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Doctor of Philosophy in Computer Science

Computing Handbook, Third Edition
Information Systems and
Information Technology

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“I do hereby attest that I am the sole author of this report and that its contents are only the result of my reading of the above mentioned textbook.”

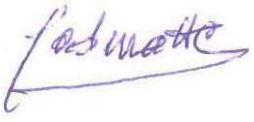
Signature: 

TABLE OF CONTENTS

PART 1 DISCIPLINARY FOUNDATIONS AND GLOBAL IMPACT

1.1 EVOLVING DISCIPLINE OF INFORMATION SYSTEMS

This chapter wants to provide its readers with an overview of the topics that have been most influential in the course of the history of the Information System field. Second, the chapter introduces a contextual structure that helps in positioning the chapters in this volume in the broader context of the field. Both the analysis of the highly cited articles and the review of the broad conversations provide insights regarding the topics that the field itself and those using its results have considered most important.

1.2 DISCIPLINE OF INFORMATION TECHNOLOGY

IT, as an academic discipline, is concerned with issues related to advocating for users and meeting their needs within an organizational and societal context through the selection, creation, application, integration and administration of computing technologies. IT is primarily focused on integration and system-type thinking in computing. Its purview includes anything in computing, but it is generally not deep in any single domain of computing.

1.3 INFORMATION SYSTEMS AS A PRACTICAL DISCIPLINE

The present chapter argues that Information System is as a practical discipline of computing that specifically focuses on IT applications, on their

development, use, and impact at individual, group, organizational, community, society, and global levels

1. The chapter encourages IS researchers to seek technological continuities and invariants in order to foster a cumulative research tradition in this world of technological change
2. The chapter advices IS researchers to identify the extra-scientific practices research aims at supporting and the associated actor groups to be informed
3. The chapter proposes that design of IT applications should be a central topic of IS research, because it is the key practice to be supported by IS research and because design of IT applications essentially affects the quality of IT applications and their success.
4. The chapter suggests that IT applications can be conceptualized in terms of designable qualities.

1.4 INFORMATION TECHNOLOGY: PRINCIPLES, METHODS, AND THEORY

Information technology (IT), in the narrow sense in which the term is used in particular in North America, is the newest computing discipline to emerge over the past 20 years or so. “Information technology” is defined as follows by Lunt et al.
IT, as an academic discipline, is concerned with issues related to advocating for users and meeting their needs within an organizational and societal context through the selection, creation, application, integration and administration of computing technologies.

1.5 SOCIOTECHNICAL APPROACHES TO THE STUDY OF INFORMATION SYSTEM

The sociotechnical premise can be articulated as

1. The mutual constitution of people and technologies
2. The contextual embeddedness of this mutuality
3. The importance of collective action

Our goal in writing this chapter is to encourage scholars to move beyond this rhetorically pleasant articulation of sociotechnical thinking toward more deliberate conceptual development, increased empirical activity, and greater methodological capacity.

Chern's Principles of Sociotechnical Systems	
Compatibility	The design process should be compatible with its objectives
Minimal critical specification	No more should be specified than is absolutely essential
The sociotechnical criterion	Variances, as deviations from expected standards, must be kept as close to their point of origin as possible
Multifunctionality principle	In order for groups to respond to the changing work
Boundary location	Boundaries exist where work activities pass from one group to another and where a new set of skills is required
Information	Information must reside where it is principally needed for action
Support congruence	A social support system must be in place to enjoin the desired social behaviors
Design and human values	High-quality work involves 1. Jobs to be reasonably demanding 2. Opportunity to learn 3. An area of decision-making 4. Social support 5. The opportunity to relate work to social life 6. A job that leads to a desirable future
Incompletion	Practitioners must recognize the fact that the design in an iterative process

1.6 IT AND GLOBAL DEVELOPMENT

The increasing role of information technology (IT) in global development has a fascinating history, especially from the viewpoint of information systems. Moreover, the foreseen impact of IT and global development on the discipline of computing by the underlying principles of modeling, design, abstraction and encounter.

1. *Modeling* emphasizes the empirical orientation in the context. The interdisciplinary orientation that is required for IT to make a difference in a given context strengthens the role of humanities in the discipline
2. *Participatory design* generates unconventional crosses between disciplines. Environmental challenges in developing contexts and the demand for renewable local energy connect IT to forestry.
3. *In the area of abstraction,* digital storytelling generates novel representations for IT. The contextual orientation transforms usability toward cultural usability, and replaces the idea of localizing universal services to contextualization that starts from the requirements of a given context

4. *Encounter* emphasizes ethics and an anthropological orientation throughout the discipline.

1.7 USING ICT FOR DEVELOPMENT, SOCIETAL TRANSFORMATION, AND BEYOND

Over the past decade, Egypt has made significant progress toward realizing the vision of the knowledge society through ICT. The developments of the initial phase addressed legal, technical, and business fundamentals, enabling the ICT industry to develop significantly. The national ICT Action Plan 1999-2009 was realized in many ways over the past decade. This action plan, set shortly after the establishment of MCIT, aimed to build a knowledge-based society that can boost socioeconomic development and entire economic growth. The plan identified eight goals:

1. *Completing the ICT infrastructure build-up*
2. *Realizing info structure interconnectivity*
3. *Linking Egypt locally and globally*
4. *Investing in human capital*
5. *Building an electronically ready community*
6. *Updating Egypt's information infrastructure*
7. *Encouraging an ICT export industry*
8. *Collaborating through public-private partnerships*

PART 2 TECHNICAL FOUNDATIONS OF DATA AND DATABASE MANAGEMENT

2.1 DATA MODELS

Modeling s done at three levels of abstraction: physical, logical, and view.

- The physical level describes how data are stored at a low level
- The logical level describes the real-world entities to be modeled in the database and the relationship among these entities
- The view level describes only a part of the entire database and serves the needs of users who do not require access to the entire database

2.2 TUNING DATABASE DESIGN FOR HIGH PERFORMANCE

This chapter introduces a principled foundation for tuning, focusing on principles that have been robust for years and promise to still hold true for years to come. Database are used for two purposes: on-line transaction processing and

decision support. Having divided the database applications into two broad areas, we can now discuss what slows them down.

