COMMUNICATIONS OF THE ICISA

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Feature: MIS Education and Career in Taiwan

In This Issue:

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International Chinese Information System Association (ICISA)
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International Chinese Information Systems Association (ICISA)

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President's Message

David Chou

West Texas A&M University

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It is my honor to serve as the President of the ICISA this year. We have grown every year. Every officer of the ICISA works hard to serve our members and the Association. I would like to thank to our officers this year. They are Dr. Eldon Y. Li - President-elect and Editor-in-Chief of the Communications of the ICISA, Dr. Minder Chen - VP Publications, Dr. Pai-Cheng Chu - VP Public Relations, Dr. Ruth C. King - VP Finance, Dr. Joseph Wen - VP Membership, Dr. Wai-Man Cheung and Dr. Binshan Lin - Contributing Editors. I would also like to appreciate the supports from our directors Dr. Bernard Han, Dr. Binghui Huo, Dr. Ray Tsai, Dr. Joseph Wen, and Dr. Yufei Yuan.

Thanks to Dr. Eldon Y. Li for creating The ICISA home page and online publications of the ICISA. Our members can visit this home page at the following URL: <http://misnt.calpoly.edu/ICISA>. Please pass this information to your friends and colleagues and recruit them for our Association.

I attended the ACME 1997 conference in Las Vegas. We also held the ICISA officers meeting in this conference. The main purpose of this meeting was to revise the ICISA Bylaws. One of the major revision was the formation of the board of directors. The new Bylaws requests that members of the board of directors to be three ex-Presidents of the nearest terms, the current President and the President-elect. It will be effective in 1998. Please check our home page for the complete statements of our Bylaws.

We are one of the sponsors for the ACME conference. The ACME stands for The Association for Chinese Management Educators now. Next year's conference will be held in Vancouver, Canada. Please read the conference announcement in this issue.

Thank you very much for being part of our Association. We need your continuous support to make our Association grow. Please send your ideas, suggestions, and news to Dr. Eldon Li or me. Also, the elections for 1998 officers is nearby. Please nominate someone you feel appropriate. Thanks again for your support.

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President-Elect's Message

Eldon Y. Li

Cal Poly, San Luis Obispo, U.S.A.

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It is a great pleasure for me to serve as the President-Elect and Editor-in-Chief for the ICISA. During my tenure, I intend to increase our services to the ICISA members at large and to improve the communications between the officers and the members. My intuitive action is to create a permanent web site (please visit http://misnt.calpoly.edu/ICISA) and develop homepages for the ICISA. The homepages contain the bylaw of the ICISA. In addition, all names of the officers since the first day of the Association are listed chronologically. A member directory is created and updated regularly. All officers and members having e-mail or www addresses are hyperlinked to facilitate communications. Most past issues of the Association's newsletters are manually reformatted and converted to allow on-line access. The goal is to make every issue accessible through the Internet. Most significant is a homepage that provides members or prospects with an on-line membership application, renewal, and update capability. These homepages serve the roles as a historian, a spokesman, a custodian, and a messenger for the Association.

As the President-Elect, my duty shall be in charge of research and technical activities according to the ICISA bylaw. However, the Association cannot operate without members support. Many of our members did not pay their membership fees while even more Chinese MIS faculties did not join the Association. We would like to attract and retain more members through the use Internet services. If you really value such services, please give us a pat on the back and join us as a member. To do so, please visit our homepage at http://misnt.calpoly.edu/ICISA/memberspp.htm. The membership fee is $20 per year. Depending on your location, you may send your payment to Dr. Houn-Gee Chen in Taiwan, Dr. Ming-Te Lu in Hong Kong, or directly to our VP-Finance, Dr. Ruth King (rc-king @cba.uiuc.edu), in the U.S. I thank you very much for your continuous support to the Association.

One final note is that we want to help a new faculty/ doctoral student members to grow in the information system field. We need to continue exchanging and sharing information and/or ideas on job market, research trend, publication availability, and conference announcements with them. There was a Doctoral Student Club initiated and operated by Fu-Ren Lin at University of Illinois and Yi-cheng Tu at MIT. Now that they are no longer students, we need to find a volunteer to organize and oversee this club. If you have any suggestions or comments, please contact our President, David Chou (dchou@ wtmail.wtamu.edu), myself (eli@calpoly.edu), or any of our VP's. Once again thank you very much for your support.

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Editor's Message

Eldon Y. Li

Cal Poly, San Luis Obispo, U.S.A.

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It has been a very difficult task for me serving as the Editor-in-Chief of this publication. I have changed its format to make it more professional. Yet, the most difficult task is to publish quality articles. Ethically speaking, as the E-I-C I should not publish any of my work. However, I did it for two good reasons: 1) there are not enough articles to be published in this issue, and 2) performance criteria for appointment, tenure, and promotion are far too important for the junior faculties to miss.

In this issue, Michael J. Shaw shares with us his experience with Taiwan's emerging national information infrastructure (NII) project during his 6-month visit as a Fulbright scholar. Houn-Gee Chen, assisted by devoted students, compares the current curricula of Taiwan's undergraduate MIS programs and provide the profile of MIS faculties in Taiwan. Eldon Y. Li describes a structured process used by an MIS department in Taiwan to develop a criterion document for appointment, tenure, and promotion evaluation. Jinsheng Roan and Chiu-Yen Lee survey 500 companies in Taiwan to identify the key issues of accounting information systems as perceived by 1000 accounting executives. Finally, Joseph H. Wen, David C. Chou, and David C. Yen explain the concept of data warehousing and identify the issues behind the implementation of a data warehouse.

I would like to thank the authors who submitted articles for this issue of the Communications of the ICISA. Special thank you goes to our President, Dr. David Chou, for printing and mailing this issues to our members and friends. I also thank you, our readers, for your continuous support to this organization and this publication. I look forward to receiving your article submission or any feedback about this publication in the future.

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Sharing Moment

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Wiring Formosa

by

Michael Jeng-Ping Shaw
University of Illinois at Urbana-Champaign, U.S.A.

David Chou asked me to write an article reflecting upon my six-month visit in Taiwan in the spring of this year. As many of you may know, I received a Fulbright research fellowship and took a sabbatical leave from January to July. I spent most of my time during that period at the National Taiwan University as a visiting professor. It was a wonderfully rewarding experience, both personally and professionally. But where should I begin? I told David I could only do an informal article due to the busy travel schedule ahead. To that end, I decided to focus on my observation of the development of National Information Infrastructure in Taiwan.

The proposal I submitted to the Fulbright Foundation was for studying the emerging national information infrastructure (NII) on the international level and its potential impact. After arriving in Taipei in January, it was clear to me that NII was very much in the spotlight of attention from Taiwan's government and the general public. For one thing, it was in the news media daily and there was a lot of hype centered around the idea of a global virtual community connected by the internet.

The Foundation for Scholarly Exchange (FSE), which overlooks the Fulbright program in Taiwan, was setting up its own WWW homepage for distributing educational program information. I developed a good relationship with the staff of FSE and its director, Dr. Wu, for whom I have a great deal of respect. Through the Foundation I got to meet a young group of internet "visionaries" consisting of publishers, reporters, managers, and professors. The group met regularly over box lunches at the FSE. Ideas were flying in these meetings, and there was a great sense that everything was possible. I really enjoyed those meetings, and through one of the members of the group, I got to know the coordinator of the NII project team. I was interested in collecting information for the course I taught at NTU, but he kindly invited me to attend their monthly NII meetings as an observer.

I was very impressed by the NII project team, which had the difficult task of coordinating various departments such as the Ministry of Education, the Bureau for Telecommunications, the Institute for the Information Industry, the Center for Supercomputing Research, etc., to promote NII. I found the NII project team to be very well informed of the issues both in terms of enabling technologies and the necessary policy. They painstakingly developed the agenda and coordinated the implementing efforts. It was a turbulent time in Taiwan. Politically the presidential election, the first democratic one in Taiwan's history, was approaching. And there were the military threats from China. Yet everyone involved in the NII project seemed to be incredibly focused under the circumstances to push ahead, determined to finish the first stage of the NII plan by the time the newly elected president took office. (Mr. S. Yang became the chair of the NII committee in the new cabinet after the election.) Taiwan may have appeared to be in great jeopardy from foreign press reports at that time, but I generally didn't sense any sign of panic throughout my stay. That spoke volumes for the courage of the people there.

Although a widely quoted estimate put the internet user population in Taiwan to be around 200,000 to 400,000, most of the users are still either affiliated with universities or research institutions. I have very high regards for my colleagues at the Information Management Department of NTU. Their research and courses are all world-class, as evident by students in my electronic commerce class, who, among other things, were perfectly comfortable with using JAVA, CGI, and any new language/system when necessary. I think that technical expertise is a big plus and should be translated into the strength of Taiwan in her developing the national information infrastructure. That strength certainly has already been demonstrated in her booming information industry.

In terms of laying out the networks for the residential buildings -- i.e., wiring the "last mile"-- the results are still mixed. A great deal of effort has been spent on setting up more ISDN networks and on developing new high-speed transmission lines using ATM and frame relays. Yet the prices are still relatively high. That is the classic IT investment issue concerning network externalities (i.e., computer networks benefit from a larger user base and require substantial initial investments because of the lack of users in the beginning) and there were considerable debates during the NII meetings on the pricing policies. Taiwan has been going through the process of deregulating her telecommunications industry this year. The state-owned telecommunications company was splitting up into two in early summer, similar to the recent breakup of AT&T. In that sense, the more competitive environment and market forces may help move the pricing to a more reasonable level.

It is my personal view that, for Taiwan's general public to truly embrace internet, the development, and the successful delivery, of more interesting contents and killer applications will be the key. " If you build it, they will come" may work for building the field of dreams, but it would not work for building NII simply because of a lack of attractions. The recent web survey shows that Taiwan is still in the third tier of countries in the world in terms of the total number of host computers connected to the global internet.[1] (The survey can be found at http://www.genmagic.com/Internet/Trends/slide-l0.html). Therein lies the difficult challenge facing Taiwan's NII project. One the other hand, I noticed a very dynamic host of start-up companies sprung up in the internet arena. One of the students in my class was starting an internet café. My wife while in Taipei subscribed to an internet access provider to continue her software development work for the NCSA (National Center for Supercomputing Applications; Crystal is working on visualization and storm simulation tools) at Illinois. Yes, the service could have used some improvements, but these start-ups are the seeds for the electronic commerce of tomorrow. I attended a conference on Electronic Data Interchange sponsored by the Ministry of Economic Affairs with more than 500 attendants. Companies were presenting their experiences in using EDI. It was quite impressive.

The potential for Taiwan to be an intelligent, networked island (forgive me for the cliché) is good and, from a variety of angles, opportunities are closing in, waiting for the right moment to serge. I found it extremely interesting when Asian Wall Street Journal reported in April that Taiwan had the largest proportion of the households, more than 70%, that had cable TV connection - higher even than that of the U.S.! Through the emerging technology for high-speed cable modem and for converting cable transmission of video signals to two-way broadband, interactive transmission, Taiwan then will have a high bandwidth information infrastructure already in place, ready for interactive information services directly provided to close to three-fourths of the residential homes. That immediately will put Taiwan at the forefront of network connectivity and accessibility - not to mention the many cable stations that can play a role right away in that information infrastructure.

Moreover, people in Taiwan probably are the most information craving people I know. Take my father for example. He subscribes to at least five to six daily newspapers and still buys more from the news stands all the time! That is pretty common throughout the whole island. Potentially, this hunger for information as well as the aforementioned existing cable infrastructure can give Taiwan a head start in building the NII to enhance her national competitiveness and to increase the quality of life of her people.

Life in Champaign-Urbana will not be the same after those six months in Taipei. While I enjoy the quiet and the convenience of life in Midwest America, I do miss the hustling, bustling ambiance of Taipei and, especially, the feeling that anything is possible. While the pundits are saying that distance is fast disappearing due to the global network connection, the physical distance still plays a pronounced role in our life. On the other hand, we can all read news bulletins electronically worldwide over the web in real time, and any greeting is just an email away. In that sense, perhaps the mission of our association is such that we should consider more electronic communications among our members soon? We are witnessing a revolution brought about by IT which is as impactful as the industrial revolution. Members of ICISA, by virtue of our chosen profession, have the responsibility and obligation to contribute to the effort.

About the Author: ***Mike J. Shaw*** is currently a Professor in Information Systems and Technology at the Department of Business Administration, University of Illinois at Urbana-Champaign. He can be reached at shaw@ai.uiuc.edu.

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Future Conferences

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1997 Decision Sciences Institute Annual Meeting: November 22-25, 1997, San Diego, California, USA. (http://dsi.gsu.edu)

1997 International Conference on Information Systems (ICIS): December 14-17, 1997, Atlanta, Georgia, USA.

1998 Western Decision Sciences Institute Annual Meeting: April 7-11, 1998, Reno, Nevada, USA. (http://www.coba.univnorthco.edu/wdsi.htm)

[1] It is perhaps worth noting that Singapore and Hong Kong are in the same league with smaller populations

A Study of MIS Curriculum in Taiwan's Undergraduate Programs

Houn-Gee Chen
National Chung Cheng University, Taiwan, R.O.C.

Abstract

This study examines MIS curriculum of 23 MIS undergraduate programs in Taiwan. In addition to the profile analysis, we also examine relationships of faculties' backgrounds and MIS curriculum. The results indicate that (1) most MIS faculties major in computer engineering and computer science, (2) the more management background faculties a department has, the more management-oriented courses the program offers, (3) schools with more industrial management background faculties tend to offer less technical courses.

Keywords: MIS curriculum; MIS education

Acknowledgment: The author greatly thank York M. Sun, Mingjiin Jzung, Chang-Hua Chen, Cliff Y. Liu, and Michael Chung for their assistance in collecting and analyzing the data.

The 21-century will be an information age, any enterprise or any organization can not resist this torrent. A leader with solid computer knowledge is crucial for the success of the computing application. Computerization is a complex process, which often starts with well-developed plan covering business management, organization culture, information technology management, human psychology, and political conflicts.

