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\* N E W D O C \*

# THE KNOWLEDGE AND SKILL REQUIREMENTS FOR THE DOCTORATE IN MIS

GORDON B. DAVIS

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## 1. INTRODUCTION

A doctorate in MIS is primarily to prepare for an MIS education career, although some persons with MIS doctorates go into consulting or into industry. There are (in 1980) probably between 200 and 300 persons with MIS or essentially MIS doctorates. The current annual rate of graduation of MIS and near-MIS doctorates is estimated at 50 per year. The MIS doctorate is not a uniform product; there is substantial diversity based on the college, the faculty, and individual program design.

The body of knowledge for a doctorate in MIS is defined by four methods: derivation from MIS subject content of MIS bachelors/masters degrees, a derivation from a model of MIS research, an examination of the intersection of MIS with other fields or study, and a reading list. This MIS domain is large and diverse which means that an MIS doctorate cannot be expected to have uniform depth of knowledge across all knowledge topics that are included in the domain.

The research skill requirements for receiving the MIS doctorate are similar to those expected of most doctorates in business or social science. However, a person having an MIS doctorate should also be familiar with MIS research frameworks, the application of research strategies to MIS topics, and the management of knowledge work. Doctoral-level workshops and seminars are important in developing depth knowledge in MIS concepts, theory, structure, and research.

There are about 30 universities that have indicated a capability to offer a doctorate with a major in management information systems. Not all of these universities provide the same level of support, but they provide a starting list for a person considering an information systems doctorate.

The purpose of this paper is to provide a basis for discussion and exploration. (This paper uses some material from an article by Gordon B. Davis, "The Education of Information System Educators," *Interface*, Fall, 1979.) It is not prescriptive in the sense that a single "answer" is developed. The

diversity of doctoral programs makes it undesirable to define a single normative set of skill and knowledge requirements for an MIS.

## 2. ASSUMPTIONS ABOUT THE PURPOSE OF A DOCTORATE IN MIS

The doctoral degree in management information systems should prepare a person to:

1. teach
2. do research, and
3. interact with the information systems community.

Some who obtain the doctorate in information systems may choose to be consultants or work in industry; however, the major purposes of the doctorate in the information systems area (as in other subject areas related to management and organization) are teaching and research. Table 1 illustrates this point for Minnesota Ph.D.'s in MIS. Partial returns from a survey of Ph.D. granting schools show approximately the same results.

TABLE 1

### Minnesota MIS Ph.D.s, 1971-79

<u>Current Occupation</u>	<u>Number</u>	<u>Percent</u>
College Professor in MIS	16	70
Consultant	4	17
Industry Executive	3	13
	<u>23</u>	<u>100</u>

This paper will therefore focus on the doctorate as a preparation for a career as a college professor. It does not address the issue of vocational-technical or community college instructors who may need practical experience, but do not need a doctorate.

### 3. NUMBER OF MIS DOCTORATES

The number of people with doctorates in MIS is difficult to estimate because of the number of different ways a doctoral student may have obtained a degree that is sufficiently directed to MIS as to be included. One basis for estimation is the number of dissertations on MIS topics. This is not a direct measure because a dissertation may be on an MIS topic but the doctoral candidate may not be in MIS. A study of doctoral dissertations from 1973 to 1979 (Ives, Hamilton, and Davis, 1980) identified 365 that were MIS dissertations. Assuming roughly half of these students received formal or informal MIS doctorates, this translates to 180 MIS doctorates through 1979. At an estimated current rate of 50 new MIS doctorates per year (including some 20 to 25 informal majors where a formal MIS program does not exist), there are at the end of 1980 about 230 persons with MIS or mainly MIS doctorates.

### 4. VARIATIONS IN THE DOCTORAL PROGRAM IN INFORMATION SYSTEMS

The doctoral degree (either DBA or Ph.D.) typically has three components: coursework, qualifying examinations (written and oral), and a dissertation. Although there is a central content tendency in doctoral programs in information systems, there is also considerable variation, so that new doctorates in information systems do not necessarily "look alike." The variations reflect three basic differences:

1. College offering doctorate.
2. Perception of information systems field by the doctoral faculty.
3. Individual doctoral program design.