1. *Random vs. sequential disk accesses*
2. *Lack of parallelism*
3. *Imprecise data searches*
4. *Many short data interactions, either over a network or to the database*
5. *Delays due to lock conflicts*

2.3 ACCESS METHODS

In this chapter, we discuss the most important issues related to the design of efficient access methods which are the fundamental tools in database systems for efficient query processing.

The two dominant categories of fundamental external memory indexing methods are tree-based methods and hash-based methods. Access methods are necessary toward efficient query processing. The success of an access method is characterized by its ability to organize data in such a way that locality of references is enhanced. This means that data that are located in the same block are likely to be requested together.in this chapter as well, we discussed R-trees, which is the most successful family for indexing spatial and other types of multidimensional data. Finally, we touched the issues of on-line and adaptive indexing, which enjoy a growing interest due to the ability to adapt dynamically based on query workloads

2.4 QUERY OPTIMIZATION

The query optimizer searches a large space of alternatives and chooses the one that is expected to be least expensive to evaluate. Query optimization is absolutely necessary in a DBMS because the difference in runtime among alternatives and thus the overhead of a bad choice can be arbitrarily large. The task of an optimizer is nontrivial given the large number of execution plans for an input query, the large variance in response time of the plans in the search space, and the difficulty of accurately estimating costs. A desirable optimizer is one for which

(i) The search space includes low-cost plans

(ii) The cost model is accurate

(iii) The enumeration strategy is efficient

2.5 CONCURRENCY CONTROL AND RECOVERY

Two of the core functions of DBMS are

1. To protect the data stored in the database
2. To provide correct and highly available access to those data in the presence of concurrent access by large and diverse user populations, despite various software and hardware failures.

Concurrency control ensures that individual users see consistent states of the database even though operations on behalf of many users may be interleaved by the database system. Recovery ensures that the database us fault-tolerant, that is, that the database state is not corrupted as the result of a software, system, or media failure. Transaction execution are said to respect the atomicity, consistency, isolation and durability (ACID) *properties.*

2.6 DISTRIBUTED AND PARALLEL DATABASE SYSTEMS

A parallel computer, or multiprocessor, is itself a disturbed system made of a number of nodes connected by a high-speed network within a cabinet. Distributed database technology can be naturally extended to implement *parallel database systems,* that is, database systems on parallel computers. Parallel database systems exploit the parallelism in data management in order to deliver high performance and high-availability database servers.

A distributed database is a collection of multiple, logically interrelated database distributed over a computer network. A distributed database system is defined as the software system that permits the management of the distributed database and makes the distribution transparent to the users.

2.7 MULTIMEDIA DATABASES

In this chapter, we have surveyed multimedia databases in terms of data analysis, data querying, and indexing. In multimedia databases, raw multimedia data are unfortunately of limited use due to its large size and lack of interpretability. Consequently, they are usually coupled with descriptive data obtained by analyzing the raw media data. Various types of features and concepts related to image, video and audio data are thus required along with some popular techniques for extracting them. Some latest work on integrating multiple media modalities to better capture media semantics has also been reviewed.

Retrieving a specific image, video, or song that a user has in mind remains a challenging task. Currently, the search relies more on metadata than on the media content. The general problem with images and videos is that their digital representations do not convey any meaningful information about their content. Often to allow semantic search, an interpretation must be added to the raw data, either manually or automatically. Manual annotation of images and videos is tedious, and automatic inference of the semantic of images and videos is not always accurate. Multimedia data annotation is still an active research topic, and existing approaches motivate users either to annotate images by simplifying the procedure or to annotate images in an automatic or semiautomatic way.

PART 3 DATA INFORMATION, AND KNOWLEDGE MANAGEMENT

3.1 BUILDING CONCEPTUAL MODELING ON THE FOUNDATION OF ONTOLOGY

Conceptual models provide a representation, often graphical, of some features of real-world domain. The conceptual modeling techniques that have been proposed over the years tend to fall into one of two categories. The first category primarily provides constructs to model *substance and form in the real world.* The second category of conceptual modeling techniques that have been developed primarily provides constructs to model *possibility and change in the real world.*

Building conceptual modeling on the foundation of ontology is now an accepted approach in the conceptual modeling field. The purpose of this chapter, therefore, is to provide an overview of this approach, describe two theories used by researchers that are based on ontology, and illustrate the kinds of the results that have emerged from empirical investigations of these theories. Specifically, we have discussed how two theories that reply on ontological foundations have been used to predict, explain, and understand conceptual modeling phenomena. The first is TOE (*theory of ontological expressiveness),* which allows the ontological completeness and clarity of conceptual modeling grammars to be evaluated. The second is TMGS (*theory of multiples grammar selection),* which assists stakeholders to decide which combinations of conceptual modeling grammars they should use to undertake conceptual modeling work.

3.2 DATA AND INFORMATION QUALITY RESEARCH: ITS EVOLUTION AND FUTURE

Organizations have increasingly invested in technology and human resource

to collect, store, and process vast quantities of data. Even so, they often find themselves stymied in their effort to translate this data into meaningful insights that they can use to improve business processes, make smart decisions, and create strategic advantages.

Framework for Characterizing Data Quality Research

It was adapted from ISO 9000 based on an analogy between physical products and data products. The framework consisted of seven element that impact data quality:

1. *Management and responsibilities*
2. *Operation and assurance costs*
3. *Research and development*
4. *Production*
5. *Distribution*
6. *Personnel management*
7. *Legal function*

Looking ahead, we anticipate that data quality research will continue to grow and evolve. In addition to solving existing problems, the community will face new challenges arising from ever-changing technical and organizational environments. For instance, most of the prior research has focused on the quality of structured data.

