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Impact of Information Technology on Battle Command: Lessons From Management Science and Business

George E. Dodge and Harold W. Webb
Texas Tech University
Consortium Research Fellows Program

Richard E. Christ
U.S. Army Research Institute

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A Directorate of the U.S. Total Army Personnel Command

EDGAR M. JOHNSON
Director

Technical Review by

Robert Kilcullen
Bruce Sterling
Carl W. Lickteig
Theodore M. Shlechter

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14. ABSTRACT: The possible effects of information technology insertion on organizations and their personnel are derived from an analysis of published management science and business literature. Two major points are developed. First, many factors other than the technical potential of a given information technology interact with one another and with the technology itself to determine the resultant nature, form, and functionality of the "digitized" organization. Second, the most significant impact on commanders and their staffs for the foreseeable future will not be quantum improvements in operational performance made possible by information technology but, rather, the technology insertion process, itself.

Based on this analysis, we propose that implications for command in a digitized environment can be best described by reference to a continuum of organizational structures and associated behaviors. The extremes of this continuum are defined as digital mechanistic and digital organic. A third point between these two extremes is defined as digital adaptive. We discuss the nature of command over the range of the proposed continuum. The new competencies that might be required of commanders and their staffs regardless of the outcome of the technology insertion process are then discussed. The chapter concludes with suggestions for improving the technology insertion process.

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George E. Dodge and Harold W. Webb
Texas Tech University
Consortium Research Fellows Program

Richard E. Christ
U.S. Army Research Institute

Armored Forces Research Unit
Barbara A. Black, Chief

U.S. Army Research Institute for the Behavioral and Social Sciences
5001 Eisenhower Avenue, Alexandria, Virginia 22333-5600

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FOREWORD

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) recognized early on that there were important behavioral and social implications in the Army's campaign plan for developing a digitized force for the 21st century. The report that follows is a product of ARI's commitment to support the Army's Force XXI goals and to contribute to understand the effects of information technology on soldiers and their units. The specific goal of this report was to address the impact of information technology on the human dimensions of battle command.

This effort was entitled "Impact of Information Technology on Battle Command: Lessons from Management Science and Business." ARI accomplished this effort as a part of Work Package 2124 "Strategies for Training and Assessing Armor Commander's Performance with Devices and Simulations (STRONGARM)." The relevant requirements document is a Memorandum of Agreement (MOA) between the U.S. Army Armor Center and ARI entitled "Manpower Personnel and Training Research, Development, Test and Evaluation for Mounted Forces," dated 16 October 1995.

This report reviews and analyzes the individual and collective effects of information technology as presented in the management science and business literature. The report begins by documenting a knowledge base of the human dimensions aspects of the process of inserting information technology and of its effects on individuals, groups, and organizations. The second half of the report is more speculative and forward-looking. Building on the knowledge base derived from the literature and tempered by the authors' collective knowledge of Army policies, doctrine, and practices, it provides a resource for persons concerned with the short- and near-term impact of information technology on Army soldiers, their units, and, especially, their battle commanders. Information contained in this report has been provided to the Digital Force Coordination Cell at Fort Hood, and to the Directorate of Training and Doctrine Development at Fort Knox.

Zita M. Simutis

ZITA M. SIMUTIS
Technical Director

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The authors need to acknowledge they could not have performed the work necessary to prepare this report were it not for a partnership between the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) and the Consortium Research Fellows Program. Equally important to this report was the desire of the directors of these two organizations that their partnership not be arbitrarily bound by any limits imposed by conventional or traditional thinking. The Consortium Program hired the two senior authors of this report as Research Fellows to work with the third author (who served as their ARI mentor at Fort Hood, Texas), as they also worked to satisfy the requirements of their Ph.D.-level graduate school programs at Texas Tech University.

Fortunately, this student-mentor relationship was facilitated by the very technologies that it was to examine. Telephone conference calls, facsimile transmissions, and, especially, electronic internet mail exchanges permitted this relationship to flourish, and allowed all three players and ARI to gain benefits that would not have been otherwise possible. We wish to express our special appreciation to Dr. Edgar M. Johnson, Director of ARI, and Dr. Robert S. Ruskin, Director of the Consortium Program, for their recognition of the capabilities provided by information technologies and for their belief that we would know how to exploit those capabilities.