#### 4.1 COLLEGE OFFERING THE DOCTORATE

The doctorate in management information systems (or whatever title is used) may be offered in different colleges within a university. Because of the organizational environment of information systems, the most common location is the graduate school of business, but other locations may be computer science, industrial engineering, public administration, and information sciences. The location of the doctorate-granting faculty provides the educational framework for the degree. For example, a business school will generally expect that a person with a doctorate from the college will have an understanding of the functional areas of organizations (production, marketing, finance, etc.) and knowledge of

organizations and management. Within this framework, the doctoral candidates do concentrated study in information system topics. If the information systems doctoral program is embedded within computer science, there will tend to be a framework of requirements for technical computer science understanding and organizational knowledge is likely to receive less attention.

#### 4.2 PERCEPTION OF INFORMATION SYSTEMS FIELD BY THE DOCTORAL FACULTY

Information systems faculty members have an advantage because of diversity of backgrounds, but this may also cause a rather unbalanced view of the information systems field. To one, information system means database technology; to another, it means computer technology; to a third, it means decision support systems. For a college with a fairly small faculty group who have selected others like themselves, the result may be a strong emphasis on only one approach to information systems education, such as a heavy emphasis on technology to the exclusion of organizational and behavioral considerations.

#### 4.3 INDIVIDUAL DOCTORAL PROGRAM DESIGN

Although a college may specify a framework of required background knowledge, there is generally considerable latitude in the design of areas of emphasis. Figure 1 illustrates a conceptual structure for a doctoral program in MIS. Since the domain of organizational information systems is very large and intersects with several other areas of university study, an individual doctoral program normally includes depth study in only one or two of them. For example, one individual's doctoral program may emphasize supporting depth in computer science as a reference discipline while another candidate may emphasize a supporting program in behavioral science.

### 5. THE BODY OF KNOWLEDGE FOR A DOCTORATE IN MIS

The body of knowledge for an MIS doctorate may be defined in different ways. Four methods for defining the domain are used here:

1. A derivation from MIS subject content of MIS bachelors/masters degrees.
2. The MIS domain derived from a model of MIS research.
3. The domain of MIS as unique MIS topics plus the intersection of information systems with other fields of knowledge.

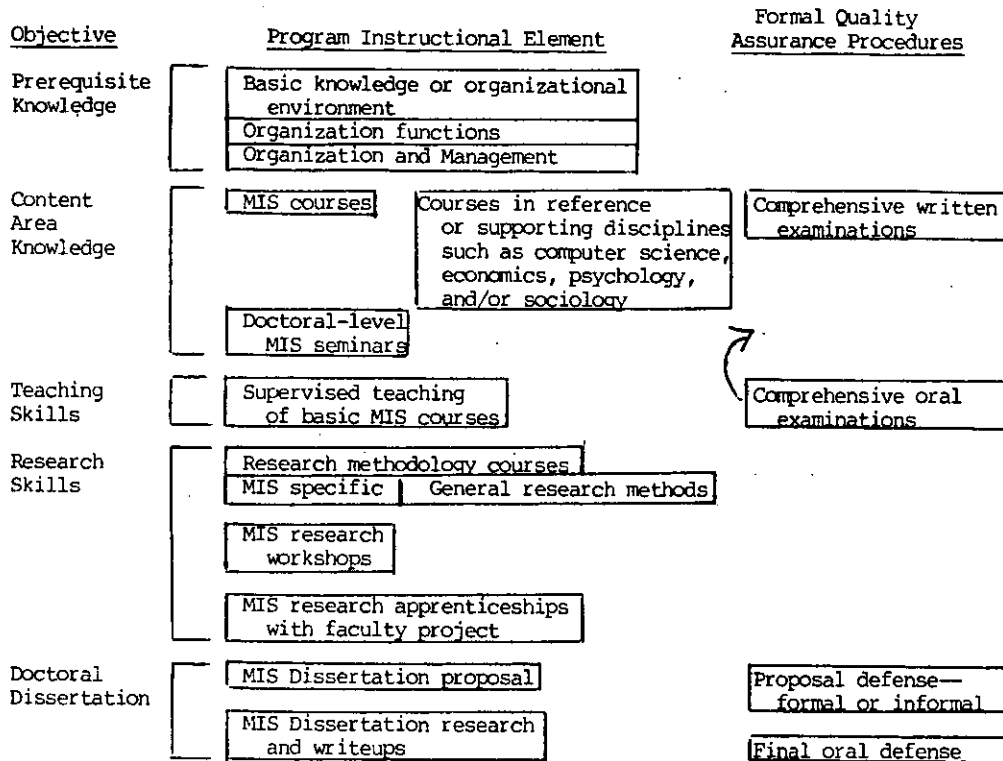


Figure 1 Conceptual structure for doctoral program in MIS

4. A reading list for the doctorate as a defacto method of defining knowledge requirements.

These methods define a very large and rich body of knowledge for the MIS doctorate. Given this large domain, it is well to reemphasize that an individual doctoral student cannot do depth study in everything. The doctoral program will normally emphasize depth knowledge in some topics and survey knowledge in others.