3.3 KNOWLEDGE MANAGEMENT

Knowledge management (KM) refers to the multiple processes that support the creation and use of knowledge in an organization. KM is relevant to the information systems (IS) discipline, because information and communication technologies (ICT) are important tools involved in managing knowledge, especially given the increasingly distributed nature of organizational activity.

Knowledge management (**KM**) is the process of capturing, developing, sharing, and effectively using organizational knowledge. It refers to a multi-disciplined approach to achieving organizational objectives by making the best use of knowledge.

3.4 DIGITAL LIBRARIES (DL)

DL Definitions

1. “A digital library is an assemblage of digital computing, storage and communications machinery together with the content and software needed to reproduce, emulate and extend the services provided by conventional libraries, based on paper and other material means of collecting, cataloging, finding and disseminating information”
2. “A set of electronic resources and associated technical capabilities for creating, searching and using information.”
3. “Digital libraries are a focused collection of digital objects, including text, video and audio along with methods for access and retrieval and for selection, organization and maintenance of the collection”

3.5 KNOWLEDGE DISCOVERY AND DATA MINING

Knowledge discovery and data mining, which is often referred to as knowledge discovery from data (KDD), is a multidisciplinary field bringing together several disciplines, including computer science, information systems, mathematics, and statistics.

The field emerged in response to the demand for knowledge management and decision support based on large volumes of data in business, medicine, sciences, engineering, and many other domains.

KDD Process

1. *Data*
2. *Cleaning and integration*
3. *Selection and transformation*
4. *Data mining*
5. *Evaluation and presentation*

- Association Mining
- Classification and Prediction
- Clustering
- Outlier Analysis
- Other Data Mining Types
  - Text mining
  - Web mining
  - Network mining

3.6 BIG DATA

Big data refers to data sets whose size is beyond the ability of typical database software tools to capture store, manage and analyze.

The big data sources we will cover include

- *Auto insurance: the value of telematics data*
- *Multiple industries: the value of text data*
- *Multiple industries: the value of time and location data*
- *Retail and manufacturing: the value of radio-frequency identification(RFID) data*
- *Utilities: The value of smart-grid data*
- *Gaming: the value of casino chip tracking data*
- *Industrial engines and equipment: the value of sensor data*
- *Telecommunications and other industries: the value if social network data*

3.7 GOVERNANCE OF ORGANIZATIONAL DATA AND INFORMATION

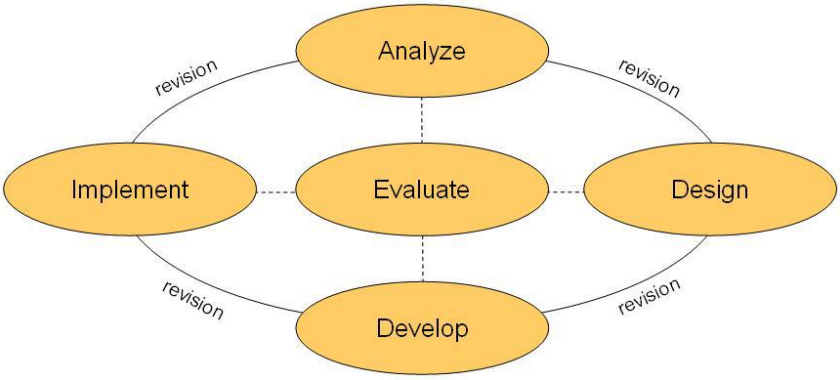
A governance program is used to define the decision-making processes and authority around a specific domain. In other words, a governance program is about deciding how to decide in order to be able to handle complex situations or issues in the future in the most controlled and efficient way possible.

PART 4 ANALYSIS, DESIGN, AND DEVELOPMENT OF ORGANIZATIONAL SYSTEMS

4.1 DESIGN SCIENCE RESEARCH

Design Science Research (DSR) in computing technology and systems (ICTS) fields involve the construction of a wide range of socio-technical artifacts such as decision support systems (DSSs), modeling tools, and governance strategies, methods for software systems development and evaluation, and system change intervention.

DSR Process Models



- Activity 1: Problem identification and motivation
- Activity 2: Define the objectives for a solution
- Activity 3: Design and development
- Activity 4: Demonstration
- Activity 5: Evaluation
- Activity 6: Communication

4.2 IDENTIFYING OPPORTUNITIES FOR IT-ENABLED ORGANIZATIONAL CHANGE

In this chapter, we look at the ways we allow for what Markus (2004) calls techno change to happen more often. Techno change means that instead of limiting scope of change to process and technology modification, organizations should link the technical elements to the social, personal, and political aspects of the units and individuals who are undergoing the change. We identified the possibilities IT creates in organizational transformation processes. It was found that IT has two roles in the transformation: it helps to implement change into the core operations of the company through Enterprise Systems and architecture, and it helps by allowing future change through improvising at the edges of the systems.

4.3 DECONSTRUCTING ENTERPRISE SYSTEMS

Enterprise systems (ES) are packaged systems serving a wide range of functions in organizations. Such enterprise-wide systems are designed to achieve scalable intra-unit integration and rapid dissemination of information.
ES applications are industry-specific, customizable software packages that integrate information and business processes in organizations.

4.4 ENTERPRISE ARCHITECTURE

Enterprise Architecture (EA) evolved into an extensive domain with numerous approaches and frameworks. A core characteristic of EA is that it enables and supports constant transformations of an enterprise from a current to a target state.

Business architecture, the top layer of Enterprise Architecture. Typically contains business processes/services, organizational structures, and value drivers, which are aligned to a strategy divided into goals and objectives.
Business architecture marks the foundation of effective BITA, and sample scenarios in business architecture context include the following:

- Mergers and acquisition planning and developments
- Business unit consolidation
- New product and service rollouts
- Introduction of new lines of business
- Consolidating suppliers across supply chains
- Outsourcing business functions
- Divesting business lines
- Management changes
- Regulatory compliances
- Operation cost reductions
- Federated architecture alignments in government
- Business transformations
- Entering international markets

4.5 BUSINESS PROCESS MANAGEMENT AND BUSINESS PROCESS ANALYSIS

The Business Process Management, as it is understood today, evolved around two main strands.