To take the advantage of the information technology and attain the competitive advantage, the adoption of information system is required for public and private organizations. As a result, the demand for information professional is on the rise and encounters a shortage in many areas. To resolving this manpower shortage, many schools in Taiwan have started up the information engineering and information management programs per se or doubled the size of the current programs. The applications of information technology are well perceived in the business communities.

Since Fu Jen University started the MIS undergraduate program in 1982, the MIS program in Taiwan has steadily grown to cover 25 undergraduate programs, 12 master programs and 5 doctoral programs now. In the early developing stage, there are few pure MIS faculties and most of the faculties are from related areas in information engineering, information science, business management, and industry engineering. This faculty background difference and the abolishment of the College regularization have triggered the development of school own curriculum and resulted in diversity of MIS curriculums. In 1990, the Ministry of Education once set up 11 core courses, total 36 credits as Table 1. These courses were divided into 4 groups (mathematics, management, technology and information System) used as the guideline for the MIS curriculum development. However, this regulation was abandoned recently and each program is now developing its own curriculum to serve various requirements.

Table 1: MIS core courses (by the Ministry of Education)

Field	Course	Credit
Mathematics	Management Mathematics	3
	Statistics	3
Management	Economics	3
	Accounting	3
	Management	3
	Business Law	3
Technology	Computer Organization	3
	Business Data Communications	3
Information System	Database	3
	System Analysis and Design	3
	Management Information System	3

The purpose of this study is to examine the profiles of MIS curriculums in Taiwan and investigate the affecting factors of the design such as faculties' background, school culture, school history, and the numbers of students.

Research methodology

We collect 23 MIS undergraduate curriculum from

Table 2: MIS courses of 23 undergraduate programs

Fundamental/ Professional/ Advanced Curriculum	Common Courses	Fundamental Courses	Professional Fundamental Courses (IT)	Professional Fundamental Courses (SE)	Professional Fundamental Courses(OM)	Advanced Courses
Chinese	23					
Foreign Language	53					
Constitution & The thought of Dr. Sun Yat-Sen	27					
History	31					
Others basic courses	81					
Management		51				
Behavior Science					25	
Functional Management					97	
Business Law		19				
Economics & Accounting		68				
Information Management/ Management Info.Systems		66				
Business Management & Information Technology					19	
Information System Development				38		
Functional Information System					1	58
Decision Support				27		
Information System Project Implementation						29
Others (Information Management)		1		2	8	6
Software Development Technology				21		
Data Communications			48			
Database			32			
Artificial Intelligence/ Expert System			35			
Information Technology		44				
Program Language/ Program design		97				
Operation System			27			
Application Software		28				
Data Structure/ File Structure/ Algorithm		54				
Data Security			8			
Multimedia			26			
Object Oriented System			18			
Computer Assistant System						11
Graphics & Images			21			
Others (Information Technology)		1	22	26	1	
Statistics & Operation Research		62				
Others (Mathematics)		75	3			

colleges/universities and police schools in Taiwan. We classify the courses into 1) common courses, 2) management courses, 3) information management courses, 4) information technology courses, and 5) quantitative courses. In addition, we also categorize the courses into “fundamental”, “professional fundamental” and “advanced”. Among these, professional fundamental courses include information technology, information system and organization management courses.

The collected curriculum data includes course name, credit hours, elective/required courses, year/semester offered. The school data contains the number of programs and their characters, male/ female students, the number of full-time MIS faculties and their specialties, and the number of students. A cross analysis is then conducted to address the affecting factors in MIS curriculum design.

Data Analysis

The results of the classification are summarized in Table 2 in which the fundamental courses, professional fundamental courses, and advanced courses are the three major groups. In the faculty backgrounds, we classify them into information management, general management (including business management, management science, and organizational management), industrial management, information technology (information engineering/information science), electrical engineering, and others (psychology, education, art). In term of geographic areas, we confine school location as Northern, Midwest and Southern areas.

Table 3 shows the courses classification and we see that MIS programs offer more fundamental courses than professional courses. The fundamental courses include mathematics, management, business law, economics and accounting which cover almost 50% of the courses in the MIS curriculum. The advanced professional courses (functional information system, information system project implementation, and computer assistant system) account for only 8.85% of the courses. Among the three types of professional fundamental courses, the information technology courses are offered the most (20.43%), followed by

Table 4 : The top 5 course-offering schools in each group

Top 5 schools	Management Courses		Information Management Courses		nformation Technology Courses		Quantitative Courses	
1	National Taiwan Institute of Technology	31.0%	Da Yeh Institute of Technology	38.1%	National Cheng chi University	50.0%	National Taiwan University	16.1%
2	Yuan Ze Institute of Technology	29.8%	Chinese Culture University	37.0%	National Yuanlin Institute of Technology	43.6%	National Yuanlin Institute of Technology	15.4%
3	Chung Yuan Christian University	27.9%	Tamkang University	34.7%	Chung Hua Polytechnic Institute	41.9%	Tamkang University	14.7%
4	National Pingtung Polytechnic Institute	25.8%	Chung Yuan Christian University	32.8%	Ming Chuang College	40.5%	Tamkang College	14.6%
	National Taiwan University	25.8%						
5	National Yuanlin Institute of Technology	25.6%	National Sun Yat-Sen University	32.1%	National Defense Management College	37.9%	Kaohsiung Polytechnic Institute	14.3%
Avg.		19.1%		20.6%		30.8%		10.8%

organizational management (12.85%) and system engineering (9.7%). The results somehow indicate that the undergraduate program primarily focus on the basic MIS skill training and advanced professional courses are set more toward to a graduate level. The MIS undergraduate students need to take more fundamental courses than those do in other business discipline areas.

To understand the profile of schools, the top five courses-offering schools in each group are given in Table 4. Note that the data is tallied based on the groups of "management", "information management", "information technology", and "quantitative method."

Table 3: Types of MIS courses

Type of MIS courses	Total	Ratio
Fundamental Courses	566	48.17%
Professional Fundamental courses(IT)	240	20.43%
Professional Fundamental courses(SE)	240	9.7%
Professional Fundamental courses(OM)	151	12.85%
Advanced Professional courses	104	8.85%

From Table 4, we observe the followings:

1. The information technology courses are the most prevailing courses which accounting for 30.8% of the total courses while the courses in quantitative methods only account for 10.8%. The data also shows that the MIS programs offer more information technology courses than information management courses.
2. For the management courses, three (National Taiwan Institute of Technology, National Yuanlin Institute of Technology, National Pingtung Institute of Technology) of the top schools are schools of Institute of Technology. Among them, the Taiwan Institute of Technology offers 31% "management" courses which is 19% more than the average, 12%.
3. For the information management courses, Da Yeh Institute of Technology offers the most in this category. The percentages in the top five schools range from 38.1% to 32.1% which all higher than the average 20%. This finding indicates that some schools, indeed, offer more information management courses to emphasize the MIS identity.
4. For the information technology courses, the National Cheng Chi University is the top school at this group. Traditionally, this school is more a "social science" type school. Compared to the school tradition, its MIS program offers quite many information technology courses (50%).
5. For the quantitative method courses, the difference between the number 1 school and the number 5 school is only 6%. The overall average is 10.8%. It indicates that schools have almost equal workloads in this group. No schools ever promote this as their identity.

We then conduct the cluster analysis to divide schools into 3 groups, "Balanced type", "Information Technology type" and "Extreme type" as follows:

1. **Balanced type**: Da Yeh Institute of Technology, National Cheng Chi University, Chung Yuan Christian University, National Yuanlin Institute of Technology, and National Pingtung Polytechnic Institute, are in this group. They balance the courses of information management and information technology in the curriculum.

2. **Information technology type**: These schools offer more information technology courses. Examples like Chinese Culture University, Central Police University, National Taiwan University, National Defense Management College, Tamkang University, and Providence University.

3. **Extreme type**: These schools emphasize on the

Table 5: Top 5 schools faculty profiles for each major area

School	MIS	School	Mgt.	School	IM	School	I.E.	School	E.E.	School	Others
National Cheng chi University	29%	Tamkang University	13%	National Sun Yat-Sen University	63%	Ming Chuang College	63%	National Yuanlin Institute of Tech.	13%	Central Police University	54%
National Sun Yat-Sen University	24%	Fu Jen University	13%	National Taiwan Institute of Tech.	62%	Providence University	62%	Tamkang University	13%	National Central University	29%
National Central University	19%	National Central University	12%	National Taiwan Univ.	56%	Chinese Culture University	56%	National Cheng chi University	12%	Da Yeh Institute of Tech.	39%
Chung Yuan Christian University	33%	National Cheng chi University	6%	National Cheng chi University	47%	National Taiwan Institute of Tech.	47%	Providence University	6%	Ming Chuang College	11%
National Yuanlin Institute	20%	Ming Chuang College	6%	Chung Yuan Christian University	54%	Shih Hsin College	54%	Chinese Culture University	6%	National Defense Mgt. College	21%

IM: Industrial management, IE: Information engineering, EE: Electrical engineering

training of information technology and management and pay less emphasis on information management courses. Schools include Chung Hua Polytechnic Institute, Yuan Ze Institute of Technology, The World College of Journalism and Communications, National Taiwan Institute of Technology, National Cheng Chi University, Kaohsiung Polytechnic Institute, Ming Chuang College, and Fu Jen University.

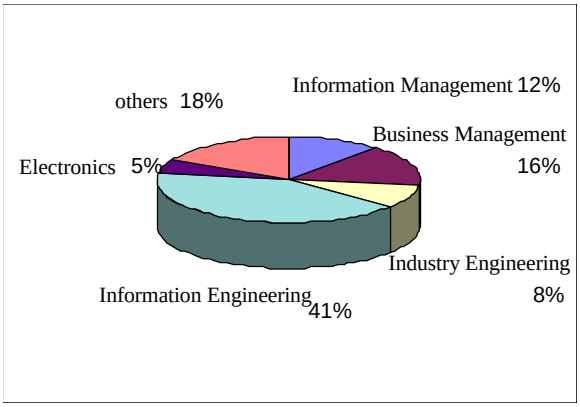

Figure 1: Faculty Background Profiles

Figure 1 shows the profiles of faculties' background. It indicates that most faculties major in information engineering and information science (41%) while MIS-major faculties only account for 12%. The business management and industrial engineering account for 16% and 8% respectively.

A detailed analysis of the profiles of the students was conducted. Table 5 shows top 5 schools faculty profiles for each major area.

We see that 29% of the National Cheng Chi University faculties major in MIS. Followed by National Sun Yat-Sen University and National Central University. Most of the faculties in Ming Chuang College have information engineering background. In National Sun Yat-Sen University, National Taiwan Institute of Technology, and National Taiwan University, more than half of the faculties major in industrial management. The faculties in Central Police University and Central Defense Management College have more diversified faculties profiles.

To understand the correlation of faculty's background and curriculum design, a Pearson correlation analysis is conducted and the result is as follows (see Table 6).

1. The number of MIS faculties is negatively correlated with the number of Information Engineering faculties.
2. The number of Management faculties is positively correlated with the number of information management offered.

The number of Industry Management faculties is negatively correlated with the number of information technology offered; it is that the more Industry Management faculties a department has, the less information technology courses the department offers.

Table 6: The correlation of faculty's background and curriculums

	No. of MIS faculties	No. of Mgt. faculties	No. of IM faculties
Number of MIS faculties	1	-0.131	0.392
Number of Mgt. faculties	-0.131	1	-0.319
Number of IM faculties	0.392	-0.319	1
Number of IE faculties	**-0.626***	-0.398	-0.105
Number of EE faculties	-0.234	0.298	-0.31
Management	0.25	0.163	0.13

Courses			
Information Management Courses	-0.082	**0.42***	-0.087
Information Technology Courses	-0.059	0.249	**-0.451***
Quantitative Courses	0.003	0.228	-0.156
Other Courses	-0.267	-0.04	-0.28
Common Core Courses	-0.24	-0.027	0.049

*Significant Level = 0.05

Conclusion

We summarize our findings as follows:

1. The required courses in technology institutes are more than those in ordinary universities. This might be due to the fact that most the technology institutes traditionally require more credit hours for graduation such that more core courses are included in the MIS curriculum. As a result, programs offer less elective courses and the diversity of MIS training is very limited.
2. The more the number of information engineering faculties a department has, the less the number of MIS faculties the department has. This might partly tribute to the expertise overlay in these two areas. Basically, both MIS and IE major faculties can teach information technology courses and part of the information management courses.
3. The more IM-major faculties a department has, the less the information technology courses the department offers. This implies that the information technology training of IM faculties is yet as good as the MIS or IE faculties.
4. The more management-major faculties a department has, the more information management courses the department offers. It indicates that schools tend to hire management background faculties to teach information management courses at the shortage of MIS faculties.
5. There are no significant correlation of the number of MIS faculties and courses offered. Our survey shows that most of the undergraduate MIS programs focus on basic skill and knowledge training. Faculties in other related areas are all able to teach those courses.
6. Nowadays, the majority of MIS faculties still major in information engineering or information science. It indicates a demand for MIS faculties in MIS programs.

In this study, we only classify courses by their name without addressing the contents of the courses. Any future study should provide a comprehensive content exploration of the courses and in-depth correlation analysis of the factors.

Information management is an application-oriented field that is constructed on varieties of practical knowledge. To fully take the advantage of the information technology, it has become a necessity to teach students MIS practices and strategic implications. Future MIS curriculum design should at least address some of that in this regard.

Reference

1. "National MIS Undergraduate Curriculum Design Planning Seminar," Yuan Ze Institute of Technology, 1995, November.

2. "ROC Information Management Academic Communication," ROC Information Management Academy, 1996, 1997.

About the Authors: ***Houn-Gee Chen*** is Professor and Chair of Department of Information Management at National Chung Cheng University in Taiwan. He holds a bachelor degree from National Tsing Hua University and MS and Ph.D. degrees from University of Wisconsin-Madison. His current research interest lies in decision support systems, group technology, information technology management, software engineering, and quality management. He has published in *IEEE Transactions on Systems, Man, and Cybernetics, International Journal of Production Research, International Journal of Flexible Manufacturing Systems, Computers and OR, Journal of Manufacturing Systems, Journal of intelligent Manufacturing, International Journal of Man-Machine Studies, Journal of Information Technology Management, Computers and Industrial Engineering*. (E-mail: mishgc@mis.ccu.edu.tw)

◆***CICISA***

Measuring Faculty Performance: A Model Made in Taiwan

Eldon Y. Li
California Polytechnic State University - San Luis Obispo, U.S.A.