5.1 THE MIS DOMAIN FOR THE DOCTORATE DERIVED FROM THE MIS SUBJECT CONTENT OF MIS BACHELORS/MASTERS DEGREES

The person receiving a doctorate in MIS should be prepared to teach the standard subject matter for a bachelors or masters degree (although not to teach advanced courses in all topics). The MIS subject content for a bachelors or masters degree with a major in MIS is not well defined, but there is a central tendency. The MIS topics in the curriculum should be fairly directly related the analysis, design, implementation, and MIS management

activities that will be performed by the graduates. The new MIS graduate performs the tasks in an apprentice mode; with experience he/she works independently and may direct the work of new inexperienced employers. Figure 2 summarizes the major topics in the curriculum that prepare students for work activities by providing a knowledge of basic methodologies and processes. Also, these topics define the MIS domain for a "producer" of MIS graduates (the MIS professor who teaches the topics).

5.2 THE MIS DOMAIN FOR THE DOCTORATE DERIVED FROM A MODEL OF MIS RESEARCH

There are a number of models of MIS research. Examples are Mason and Mitroff (7), Chervany, Dickson, and Kozar (2), Lucas (6), Mock (8), Gorry and Scott Morton (4), and Nolan and Wetherbe (9). The model used for this paper is a comprehensive classification by Ives, Hamilton, and Davis (5) that has been accepted for publication in Management Science. This model, described below, identifies eight major topic areas: three

<u>TOPIC</u>	<u>ACTIVITIES PERFORMED BY MIS PROFESSIONALS</u>
Computer hardware	Select hardware configurations that will meet processing requirements. Use the hardware. Supervise operation of hardware.
System Software	Design, operate, and use processing systems that employ system software functions.
Data communications	Design, operate, and use systems having data communications as a component.
Data structures	Design files and evaluate alternative data structures.
Database management systems	Evaluate alternatives, install database software, and operate and use the database system.
Application programming	Design application programs. Evaluate alternative programming and software development practices. Select applications packages.
Information systems planning	Develop a comprehensive management information systems plan including necessary technology and a planned portfolio of application systems. Includes an understanding of organizational characteristics affecting information requirements, decision making processes, methods for eliciting and analyzing information requirements, and information system development stages.
Humans as information processors	Design the processing system and user interfaces within the constraints of humans as information processors, humans as intuitive statisticians, and human response to input and output design (technology, media, format, amount of summarization, etc.)
Evidence and measurement	Design of data collection and evaluation procedures.
Decision making concepts	Design decision support systems. This includes rational and behavioral decision making concepts.
System concepts	Design application systems based on system concepts of boundaries, interfaces, factoring, feedback, and equifinality. System knowledge includes human behavior in systems and human resistance to change.
Application design	Design a processing delivery system including the inputs and outputs for both primary and secondary users.
Application development processes	Design and manage an application development process that will elicit user requirements and develop assurance that requirements are complete and correct. Include social as well as technical factors in the design, provide for system change procedures, and do the implementation.
Management of information systems	Use general management techniques within context of MIS and use specific, unique techniques developed for information systems management, such as hardware and software performance measurement, system simulation, application development management systems, etc.
Privacy and security	Design and implement measures to assure data security and privacy.

Figure 2

Teaching domain for MIS Ph.D. based on activities performed by MIS students after graduation

Table 1

A Classification Scheme for MIS

<u>Topic Area</u>	<u>Description</u>	<u>Academic Courses or Topics Where Covered</u>
External environment	Legal, social, political, cultural, economic, educational, resource, and industry/trade considerations.	General educational background including computers and society. Security and privacy.
Organizational environment	Organizational goals, tasks, and structure. Management philosophy and style.	Organization and management.
User environment	Characteristics of the user, user organization, and user tasks.	Human behavior in organizational systems. Humans as information processors. Human factors in job design. Decision making behavior. Organizational functions such as accounting, finance, marketing, etc.
Information system development environment	Development organization and management, development personnel, and development methods and techniques.	MIS planning. Information system analysis and design. Project management.
Information system operations environment	Technology and resources. Organization and management of IS operations.	Computer hardware. Computer software. Data structures. Data communications. Database organization. Management of information systems.
Information Subsystem	Application system desing.	Information concepts. Measurement theory. System theory. Evidence concepts. Decision support systems. Application design.
Operations process	Physical operation of the operations resource.	Socio-technical design for secondary users. Physical system design affecting operations performance evaluation.
Use process	Usage of information systems.	Decision support systems. Socio-technical analysis and design for primary users. Physical system design affecting use.

information system environments, three information system processes, the information subsystem, an organizational environment, and an external environment (see Table 1).