IMPACT OF INFORMATION TECHNOLOGY ON BATTLE COMMAND: LESSONS FROM MANAGEMENT SCIENCE AND BUSINESS

EXECUTIVE SUMMARY

Research Requirements:

The U.S. Army is developing a digitized force for the 21st Century that can exploit the enormous opportunities made possible by advances in information technology. This developmental effort has been largely focused on technical issues related to the performance of leading-edge computer and communications hardware and software. However, even as this development continues, it has been recognized that there is a knowledge gap about the human dimensions of digitization. This knowledge gap is of great concern since there may be both positive and negative impacts of this digitization effort on the human dimensions of the force. The goal of this report is to help close the knowledge gap. It will provide lessons derived from the management science and business literature on the impact of information technology on individuals, groups, and organizational units. The report also will provide the results of some informed speculation or theorizing about how battle commanders, their staffs, and Army organizations will be specifically affected by both the process of inserting advanced information technology into the force and by the outcome of that insertion process.

Procedures:

A search was conducted of electronic databases of management science and business literature for insights into the effects of digitization. These databases include over 800 different professional journals as well as related books and other reference material. The literature in the databases address scholarly work in areas such as organizational behavior, organizational theory, organizational development, business strategy, and management information systems. Over 700 separate articles from 1985 onward were identified and summarily reviewed that related to the topics at hand. Articles selected for further review and analysis focused on results from groups of studies, studies of key technologies, or findings from managers in industry. Although few in number, theoretical articles were also pulled for further review. Several of the articles report on studies dating back to the mid-1970s, and hence present findings that cover over twenty years of research and experience in the development and use of information systems in organizations. We use the insights gained from the literature review and analysis to establish and present a conceptual basis for the human dimensions of information technology implementation. Building on that conceptual basis, we then engage in and report on the results of our speculations on how information technology may affect battle commanders and other individual leaders, as well as Army organizations.

Findings:

There are very few "hard and fast" lessons to be gleaned from the management science and business literature pertaining to the effects of information technology. This is due primarily to

conflicting findings and incommensurable experimental designs that preclude generalizability of findings beyond the specific samples considered. This "non-finding" is a finding in the sense that it underscores the inability to precisely predict the effects of information technology at the organizational, group, and individual levels, and the risks inherent in technology insertion. Those generalizations that can be made because of the review, such as the importance of training to the success of the insertion effort and the necessity for top leadership support throughout the insertion process, are documented.

Clearly, many factors other than the technical potential of a given information technology determine the resultant nature, form, and functionality of the "digitized" organization. These other factors are identified in the report. An adaptive process by which technology and existing organizational and contextual forces converge and interact to form an emergent technology-enriched organizations is described to illustrate the compound complexity of understanding the process and outcome of digitization. Based on the information available, we concluded that for the next several years, the most significant impact of digitization on commanders and their staffs will not be quantum improvements in operational performance, but those associated with the technology insertion process itself. The nature of command in a digitized environment and new competencies that may be required of commanders and their staffs as a result of mechanistic, organic, or adaptive organizational forms that have the potential to emerge are discussed.

Utilization of Findings:

The "lessons" and subsequent discussion contained in this report can be used by the Army as a starting point in the need to understand and accommodate the human dimensions of digitization to include training and leader development. Further, the speculative organizational types depicted in the report can be of use to force design developers as they consider design of future digitized units.