- *Continuous change*
- *Radical change*

Core Elements of Business Process Management

From research on maturity models, six central core elements for BPM were derived:

- ***Strategy**:* Process management needs to be guided by strategic organizational goals
- ***Governance**:* Process management needs to be rooted in the organizational structure
- ***Methods**:* Process management needs methods for process design supporting different phases of process development
- ***Technology**:* Process management needs to be supported by technology, particularly information technology (IT), as the basis for process design
- ***People**:* Process management needs certain capabilities and skills on the part of an organization's staff
- ***Culture**:* Process management needs a common value system in order to effect certain changes required

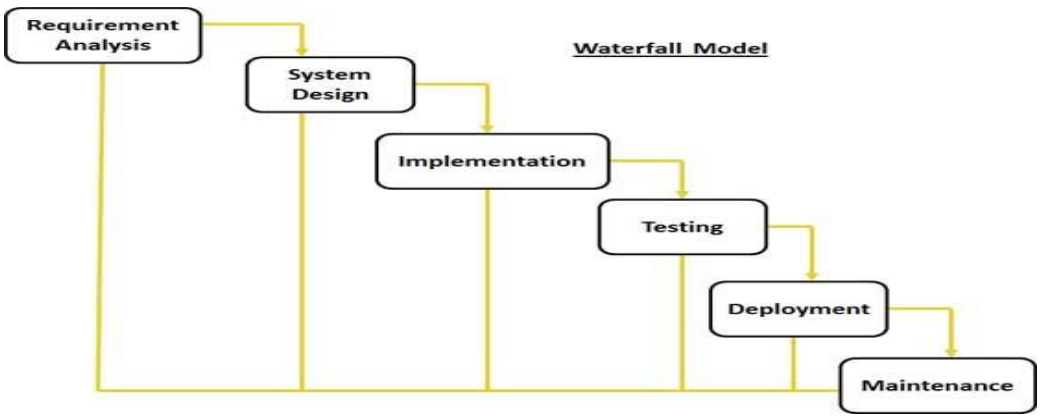
4.6 INFORMATION REQUIREMENTS DETERMINATION

Information requirements determination is the process of eliciting, representing, and verifying the functional and nonfunctional needs for an information system. More broadly, IRD is a form of needs analysis, an activity required in any designed artifact, ranging from consumer to software to industrial processes.

The importance of IRD to systems development is difficult to overstate. Because the IRD process occurs early in development and determines the needs for the system, all remaining activities in development, from modeling to design to coding to implementation, depend on specifying requirements that are as accurate and complete as possible. Elegantly designed system that do not meet user requirements will not be used. Queries to databases that do not contain information users need will not be made.

4.7 FROM WATERFALL TO AGILE:

The Waterfall Model was first Process Model to be introduced. It is also referred to as a **linear-sequential life cycle model**. It is very simple to understand and use. In a waterfall model, each phase must be completed fully before the next phase can begin. This type of model is basically used for the project which is small and there are no uncertain requirements. At the end of each phase, a review takes place to determine if the project is on the right path and whether or not to continue or discard the project. In this model the testing starts only after the development is complete. In **waterfall model phases** do not overlap.



The agile methodologies share 12 principles which can be summarized in three key points:

1. A focus on adaptive rather than predictive methodologies

2. A focus on people rather than role
3. A focus on self-adaptive processes

4.8 HUMAN-CENTERED SYSTEM DEVELOPMENT

At the most basic level, the output from any development project emerges from the conversations and collaboration among individuals working together over time. As such, success can be influenced by the ability to manage the following types of human dynamics:

- *Individual development*
- *Team collaboration*
- *User communication*

4.9 DEVELOPING AND MANAGING COMPLEX, EVOLVING INFORMATION INFRASTRUCTURES

The Software Engineering Institute (SEI) at Carnegie-Mellon University describes this trend as the emergence of ultra-large-scale (ULS) systems. The report argues that these ULS systems will push far beyond the size of today's systems and systems of systems by every measure:

- Number of technological components of various kinds
- Number of people and organizations employing the system for different purposes
- Number of people and organizations involved in the development, maintenance, and operations of the systems
- Amount of data stored, accessed, manipulated, and refined
- Number of connections and interdependencies among the elements involved

4.10 IMPACT OF CULTURE ON INFORMATION SYSTEMS DESIGN AND USE

This chapter emphasizes website design as the medium of communication in e-business. For several years, researchers have examined the effectiveness of website design related to culture, and the subsequent impact on user trust and e-loyalty in e-business.

These investigations are a reasonable proxy for the impact of culture on information system design and use more generally. Therefore, this chapter aims to contribute to understanding website design elements, which facilitate e-business success in diverse cultural settings, since a primary goal of e-business vendors us to solicit e-business success in diverse culture setting.

PART 5 HUMAN-COMPUTER INTERACTION AND USER EXPERIENCE

5.1 USABILITY ENGINEERING

First, Human Computer Interaction was conceived of as an area in which new science and theory would emerge and develop, not merely as an application area for existing basic knowledge.

Second, Human Computer Interaction was conceived of as an area in which new models and techniques for software design and development would emerge and develop, not merely as a project to enrich or improve existing software development models.

Third, Human Computer Interaction was conceived of as a technology area in which new user interface software and new applications, new software architecture and tools, and even entirely new types of software would be developed and investigated.

5.2 TASK ANALYSIS AND THE DESIGN OF FUNCTIONALITY

The purpose of this chapter is to provide some historical and theoretical background, and beginning “how to” information on how to conduct a task analysis and how to approach the design of functionality.

A task analysis presupposes that there already exists some method or approach for carrying out the work, involving some mixture of human activity and possible machine activity. The method may have existed for a long time, or might be a new, even hypothetical, method based on new technology. The goal of the initial task analysis is to describe how the work is currently being done in order to understand how computing may improve it.