### 5.3 THE MIS BODY OF KNOWLEDGE AS AN INTERSECTION OF INFORMATION SYSTEMS WITH OTHER FIELDS OF STUDY

The major fields of study and research which intersect with information systems are computer science, behavioral science, organization and management, organizational functions, and management accounting. (Figure 3). The intersection is defined by MIS topics to which the intersecting field of study directly applies (and might well include in its domain). Some of the intersecting fields of study are reference disciplines; others are utilizing fields. These fields are described below.

Using the intersection method, the body of knowledge for the MIS doctorate is defined by these intersections plus the unique domain of MIS. The unique domain of information systems includes information systems planning, application design (including decision support systems), application development, and some elements in the management of information systems.

### 5.4 THE READING LIST

Every field has a set of highly regarded articles, books, or reports with which everyone starting in the field is more or less familiar. It may be difficult to get agreement on a required reading list for MIS but Appendix A provides a starter set of highly regarded readings on theories and concepts related to MIS. It is only a partial list because it focuses on readings that have some characteristic suggestions they should be read by all doctoral candidates. Excluded from the list are readings required for technical and application coverage.

To be included in the reading list for doctorates in MIS in Appendix A, the publication should meet one of the following criteria:

1. The first or "best" exposition of an important MIS concept, theory, case situation, or set of research.
2. A significant (in clarity and/or completeness) summary or survey of an MIS topic or area of MIS theory.

## **6. THE RESEARCH SKILL REQUIREMENT FOR THE MIS DOCTORATE IN INFORMATION SYSTEMS**

A doctoral dissertation is required in all doctoral programs. The dissertation work should demonstrate research competence and the dissertation should represent a contribution to knowledge. Doctoral candidates generally face three major problems relative to the dissertation: selecting a research topic, applying an appropriate research strategy, and managing the dissertation process. Although these problems are common to all doctorates, there are specific requirements for the MIS doctorates.

### 6.1 RESEARCH TOPIC SELECTION

The specific MIS knowledge requirement for selection of a research topic within the MIS area is a knowledge of existing MIS research and needed MIS research. This knowledge is systematically presented in various research models or research frameworks. A knowledge of major MIS frameworks is therefore a desirable part of MIS research skill requirements.

The frameworks can be used to classify past MIS research and to generate research topics. This has been demonstrated in Ives, Hamilton, and Davis (5). For example, the eight elements of the Ives, Hamilton, and Davis framework suggest research either on individual variables from the nine classes of variables or on combination of variables. For instance, users can be studied as an environment or user behavior can be studied relative to system characteristics such as content, time, and form.

### 6.2 APPLYING RESEARCH STRATEGIES

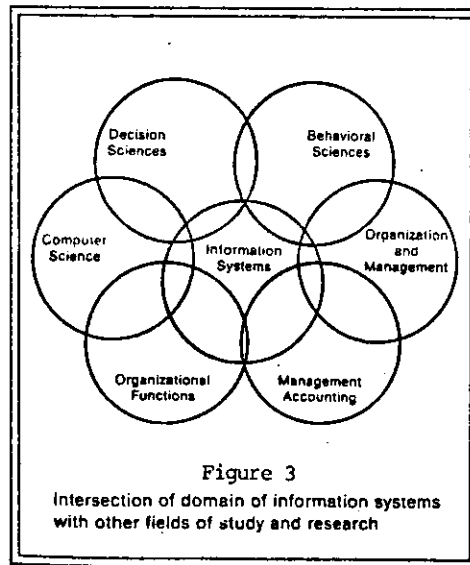
Van Horn classified MIS research methods as:

1. case studies
2. field studies
3. field tests
4. laboratory studies

A fifth method that has been suggested as useful in MIS research is action research in which the researcher is an active participant.

Field studies dominate as the strategy of choice in 30 percent of existing research but not all MIS research fits these five categories. These categories are "data" research strategies. Non-data research strategies involving conceptual formulations and analysis from secondary data represent approximately 30 percent of all MIS doctoral research.