Abstract

Developing an objective and clear measure of faculty performance is a complex task. Conventionally, a faculty's performance is measure with three categories of criteria: teaching, research, and services. At the National Chung Cheng University (NCCU) in Chia-Yi, Taiwan, student guidance is also measured in addition to the universal three criteria. This article describes the development of a structured approach to measuring faculty performance in the Graduate Institute of Information Management at the NCCU. The four categories of criteria are fully discussed. It provides a point of reference for those who are in search of a similar measure. They may adopt the evaluation process and tailor these criteria to their own expectations.

***Keywords*:** Faculty appointment; Tenure system; Promotion; Performance criteria; Performance evaluation

The educational system in Taiwan has been changing dramatically for the past few years, especially in the university system. In the midst of 1980's, the Legislative Yuan (Taiwan's Congress) upheld the old constitutional requirement that 15% of the annual national budget must be allocated to educational system. Since then, the higher educational system has been prosperous. National Chung Cheng University is one of several institutions that were established during the peak of educational funding allocation. The university began its operations in the Fall of 1989 with five colleges in place: College of Literature, College of Sciences, College of Engineering, College of Management, and College of Social Sciences. The College of Management currently consists of 4 undergraduate and 5 graduate programs. These include Economics, Business Administration, Finance & Banking, Accounting, and Information Management. Only the Information Management program does not offer an undergraduate degree. However, it has been approved to offer a B.S. degree in the Fall of 1998.

Another big change is the new University Law passed recently by the Legislative Yuan, which broke the traditional faculty ranking and tenure system. The old ranks include Teaching Assistant, Instructor, Associate Professor, and Professor. The new ranks are Instructor, Assistant Professor, Associate Professor, and Professor. The latter system is consistent with the current American system. However, the Legislative Yuan until recently did not approve the salary scale for this new system. Therefore, all of the new faculties with a fresh Ph.D. were hired as either an Associate Professor or an Instructor during the last 5 years. Beginning this Fall (1997), any new Ph.D. graduate has been hired as an Assistant Professor.

As for the tenure system, traditionally there is none. A faculty once being hired is on tenure track for two years. The contract is then renewed annually. However, after two renewals the institution must provide the same annual contract continually unless the faculty resigns or has an intolerable conduct. Normally, a faculty will be virtually tenured after two years of service. At that time, it will be impossible to terminate a faculty with poor performance in every aspect. The new law abandons this regulation and allows an institution to establish a tenure system. And, many have done so today.

After two years of planning, the National Chung Cheng University (NCCU) began a tenure system in the Fall of 1996. This tenure system provides an Assistant Professor with 8 years of probationary period. However, Full Professor is considered to be a tenured position while Associate Professor is left to be in a gray area. Of course, a faculty with Associate Professor would become officially tenured if he or she passed the promotion review process. Furthermore, a department can establish its own rules on renewing the contract for associate professors since these are not specified in the bylaw of the university. For example, the Graduate Institute of Information Management (GIIM) at NCCU has institutionalized a rule that any new faculty holding an associate professor or lower rank shall be evaluated for re-appointment after serving

the current rank position for four years. Those who do not pass the evaluation shall be given one year as the terminal year.

Due to the aforementioned changes, the criteria for being hired or promoted to Associate or Full Professor have become tougher. Nevertheless, this does not affect the Graduate Institute of Information Management (soon to be the Department of Information Management once it offers an undergraduate program) at the NCCU because it already had the toughest criteria among the MIS programs in Taiwan. During the Fall of 1993, a Founding Director was selected and appointed by the NCCU to plan for setting up the GIIM. He soon recruited 3 more faculties who all have worked for 6 or more years in the U.S. During that year, he supervised the admission examination, design the curriculum and purchased the computer equipment for the Institute, and recruited an administrative assistant for the office. Finally, the Institute began its operations in the Fall of 1994. Through teamwork, the faculties of the Institute began to establish standards, policies, and procedures; one of them is the set of faculty appointment and promotion criteria. This set of criteria at that time was the most specific, objective, and vigorous one among the various MIS programs in Taiwan because they established these criteria with the expectation of Assistant Professor rank coming soon in effect. The purpose of this article is to share these criteria with other MIS colleagues around the world in the hope that these would provide them some points of reference in the event of developing faculty performance measures.

The Process of Faculty Promotion in Taiwan

In Taiwan, the Ministry of Education (MOE) oversees every faculty appointment or promotion in a higher educational institution. Every faculty must receive a "Certificate of Faculty Rank" awarded by the MOE. Most colleges or universities must submit their faculty application packages for appointment or promotion to the MOE after they completed their own internal review and approval process. The MOE then subject these applications to an official review process. There are only a few national universities that are authorized by the MOE to perform such review process (NCCU is one of them). The process requires each application package be distributed to two or three external reviewers. Each reviewer will receive a form asking for information based on two review criteria: 1) The detailed quality of and comments on a representative work, selected by the applicant and published during the past five years, and 2) The quality and quantity of all published work for the past five years. The former is assigned with 60% weight and the latter 40%. Each reviewer must follow the official point system to classify the applicant into four categories: Strongly Recommend (≥90%), Recommend (≥80%), Reluctantly Recommend (≥70%), and Not Recommend (<70%). Only those that consistently fall into the first two categories have the chances to be approved by the MOE. Finally, the MOE processes the approved cases and mail each applicant the appropriate Certificate of Faculty Rank. In our opinion, this official review process in most cases does significantly the quality of faculty appointment and promotion in Taiwan.

An Objective Measure of Faculty Performance

Since its inception, the GIIM of NCCU has been striving for an objective measure of faculty performance. Conventionally, the common criteria around the world seem to include three categories: teaching, research, and services. The only difference from one institution to another is the weights of these criteria. At the NCCU, however, one additional category, student guidance, is required. Although a true objective measure is impossible to arrive, the goal is to minimize the subjectivity. To do so, the Institute's faculty evaluation committee adopted two methods: 1) the use of a point system, and 2) the use of group opinions, specifically, published surveys of journal quality and composite average of performance scores assigned by the committee members. In addition, the university regulations dictate the minimal size and qualification of the review committee (5 members with ranks higher than the applicant) and the maximal weight of the research category (60%). The following materials are adapted from the "Guidelines for Faculty Appointment and Promotion" developed by the GIIM at the NCCU.

- **The Point System:** The Departmental Faculty Evaluation Committee (DFEC) evaluates the promotion of a faculty based on a point system. The system assigns 60 points to Research Work, 20 points to Teaching, 15 points to Services, and 5 points to Guidance.
- **Research:** The work of research may include published papers, books, and project reports during the last 5 years or shorter.)
    - A faculty must have the following conditions to qualify for promotion:
        - Promotion to Full Professor: In addition to having the conditions for promoting to Associate Professor rank as listed below, one must have published, during one's current rank position, at least one Class A article and two Class B articles, and at least one single-authored article in Class A

or B journals. Furthermore, one must have published at least four articles in Class A, B, or C journals.

- Promotion to Associate Professor: In addition to doctoral thesis, one must have published, during one's current rank position, at least one Class A article and one Class B article, and at least one single-authored article in Class A, B, or C journals. Furthermore, one must have published at least five articles in Class A, B, or C journals.

- The representative work designated by the applicant for promotion evaluation must be related to MIS field and completed within the last five year. It must not be a part of one's degree thesis.

- Classes of Research Work:

  Class A: Internationally well known and rigorously refereed journal articles,

  Class B: Other rigorously refereed international journal articles,

  Class C: Other refereed journal articles, books, or book chapters,

  Class D: Conference proceedings papers or project reports,

  Class E: Other published work being recognized by the DFEC.

  The amendment of the journals listed in each of the above categories shall be approved by the DFEC.

- The Point System: The points received by each class of work are:

  Class A: 13~20 points
  Class B: 8~15 points
  Class C: 3~10 points
  Class D: 1~5 points
  Class E: 1 point

  The points of a short research work shall be determined by the DFEC based on its quality.

  The points of a work with multiple authors are adjusted by:

  $$(\textit{The points of the work as if it is single authored} \div \textit{The number of authors}) \times 1.4$$

- Non-MIS related journal articles may be accepted and evaluated by their qualities. However, the number of such journals shall not exceed one-third of the total quantity of journal articles in Class A, B, or C.

- **Teaching:** The evaluation is based on the applicant's years of teaching, instructional contents, thesis advising work and student evaluation at this university during his/her current rank position. A faculty transferred from another university may submit evidence of teaching performance at that university for promotion evaluation.

- **Services:** The evaluation is based on the years of services provided by the applicant during his/her current rank position, as well as the types and outcomes of volunteer work relating to one's university, college, department, or own profession. Such services are of two types: an administrative service refer to the volunteer work within or outside this university that is related to one's university or profession; an academic service refer to the work of obtaining contracts/funds/aids, hosting professional conferences, editing academic publications, etc.

- **Guidance:** The evaluation is based on the types and outcomes of volunteer work relating to student guidance at this university that were performed by the applicant during his/her current rank position. These may include class advisor, living advisor, club advising, summer studies, student exchanges, etc.

- **Minimum Requirements:** The applicant must have at least 60% of the points allocated to each category, namely, research, teaching, services, and guidance. Furthermore, the total weighted points of the four categories must be at least 70 points.

- **Provision for Appeal:** If the applicant does not agree with the outcome of the first-level reviews process, he or she may file a written appeal to the College Faculty Evaluation Committee (CFEC) within 15 days after receiving the notice of the reviews outcome. If the appeal is denied by the CFEC, one must not file an appeal at any other level.

Discussion

The point system used by the GIIM indicates that the faculties of the Institute emphasize research performance (60%) much more than anything else. They also encourage collaboration between colleagues by assigning a factor of 1.4 to a published work with joint-authorship. They anticipate a faculty to publish at least one journal article per year. They expect a balance in quantity and quality of the journal articles. They foresee that a young faculty will be striving for the quantity of the articles while a senior faculty will be establishing his/her reputation by publishing high quality articles. In

order to identify journal quality objectively, they reviewed two published surveys, one from *MIS Quarterly* (December 1991, pp. 447-452) and the other from *Communications of the ACM (*March 1995, pp. 93-107). After careful comparison, they found that the lists of the top 13 journals are very consistent between the two surveys and decided to accept them as the Class-A journals. The names and rankings of these journals are listed in Table 1. Note that three additional high quality journals (see No. 9, 14, 15 in the list of Class-A journals) as suggested in *MIS Quarterly* survey are included. In order to assure the quality of various *ACM Transactions* and *IEEE Transactions*, all members of DFEC dully reviewed and evaluated the above journals in the NCCU library. They identified 7 corresponding journals (see No. 2, 3, 4, 5, 6 & 11, 12 in the list of Class-A journals) which are included as well. The total number of Class-A journals is thus up to 19.

Table 1. Reported Rankings of Journals

Name of the Journal	MISQ 1991 [a]	ACM 1995 [b]
List of Class-A Journals:		
1. *ACM Computing Surveys*	9	10
2. *ACM Transactions on Computer-Human Interaction*	7	6
3. *ACM Transactions on Database Systems*	7	6
4. *ACM Transactions on Information Systems*	7	6
5. *ACM Transactions on Modeling & Computer Simulation*	7	6
6. *ACM Transactions on Software Engineering and Methodology*	7	6
7. *Communications of the ACM*	3	2
8. *Decision Sciences*	4	8
9. *Decision Support Systems*	*	11
10. *Harvard Business Review*	10	9
11. *IEEE Transactions on Software Engineering*	8	5
12. *IEEE Transactions on Systems, Man, and Cybernetics*	8	**
13. *Information & Management*	12	12
14. *Information Systems Research*	*	3
15. *International Journal of Man-Machine Studies*	*	**
16. *Journal of Management Information Systems*	5	7
17. *Management Science*	1	4
18. *MIS Quarterly*	2	1
19. *Sloan Management Review*	13	13
List of Class-B Journals:		
1. *Computers and Industrial Engineering* (not including conference papers)		
2. *DATA BASE*	19	20
3. *European Journal of Information Systems*		
4. *Expert Systems with Applications*		**
5. *Human Computer Interaction*		**
6. *I/S Analyzer*		
7. *IEEE Computer*	11	**
8. *IEEE Software*		**
9. *IEEE Transactions on Knowledge and Data Engineering*		
10. *INFOR: Canadian Journal of Operational Research and Information Processing*		**
11. *Information and Decision Technologies*		
12. *Information Management* (London, UK: IDPM Publication)	18	
13. *Information Processing and Management*	23	
14. *Information Resources Management Journal*	16	**
15. *Information Society*	27	
16. *Information Systems* (Oxford, UK: Pergaman Press)	15	**
17. *Information Systems Management* (Boston, USA: Auerbach)	14	17
18. *Interfaces: An International Journal of TIMS and ORSA*		
19. *International Journal of Information Management*		
20. *Journal of Computer Information Systems*	20	22
21. *Journal of Information Technology*		
22. *Journal of Organizational Computing*		
23. *Journal of Strategic Information Systems*		**
24. *Journal of Systems Management* (Discontinued in 1996)	17	21
25. *OMEGA: The International Journal of Management Science*	*	15
26. *Organizational Behavior and Human Decision Processes*		**
27. *Simulation and Gaming: An International Journal of Theory, Design, and Research*		
28. *Software Engineering Journal* (UK)		
29. *Software Practice and Experience*	24	

[a] Rankings are adopted from Gillenson, Mark L. and Stutz, Joel D. [1991]

[b] Rankings are adopted from Walstrom, Kent A., Hardgrave, Bill C., and Wilson, Rick L. [1995].

* This journal is recommended by the respondents to be of significant quality.