Role of Task Analysis in Development

- *Development of Requirements*
- *User Interface Design and Evaluation*
- *Follow-Up after installation*

5.3 DESIGNING MULTIMEDIA APPLICATIONS FOR USER EXPERIENCE

In this chapter, the author takes a User Experience UX-oriented view of multimedia, so interaction will be treated as one medium in the multimedia design space.

This chapter has four aims:

1. Describe the properties of media resources and how they are used in design
2. Propose design guidelines for conveying information in multimedia

3. Explain the concept of UX and its relationship to interactive multimedia
4. Propose multimedia design guidelines for UX

5.4 APPLYING INTERNATIONAL USABILITY STANDARDS

Usability has become recognized as a major factor in determining the acceptance of information systems. Poor usability has been identified as a significant cause of system failure – from large-scale government systems to small bespoke developments. The expanding use of information technology in all types of consumer products from music players and mobile phones to websites and washing machines has brought usability into even sharper focus.

Using Standards to Support Human-Centered Design

They have to ensure that they

- Understand and specify the context and use (including users, tasks, environments)
- Specify the user requirements in sufficient detail to drive the design
- Produce design solutions which meet these requirements
- Conduct user-centered evaluations of these design solutions and modify the design taking account of the results

5.5 DESIGNING HIGHLY USABLE WEB APPLICATIONS

This chapter introduced a usability inspection strategy that can be integrated into specific model-driven web development methods to produce highly usable Web applications. This strategy relies on a usability model that has been developed specifically for the Web domain and which is aligned with the Square standard to allow the iterative evaluation and improvement of the usability of web-based applications at the design level.

Usability Attributes

- *Appropriateness recognizability*
- Learnability
- *Operability*
- *User error protection*
- *Accessibility*
- *User interface aesthetics*
- *Compliance*

5.6 TRANSFORMING HCI: THE ART, SCIENCE, AND BUSINESS OF USER EXPERIENCE **Design**

This chapter examines changes in the marketplace for technology products

over the past 30 years and proposes transforming our traditional human computer interaction (HCI) framework based on an expanded perspective offered by user experience research and design.

Changing Market Conditions

Three dominant market forces contributed to this evolution:

1. The evolving expectations of users
2. The expanding diversity of the user community
3. The growing application of technology in all aspects of our lives

Ethics and Unintended Consequences

- Accommodating and Influencing User's Behavior
- Human Cost of Automation and Devaluing Work
- Deskilling
- Erosion of privacy
- Dangers of Distraction

PART 6 USING INFORMATION SYSTEMS AND TECHNOLOGY TO SUPPORT INDIVIDUAL AND GROUP TASKS

6.1 INDIVIDUAL LEVEL TECHNOLOGY ADOPTION RESEARCH

Strenths, Weaknesses, Opportunities, and Threats for Current Technology Adoption Research	
Strengths	Remains a highly influential body of work within the IS discipline
	Investigates a problem important to researchers and managers
	Integrates disparate bodies of research
	Applies to many different technology contexts
	Provides a well-understood model
	Explains a high percentage of variance in intentions and use
	Is easily applied and modified
Weaknesses	Does not offer direct design guidance for improving system acceptability
	Emphasizes the importance of perceptions over actual behavior
	Focuses on use as the primary dependent variable of interest
Threats	Creating and reinforcing a dominant theoretical paradigm
	Creating and reinforcing a dominant methodological paradigm
	Propagating the perception that there is nothing new to be learned
	Stifling scientific creativity and innovation
	Finding ways to demonstrate a significant contribution
	Becoming stuck in the normal science phase
Opportunities	

In this chapter, we have made a case for the continued relevance and vitality of the technology adoption research stream. In so doing, we acknowledge many of the

criticisms that have recently been levied at research in the area and agree with the broad conclusion that this important stream of research runs the danger of becoming stagnated unless we, as a community of researchers, can harness our creative talents to reinvigorate research in the domain.

6.2 COMPUTER SELF-EFFICACY

The study of both Computer Self-Efficacy (CSE) and GCSE has had a significant impact on both the applied and academic communities. Given the known relationship to performance, the applied community has a powerful tool to effect improvements to computer-related task performance throughout its workforce.

The CSE construct, and its related general level, has enjoyed, and continues to enjoy, a rich nomological net developed from a wide variety of disciplines and empirical studies. Further, it stands as one of the few academic foci that can be easily extended into the applied realm to effect material changes and value with regard to the continued development of computer-related skill sets.

6.3 DEVELOPING INDIVIDUAL COMPUTING CAPABILITIES

Individual computing capabilities development continues to be a rich area of investment for enhancing the productivity of individuals, with over 38% of all training directed toward IT training. With an increasing percentage of both large and small businesses using computer applications in their daily work, this trend is likely to continue.

Defining Individual Computing Capabilities

Individual computing capabilities can be classified into four categories:

1. Skill-based capabilities
2. Cognitive capabilities
3. Affective capabilities
4. Metacognitive capabilities

6.4 ROLE OF TRUST IN THE DESIGN AND USE OF INFORMATION TECHNOLOGY AND SYSTEMS

Trust research has its long history in sociology, psychology, and business fields. Numerical research have suggested that trust is a key to understanding social relationships, as well as people's attitude and behaviors in the circumstances that uncertainty and/or risks are perceived.

This chapter tries to close this gap by providing an overarching framework of trust in IT/IS contexts. The framework integrates various trust constructs and

concepts studied in previous research, including interpersonal trust, technology trust, trust levels, trust developing stages, trust antecedents, and trust outcomes.

6.5 IMPACTS OF INFORMATION SYSTEMS ON DECISION-MAKING

Our treatment of computer-aided decision making has been largely limited to MIS research. However, we hope our treatment effectively illustrates the complexity of computer-aided decision-making.