<u>Field of Knowledge</u>	<u>Intersection with Information Systems</u>
Computer Science	Computer hardware System software Data communications Data structures Database management Software engineering Application programming
Behavioral Science	Humans as information processors Human behavior in organizational systems Human factors in job design Human resistance to change Behavioral factors in decision making
Decision Sciences	Decision making Decision models System concepts Information theory Measurement
Organization and Management	Organizational design Management style Leadership concepts Supervision concepts Planning and control processes
Organizational Functions	Functional processes in organizations Models of decision making in functional areas
Management Accounting	Cost behavior Management control reporting Performance reporting Variance analysis

The MIS knowledge and skill implications of this research strategy discussion is that a person receiving a doctorate in MIS should have reasonably broad skills, including some experience in field studies methodology, an ability to pursue laboratory study methods if these are more appropriate to a research topic, plus an exposure to field test, case study, and action research methods. These all assume suitable skills in statistics.

### 6.3 MANAGEMENT OF KNOWLEDGE WORK

The field of MIS is heavily involved in application of information systems to knowledge work. The MIS researcher needs to be familiar with principles and methods of knowledge work management and be able to apply these principles to the management of research including the management of the dissertation process. The problems of managing the dissertation process are not unique to information systems doctoral students but the management process fits the research domain of MIS. A systematic approach to managing the completion of a dissertation is described in Davis and Parker (3).

## **7. MIS DOCTORAL-LEVEL SEMINARS AND WORKSHOPS**

Doctoral students in MIS should develop, as part of their academic preparation, both a breadth of general MIS understanding and a special depth of understanding in MIS concepts, theory, frameworks, and MIS research. This usually means study beyond the standard courses. There is, of course, substantial learning that takes place informally, and through non-directed individual study. The formal mechanisms for providing depth of understanding in MIS concepts, theory, frameworks, and research are doctoral workshops and seminars.

### 7.1 WORKSHOPS

There are a variety of possible formats for doctoral-level workshops. The format that appears to be especially appropriate to development of doctoral-level research evaluation skills is a regular workshop in which research is presented. Based on the author's experience the optimal format is a requirement that the research paper be distributed in advance and that the workshop time is devoted to questions, answers, comments, etc. The atmosphere should be supportive, so that not only is completed research presented but ideas can also be presented and discussed early enough in the research cycle to benefit from the workshop results.

Another workshop idea is a current MIS literature discussion taking topics from

journals, newsletters and newspapers such as ComputerWorld, Datamation, MIS Quarterly, Harvard Business Review, Database, etc. This provides discussion of current events, current problem areas, impact of new technology, etc. Research ideas can be generated from this discussion.

### 7.2 MIS DOCTORAL SEMINARS

The MIS doctoral seminar should allow depth examination of topics, especially topics related to underlying concepts, theory, and structure for MIS. An underlying concept should be related to MIS theory, practice, and research. The seminar should be research oriented, examining prior research and developing research ideas. Students should write position papers, literature surveys, research evaluations, and research topic analyses. (For discussion of research topic analysis format, see Davis and Parker (3)).

Some examples of doctoral seminar topics that meet the objectives defined for them are:

1. Systems theory and its relationship to information systems.
2. Human behavior in acquisition and use of information.
3. Information theory, information economics, and value of information.
4. Theory and concepts underlying the processes for planning MIS systems and designing and implementing applications.

## **8. WHERE THE DOCTORATE IN INFORMATION SYSTEMS MAY BE OBTAINED**

Because of the diversity of educational combinations which may provide a doctoral program suitable for education and research in information systems, it is risky to publish a list; some very good university program will almost certainly be left out. On the other hand, even an incomplete list is probably more valuable than no list. The reader is warned that schools worthy to be on the list may be omitted. Also, I have not tried to evaluate quality or adequacy. Faculty at these schools indicate an information systems area for a doctorate, but some on the list may not be providing adequate current support for information systems doctoral work. The list shown in Table 2 has been derived from personal knowledge plus the ACM Survey of Existing Information Systems Programs Report (1) and the University of Calgary MIS area newsletter Interrupt.