** This journal is suggested by the authors be an additional publication outlet.

Table 2. Checklist for Performance Criteria

1.	The **research** category points received by the applicant are **not below 60** points.	True	False	Actual points received: _____
2.	The **teaching** category points received by the applicant are **not below 60** points.	True	False	Actual points received: _____
3.	The **services** category points received by the applicant are **not below 60** points.	True	False	Actual points received: _____
4.	The **guidance** category points received by the applicant are **not below 60** points.	True	False	Actual points received: _____
5.	The **weighted total points** received by the applicant are **not below 70** points.	True	False	Actual points received: _____
6.	The applicant's **representative work** is related to MIS field and published within the last five year.	True	False	
7.	The applicant's **representative work** is not a part of his/her degree thesis.	True	False	
8.	The applicant's total number of non-MIS related journal articles in Class A, B, or C ***does not exceed one-third*** of the total number of journal articles in these three classes.	True	False	

Promotion to Associate Professor: (Please skip if not applicable.)

9.	The applicant has published at least **1** article in Class A journal.	True	False	Actual quantity: _____
10.	The applicant has published at least **1** article in Class B journal.	True	False	Actual quantity: _____
11.	The applicant has published at least **5** articles in Class A, B, or C journals.	True	False	Actual quantity: _____
12.	The applicant has published at least **1** single-authored article in Class A, B, or C journals.	True	False	Actual quantity: _____

Promotion to Full Professor: (Please skip if not applicable.)

9.	The applicant has published at least **2** article in Class A journal.	True	False	Actual quantity: _____
10.	The applicant has published at least **3** article in Class B journal.	True	False	Actual quantity: _____
11.	The applicant has published at least **9** articles in Class A, B, or C journals.	True	False	Actual quantity: _____
12.	The applicant has published at least **1** single-authored article in Class A or B journals.	True	False	Actual quantity: _____
13.	The applicant has published at least **2** single-authored article in Class A, B, or C journals.	True	False	Actual quantity: _____

The **Class-B** journals listed in Table 1 are adapted from two sources. One is from the two published surveys of journal quality. The other is from a list of journals identified by all members of the GIIM as of comparable and consistent quality with each other, after they dully reviewed and evaluated all the MIS related journals in the NCCU library. As for the Class-C publications, any other refereed journal articles, books, and book chapters are classified as such.

When assigning the points for journal articles, it may occur that different articles manifest different qualities even in the same journal, that two articles of different classes may have the same quality, and that a lower-class article may have a quality higher than a less significant upper-class article. Therefore, in the first case, the two articles may be assigned with different point scores. For example, two articles in a Class-A journal, one may receive 13 points while the other 20 points. In contrast, the two different-class articles may receive the same point score in the second case. For example, two articles in Class-A and Class-B journals, the Class-A article may receive 13 points while the Class-B one may receive 13, or even 14, or 15 points if its quality is as good or better than the Class-A one.

Note that the committee acknowledges that the MIS field includes many social science and engineering disciplines. An MIS faculty may publish research work not related to MIS. However, the quantity of such work should be limited. Otherwise, one should not call oneself as an MIS faculty. In this sense, the committee accepts and counts such kind of journal articles under one restriction that the quantity of these articles must not exceed one-third of the total quantity of all journal articles. In addition, the representative work designated by the applicant must be MIS related and completed within the last five year. It must not be a part of one's degree thesis.

In order to facilitate the evaluation process using the point system, a form of faculty promotion evaluation was designed. The form requires the evaluator to write down all the information used to evaluate the applicant, to assign ranking to each category of performance, and to make comments on each category of performance. Finally, the rankings are weighted by the 60-20-15-5 weights in order to come up with a total weighted point. Moreover at the end, a checklist is provided to ensure that the applicant passes all the criteria stated in the promotion evaluation document (see Table 2).

All these provide the applicant with a clear message of whether his or her performance meets the expectation of the Promotion Evaluation Committee. If not, the applicant can obtain the information from the form on what he or she needs to do in order to meet the expectation. Such an evaluation practice provides a measure that can be used to compare across different faculties and disciplines. It ensures clear communications between the applicant and the committee. This in turn avoids any favoritism, dispute, antagonism, and disharmony in the department.

Conclusions

The document for promotion criteria and process developed by the GIIM at the NCCU is very clear, objective, and reasonable. In order to develop such document, the committee must be open-minded, unselfish, rational, and foresighted. After reviewing this document, several conclusions can be drawn:

- There should be a committee large enough that cannot be dominated by any one or two persons in the committee.
- A faculty should publish on average at least one journal article per year.
- The evaluation process only measures the performance that a faculty has accomplished in the last five years. This keep the faculty on his or her toes.
- Promotion to Full Professor should emphasize quality while promotion to Associate Professor should emphasize quantity.
- There should be a balance in quality and quantity of journal articles.
- The quality of a journal should be determined first by credible published surveys then by committee as a whole.
- There should be a limitation of the quantity of non-MIS related work published by an MIS faculty.
- A faculty must have both single-authored and co-authored journal articles.
- The performance criteria should measure four categories: Research, Teaching, Services, and Guidance.
- The point system is a viable means to measure and compare the faculty performance across different ranks and disciplines.

The rationale and approach taken by the GIIM at the NCCU to develop and implement the evaluation criteria are clearly described in the document. As the university system advances, the criteria for tenure and promotion in Taiwan is getting tougher each year. For example, one university already requires their faculties to have double-digit quantity of journal articles and a single-authored representative work. I am sure that the GIIM at the NCCU will soon follow suit and update its criteria document to meet the changing demand.

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1998 Faculty Position Opening

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National Chung Cheng University

National Chung Cheng University in Chia-Yi, Taiwan began its operations in the Fall of 1989. Today it has established a decent reputation in Taiwan. Its newly constructed campus facilities and layout have been rated several times the #1 campus by the Ministry of Education in Taiwan. There are many National Science Council (Taiwan) funded projects undergoing in the university. Its research facilities and budget are abundant. The Department of Information Management has been established in the fall of 1994. Currently, it offers a Master of Science program. It will start its B.S. program in 1998. The department has 5 full-time faculty members and is recruiting for three opening positions at all ranks in the fall of 1998. Please help us circulate the following position announcement.

RANK:
Assistant, Associate or Full Professor, depending on qualification

STIPENDS:
Similar to the other national university in Taiwan

QUALIFICATION:
1. Ph.D. or DBA degree from an AACSB accredited institution major in Management Information Systems, or related areas.
2. For senior position (Associate or Full), at least 4 years of full-time working experiences after receiving terminal degree.

EXPECTATIONS:
Demonstrated excellence in the classroom, capability for quality research and publication, willingness to participate as a team member in service efforts at all levels.

LANGUAGES:
Proficiency in speaking, reading, and writing in Mandarin Chinese is required.

DEADLINE:
March 1, 1998 or until filled

TO APPLY:
Send resume, publications, three letters of reference, and copy of passport information (the page containing your photo)

SEND TO:
Dr. Houn-Gee Chen
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Department of Information Management
College of Management
National Chung-Cheng University
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Chia-Yi 621, Taiwan, R.O.C.

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Key Issues of Accounting Information Systems in Taiwan

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Abstract

Accounting functions provide most internal information for decision making in an business organization. Most organizations have adopted information technology (IT) to support their accounting operations. Therefore, IT would heavily influence the role of accounting function in an organization and the way accounting professionals performing their jobs. Although the importance of IT to accounting is obvious, in-depth study of how IT influences accounting functions in an organization and how should the organization manage its IT has been ignored. This paper reports the key IT issues of the accounting executives of the top 500 manufacturing and service corporations in Taiwan. The accounting executives are more concerned with the internal efficiency issues while the IS executives in both Taiwan and the U.S. pay more attention to utilizing IT for competitive advantages.

***Keywords*:** Information technology; Accounting function; Accounting Information Systems; Competitive advantage

Harnessing information technology (IT) is an extremely important topic that is of considerable interest to information systems (IS) researchers, practitioners [Ives and Javenpaa, 1991], and government agencies in order to help organizations achieve market leadership. The identification of key information issues (KII) would enhance the opportunity not only to alleviate the impacts of IT on the organizations but also to achieve competitive advantages.

Most of the organizations started their adoption of IT to support their accounting applications because accounting functions provide most internal information for decision making. With the publication of Kaplan's 1987 famous book 'Relevance Lost---The Rise and Fall of Management Accounting,' researchers had started their exploration of the relevant information that accounting should provide for decision making in the highly competitive business world where IT plays an important role. IT might have a great opportunity to heavily influence the role the accounting functions play and the way accounting professionals perform their jobs. However, in-depth study of how IT influences accounting functions in an organization and how should the organization manage its IT has been ignored. Of those studies appeared in the literature, most were non-empirical in nature, based on case studies, and dealt with key issues for IS professionals. One of the earlier case-based research studies in the area was conducted by Kneitel [1980] that described the development and implementation of worldwide sales management information systems. Selig [1982] reported strategic planning activities for information resources in a multinational corporation (MNC). Keen, Bronsema, and Zuboff [1982] discussed the problems encountered in implementing integrated bank transaction processing system.

Most empirical studies in the area identified key information issues from US perspective. Ball and Harris [1982] surveyed the Society of Information Management (SIM) members to determine the levels of importance of 18 IS management issues. Martin [1991] reported the critical success factors of 15 chief IS executives. Using leading information systems professionals, Dickson et al. [1984] used a Delphi technique to identify and rank ten key IS managerial issues for the 1980s. Using chief IS executives and corporate managers, Brancheau and Weatherbe [1987] repeated the previous study to identify the most critical information systems management issues. Hartog and Herbert [1986] did an opinion survey of MIS managers to identify top 10 issues of MIS management. An updated version of their work was also published in Datamation [1986]. Amoroso et al. [1989] divided key information issues into two categories, managerial and technical, using factor analysis. They found that information directors had gradually shifted their attentions from technical to managerial issues. Niederman et al. [1991] surveyed the SIM members and discovered that maintaining flexible information infrastructure had become one of the important

issues.

Key information issues of Taiwan were reported in [Harrison and Farn, 1988] and [Wang, 1994]. Harrison and Farn [1988] compared the information management issues of the US and Taiwan. Wang [1994] reported IS management issues for Taiwanese corporations for the 1990s. [Watson and Brancheau, 1991] compared the key issues among the IS executives of Australia, Europe, Singapore, and US. Similar investigations were also conducted in several other countries [for example, Carey, 1992; Davenport and Buday, 1988; Palvia and Palvia, 1992; Dexter et al., 1992]. Deans et al. [1991] studied the key IS issues of US-based MNCs. Roan and Hwang [1995] reported the key Issues of Taiwan-based MNCs.

Key information issues for accounting professionals were seldom addressed. Among the few, Kaplan [1987] proposed a new cost accounting technique, namely, Activity-Based Accounting (ABC), to provide sufficient 'relevant' information to improve process control. He also suggested that the ABC system would not function cost-effectively without the support of IT. Elliot [1991] and Hollander & Hillison [1995] argued that a new concept for accounting information systems design was required to provide sufficient information for decision making in the information era. Williams and Spaul [1989] suggested that an organization could improve the communications between its subsidiaries through communication networks and the quantity and quality of accounting information by utilizing decision support systems and expert systems to simulate business situations. Robert [1993] predicted that the future role of accounting professionals is dependent upon their commands of IT. These studies revealed the importance of IT for the accounting professions. However, they did not address the issues accounting professionals encountered in performing their jobs.

Because of the ignorance of the IT management research in accounting area, the industry could not make necessary changes in accounting practices and identify important job skills that are required for accounting professionals in the new IT age. A thorough study of KII for accounting professionals becomes important. Our study identified and prioritized the key issues accounting executives of top 500 manufacture and service companies in Taiwan encountered and compared these issues with that of IS executives in Taiwan and the US reported in [Wang, 1994] and [Niederman et al., 1991], respectively.

Next section discusses our research methodology. A discussion of our findings follows. A summary of our research and a list of future research directions then conclude the paper.

Research Methodology

The procedure, questionnaire, and subject used for this study are described as follows.

Procedure

Since there had been no previous research in key accounting IS issues available in the literature, we conducted the study in a two-stage manner. At the first stage, a list of key accounting IS issues were compiled from both the accounting and IS literature addressed above. A questionnaire, included this list as the first part and some open-end questions as the second part, was sent to 5 certified public accountants/management consultants, 9 accounting professors, and 11 accounting/IS managers to solicit comments. The list of key accounting IS issues was revised according to the comments in the 15 questionnaires we received. The revised questionnaire (see Appendix 1) was then sent to the subjects of this research.

Questionnaire

25 key accounting IS issues were included in the questionnaire. Respondents were asked to rate both the current and the future importance of the 25 issues using a 5-point Likert scale (1 indicating not important at all and 5 indicating extremely important). The questionnaire also included questions such as the degrees of computerization at the corporate and at the accounting department levels, the sizes of computers used, and the operations that had been computerized. To encourage frank answers, the respondents could select to remain anonymous.

Subjects

The 1000 top accounting executives of the top 500 corporations in both manufacturing and service industries reported by China Credit Information Service, Ltd., were included in this study. Of the 233 responses, 173 were obtained in the first month and 60 were received after phone contacts and a second-wave mailing in the second month. The response rate was 23.3%. The annual sale distribution of the responding companies is reported in Table 1. 106 respondents were from service industry and 123 from manufacturing industry. A series of 't' tests of the questions between the respondents in the first month and the rest were conducted to examine the late-response bias. Only three of the 50 issues (25 for current and 25 for future) were found to be significantly different. Since the ratio (6%) is slim, the two groups were merged for further analysis. A chi-square test was also conducted to identify significant difference in each distribution (industry, annual sale, and number

of employees) between the respondents and the entire sample. No significant difference was found, indicating the respondents should be representative of the entire sample.

Almost all the accounting departments of the responding companies use computers in their day-to-day operations (Table 1). Midsize/mainframe and personal computers are the most popular computers these companies use (Table 3). More than a half of the companies connect their computers into networks. Regarding the applications, most were computerized except purchasing and cost accounting for service industry and budgeting for both industries (Table 4). Purchasing is usually less complicated and the cost is usually more difficult to estimate for service industry might explain why the two applications are less computerized in the service industry than in the manufacturing. In general, service industry is less computerized than manufacturing industry.