Phases of Decision-Making and Technology Support

- *Information acquisition*
  - *It deals primarily with sensory processing as decision makers gather information about their surrounding environment through sensory receptors*
- *Information analysis*
  - *Information is selectively and consciously perceived, and then processed. Information analysis "involves cognitive functions such as working memory and inferential processes"*
- *Decision selection*
  - *A single option is selected from among the decision alternatives. The role of the decision aid in this stage of the decision process involves "varying levels of augmentation or replacement of human selection of decision options with machine decision making*
- *Action implementation*
  - *Action implementation is the execution of the selected decision. Action implementation has not received as much attention in MIS research as the previous three stages of computer-aided decision making.*

6.6 COMPUTER-SUPPORTED COOPERATIVE WORK

Computer-supported cooperative work (CSCW) is a field of research addressing the intersection of collaborative behaviors and technology. CSCW includes collaboration among a few individuals, within teams, within and between organizations, and within online communities that may span the globe.

Classes of Collaboration Context

- *Small groups*
  - *Collaborating in the same location at the same time by speaking to one another and by creating and sharing artifacts retained in the room*
- *Organizations*
  - *It facilitates coordinated action across all members*
- *Communities*
  - *Are collections of people with common interest*

6.7 INFORMATION TECHNOLOGY FOR ENHANCING TEAM PROBLEM SOLVING AND DECISION MAKING

This chapter addresses how organizations can enable teams to be more productive with collaboration technology. We first present a classification of the different types of collaboration technologies that organizations can use. Then, we introduce a model of team processes that describes the fundamental patterns of collaboration that teams can engage in, regardless of whether they use collaborative software applications or not.

Classification of Collaboration Technologies

Categories	Description
Jointly authored pages	Technologies that provide one or more windows that multiple users may view, and to which multiple users may contribute, usually simultaneously
Conversation tools	Optimized to support dialog among group members
Shared editors	
Group dynamic tools	
Streaming technologies	Technologies that provide a continuous feed of changing data
Information access tools	Technologies that provide group members with ways to store, share, find, and classify data object
Shared file repositories	
Social tagging systems	
Search engines	
Syndication tools	
Aggregated Systems	Technologies that combine other technologies and tailor them to support a specific kind of task

Types of Team Work: Patterns of Collaboration

There are six different patterns of collaboration:

- Generate
- Reduce
- Clarify
- Organize
- Evaluate
- Build commitment

6.8 ORGANIZATIONAL ADOPTION OF NEW COMMUNICATION TECHNOLOGY

Time has changed. A wave of popular new communication technologies followed e-mail. Instant and text messaging, wikis, blogs and microblogs, social networking sites, video – many with free versions that employees can download,

access via browsers, or bring in on smart phones. Many are used first for personal tasks. Work-life boundaries are blurring.

The changed dynamic has benefits for an organization – acquisition and training costs are lower than they once were. It also creates challenges: Employees' preferences and behaviors can conflict with a planned deployment or produce a de facto deployment that takes management by surprise.

This chapter focuses not on architecture and only a little on design; mu concern is organizational use of messaging, wikis, weblogs, and social networking sites – communication technologies that support information sharing and coordination as well.

6.9 SOCIAL MEDIA USE WITHIN THE WORKPLACE

The purpose of this chapter is to provide a starting point for scholarship on Social Media with the workplace by discussing the current state of research in this area. Workplace Social Media research deals with how organizations implement social media to manage their internal operations such as employee relationships, communication, knowledge management and innovation. This differs from external Social Media implementations, which deal with organizations using social media to manage customers, suppliers, and business partners.

PART 7 MANAGING AND SECURING THE IT INFRASTRUCTURE AND SYSTEMS

7.1 VIRTUALIZATION OF STORAGE AND SYSTEMS

Virtualization is the abstraction of physical components, such as CPU, and storage, into logical management entities. In other words, virtualization provides an additional layer of *indirection* that separates the actual resource pool from the management function, in order to achieve better system utilization with improved manageability.

Types of Virtualization

Virtualization provides a logical abstraction of the physical resources in a variety of forms such as host machine hardware, networking resources, and storage capacity, among many others.

- *Platform Virtualization*

  - *According to the methods of interaction with host hardware platform, hypervisor can be categorized into two major classes, bare metal* hypervisor and *hosted hypervisors*
- *Storage Virtualization*
  - *Storage virtualization is the abstraction and aggregation of physical storage capacity from multiple devices for efficient allocation and management in a coordinated way*
- *Network Virtualization*
  - *Network virtualization is the abstraction of network resources, such as routers and switches, as well as the physical network link bandwidth, into a logical slice of resources*

7.2 CLOUD COMPUTING

the U.S. National Institute for Standards and Technology defined cloud computing as *a model for enabling ubiquitous, convenient, on-demand network access to a shared to a shared pool of configurable computing resources (e.g, networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.* According to NIST, clouding computing should exhibit the following "essential characteristics":

- *On-demand self-service*
- *Broad network access*
- *Resource pooling*
- *Rapid elasticity*
- *Measured service*

Cloud computing is becoming a computing style of choice by users, a dominant mode of computing within small- and medium-sized businesses, and a key component of the computing portfolio of large enterprises.

7.2 Enterprise Mobility

Enterprise mobility – the organizational application of mobile and ubiquitous information technologies is a significant, yet under researched, area of computing. The challenges for practitioners and academics alike are to understand the specific opportunities and challenges imposed by this technological development and the associated organizational practices.

7.3 SUSTAINABLE IT

Sustainable IT is the design, production, operation, and disposal of IT and IT-

enabled products and services in a manner that is not harmful and may be positively beneficial to the environment during the course of its whole-of-life.

Two Faces of Sustainable IT

Sustainable IT is a broad topic that can have many motivations including:

- Self-interest (image, competitive advantage, innovation)
- Social, cultural, and political influence
- Regulatory and compliance requirements
- Environmental concerns
- Economic benefit

7.4 BUSINESS CONTINUITY

Business continuity (BC) or business continuance is a general term that emphasizes the ability of a business to continue with its operations and services even of some sort of failure or disaster on its business with regard to capability of its computing platform occurs. Therefore, BC is rather to be defined as an ultimate objective of modern business with regard to capability of its information system to provide both continuous computing and business resilience.