Table 2

<u>University</u>	<u>Department</u>	<u>Degree</u>
University of Arizona, Tucson	Department of Management Information Systems	Ph.D.
University of British Columbia	Accounting and MIS Division	Ph.D.
University of California, Irvine	Graduate School of Administration	Ph.D.
University of California, Los Angeles	Department of Management	Ph.D.
Carnegie-Mellon	Graduate School of Industrial Administration	Ph.D.
Case Western Reserve	Management Information Decision Systems Division	Ph.D.
University of Chicago	Graduate School of Business	Ph.D.
University of Georgia	Department of Management	DBA
Georgia State University	Department of Information Systems	DBA
Harvard University	Controls, Department, Graduate School of Business	DBA
University of Houston	Department of Management	Ph.D.
Indiana University	The Graduate School of Business	DBA
University of Iowa	College of Business Administration	Ph.D.
Universite Laval, Quebec		Ph.D.
Massachusetts Institute of Technology	Sloan School of Management	Ph.D.
McMaster University		Ph.D.
University of Michigan	School of Business Administration	Ph.D.
University of Minnesota	Department of Management Sciences	Ph.D.
University of Nebraska, Lincoln	Department of Management	Ph.D.
New York University	Department of Computer Applications and Information Systems	Ph.D.
North Texas State University		Ph.D.
Northwestern University	Graduate School of Management	Ph.D.
Ohio State University	Department of Computer Information Sciences	Ph.D.

<u>University</u>	<u>Department</u>	<u>Degree</u>
University of Pennsylvania	Department of Decision Sciences	Ph.D.
University of Pittsburgh	Graduate School of Business	Ph.D.
Purdue University	Department of Computer Sciences	DCS
University of Rochester	Graduate School of Management	Ph.D.
University of Southern California	Graduate School of Business Administration	Ph.D.
University of Southwestern Louisiana	Department of Computer Sciences	DCS
Texas Technology University	Department of Information Systems and Quantitative Sciences	DBA
State University of New York at Bringhamton	School of Management	Ph.D.
State University of New York at Bringhamton	Department of Management Sciences and Management Systems	Ph.D.

## 9. SUMMARY

The paper has examined several topics related to the doctorate in MIS. The topics, with related method of analysis or conclusion, are as follows:

### Purpose of the MIS doctorate

Primarily MIS education but some consulting and business career use.

### Numbers of MIS (or near MIS) doctorates

Between 200 and 300 with current rate of 50 degrees per year.

### Variations in MIS doctorates

Considerable diversity based on college, faculty, and individual program.

### The body of knowledge

Derived from an analysis of MIS degree coverage, an analysis of an MIS research framework, an analysis of intersection with other areas, and a reading list.

### Research skill

Knowledge of research frameworks, ability to apply a research strategy, and ability to manage knowledge work.

### MIS doctoral-level workshops and seminars

Necessary to develop depth of knowledge in MIS concepts, theory, structure, and research.

### Where doctorate can be attained

Tentative list of 30 U.S. universities, that indicate they offer it.

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## APPENDIX

### AN INITIAL SET OF HIGHLY REGARDED READINGS FOR DOCTORAL CANDIDATES IN MIS ON THEORIES AND CONCEPTS RELATED TO MIS

#### CONTENT OF LIST

The attached reading list is a second draft of a partial reading list for doctoral candidates in MIS. It is a partial list in the sense that there is no attempt to include complete coverage of all topics an MIS doctoral candidate should know. Rather, only references that meet one of the two criteria are included.

1. The first or "best" exposition of an important MIS concept, theory, case situation, or set of research.
2. A significant (in clarity and/or completeness) summary or survey of an MIS topic or area of MIS theory.

#### WHAT IS NOT INCLUDED

Basic technology references are omitted because these areas are well covered by current textbooks and current survey articles. Examples of Technology and Application topic areas not included in this list are:

Computer economics

Computer hardware

System software

Data communications

Data structures/database

Programming languages

Programming and software engineering practice

Computer and software selection, pricing, cost-benefit

Performance evaluation

Review of the first draft resulted in a few items being added and a few dropped. However, the number of suggestions to be evaluated were too large and diverse to make good evaluations; an attached list includes the suggestions made but not incorporated.

#### USE OF THE LIST

Based on the reviews of the first draft of the list, it is not feasible to come up with an agreed-upon Ph.D. reading list. However, many have commented upon the value of a list. One commented on the danger of any classification. The suggested use of the list is therefore as a starting point to build a list suited to the philosophy of each school. Such a list might be developed as follows:

1. Expand or eliminate categories
2. Add references for topic areas excluded from list
3. Eliminate references considered not suitable or for which superior replacements have been added.

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#### Information Theory

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#### Systems Theory

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(References to be added)

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