IMPACT OF INFORMATION TECHNOLOGY ON BATTLE COMMAND: LESSONS FROM MANAGEMENT SCIENCE AND BUSINESS

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IMPACT OF INFORMATION TECHNOLOGY ON BATTLE COMMAND: LESSONS FROM MANAGEMENT SCIENCE AND BUSINESS

Introduction

Purpose

The purpose of this report is to present the results of an investigation of potential impacts of information technology on battle command. First, we review the management science and business literature for empirical or theoretical insights into the ***human dimensions*** of information technology. Management science and business literature includes scholarly work in the areas of organizational behavior, organizational theory, organizational development, business strategy, and management information systems. The goal of this review is to establish a conceptual basis for describing the relationships between information technology and the organizations, groups, and individuals that develop, operate, and use that technology. Then, having established that conceptual basis, we speculate and develop implications for how information technology may affect battle commanders and their staffs, as well as Army organizations more generally. The results of this investigation are sensitive to the ***process*** of developing and then inserting information technology into organizations as well as the ***outcome*** of that process.

Throughout this report, the jargon of the Army and the management information system communities is used interchangeably. For example, the Army speaks of digitized units and the digitization process. Here, digitization is synonymous with information technology enrichment. The Army also speaks of information technology insertion while the civilian community speaks of technology implementation. Individual and collective effects of technology or the effects of technology on individuals, groups, and organizations are synonymous with the human dimensions of the technology.

The Problem

In a conscious effort to overcome organizational inertia (F. Franks, personal communication, February 28, 1998), the Army has dedicated a massive effort toward the development of a digitized force. That is, a flexible force based on a modular design, able to organize around information, and facilitated by information technology. The U.S. Army Training and Doctrine Command (TRADOC) Pamphlet 525-5, *Force XXI Operations* (1994) describes the Army's vision for this digitized force. The developmental effort for the digitized force has been supported by large-scale experimentation with information technology.

Experimentation has been largely focused on issues related to leading-edge computer hardware and software performance and to system interconnectivity over a wireless tactical internet, with a view toward the rapid acquisition of this technology. However, as experimentation continued, a gap was recognized in our knowledge about the human dimensions of digitization. Consequently, there is a need for more information on the potential positive and negative impacts of both the information technology insertion process and the outcome of that insertion process on commanders, their staffs, and Army organizations.

The insertion of information technology across the force has many potential implications. For example, information technology has the potential to automate many tasks supporting the commander's responsibilities. At the same time, information technology has the capability to overload the commander and staff with huge quantities of data presented at an unprecedented high input rate. Furthermore, information technology provides commanders the capability to exercise tight control that might adversely affect the motivation of subordinates. Anticipating and achieving the most appropriate effects of information technology on individuals, groups, and organizations is a highly complex undertaking. The success of digitization efforts by the Army or any organization will depend upon how well the human dimensions are understood and taken into account.

The effects of human dimensions on information technology insertion and use have been raised as a concern across the various hierarchies within the Army. To date, however, there is scant evidence of any dedicated effort to determine these effects. This report will document the management science and business literature on this subject and will engage in informed speculation or theorizing about how battle commanders, their staffs, and Army organizations will be specifically affected.

The Promises and Perils of Digitization

In general, efforts to provide information technology to organizations have been driven by three fundamental promises held out by the technology (McGrath & Hollingshead, 1994). These promises, highlighted in Table 1, are not independent of one another. Instead, they combine and interact to form the basis of what some have called an information revolution. The promise of improved task performance, the promise of overcoming time and space constraints on collaborative work, and the promise of increasing the range and speed of access to information are the fundamental motivations behind commercial investments in information technology. Those investing in this technology often seem to assume these promises, almost as a matter of faith.

Table 1.
Promises of Information Technology

- Improved task performance
- Overcoming time and space constraints on collaborative efforts
- Increasing the range and speed of access to information

Huber (1990) cites numerous observations to support his argument that these types of promised outcomes when combined with the increasingly wide availability of advanced information technologies will inevitably lead to their ultimate adoption and use. He further argues that this movement towards the adoption and use of information technologies is true for organizations characterized by their adherence to norms of economic rationality as well as more highly politicized and power-driven organizations. He bases this latter argument on the assumption that organizations and managers see information technology as a means of reducing personnel, increasing efficiency, and legitimizing their activities.