Findings and Discussion

We first present our research results and then compare them with that of another study.

Our findings

The key IS issues ranked by the respondents are listed in Table 5. The means of all the issues are above 3.00 except the current ratings of 'end-user computing' and 'multimedia technology'. The low current ratings and higher future (5 years from now) ratings of these two issues indicates that end-user computing and multimedia technology are still new for accounting executives but will become popular in the future. The future ratings of all the issues are higher than the current ratings (the differences are all significant) indicating that accounting executives felt the importance of all the issues will increase over time and the relative importance of the issues is not much different (r-square = .93). The current ratings of 'communication with IS department' and 'placement of IS department' are among the top ten issues indicating that the IS department currently plays an important role in the accounting IS. However, these two issues drop out of the top ten list in 5 years from now seems to imply that accounting end-users become less reliance upon IS personnel as their applications become fully computerized in the future. It is also evidenced by the increasing importance of end-user computing. The popularity of software packages and outsourcing might also contribute to this phenomenon. 'Telecommunications' and 'information architecture' jump into the future top ten indicating that the accounting executives realize all the computers and databases within and outside the organizations should be connected in order to share the data resource.

Table 1 Revenue distribution of the responding companies

Revenues in 1995	Number of Firms	Percentage
Manufacturing Industry		
Below 60 Millions	34	28%
61 – 105 Millions	31	26%
106 – 175 Millions	27	22%
Over 175 Millions	29	24%
TOTAL	121	100%
Service Industry		
Below 32 Millions	31	29%
33 – 70 Millions	23	22%
71 – 140 Millions	22	21%
Over 140 Millions	30	28%
TOTAL	106	100%

Table 2. Computerization of the accounting operations

	Manufac-turing	**Service**	**Total**
Computer-based	116 (95.9%)	102 (96.3%)	218 (96.0%)
Under Development	4 (3.3%)	2 (1.9%)	6 (2.6%)
Not Computerized	0 (0.0%)	1 (0.9%)	1 (0.5%)
Not Answered	1 (0.8%)	1 (0.9%)	2 (0.9%)
	121 (100%)	106 (100%)	227 (100%)

Table 3 Computers used for accounting applications

	Manufac-turing	**Service**	**Total**
Midsize/Mainframe	75 (62.0%)	42 (39.6%)	117 (51.5%)
Workstation	23 (19.0%)	18 (17.0%)	41 (18.1%)
Personal Computer	75 (62.0%)	48 (45.3%)	123 (54.2%)
PC Network	66 (54.5%)	53 (50.0%)	119 (52.4%)
Not Answered	1 (0.8%)	3 (2.8%)	4 (1.8%)

Note: Subjects are allowed to check whatever applies.

Table 4 Computerization of accounting applications

	Manufac-turing	Service	Total
General Ledger	107 (88.4%)	94 (88.7%)	201 (88.5%)
A/R, A/P	102 (84.3%)	86 (81.1%)	188 (82.8%)
Inventory	121 (83.5%)	59 (55.7%)	160 (70.5%)
Fixed Assets	90 (74.4%)	62 (58.5%)	152 (67.0%)
Wages	107 (88.4%)	85 (80.2%)	192 (84.6%)
Cash Management	70 (57.9%)	53 (50.5%)	123 (54.2%)
Purchasing	84 (69.4%)	29 (27.4%)	113 (49.8%)
N/R, N/P	98 (81.0%)	80 (75.5%)	178 (78.4%)
Sales	102 (84.3%)	63 (59.4%)	165 (72.7%)
Cost Accounting	90 (74.4%)	46 (43.4%)	136 (59.9%)
Budgeting	59 (48.8%)	49 (46.2%)	108 (47.6%)
Others	5 (4.1%)	3 (2.8%)	8 (3.5%)

Note: Subjects are allowed to check whatever applies.

The top ten issues are discussed below.

1. **Computerization of Accounting Systems**: Although 96 percents of the responding companies indicated that they had already used computers in their daily accounting operations, computerization of the operations is still the most important issue they are concerned with now and five years from now. This is no surprising. Further analysis of the accounting operations that are computerized find that the percentages of the accounting operations that have already computerized are all lower than 96 percents. Even one of the most popular systems---general ledger is computerized in only 88.5 percents of the responding companies. This suggests that the accounting operations are not fully computerized in a significant number of companies yet and further computerization of some operations is crucial for these companies. Kaplan (1987) recommended a new cost accounting system in order for the accounting to provide 'relevant' cost information for decision making. The new ABC accounting system requires a redesign of the cost accounting concept and a well- computerized system is critical to the success of the system. Other researchers also supported the need for a new concept of accounting IS design. The computerization of accounting systems is therefore a continual maneuver in order to keep the companies competitive.

2. **Top Management Support**: Computerization usually takes a long time and involves resources and power re-allocation (Wang, 1994). Therefore, top management support is the key to the success of computerization. Since computerization of the accounting systems is the most important issue for the accounting executives, it is reasonable to find top management support the second most important issue. It was also the second most important issue for Taiwanese IS executives (Wang, 1995). However, the issue was never included in the list of key issues in similar studies conducted in the US (Ball and Harris, 1982; Dickson, et al., 1984; Hartog and Herbert, 1986; Brancheau and Wetherbe, 1987; Amoroso et al., 1989; Niederman et al., 1991). It suggested that Taiwanese top management needed to pay more attention to IT to improve the competitiveness of their organizations.

3. **System Integration**: Computerized applications were usually introduced into an organization at different times. It created a potential problem of system integration because different standards were designed into different applications, resulting in the difficulty in connecting systems. This is a serious problem because it is difficult for the accounting department to provide company-wide information efficiently without sharing data among the various accounting application systems in the very same institution.

4. **Data Management**: The purpose of computerization is not to replace the human workers but to achieve effective utilization and management of data resources (Nolan, 1979). Since accounting applications provide a major portion of data for decision making, the management of data resources is naturally an important issue for accounting executives. Loose control impedes the security of data and tight control prohibits the effective uses of the data. It is always a dilemma regarding the control and management of data resources.

5. **Communication with IS Department**: It is crucial for an IT user to acquire sufficient supports in order to effectively utilize IT to achieve his/her goals. Therefore the communication between the user and the support providers is important. The accounting department is usually an IT user rather than an IT service provider or administrator. Therefore,

Table 5 Means, Standard Deviations, and Rankings of Key IS Issues

ID	CURRENT ISSUE	Avg.	S.D.	ID	FUTURE ISSUE	Avg.	S.D.
1	Computerization of accounting system	4.599	0.712	1	Computerization of accounting system	4.819	0.532
2	Top management support	4.396	0.881	3	System integration	4.792	0.522
3	System integration	4.335	0.933	4	Data management	4.655	0.615
4	Data management	4.317	0.839	8	Support to management decision-making	4.615	0.658
5	Communication with IS department	4.159	0.983	2	Top management support	4.604	0.784
6	Adaptation to computerized systems	4.111	0.929	12	Telecommunication	4.573	0.747
7	Participation in IS planning	4.093	0.985	13	Information architecture	4.538	0.762
8	Support to management decision-making	4.088	0.964	7	Participation in IS planning	4.496	0.720
9	Placement of IS department	4.075	1.004	6	Adaptation to computerized systems	4.440	0.895
10	Measuring IS productivity	4.031	0.977	10	Measuring IS productivity	4.435	0.808
11	IT training	3.973	0.988	5	Communication with IS department	4.420	0.846
12	Telecommunication	3.956	1.154	11	IT training	4.329	0.891
13	Information architecture	3.934	1.077	9	Placement of IS department	4.314	0.901
14	Communication with other departments	3.758	1.084	14	Communication with other departments	4.248	0.849
15	Internal control	3.738	1.121	16	Competitive advantage	4.243	0.983
16	Competitive advantage	3.689	1.158	15	Internal control	4.223	0.982
17	Business process reengeering	3.571	1.146	19	Distributed systems	4.147	1.033
18	Regulations	3.507	1.273	17	Business process reengeering	4.128	0.985
19	Distributed systems	3.498	1.261	18	Regulations	4.126	1.026
20	Decision support systems & expert systems	3.321	1.276	20	Decision support systems & expert systems	4.045	1.012
21	Insufficient human resource	3.274	1.035	23	Transnational IS planning	3.951	1.187
22	Communication with other organizations	3.098	1.209	21	Insufficient human resource	3.809	1.024
23	Transnational IS planning	3.067	1.408	22	Communication with other organizations	3.789	1.038
24	End-user computing	2.991	1.250	25	Multimedia technology	3.525	1.207
25	Multimedia technology	2.707	1.265	24	End-user computing	3.466	1.203

communication with the IS department becomes a highly ranked accounting IS issue for the accounting executives. However, the importance of this issue decreases in five years from now. As IT becomes more user-friendly and end-user computing becomes more popular, the accounting department becomes less reliance on the IS department. The communication between these two departments is then relatively less important.

6. **Adaptation to Computerized Systems**: IT changes the way accounting professionals performing their jobs. Although accounting applications are among the earliest to be computerized, IT training has been included in the accounting professional training on an out-of-context basis in Taiwan. It is difficult for accounting people not to feel alien to IT unless they acknowledge that IT is a part of their professional requirements and also their professional talents. A revision of accounting curriculum to teach IT on an in-context basis should be able to not only alleviate the stress of adapting to computerized systems but also explore the potentials of accounting IT applications.

7. **Participation in IS Planning**: User involvement is always essential for successful IS development. Accounting department collects data from almost every part of the organization. The process of the compilation and integration of data from other departments would be difficult or even impossible unless all the systems are compatible and well connected. Participation in the IS planning by the accounting professionals assures it. The security and control of an IS must be obtained by maintaining electronic data processing (EDP) auditing standards and procedures. It is the responsibility of the accounting department to

provide this professional service.

8. **Support to Management Decision Making**: Kaplan (1987) introduced the ABC cost accounting system to provide more 'relevant' information for management decision making. Some other researchers, such as Elliot (1991) and Hollander and Hillison (1995) also suggested the redesign of accounting information systems in order to provide richer, more flexible, and quicker information for decision making. It is important for accounting professionals to rethink their roles in an organization. The traditional passive book-keeping attitude is no longer appropriate in the competitive business world.

9. **Placement of IS Department**: As an IS planner and IT service provider, the placement of the IS department in an organization heavily influences the resources the IS department hold to explore IT potentials and to support user departments. The placement of the IS department became a key issue for the accounting executives because the accounting department could not effectively collect and compile company-wide data without IT and the support from the IS department.

10. **Measuring IS productivity**: The investment of IT consumes resources of an organization but also creates information resources for it. To maintain a good command of resources, it is necessary to measure IS productivity in order to ensure the effective utilization of resources. As IT increases its share of total investment, the measurement of its performance becomes more important.

Differences between IS and Accounting Executives

We studied the key IT issues from users' perspective. A comparison of our findings with that from IS executives' perspective could help narrow down the gaps of the perceptions of IT between the user and the IS departments. Both sides could benefit from knowing what their counterparts concern about and adjusting their priorities in order to cooperate better. A comparison of the study by Wang (1995) and ours was made after extracting the issues addressed in both studies (see Table 6). We find that the rankings of the issues in the two studies are quite similar except the followings:

1. Adaptation to computerized systems is ranked much higher by the accounting executives than is ranked by their IS counterpart. User adjustment to computerized operations is more difficult than the IS executives expect. The IS department should not only design more user-friendly systems but also spend more time to help user departments to break the barriers to using computers.

2. Security control (internal control) is a more serious issue for the IS executives than the accounting executives. It does not seem to be reasonable because accounting department is usually the one that stresses more on the security issue than any other departments in an organization. The reasons might be that the accounting executives do not realize what risks IT could bring about to them and the security of the systems is usually not what the accounting department is responsible for. However, further investigation is needed for more assured explanation.

Table 6 Rankings of Key IS Issues of Different Studies

Key Issue	Wang (1994)	This study
Computerization of accounting systems	4	1
Top management support	2	2
System integration	5	3
Data management	7	4
Communication with the IS dept.	1	5
Adaptation to computerized systems	13	6
Participation in IS planning	8	7
Placement of IS department	11	8
Measuring IS productivity	12	9
IT training of accounting personnel	9	10
Telecommunications	15	11
Information architecture	10	12
Internal control	6	13
Competitive advantage	3	14
Distributed systems	14	15
Decision support systems & expert systems	17	16
Insufficient human resource	9	17
End-user computing	16	18

Note: The issues presented in this table are those included in both Wang (1994) and our study. The rankings of the issues are rearranged according to their original orders.

3. The IS executives feel insufficient IS human resources a more severe problem that the accounting executives. The reason might be that the accounting department expects supports from the IS department rather than becoming self-sufficient. It results in the shifting of the burden of recruiting IS professionals from the accounting department to the IS. This proposition is also evidenced by the low ranking of end-user computing issue by the accounting

executives.

4. Using IT to achieve competitive advantage is treated a much less important issue by the accounting executives than the IS executives. It is not surprising because accounting department usually stresses more on internal operations. However, the traditional role of accounting is in transition. More 'relevant' information is required for an organization to increase its competition power (Kaplan, 1987). Keeping the competition in mind would forces the accounting executives to change their attitude and to stress their efforts on achieving competitive advantages.

Table 7 The 10 most important accounting IT issues

Rank	Current	5 years from now
1	Computerization of accounting system	Computerization of accounting system
2	Top management support	System integration
3	System integration	Data management
4	Data management	Support to management decision-making
5	Communication with IS department	Top management support
6	Adaptation to computerized systems	Telecommunication
7	Participation in IS planning	Information architecture
8	Support to management decision-making	Participation in IS planning
9	Placement of IS department	Adaptation to computerized systems
10	Measuring IS productivity	Measuring IS productivity

Conclusion

We conducted a two-stage survey to investigate the key IT issues for the top 500 companies in both the manufacturing and service industries. The current rankings of the issues are quite similar to that of the future (five years from now). The ten most important issues are as Table 7. Computerization of accounting systems and system integration are the two most important missions for the accounting executives now and in five years. Participation in IS planning and support for management decision making are also highly rated indicates that accounting executives have perceived the importance of IT and the pressure of role transition from passive data collector and compiler to active management information provider and consultant. Telecommunication and information architecture enters the future top 10 list suggests that the accounting executives have perceived the coming of the network era and the need to be prepared for it.