Business Continuity Defined

Today's IT-related threats/risks that may cause system unavailability and hence affect the business can be classified into the following major categories:

- *Technical glitches*
- *Physical damage*
- *Operating system crashes*
- *Internal threats*
- *External threats (hacking)*
- *File or process-based problems*
- *LAN/WAN/Internet disconnections*
- *Loss or leaving of key IT personnel*
- *Natural threats such as fire, earthquake, hurricane*

7.5 TECHNICAL FOUNDATIONS OF INFORMATION SYSTEMS SECURITY

Computer security addresses policies and mechanisms to protect automated computer systems so that the confidentiality, integrity, and availability of their resources are protected. These resources can be software (the OS and application programs), firmware, hardware, information and data and all networked

communication between two end systems.

Why is Securing a System hard?

First, systems will never be vulnerability-free because they are becoming more and more complex and diverse and are devised by humans, who are likely to introduce flaws in the system. Another challenge, is that the problem of checking if a piece of code contains malicious logic is undecidable. Also computer security is an arms race between attackers and security researchers and engineers.

7.6 DATABASE SECURITY AND PRIVACY

The goal of this chapter is to provide an overview of the main data security and privacy issues that characterize the two scenarios mentioned previously along with possible approaches for their solution. For each problem considered, we also briefly mention some open issues that still need further consideration and analysis. Clearly, since the data outsourcing and data publishing scenarios have some similarities, we also describe the main issues that are common to the two scenarios.

7.7 BEHAVIORAL INFORMATION SECURITY MANAGEMENT

Modern organizations' critical dependencies on information assets have resulted in information security being included among the most important academic research issues within the field of information systems.

The four goals of the management and protection of information assets are to ensure their confidentiality, integrity, availability, and accountability throughout the organization.

The external threat that can harm the organization can be divided into three categories

- *The first category of perpetrators within the external human threat is made of individuals believed to be fueled by curiosity, boredom, and the need for notoriety.*
- *The second category of external human threat perpetrators is made of individuals fueled by the promise of financial gain.*
- *The last category of perpetrators within the external human threat is made of individual whose intent is that of activism or covert operations performed by governments*

7.8 PRIVACY, ACCURACY, AND ACCESSIBILITY OF DIGITAL BUSINESS

In the early 2000s, marketing organizations started categorizing end users based on their inherent privacy beliefs. Overall, there are three basic categories:

1. *Privacy fundamentalists are the users who do not see any benefit in disclosing any personal or sensitive information*
2. *Privacy pragmatists are those users who undertake a cost-benefit analysis to the collect of their personal information*
3. *Privacy unworried are users who are unconcerned in general with how organizations use their personal information*

Protecting Users

7.9 DIGITAL FORENSICS

The overall objective of digital forensic analysis is to reconstruct a chain of events that have resulted in the currently observable state of a computer system or digital artifact. The purpose of the analysis is to help answer six basic questions that arise in most inquiries: what happened? Where did it happen? When did it happen? How did it happen? Who did it? Why did they do it?

PART 8 MANAGING ORGANIZATIONAL INFORMATION SYSTEMS AND TECHNOLOGY CAPABILITIES

8.1 ORGANIZING AND CONFIGURING THE IT FUNCTION

Centralized Model

In a centralized model, most IT decision rights are allocated to the corporate level and IT resources are reporting to a central IT unit subordinate to corporate control while serving multiple business units.

Decentralized Mode

In a decentralized model, business unit make IT decisions and are also responsible for managing IT resources. In the pure decentralized model, a central IT

unit does not exists, which means that today it can be viewed as an almost "anarchic" configuration, with no or little coordination on a corporate level.

8.2 TOPICS OF CONVERSATION: THE NEW AGENDA

Most businesses could not survive for very long without their IT systems. Hi-Impact CIOs recognize this and to improve involvement and engagement have engineered subtle shifts in their conversations with CxO colleagues. These shifts establish a new agenda for the cIO, one built around conversations focused on: co-evolution, business priorities, value realization, shaping change, business capability, information exploitation, IT governance as behavior and running IT for the business.

8.3 INFORMATION TECHNOLOGY MANAGEMENT FRAMEWORKS:

This chapter provides an overview of IT management frameworks with a particular focus on frameworks that support three specific IT management areas: (a) *IT governance,* (b) *IT service,* and (c) *IT security.*

Emergence of IT Management Frameworks

IT Management Frameworks	Definition	Example
IT governance frameworks	Frameworks that help organizations define and manage leadership and organization's IT sustains and extends the organization's strategies and objective	• COBIT
IT service management (ITSM) framework	Frameworks that help organizations ensure that the IT services are aligned to the business needs and actively support them	• ITIL • ISO 20000 • ISO/IEC 27000 series
Information security management	Frameworks that offer best practice recommendations on information security management, risks, and control within the context of an overall information security management system (ISMS)	
IT project management frameworks	Frameworks that provide standardized methodology, guidelines, rules, and characteristics for IT project management	• PMBOK (project management Body of Knowledge) • PRINCE2

8.4 SOURCING INFORMATION TECHNOLOGY SERVICES

Information technology (IT) sourcing is the acquisition of resources, including human capital resources, to deliver IT services such as application development, application support, systems integration, data management, data center

management, telecommunications and network management, and distributed computing.

8.5 IS/IT PROJECT MANAGEMENT: THE QUEST FOR FLEXIBILITY AND AGILITY

This chapter explores IS/IT project management in contemporary firms. We start by considering the underlying principles of IS/IT project management. This includes an overview of modern project management as well as a detailed examination of the context of IS/IT projects, with a particular focus on flexibility and agility.

8.6 IS/IT HUMAN RESOURCE DEVELOPMENT AND RETENTION

When considering IS/IT human resource development and retention, an organization's chief information officer (CIO) faces these major questions:

1. What knowledge, skills, and abilities (KSAs) are needed by the personnel for whom I am responsible?
2. For what length of time would I prefer to retain the personnel for whom I am responsible, and what human resource management practices will support that?