The Army's movement towards the digitized force is also driven by these promises. However, precisely how the application of information technologies will affect commanders' capability to command in ever expanding battle space with potentially less available time is a critical issue. This issue must be addressed as new digital systems supporting a variety of command functions are developed, built, experimented with, and integrated into everyday training and operational use by Army units.

Organizational efficiency and effectiveness gains will not be realized automatically. Inefficiencies can occur during the technology insertion process or because of technology insertion. In the case of information technology insertion, efficiency gains or losses will be the result of a complex interaction between contextual and organizational forces and information technology. The outcome of this interaction is not easy to predict.

The primary source of difficulty in predicting the process and outcome of information technology insertion is not the ***technology as conceived*** by its designers and proponents. The primary source of unpredictability of process and outcomes is the ***technology already in use*** within a given sociocultural system. All organizations, including military units, are a nexus of psychological, social, cultural, political, and economic subsystems – all aspects of the human dimension. These subsystems vary in their ability to adjust to technological innovation and each may lag in its adjustment to a given innovation by a different amount. For example, there may be a great deal of impetus to digitize the Army as quickly as possible. However, it normally takes from six to ten years for a major system acquisition, such as major command system, to enter the budgeting cycle and work through the materiel acquisition process. In this example, it is not clear which subsystem will prevail – the political or the economic. Further, these and other subsystems may act to restructure the technology in unforeseen ways.

The next section of this report presents and discusses information gained from the review and analysis of empirical findings in the management science and business literature. Whenever possible, the findings reported in this literature are related to our understanding of issues and concerns relevant to the Army's program to insert information technology into its warfighting and support forces. In subsequent sections we offer our more speculative interpretation of the possible impact of digitization on and its implications for battle command.

EMPIRICAL FINDINGS FROM THE MANAGEMENT SCIENCE AND BUSINESS LITERATURE

This section of the report presents the results of the review and analysis of the management science and business literature. It is partitioned into five subsections. The purpose of the first subsection is to convey the depth and breadth of the literature that has been reviewed. The second subsection provides a general overview of many factors that have been investigated in research on the human dimensions of information technology. A third section briefly describes several major trends in the management science and business communities that reflect innovative applications and the consequences of the rapidly changing capabilities of information technology. The fourth subsection addresses the relationship between human dimensions and the processes of developing and inserting information systems into both civilian and Army organizations. The fifth and final subsection contains a summary of insights for the impacts of information technology on the organization (across all levels of command), the group (collective members of teams or staffs), and the individual operators and users. Unfortunately, only a relative few "hard and fast" lessons can be extracted from the literature, as will be explained in each subsection,

Overview of the Literature Database

For the present effort, insights into the effects of digitization have been drawn from the management science and business literature exclusively. An overview of insights from this source of information is needed to complement information already available from other sources. For example, several recently edited anthologies (e.g., Mouloua & Pasasuraman, 1994, 1996) discuss the effects of information systems as determined by researchers in the domain of the more basic behavioral and social sciences. Likewise, reports are beginning to appear that describe applied behavioral science research and studies that address Army performance and training requirements for and the effects of digital systems (e.g., Elliott, Sanders, & Quinkert, 1996; Graham, Valentine, & Washington, 1997; Throne & Lickteig, 1997). Almost without exception, these behavioral and social science publications cite few, if any, references from the management science and business literature.

A search was conducted of the ABI INFORM and Psych/LIT electronic databases. These databases include information derived from over 800 different professional journals. The search was conducted using the following keywords: management, digitization, decision support, information system, information technology, insertion, leadership, top management teams, organizations, information, automation, study, groups, group decision support, and executive support. The search was directed at material published from 1985 onward.

Over 700 separate articles were identified and summarily reviewed that related to the topics at hand. Articles selected for further review and analysis focused on results from groups of studies, studies of key technologies, or findings from managers in industry. Although few in number, theoretical articles were also pulled for further review. Several of these focal articles report on studies dating back to the mid-1970s, and hence present findings that cover over 20 years of research and experience in the development and use of information systems in organizations.