Our study concentrated on large corporations. However, 94.46 percents of the companies in Taiwan are either medium or small. Research on medium/small companies is seldom found, not to mention key accounting IS issues. Medium/small companies face not only the problems at different scale from the large ones but also different problems. The issues studied and prioritized in this study have a substantial chance not to apply to medium/small corporations. A research project for medium/small companies is needed to complete the spectrum of key accounting IS issues in Taiwan.

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Building A Data Warehouse: An Overview

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Abstract

This paper explains what a data warehouse is and what it isn't. The major focus is placed on the discussions of the issues that should be addressed in building a data warehouse and some of the reasons so many data warehouses fail. This paper, also, presents some questions a company should ask before jumping onto the very expensive bandwagon.

***Keywords*:** Competitive advantage; Operational strategies; Executive information systems; Enterprise data warehouse

Strategic planning provides direction, focus, perseverance and adaptability as a business relentlessly strives to improve its position in all strategic areas. The purpose of strategy is to build, compound and sustain advantage and therefore business strategy must focus on building new advantages that increase customer satisfaction and create distance from competitors, maintain existing advantages that increase customer satisfaction and create distance from competitors and compress or eliminate the advantages of competitors. The culmination of advantage (by cost, value-added, focused attention, speedy service and maneuverability) is building a set of Sustainable Competitive Advantages (SCA) for the business. An SCA is a resource, capability, asset, process etc. that provides the enterprise with a distinct attraction to its customers and a unique advantage over its competitors. SCA attributes are customer perception, SCA linkage, durability, transparency, accessibility, replication, and coordination. Through SCA, (1) a customer perceives a consistent difference to one or more key buying factors; (2) differences in customer perception is directly attributable to the SCA; (3) both customer's perception and SCA linkage are durable over an extended time period; (4) mechanics and details of SCA are difficult to understand by competitors; (5) competitor has unequal access to the required resources to mimic the SCA; (6) competitor would have extreme difficulty reproducing the SCA and (7) SCA requires difficult and subtle coordination of multiple resources. The strategic ideas from data warehousing emanates from learning continuously and not repeating mistakes, finding the best way to go and maneuver to exploit gaps, to knowing plans of opponents and needs of customers. The overshadowing factor of data warehousing is the dimension of time and data warehousing meets the fundamental business needs to compete in a superior manner across time, and permits one to compete across time. It allows one to learn from the past, adapt to the present and position for future. Data warehousing is a rare instance of a strategic weapon that yields tremendous leverage and raises the ability of all employees to serve their customers and out-think their competitors. The value of this strategic weapon arises from the ability to win profits but deftly avoid expensive and endless battles with competitors. A powerful introduction to a data warehousing business case would therefore be to enable the business to win in the marketplace everyday, with every customer, with every purchase. By repositioning operational data and combining it with selected foreign data, a company could empower its employees so that they can routinely delight and excite their customers.

Data Warehouse has been extensively used in retail channels, such as Wal-Mart, Kmart, Sears, and Otto Versand Mail Order, for tracking, analysis and tuning of sales promotions and coupons, price reduction modeling, negotiating leverage with

supplier, product selections by granular market segmentation. AT&T, Ameritech, British Telecom have adopted data warehouse in telecommunications for analysis of call volumes, equipment sales, customer profitability, costs, inventory, purchasing leverage with suppliers, and frequent buyer program management. Merrill Lynch, Banc One, Citibank, Bank of America have applied data warehousing in Banking and Finance for relationship banking, cross segment marketing, risk and credit analysis, merger and acquisition analysis, customer profiles, and branch performance. The maximum return from data warehouse occurs when it is conceptualized, implemented, managed and evolved as a strategic issue.

This paper will explain what a Data Warehouse is and what it isn't. It will discuss the issues that should be addressed in building a data warehouse and some of the reasons so many data warehouses fail. Finally, it will present some questions a company should ask before jumping onto this very expensive bandwagon.

Just a Very Large Database?

Many end users consider a Data Warehouse to be simply a very large, easily accessible database which holds all the data they need. Is this really a data warehouse? There are numerous large databases maintained by corporations which are not data warehouses. Many people confuse Data Warehouses and Very Large Databases (VLDB). Richard Winter, of Winter Corp. [Winter 1996], specializing in VLDB's, has been conducting a survey of companies undertaking the challenge of building large database applications. Some of the largest databases he has found are not data warehouses at all, but transactional systems. The databases used by a transactional system are referred to as Operational Databases.

The difference between an Operational Database and a Data Warehouse is rooted in it's intended use. Transactional systems are designed to access and update data one record at a time. The databases which support them are designed to facilitate this type of access. When users want to retrieve information from the resulting databases however, they often need to see several different categories of data together. A totally different type of structure is needed to bring the data together in a way that turns stored data into information which, in the right hands, becomes knowledge that can help the business. The purpose of the Data Warehouse is to store the right data in the right structure to transform it into useable information to support decision making [Lambert 1996].

According to the acclaimed father of data warehousing, Bill Inmon [Inmon 1995], "A data warehouse is a collection of data in support of management's decision making process" which has four essential characteristics. It is subject-oriented, integrated, time-variant, and non-volatile.

The non-volatile characteristic is one that deserves special attention. Many organizations want to create one database which accepts the daily transactional updates for an application, give end users a sophisticated front-end query interface to the data and call that a data warehouse. This is a violation of Mr. Inmon's definition and will cause dissatisfaction in the performance of both the update process and the end-user query process. The update process will lock rows, preventing user access. User queries trying to access the database will attempt to perform multi-table joins selecting large volumes of data and locking out any attempts to update the data. In addition, if a user runs a query at 9:00 AM and again at 9:15 AM, the same results should be returned. If the underlying database is being updated at the same time, this may not occur.

The database that supports a data warehousing application requires a totally different design than a transactional update application. In many cases, detailed transactional data is not required. What the end-user usually needs is a summary of the transactional data, such as the number of a particular item which were sold in a given time period. The data warehouse should not be concerned with up to the minute transactional updates. A Data Warehouse should be a specialized, read-only database, refreshed periodically with data from transactional databases. Instead of detailed, highly normalized tables, it should consist of tables which have been summarized and de-normalized to match the needs of the end-user. The end-user may be given the capability to drill down to the detail data in order to investigate a particular portion of the data, but only after narrowing their selection criteria so that only a few rows of data are accessed.

A Data Warehouse is designed to answer the kinds of questions asked by Decision Support System (DSS) or Executive Information System (EIS) users. It does not contain all available data for a corporation. Instead, it specializes in aggregated, summarized, and integrated information relevant to the user. A common use of the Data Warehouse is for marketing research. This kind of Data Warehouse would typically contain data which would show the quantities of specific items sold in various market segments, customer demographics, and other factors which might help marketing managers plan their sales strategies or develop new product ideas. Detailed sales data, which are important to process day to day transactions are not required to answer DSS questions. If the accounts receivable managers wish to find which customers have accounts overdue,

that is most likely a totally separate application which should be designed as a report against the transactional database, not a Data Warehouse query.

Traditional DSS Versus Data Warehouse

It is a common belief that the objective of management Information systems is to provide the right information, in the right form, at the right time. In traditional DSS, the source of most frustration within businesses was the inability of computerized transaction systems to generate information that meets the requirements of this definition. Unfortunately, much of the data which accumulates in transaction systems is not easily accessible or has a meaning which is subtly different from what is required by the business or assumed by user such as too little or too much detail or too short time-scale or inappropriate intervals of time. More often, the data required to support decision making will come from a number of different systems which are resident on a variety of different technologies and providing this information could be done only by skilled computer professionals who may not be available at the request of business managers. If the data is extracted, merged and converted into some kind of meaningful information that meets the requirements of decision-maker, very often it cannot be made available in the usable format. Typically, the user's computer knowledge is low and the information gets loaded into a particular spreadsheet package or other PC software tool that may not ultimately turn out the right format in a nutshell.

The dilemma created for corporate information systems (IS) department by these demands for data is centered on the difficult task of attempting to control the amount of scarce information technology resource, being consumed by the insatiable demand of the business for information. Each time a report is generated by IS department and analyzed by business, it leads to an immediate demand for a number of other reports to illuminate insights gained from the first and each extract programs required were unique with very few reusable components. The interaction between information and decision maker is generally a voyage of discovery but an intolerable strain for IS department who have to not only specify, write and test query program, but also find suitable time to run the program against a production system without impairing its response times. IS providers have typically responded by employing more and more rigorous methodologies in order to comprehensively capture information requirements when designing new systems, a key objective being to align IS with the business goals and requirements. The techniques however rigorous and successful in capturing the process requirements, fail completely to capture decision support requirements, a primary reason being that IS does not know completely all requirements for information in advance. The true reporting requirements are only identified through the dynamic interaction of business process and cannot be rigorously specified in advance. Most business transaction systems are, after all, the intersection between the business and the customer.

Another issue for traditional DSS was to collect data by individual users to discern patterns that led ultimately to Data Warehousing. In the past, the frustration of computer users unable to access data led to a significant trend in 90's where independent, user led IS initiatives led to emergence of multiple versions of the truth, distilled from same data in different departments. In any case, to get the data onto their local systems, business users still depended on IS department. An important characteristic well forgotten in the past was the fact that data in itself does not offer any significant benefit to business enterprise, but information is a guide to action. Many managers made a fetish to collect data in the past in the fond hope of someday utilizing it effectively and discern some pattern, and this collection, analysis and storage of data developed its own momentum and volumes of data held by organizations proliferated to an alarming extent. The realization of significance of data as a source not just of operational control but of operational strategy was the key driver in the concept of a data warehouse. Operational strategy is an attempt to describe the need, in a competitive and turbulent market, to continually innovate and re-align strategy within time-scales too short to be comprehended by strategic planning in conventional corporate sense.

Data Warehouse represents a recognition that the characteristics and usage patterns of operational systems to automate business processes and DSS are fundamentally different. Design differences and the problem of resource contention make it impractical to run both kinds of application against the same single image of the data. Data warehouse is therefore about unbundling the two environments. In one environment, the business automates its processes on many different on-line transaction systems in the most effective and expedient manner possible. Data from these many and varied systems is then used to populate a database comprising all data necessary to support decision making in a separate data warehouse environment.

How to Nurture a Profitable Data Warehouse

According to some [Datamation Feb. 1995], corporations seeking to facilitate Decision Support should develop an "Enterprise Data Warehouse". In an ideal environment, this would be the master copy of all the corporation's data. All data would be

managed as a corporate asset, organized and controlled by the business, and separated from, yet shared by the applications. A single definition would exist for this corporate Data Warehouse and the best single source would be identified and used for each data element. Extracts of the master database would be used for various operational and Decision Support systems. This is a wonderful concept and would work great if implemented in a brand new company with no existing applications.

However, very few companies are in a position to build their data and applications from scratch. The cost of reengineering all the corporations applications and data so that all redundancy and conflicting definitions are eliminated is a noble but extremely expensive and labor intensive proposition. If an established company were to take this approach to building a data warehouse, the chances of any return on this investment would be minuscule.

Fortunately, there are other ways of looking at the data warehouse. It isn't necessary to bring all of the corporation's data into the warehouse in order to reap the promised rewards. The key is to develop a hypothesis regarding the type of information which would most benefit the corporation. Potential data warehousing applications should be prioritized according to their potential benefits, availability of source data, and availability of knowledgeable users to make the project a success. By starting small and with the right project, a company can build a pilot data mart. This will give them experience in data warehouse management while providing a chance for the warehouse project to show a faster return on investment. The model can then be refined to include additional user requirements.

Data Warehouse data is organized by subjects or categories. By building these subject areas a little at a time, the odds of users finding information which will justify the project increases. To improve your chances of success even more, you must select the right data, identify the best sources, and extract it from existing operational systems or external data sources. The Data Warehouse can be very expensive to build, so a solid business case showing the projected return on investment must be developed before you begin [Mimmo 1995]. This requires a clear understanding of what the users need. It also requires an enterprise level strategy.

Before you spent one dollar on software or hardware, you need to have a clear plan showing what you plan to accomplish by building a data warehouse. Speak to the officers of the corporation. Ask them for their vision of where the company is headed. Find out what kind of information they would like to have to help them reach that vision. Next, talk to the department heads. As mentioned before, the most common data warehouse users come from the marketing department. However, any area which indicates a need to improve processes or gain a better understanding of trends may be a potential data warehouse user.

Once you know what you want to accomplish, you will need to determine what data exists and where it can be found. This requires an analysis of existing transactional systems and may require investigation of external data sources. Armed with information regarding corporate direction and available data, you should be able to form some hypothesis regarding the types of data marts which might be beneficial. These hypothesis should be presented to the appropriate departments. If you find a department which responds positively to one or more of the hypothesis and which is willing to dedicate resources to working with you to test the hypothesis, you have a potential data warehousing pilot.

What is Involved in Building A Data Warehouse

1. Design Issues

In designing a data warehouse, several factors need to be addressed. The first is potential users. A Data Warehouse should never be developed with the "build it and they will come" philosophy. IS organizations cannot assume that all company employees will understand and appreciate the value that a Data Warehouse can provide to them. The second factor is the data architecture which will be used to implement the warehouse. As will be discussed below, there are several choices, depending on the size of the overall effort planned. The third factor is the choice of hardware and the fourth is the user interface.

1.1. Data Warehouse Users:

The key to development of a successful Data Warehouse is company-wide involvement. In designing your data warehouse, the first step is to identify the potential users. Each Data Mart should address the needs of a specific user group. In some cases a company may have organizations already asking for ad hoc query access to corporate data. These potential user organizations should be interviewed first, to see if their data requirements are truly ad hoc or whether they can be satisfied with a set of predefined queries which can be run by these users at any time to produce the information they need. If the users' data query needs are more of the "What if" variety, requiring different follow up questions each time, you have a candidate for a Data Mart.