8.7 PERFORMANCE EVALUATION/ASSESSMENT FOR IS PROFESSIONALS

Performance evaluation is a tricky business in practice, particularly when it comes to knowledge workers and IS workers in particular. Clearly there are cases where such performance evaluation is helpful, but these may rely more heavily on a set of organizational characteristics being solidly in place rather than the details of the program itself.

CIO made eight prescriptions to manage his IS employees. They are as follows

1. *Make sure all employees have the hardware, software, tools, training, and other resources they need to do the job*
2. *Ensure a cultural environment that values them*
3. *Be clear on the job insure proper direction and quick management decisions*
4. *Deal with any personnel problems contemporaneously*

5. *Make sure you the right people on the bus and the wrong people of the bus*
6. *If you have to do reviews have them do their own, make sure they are not too different from your mental model*
7. *Give everyone not under a formal HR remediation plan the same raise*
8. *Tell your HR department to take their heads out of their books and get real*

8.8 FINANCIAL INFORMATION SYSTEMS AUDIT PRACTICE

Establishing the requirements of international auditing and accounting standards for financial IS audit work is a necessary first step in a research program developing an understanding of the extent of alignment of financial IS audit practice with the international auditing and accounting standards with the highest implications for the practice of IS audit through a direct review of the international auditing and accounting standards.

PART 9 MANAGING ORGANIZATIONAL INFORMATION SYSTEMS AND TECHNOLOGY CAPABILITIES

9.1 STRATEGIC ALIGNMENT MATURITY

This chapter provides a comprehensive descriptive and prescriptive vehicle for organizations to evaluate business-IT alignment in terms of where they are and what they can do to improve the alignment. The maturity assessment applies the previous research that identified enablers/inhibitors to achieving alignment and the empirical evidence gathered by management consultants who applied the methodology that leverages the most important enablers and inhibitors as building blocks for the evaluation.

9.2 PROCESS OF INFORMATION SYSTEMS STRATEGIZING

Considerations of IS strategizing in organizations have developed from the isolated, to the more aligned, and then to the impact modes of planning. The aim of this chapter has been to provide something of a synthesis of the research literature on the concept of IS strategizing process. In doing so, we have taken a broader perspective on IS strategizing and have emphasized the dynamic, continuous, iterative, and interactive nature of the strategizing process.

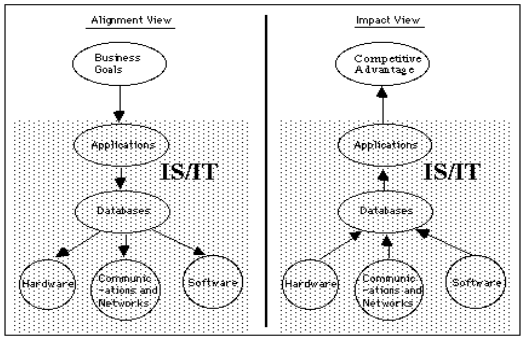


Figure1: Two Views of Strategic Systems Planning

9.3 INFORMATION TECHNOLOGY AND ORGANIZATIONAL STRUCTURE

Organizational structure has been studied over many years by scholars in several fields – including sociology, economics, organization theory, business history, strategic management, and organizational communication and information systems – with varied theoretical interests and research questions. Consequently, any attempt to review this vast literature will necessarily oversimplify and risk offending through its categorizations, (mis) characterizations, and omissions. That said, it is important to have at least a cursory appreciation for the ways that organizational structure has been understood before considering its possible relationships with information technology.

9.4 OPEN INNOVATION: A NEW PARADIGM IN INNOVATION MANAGEMENT

Chesbrough contrasted open innovation to “close connection”. Closed innovation refers to a vertically integrated innovation model. For chesbrough (2006), open innovation is about both decoupling and integrating the different phases of the innovation value chain and in so doing seeking radical innovation through business models. Open innovation is a paradigm shift “that assumes that firms can use external ideas as well as internal ideas, and internal and external paths to market.

9.5 INTER-ORGANIZATIONAL INFORMATION SYSTEMS

The successful use of IOS has had significant impacts in many industries, and is associated with such far-reaching innovations as JIT inventory management practices and the advent of computerized reservation systems. However, success if not guaranteed, and there are many instances where organizations have attempted to implement IOS only to find that partners resist adoption or adopt in ways that limit overall benefits to the various stakeholders.

9.6 FUTURE OF INFORMATION SYSTEMS SUCCESS: OPPORTUNITIES AND CHALLENGES

As Cameron and Whetten (1983) suggest, five fundamental questions must be answered before attempting any evaluation of success:

1. WHAT SYSTEM? – On what domain of activity is the assessment focused?
2. WHO? – From whose perspective is effectiveness being assessed?
3. WHY? – What is the purpose for assessing effectiveness?
4. WHEN? – What time frame is being employed?
5. HOW? – What measures and constructs are being used?

9.7 BUSINESS VALUE OF IS INVESTMENTS

Organizations measure their functional performance using metrics on the financial statements. Marketing is evaluated through revenues and market share.

- *Principle 1 – the business value of IS investments is best viewed from both a variance and a process approach*
- *Principle 2 – the business value of IS investments is best measured using balanced multiple metrics*
- *Principle 3 – the potential for realized business value of IS investments depends on the position of the asset on the technology maturation curve*
- *Principle 4 – the business value of IS investments is justifiable using multidimensional approaches*
- *Principle 5 – Sustained measurement of IS value is accomplished through a comprehensive organizational process*
- *Principle 6 – Strategic integration of IS value measurement informs planning and decision making*

9.8 INFORMATION TECHNOLOGY AND FIRM VALUE

Our goal in this chapter was to review the business value of information technology literature in last 50 years since the origin of the academic discipline of information systems in business schools in the 1960s. We identified key milestones, reviewed what we know, and suggested some promising directions for future research.

Thank you