Key focal articles on the development and use of information systems that evaluated multiple studies include the following: (a) a meta-analysis (Alavi & Joachimsthaler, 1992) systematically integrating the results of 33 studies; (b) a review of the findings of 80 works (Angehrn & Jelassi, 1994); (c) a synthesis of the results of 35 studies (Benbasat & Nault, 1990); (d) an integration of the results of 15 studies (Eierman, Niederman, & Adams, 1995); and (e) a review of the results of 12 studies (Sharda, Barr, & McDonnell, 1988). Huber (1990) draws on the published works of over 100 researchers to develop a theory on the effects that information technologies have on organizational design, intelligence, and decision making.

Articles which provide industry insights include: (a) a survey of 69 project managers (Yoon, Guimaraes, & O'Neal, 1995); (b) a model derived from inputs by 118 users of decision support systems in U.S. corporations (Guimaraes, Igbaria, & Lu, 1992); and (c) a study of 50 separate firms (Watson, Rainer, & Koh, 1991). Long-term studies of information technology insertion reviewed for this report include those conducted within several different organizations by Zuboff (1988) and Orlikowski (1995) as well as studies of the macro-level economic impact of technology by Brynjolfson (1993), Crowston and Malone 1994), and Mason, McKenney, and Copeland (1997).

Factors Affecting Information Systems in Organizations

As has been previously emphasized, a difficulty in determining the outcomes of digitization is the large number of relevant variables and their interaction, particularly during the process of technology insertion. A well-cited framework by Ives, Hamilton, and Davis (1980) is often used as a framework to organize these variables for designing or interpreting the results of research in information systems. Yadav, Webb, and Jackson (1997) developed a refinement of the Ives' et al. (1980) model that incorporates also the identification of constructs critical to theory building. These latter constructs were drawn from over 100 information system research articles spanning the field of management information systems. Figure 1 illustrates some of these constructs as they were incorporated into the organizing framework.

The framework illustrated in Figure 1 clearly highlights the difficulty encountered in addressing the human dimensions of information technology insertion into and use by organizations. The framework shows the influence of three groups of factors: environmental and process factors as well as factors related directly to the information system itself. The environmental and process factors are in turn further partitioned into three components categories corresponding to the use, the development, and the operation of the information systems. Research into relationships among these constructs has been fragmented, with selected constructs typically examined within quite restricted domains. To date, no overarching theory or paradigm has emerged to unify research in the field of management information systems or decision support systems (Eierman et al. 1995).

Industry Trends

In addition to the multiplicity of factors just discussed, the rapidly evolving capabilities and promises of information technology are continually changing and challenging its use by industry. Use of information technology in the 1990's includes a move to network paradigms using various client-server models and enterprise-wide solutions providing an integrated system for transaction processing, decision support, and executive support (Anderson Consulting, 1997; Arthur Anderson, 1997; Ernst & Young LLD, 1997). Integrated systems give management the capability to access information needed to solve problems at any level in the organization. Tools enabling analysis of information in graphical or tabular formats and the capability to "drill-down" into details with the click of a pointing device are provided by the new technologies (Hoffer, George, & Valacich, 1996). Development of these enterprise-wide systems for large corporations typically requires several years from initial conception through requirements determination, system development, system installation, and finally to routine usage. This development timeline parallels that experienced by the Army. Thus, industry and the Army face similar problems with the development of information technology to support core organizational processes.

User Environment

- Organizational Environment
- Organizational Context
- Organizational IS Maturity & Innovation
- Locus of IS Impact
- User Characteristics
- User Attitude
- User Behavior
- User Background
- User Involvement
- User Expectation
- Task

Use Process

- Productivity
- Task-Feature Congruence
- Decision-making Quality
- User Satisfaction
- User Confidence
- Quality of Work-life
- Value of Information System (IS)
- IS Understandability
- User Training
- User Learning

Development Environment

- User Requirements
- Development Methodology
- Modeling Tools
- Development Tools
- Software Process Maturity

Development Process

- Development Support
- User Participation
- User Influence
- Satisfaction with Development Efforts
- Influence of IS on Business and/or Decision Processes
- Development Training

Information System

- Adaptability
- Method of Evidence – Model of Inquiry
- Mode of Presentation
- Nature of Support
- Usability
- Revisability
- Scalability
- Topology
- Standardization

Operations Environment

- Hardware
- Software
- Data Base
- Procedures
- Documentation
- Organization & Mgmt of IS Operations
- IS Personnel Management

Operations Process

- Performance
- Throughput
- Response Time
- System Availability
- Operations Training
- System Accuracy

Figure 1. A framework for organizing information system (IS) constructs. Adapted from Yadav, Webb, & Jackson, 1997.