Once you have a group of interested users with the appropriate type of data needs, the next step is to understand what data they need, where to get that data, and who the experts are in the content of

existing data sources. It is critical that the source data be understood, documented and standardized so that the users will know what the results of their queries truly mean. In a case study discussed in DBMS magazine [Kimball 1995] last year, more than 50 users, ranging from individual contributors to senior management, were interviewed at this stage. This is critical because misinterpretation of an element of data can cause disastrous results. Imagine the case where a user accesses information that a certain process took 3 weeks for 10 employees to complete. Without understanding how many hours of work were actually included in the 3 weeks this information is meaningless. Or if a query shows that 100 units of product number 123 were sold last week, what does that mean. The user may know of a product 123 which is a table in the furniture department, with a $50 profit margin. However, if the user didn't properly qualify the query to exclude all other departments, the total might include a dress in the clothing department, which also is designated product 123 and has a profit margin of only $5. These are simplified examples, but you can easily see how an understanding of what the data values actually mean and how to use the data is critical to useful information.

1.2. Data Architecture

There are several approaches to building a data warehouse. The first issue which needs to be addressed is the concept of a virtual warehouse versus the actual data warehouse.

1.2.1. Virtual Data Warehouse

There are tools in the market which are advertised to provide the benefits of a true Data Warehouse without actually constructing the specialized database. In order to implement a virtual data warehouse, all relevant Operational Databases are first defined to the tool, using a metadata repository. When a user submits a query, the tool goes out and extracts a copy of the operational data, reformatting it and creating a temporary database to address the specific needs of the end user. This temporary database is stored locally and used to facilitate further detailed queries by the user. This type of implementation is referred to as a virtual data warehouse, because the warehouse itself is never actually built separate from the operational data. At the end of the session, the temporary database is deleted to make room for future storage needs.

There are advantages and disadvantages to this approach. The first disadvantage is that it may take a long time to extract and reformat the data when it is initially accessed. The performance drain on the source database will be very high for this initial query. If the user does not format their query carefully, they may have to repeat the process several times until they get the response they are looking for. However, once the temporary database is created, the user has exclusive, local access to the data for follow-up queries, so response time will be better than in the true data warehouse. If performance is not an issue for the Operational Database, the user is good at defining the query, and the data he/she needs can be retrieved on the first attempt, this may be an appropriate architecture for your data warehouse.

Most user queries do not fall into this category however. The average user's query will access thousands, if not millions of rows of data with each initial query, placing an enormous burden on the Operational Databases which house the source data. Since the source data was probably designed to meet the needs of the transactional systems, the reformatting operations will be intense and complicated.

1.2.2. Actual Data Warehouse

A better approach is the development of a separate database, designed and tuned to meet the needs of the end user. There are two types of actual implementations, the Data Warehouse and the Data Mart. The Data Warehouse implies that all of the data required by Decision Support Systems (DSS) or Executive Information Systems (EIS) is extracted from the Operational Databases and collected in one place. A complete Data Warehouse will take a long time to develop and will cost much more than most corporate officers will tolerate before it shows any value. The corporation must see the value of their investment within a reasonable amount of time or the data warehousing project funding will be withdrawn.

If the data required by the DSS or EIS is stored separately for each potential user group, the resulting smaller data warehouses are called Data Marts [Rajkumar 1996]. These are miniature data warehouses, containing data which concentrates on a specific corporate need. For example, one of the first subject areas which is usually chosen for a Data Mart is customer profile data. The marketing department can provide numerous examples of the types of information which they can use to better understand their customers. An understanding of the demographics of their customers might result in sales of additional products or services to customers, or development of new products which fill a previously unidentified need.

Data Warehousing expert Ken Orr [Orr 1994] proposed an effective architecture for implementing an actual data warehouse. Data is extracted from Operational Databases and reformatted in a data staging area to a normalized relational data model. Once the data has been placed in the proper business relationships, it can be loaded into the data warehouse. Data Warehouse updates are done on a

periodic, scheduled basis, such as once a day or once a week, depending on the volume of data and user requirements. Data is then pulled from the Data Warehouse Subject Area Databases, reformatted, summarized to meet specific user needs, and loaded into Data Marts. Decision Support and Executive Information Systems (DSS or EIS) can then extract the data they require from the Data Warehouse.

The advantages of the Data Mart are numerous. It can be started with a small pilot implementation and a minimal investment. User requirements can be isolated and documented to form a reasonable hypothesis of what would yield the highest results. There is no need to change existing operational systems and there should be no performance impact on those systems. A data extraction tool can be used to extract a snap shot of the operational data and restructure it into a design which will more efficiently support ad hoc queries. This data can be the seed for the development of a more complete data warehouse.

1.2.3. Hybrid Data Warehouse

A Data Mart can also be implemented as a virtual database. In this model, the data is still restructured and stored in the central data warehouse, but it is not duplicated in the Data Mart. The advantages of this implementation are as follows:

- Less storage space is required. There is no duplication of data between the Data Warehouse and the Data Mart, except for short periods of time.
- The data is already stored in a normalized design, so restructuring efforts are less complex than if the data were being extracted from the operational data.
- There is no impact on Operational Databases. Extraction has already been completed on a scheduled and controlled basis.
- The same data in the Data Warehouse can be combined in different ways to meet the needs of different users or to respond to different questions without extensive redesign of a Data Mart.

For a dynamic environment in which the questions which will be asked are truly unpredictable, this is an excellent approach. However, if the universe of data required by a specific group of users is well defined, it may be worth the effort and extra storage to build a Data Mart. The improved response time and the ability to isolate this group's queries from the rest of the user requests will be well worth it.

1.2.4. Database Design Models

At the beginning of the surge in Data Warehouse development, the relational data model was considered as the best way to implement a Decision Support database. The flexibility of the relational database was, and still is, thought to make it easier to combine information in the ways required for good information analysis. However, it has been found that the demands placed on a Data Warehouse are very different from those placed on an Operational Database. To address this, a new design called the Star Schema has been developed. There are distinct differences between the relational and star schema designs.

The relational database design incorporates multiple relationships between data entities and follows the rules of data normalization developed by Chris Date and E.J. Codd. The star schema design classifies data entities into two types - facts and dimensions [Red Brick 1995]. One core data entity is designated as containing the facts. Attributes about the facts are called the dimensions. Although an effective design, the Star Schema is best used with a relational database management system (RDBMS) which is designed to support it, such as Red Brick. Most of the other RDBMS's do not perform as well with data structured in this way, due to the need to perform multiple joins to one table. In addition, the end user query tools must also be able to effectively utilize the design type you choose.

1.2.5. Database Engines

As part of the planning for your data warehouse, you must choose the correct data base management system. This will depend on a number of factors and will impact your hardware choices. As mentioned above, if you have decided on a Star Schema design, you will need to choose an RDBMS such as Red Brick (As of the writing of this paper, this is the only database designed to fully utilize the Star Schema. Database enhancements occur rapidly however, and a full evaluation of all available database management systems should be undertaken to understand the features currently available). If you have decided that a standard relational design works best for the warehouse you plan to implement, Oracle, Sybase, Informix, IBM's DB2 and NCR's Teradata become possibilities which should be investigated Some of these have features which may be more desirable to your implementation, such as bit-mapped indexing, parallel query processing engines, or the ability to utilize different hardware options such as Symmetric Multi-Processors (SMP) or Massively Parallel Processors (MPP) [Rudin 1996].

The projected size of your Data Warehouse will also impact your choice of DBMS. The question of how much data a particular DBMS can handle is not an easy question to answer. Items such as the operating system, hardware platform, distributed or centralized design, and data administration skills must be considered. As will be discussed in a later section on

storage requirements, only experience can help you resolve this issue [Desmod 1994].

1.3. Choice of Hardware

1.3.1. Distributed vs. Centralized

The movement towards Client/Server development has led many companies to look at distributing their data across the network. If the users of your Data Mart are interested in only certain sections of the total database, this may be something you should consider. For example, if your company is organized along specific product lines, the users may be analyzing product information for their organization only and not for the entire corporation. In this case, locating each organization's data in a separate database on a server located physically near them will speed up response time [Atre 1995].

The disadvantage of this approach is that, querying the entire corporation's product data in one query, will be difficult if not impossible. The alternative to support both types of queries is to choose a database that is centralized but supports data partitioning. Data partitioning is the process of dividing the database into sections by the values in a certain data element, such as department. If the data is partitioned by department, a query which asks only for data about products within that department will only search through the one partition, thus reducing contention and improving access time.

Your choice of RDBMS will also impact your hardware choice. Oracle currently runs on PC, UNIX and mainframe platforms. If you choose a Sybase, Informix or Red Brick RDBMS, you will be restricted to a UNIX, or possibly an NT operating system and the hardware which will support it. If you choose a Teradata implementation, you may be restricted to an NCR platform or one of a few supported UNIX platforms. If you choose DB2, you will be able to run on a MVS mainframe, UNIX or PC hardware, so long as the operating system is an IBM product.

In addition, within the operating system type, not all hardware manufacturers are supported. Even when they are, software upgrades are not released for all platforms at the same time. Software vendors will implement their latest releases on the most popular (read profitable) platforms or ones they have contractual relationships with first. Among UNIX systems, this has recently been Sun and HP first, with several others not too far behind, but even that can change from year to year. The combination of hardware, operating system, and RDBMS must be chosen not only for their individual features, but also for how well they work with each other and what kind of relationships exist between the various vendors.

1.3.2. Storage and more storage

One thing that is often underestimated is the amount of storage space that will be required to develop a data warehouse or a Data Mart. The growth in the amount of data stored in a Data Warehouse can be very rapid. For example, as much as 200 million records may be generated each day by a regional telecommunications company just in tracking the information for phone calls. There are 100 billion credit card transactions each year in the U.S. alone [Zornes 1996]. There may be a tendency for users to ask for all of the data to be transferred to the Data Mart. Decisions must be made up front regarding how much historical information is really needed. Although transactional systems may require an audit trail of all transactions for many years, the types of queries submitted to the Data Warehouse usually deal with more current data and at a higher level of abstraction. Data Warehouse users want to know how this year's sales of product X compare to last year's sales for the same time period. Ten year old data is probably useless, as are details of each sales transaction for product x.

In terms of the data management challenge, Richard Winter, a specialist in very large databases (VLDB's), compares an average database of under 5GB of data to a walk in the Berkshires, while a VLDB is like an expedition to scale Mt. Everest. Very few people have successfully completed the feat and the scale intensifies day to day problems, changing them from mere nuisances to potentially fatal catastrophes. One example is performance tuning. A search time of . I seconds per 1,000 records may be fine for a small database, but if the database is 1,000 time larger, this may be out of the acceptable range.

In designing the Data Mart, the needs of the user must be evaluated so that the data is stored at the correct level of abstraction. Will the user be interested in the number of sales per month, per week or per day? If the data being queried is employee performance data, time of day may be relevant. If the user is only interested in monthly profits, don't store daily totals.

The ability to drill down to the detail data may be an important consideration. If this is an infrequent need, you may decide to implement the virtual warehouse concept for this data. Once a user has obtained the answer to a query of the summarized data in the Data Mart, they can be given the means to access detailed information about a specific area.

For example, a query may be submitted comparing the sales for each month in 1996 to the same months in 1995. In reviewing the results of this query, the user may see that the sales for February 1996 were significantly lower than that for February 1995. The

user may then wish to see the sales for February 1996 and February 1995 by product or by store. This data may still be available in the Data Mart, because it is still summarized from the transactional detail. However, if the investigation leads to a specific store and product, the user may wish to see the actual transactional data to determine if sales dropped for a specific time or sales clerk. In most cases the Data Mart query would not go to this level of detail. At this point the query will be specific enough to allow a relatively small amount of data to be extracted from the transactional database, and not the millions of rows which the initial queries would have required if summarized data were not available.

1.4. User Interface

1.4.1. Choosing the right software for the users.

There are a large number of data access and query tools available. Choosing the right one for your users is critical to their acceptance and effective use of the data warehouse. The sophistication of the query tools available spans a large functionality range. If the prospective users are not familiar with computers or relational databases, the tool should provide a plain language interface and behind-the scenes SQL generation. If the users are more experienced, they will be more effective if they have a tool which allows them to customize the SQL.

Another factor which may affect your choice of query tool is the nature of the queries to be executed. If the user is looking for patterns or trends in data, you may want to consider a data agent. A data agents is software that runs continuously, searching for predesignated conditions in a database. When an agent finds something of interest, it sends the information to a designated target. This can be in the form of an email message to a user or an entry in a database. Agents save the users time by performing laborious searches on their own. The user doesn't get involved until something of interest is found. An example of this technology can be found in the various news services that are now on the market. A user tells the news service what subjects he is interested in. The service searches all the available publications and sends articles of interest to the user. The user then only needs to read the selected articles, not all the publications.

Don't make the mistake of selecting one end user tool and designating it as the corporate standard for all Decision Support and Executive Information System users. Different groups will require different features. Forcing them to use a tool which is too complicated for them or one which isn't sophisticated enough will discourage their use of the Data Warehouse.

2. Data Conversion and Maintenance

2.1. Metadata Management

An important phase in the development of your Data Warehouse will be the metadata definition and maintenance [Sachdeva 1995]. Metadata is data about data. This is a separate database which contains information which helps the users find the information they need. For each data element, it should include the name, description, data type (character, numeric, etc.), length, valid range of values' interpretation of any codes used, and the location where the data can be found.

Metadata is critical to the effective use of the Data Warehouse for decision support, because it allows the user to use the warehouse proactively. If enough attention is not given to the collection, maintenance and integration of the metadata into your Data Warehouse architecture, the Data Warehouse will be rendered virtually useless.

You can manage your metadata in one of two ways. The first way is to manage it through a generic repository product, such as Platinum's Repository [Platinum 1995]. If you choose this route, you must make sure that there is an automated path for updating the repository from your data modeling tools, your various DBMS's system catalogs and/or your data migration and scrubbing software. The second method is to use tools specific to data warehousing, such as the Prism Solutions, Inc.'s Prism Directory Manager or Carleton Corp.'s Passport. This restricts you to use of data warehousing products provided or supported by the repository vendor.

