 32, 1.

SWANSON, E. B., KING, J. L., BENBASAT, I., AND KEMERER. 2010. The early years of ISR Recollections of the editors. *Inf. Syst. Res. 21,* 4, 665–674.

THE ECONOMIST. 2010. The data deluge: Businesses, governments and society are only starting to tap its vast potential. February 25.