A number of trends in the information technology industry have been identified by Markus (1996). These include continued declines in technology cost, a proliferation of products and services, increases in network computing, faster product development cycles, programming innovations, increased competition, inter-organizational systems, and electronic markets. Other trends identified are the emergence of new organizational forms, increasing replacement of legacy systems, decentralization of information technology management, increased requirements for employee technical knowledge and skill, and concerns about the privacy, safety, and security of data (Markus, 1996).

Network connectivity to legacy systems is an industry problem being addressed through the development of graphic user interfaces for networked personal computers and "middleware" which provides the connectivity between existing and newly developed systems (Bernstein, 1996). The Army faces a similar problem in the context of the integration of legacy systems, which previously only supported individual battlefield operating systems. Providing management access to the huge amount of data created and amassed by enterprise-wide systems is enabled through the concepts of data warehouses and data marts. The implementation of the data-warehousing and data mart concepts supports executives and managers in the process of discovering knowledge from diverse sets of data, that are, in turn, often generated by multiple systems (Fayyad, Piatetsky-Shapiro, & Smyth, 1997).

Performance support systems are systems designed to improve the on-the-job performance of users during the course of a work activity. There is a wide range of industry literature, but until recently, very little in academic management science and business literature on this specific topic. Electronic performance support systems have been identified as having the potential for delivering "Just-in-Time" knowledge to users (Cole, Fischer, & Saltzman, 1997). Electronic performance support systems were reported in 1995 to be installed in 40 percent of the 28 major U.S. companies included in the American Society for Training and Development's benchmarking survey (American Society for Training and Development, 1997). While used extensively in industry, there appears to be little theoretical or empirical research on specific process or outcomes associated with the development or use of these systems.

Impact of Human Dimensions on the Development and Implementation of Information Systems

The development of large-scale information systems is a complex undertaking, requiring a significant commitment of organizational resources. Over a number of studies, several processes involved in the development of information systems have been found to influence and be influenced by both user behavior and system performance (Eierman et al., 1995). Ideally, the strategies used to develop information systems begin early in the system development process with the identification and documentation of users' information requirements. Alavi and Joachimsthaler (1992) identified several factors that impact on the successful implementation of decision support systems. These factors include participation by users in the development of the system, training received by users, and the users' previous experience in both the functional task and the use of decision support systems. To a lesser degree, other attributes of the user (e.g., cognitive style and personality) also were shown to impact successful implementation of decision support system.

User Participation

User participation in the determination of system requirements and system design is positively related to the success of decision support systems, executive information systems, and expert systems, as well as in routine transaction processing systems. This finding is supported by a number of earlier studies in the software engineering literature, many of which were focused on or grew out of Department of Defense contracts for information systems (Boehm, 1987; Bunyard & Coward, 1982; Howes, 1987; Ramamoorthy, Prakash, Tsai, & Usada, 1984; Royce, 1970; Teague & Pidgeon, 1985; Thayer, 1988; Yeh, Zave, Conn, & Cole, 1984). The importance of user participation is also a core learning objective in courses on information systems analysis and design (Cougar, 1996; Davis, Gorgone, Cougar, Feinstein, & Longenecker, 1997; Hoffer et al., 1996; Kendall & Kendall, 1995; Martin, 1995; Whitten, Bentley, & Barlow, 1994).