2.2. Data scrubbing and migration

One of the most critical aspects of Data Warehouse creation is the quality of data being loaded into it. The data which exists in source transactional databases is not always as clean as we would like it to be. The edits on data entry may not be as robust as they should be. Entry clerks have been know to enter a standard, miscellaneous category code instead of taking the time and effort to look up the correct code for a product. If the data is a text field, such as an address, spellings and abbreviations may vary from one entry to the next. Data taken from two different data sources may use different sets of codes for the same data element. And finally, there may be several sources for the same data. Which is the best data source?

The designer must find a way to ensure that data getting into the Data Warehouse is as correct and accurate as possible. This means identifying the best source for each data element, determining a correct, standard value set for each field, and developing a process for scrubbing deviant data. All this must be

done before the designer can think about restructuring the data into a relational model and the levels of aggregation or summarization required to make the information useful in a data warehousing environment. Then as an added challenge, the source data is almost always stored on a different computing platform or at least in a different data management system than the target database. This will force the designers to deal with database conversion issues in addition to the data restructuring issues. Often, different data management systems don't support the same data types. For example, Sybase has a data type "money" but DB2 does not. In older systems such as IMS, the data types were even fewer. Each data field must be mapped and converted to the most appropriate and useful data type.

There are a number of tools on the market to assist the developer in automating the data extraction and scrubbing process. The most popular tools allow the designer to map source data to target data, exit to data scrubbing sub-routines, and automatically translate the source data to whatever format you define the target to be.

2.3. Correcting errors after the load

After the Data Warehouse is loaded and the users are busily exploring the information it contains, they will invariably find additional errors which even the most dedicated scrubbing efforts miss. When this happens, you must remember one of the cardinal rules of data warehousing: Never allow updates to the data warehouse. If you allow the data to be corrected in the warehouse, the next refresh of data from the source systems will overlay your correction. Even if you always append new data to the warehouse and never refresh, by correcting only the warehouse data you are allowing bad data to remain in the company's operational systems. You must establish a process by which the source data gets corrected and the correction then flows through the normal process to update the warehouse.

2.4. Updating the warehouse

There are three approaches to replication of data from one database to another. Tightly coupled synchronous replication is used when it is necessary to keep the data exactly this same at all times. This is appropriate for operational systems, but rarely for the data warehouses. The second type of replication is loosely coupled synchronous replication. In this method, the data in the secondary database is updated after the update to the primary is complete. It is sometimes referred to as near-immediate replication. This may be used for some data warehouses that require the most current data available at all times, but again, it is not required for most data warehouses. The type of data replication which is most often used for data warehouses is asynchronous. In this method, updates are stored and applied as periodic batch updates.

Synchronous, direct updates should never be allowed in a data warehouse. If data must be corrected quickly in order to obtain the desired results, this should only be done by the data administrator. By limiting update authority to the data administrator, you can assure the users who depend on the warehouse to respond to their queries in a reasonable amount of time that they will not have to experience update contention. By the nature of the queries normally submitted to the Data Warehouse environment, response time will be the Data Warehouse administrator's primary challenge. This database must be tuned for query only. Update processing requires an entirely different type of tuning. The two functions do not coexist well in the same database.

Updates to the Data Warehouse should be batch refreshes or appends. Applying updates real-time is not necessary and can actually be detrimental. In addition to the negative performance impacts referred to above, the user could experience inconsistent results to queries. For example, a user may submit a query which returns highly summarized data. After analyzing the data for '/~ hour, the user decides to drill down into one section of data. If the data was modified during the time the user was analyzing it, the drill down query will return results inconsistent with the original query.

In order to address this, updates must be scheduled for off-hours and the update schedule and frequency must be published to the users. This also helps the operational systems because it allows the extract process to be restricted to a time when it won't impact their performance. This type of approach is referred to as asynchronous data replication. If the Data Warehouse users ask for updates more frequently than once a day, it's a sign that their requirements might be better suited to operational data.

3. Skill Development

In addition to the technical and design considerations, one other issue needs to be addressed in your Data Warehouse plan. The skills required for effective maintenance and use of a Data Warehouse are different from those required in an Operational Database.

3.1. Database design and maintenance skills

The data base administrators (DBA's) assigned to design and maintain the Data Warehouse must be trained in several unique skills. The first involves database design. As mentioned earlier in this paper, a Star Schema design may be preferable to a standard relational design. Even if a relational design is used, the designer must understand how to de-normalize, summarize and aggregate data to the level which will

best meet the user's needs.

If you choose a different data base management system for your Data Warehouse than you use for your operational systems, your staff DBA's may need to obtain new skills in this area as well. If they are currently working with any relational database, this should involve only a short learning curve as they develop an understanding of the differences in the new system That does not mean that you can scrimp on formal training. Investment in a few days of classroom training in the new data base management system will payoff in fewer startup problems and delays.

The third skill which they must obtain involves the special needs of maintaining very large data bases (VLDB's). There are seminars and conferences available which are devoted to this topic. In preparing for your Data Warehouse development, it would be beneficial to send your best DBA's to learn all they can from people who have experience with VLDB challenges.

3.2. User skill development

User skills are even more critical than DBA skills in ensuring a successful data warehouse. The skills required fall into two categories: knowledge of how to effectively utilize available query tools and knowledge of the data. Training in how to use the end user query tool you select should be available from the vendor. With a little practice, anyone comfortable with computers should be able to master the tool and develop effective queries.

Knowledge of the data is more subjective and much more difficult to develop. The data warehouses which have produced the most valuable results have done so because the users thoroughly understood the data, knew what to look for, recognized significant information and were able to translate that information into knowledge useful to the company.

Conclusion

This paper has addressed the areas that should be reviewed before embarking on a data warehousing project and how to proceed in a way that will promote success. The following is a list of questions that need to be answered before you decide to take your company into a data warehousing project:

1. Can you isolate the requirements of one group of users for a pilot Data Mart?
2. Do you have a knowledgeable user or group of users?
3. Can your users' needs be satisfied by predefined queries or are their needs truly variable and ad-hoc?
4. What features do each group of end users require?
5. Is the data required readily available?
6. What data base management system meets your needs?
7. What hardware platform will house your data warehouse?
8. Which design methodology is best for your users, requirements and data base management system?
9. How will data scrubbing and migration be handled?
10. How will data corrections be processed?
11. How frequently should updates be applied? Note that any requirement for updates more frequent than once a day should be suspect.
12. How much data do you expect to be initially loaded into the data warehouse?
13. What growth rate is expected for the data warehouse?
14. How much history data will really be required to satisfy the users' requirements? How often can you purge old data?
15. Have you planned adequate training for your data base administrators and users?

Since a Data Warehouse contains the same information as the transactional database using a different design, why should a company build one? The answer lies in easy access to data for the people who can most effectively utilize it. A Data Warehouse is the next step in the evolution of data processing. Up until now, computer systems have been developed to support day to day operations. The data collected has been virtually inaccessible however. Ken Orr (1994) refers to this in his presentations as "Data in Jail". By releasing the data, it becomes information. In the right hands, information is knowledge and knowledge is competitive advantage.

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About the Authors: ***H. Joseph Wen*** is an assistant professor of Information Systems at New Jersey Institute of Technology. He holds a Ph.D. from Virginia Commonwealth University. Dr. Wen has 12 years information systems design experience on Decision Support Systems (DSS), Executive Information Systems (EIS) and Client/Server systems. His area of expertise is object-oriented programming, decision support modeling, relational database design, human machine interfaces, and data warehouse design. He currently conducted several large systems design projects for New Jersey Department of Transportation, National Center for Transportation and Industrial Productivity, and New Jersey Transportation Planning Authority. (Web: http://megahertz.njit.edu/~wen) ***David C. Chou*** is an associate professor of Computer Information Systems at West Texas A&M University. He received an M.S. and a Ph.D. from Georgia State University in 1987. Dr. Chou has published numerous article and papers in fields of software engineering, artificial intelligence, data base design, and internet/intranet design and applications. (E-mail: dchou@wtmail.wtamu.edu) ***David C. Yen*** is chair and a professor of Department of Decision Sciences and Management Information Systems, Miami University, Oxford, Ohio. He holds an M.S. and a Ph.D. fromUniversity of Nebraska-Lincoln. His research interests include data communication, data base, expert systems, and systems analysis and design. He has published papers in Communications of the ACM, Information & Management, and Telematics and Informatics. (E-mail: yendc @sbamail.muohio.edu)

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Member's News

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Ruth C. King has recently moved to University of Illinois at Ubana-Champaign, as an Assistant Professor in the College of Business. We sincerely wish her all the best. Please send her your best wish to rc-king@cba.uiuc.edu or to:

Dr. Ruth C. King
College of Business Administration
University of Illinois
Champaign, IL 61820
Tel: 1-217-244-8051

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1997 ACME Meeting News

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The ACME 1997 Conference has been held in August 10-12, 1997 at Imperial Palace Hotel, in Las Vegas, Nevada. Professor Otto Chang of California State University - San Bernardino was the program chair of the conference. If you need to receive any information about this conference, please contact Professor Chang at: Department of Accounting and Finance, California State University, San Bernardino, CA; Tel: (909) 880-5994; E-mail: chang@wiley.csusb.edu.

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1998 ACME Meeting Site Set

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The ACME VIII 1998 International Conference of Pacific Rim Management will be held on August 14-16, 1998 in Vancouver, B.C., Canada. Please send you papers by February 2, 1998 to the program chair:
Prof. Chia-Hao Chang
Program Chair, ACME VIII 1998 Conference
Dept. of Industrial and Manufacturing Systems Eng.
University of Michigan-Dearborn
Dearborn, MI 48128
Tel: (313) 593-5254
Fax: (313) 593-9967
E-mail: chchang@umich.edu.

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IS Papers in ACME 1997 Conference

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1. "Information System Quality and Stress: A Causal Model" by Eldon Li, California Polytechnic University, San Luis Obispo
2. "Measuring Software Quality in Development Projects: A CASE Study" by Dien D. Phan, St. Cloud State University
3. "An Integrated Process for Reengineering & Outsourcing" by David C. Yen, Miami University, and David C. Chou, West Texas A&M University
4. "Factors Affecting the Satisfaction of Health Information System" by Ching-wen Wang and Jen-Ruen Wu, Providence University, Shalu, Taichung, Taiwan
5. "Nursing Information Systems: A Survey of Current Practices" by Binshan Lin and John Vassar, Louisiana State University, Shreveport, and Norann Planchock, Northwestern State University, Shreveport
6. "Internet in the Health care Industry: Infrastructure Issues" by Binshan Lin, Louisiana State University, Shreveport, and Chang-tseh Hsieh, University of Southern Mississippi
7. "Impact of Information Technology on Health Care" by Chang-tseh Hsieh, University of Southern Mississippi, and Yao-Yang Shieh, Texas Tech University
8. "MIS Issues in Production Management" by Lester W. Yee, The University of Hong Kong, and Waiman Cheung, The Chinese University of Hong Kong
9. "Integrating Technical Analysis and Artificial Neural Networks to Support Stock Trading" by Hung-Jen Lai and T.P. Liang, National Sun Yat-sen University
10. "Software Ethics Among University Students in Hong Kong" by Jacqueline Tsang Wong, The Hong Kong Polytechnic University
11. "Summary for Developing UCP-IDSS Generating Environment" by Pengzhu Zhang, Baiwu Wan, and Yingluo Wang, Xi'an Jiaotong University
12. "Building Data Warehouse" by Joseph Wen, New Jersey Institute of Technology
13. "Using Noising Method to solve the Geometric Graph Partitioning Problem" by Wun-Hwa Chen, National Taiwan University, and Chin-Shien Lin, Providence University
14. "Process Integration for Total Quality Management and Information System Auditing" by David Chou, West Texas A&M University, David Yen, Miami University, and Jim Q. Chen, Texas A & M International University
15. "A Detection Cheating and Identify Cheaters' Secret Sharing Scheme" by Jonathan Jen-Rong Chen, National Defense Military College, and Chin-Hsiao Hsiang, Chinese Military Academy.
16. "A net work Learning Model for Problem Solving by Multiple Intelligent Agents" by Samuel Kim and Robert Chi, California State University, Long Beach
17. "The Evaluation by I.S. Professionals of Criteria for Accessing the Effectiveness of I.S. Team Projects" by James J. Jiang, Grand Valley State University, Stephen T. Margulis, Grand Valley State University, and Chang-Tseh Hsieh, University of Southern Mississippi
18. "An Improvement on Harn's Multiple Secrets Sharing Scheme" byJonathan Jen-Rong Chen, National Defense Military College, nd Chin-Hsiao Hsiang, Chinese Military Academy
19. "Internet Etiquette" by Dien D. Phan, St. Cloud State University
20. "Information Infrastructure and Virtural Manufacturing" by Chia-hao Chang and Yubao Chen, University of Michigan-Dearborn
21. "Information Technology Resources in Public and Private Organizations: Managerial Perceptions of What We should Be Teaching Our Students" by Conrod Shyao, Sue Greenfeld, Harold Dyck, and Frank Lin, California State University, San Bernardino.

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1998 DSI's Taipei Conferences

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The Second Asia Pacific DSI Conference, June 8-11, 1998 will be held in Taipei, Taiwan.

1. Please submit five (5) typed, double-spaced copies of your full paper, abstract, and/or panel proposal to conference chair Andrew C. Pan, Department of Business Administration, National Taiwan University of Science and Technology (NTUST), PO Box 118-10 Taipei, Taiwan (email: pan@ba.ntit.edu.tw). Abstracts should be a minimum of 4 pages. Full Papers are limited to 20 pages while panel proposals are limited to 3 pages.

2. Each submission must include a separate title page (on each copy) which clearly indicates (1) authors, (2) affiliations, (3) complete addresses with telephone/fax numbers and email addresses of the individual to whom all correspondence should be addressed, (4) title of the paper, and (5) selected topic area. The main body of your full paper, abstract, or proposal must have a title, but it should not include your name.

3. Important Dates:
   - Paper Submission: 1 February, 1998
   - Notification of Acceptance: 1 April, 1998
   - Camera-ready Copy: 1 May, 1998

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