User Requirements

Determining a complete and correct set of user requirements is vital to the design of an effective information system (Yadav, Bravoco, Chatfield, & Rajkumar, 1988). The definition of user requirements includes but is not limited to an analysis of the user's mission in the organization. Requirements definition must deal with three subjects: (a) context analysis, which addresses the reason why the system is to be created and the technical, operational, and economic feasibilities used as criteria forming the boundary conditions for the system; (b) functional specification, which describes what the system is to be, in terms of the functions it must accomplish; and (c) design constraints, a summary of conditions specifying how the required system is to be constructed and implemented (Ross & Schoman, 1977).

Organizations are often very complex systems of systems. This fact makes the task of determining requirements very difficult. Several structured techniques have been developed (DeMarco, 1979; Yourdon & Constantine, 1979) to facilitate the process including Data Flow Diagramming (DFD), Integrated Definition Method (IDEF0), and others (Yadav et al., 1988). The Integrated Definition Method is currently required by the Department of Defense (DOD) to document user requirements within an organization-wide operational architecture.

While structured techniques provide the underlying model for current information systems analysis and design textbooks, other techniques are also available including prototyping, joint application development, and participatory design. These latter techniques all have the goal of eliciting more directly user information requirements (Hoffer et al., 1996; Whitten et al., 1994). Use of prototyping and other user-based system development methods in the development of decision support systems has been shown to increase system usage (Benbasat & Nault, 1990). A downside to prototyping is that the technique has been found to overlook principles of software engineering such as consistency between modules, compliance with standards, and reusability of system components (Bourne, 1994).

In the context of information system development, the functions of command and the potential constraints of new command systems on command functions must be specified and communicated to systems designers. The use of structured techniques for documenting these requirements has become an industry standard and they are well documented and referenced in text books (Hoffer et al., 1996; Whitten et al., 1994) and Federal regulations (National Institute of Standards and Technology, 1993). It is critical that users participate in providing requirements to be documented. These requirements may either be previously known or discovered during experimentation. A number of accepted techniques for capturing requirements and eliciting user input exist but are not effective unless the lessons learned from prototyping, joint application development, or participatory methods find their way into the operational and technical architectures from which the objective command system will be built.

Training

Procedures for training of end users during the implementation phase of the system development life cycle are widely studied. Training end users has been identified as a significant antecedent to successful decision support systems (Alavi & Joachimsthaler, 1992; Guimaraes et al., 1992), expert systems (Yoon et al., 1995), and microcomputer use (Amoroso, 1988; Amoroso & Cheney, 1991; Igbaria, Guimaraes, & Davis, 1995; Igbaria, Zinatelli, Cragg, & Cavaye, 1997; Nelson & Cheney, 1987; Raymond, 1988, 1990; Raymond & Bergeron, 1992; Yap, Soh, & Raman, 1992).

Sustainment training of required user skills has received less attention, but is the primary focus of performance support systems identified earlier in the section on industry trends. While training is consistently related to success in the use of information technology, determining the most effective methods for delivering this training is a matter of ongoing research (Leidner & Jarvenpaa, 1995; Simon, Grover, Teng, & Whitcomb, 1996).

Top Management (Leadership) Support

Top management support is also a significant determinant of information system success (Benbasat & Nault, 1990; Eierman et al., 1995; Guimaraes et al., 1992; Mason et al., 1997; Yoon et al., 1995). The literature strongly suggests that the insertion of technology, an iterative process, requires long-term high-level support from senior organizational leaders to fully realize the potential offered by the promises of digitization. In the Army's case, this would translate to continued support and interest by the Army's Board of Directors (four star, active duty, general officers) throughout the entire development and implementation cycle – a period of at least several years.

Implications for Development

Four primary insights into the development of Army information systems can be gleaned from this subsection. First, user needs and requirements must be captured and incorporated during the development and insertion process. Second, user participation in the development process is beneficial, but also has pitfalls that must be avoided. Third, effective implementation and sustainment training is critical to successful system insertion and use. Finally, continued support throughout the insertion process--by senior Army leaders is essential. This last point could be a significant challenge given that the insertion process (which takes several years) exceeds the typical tenures of the Chief of Staff and the Commanders of the major commands.

Impact of Information Technology on Organizations, Groups, and Individuals

This section of the paper addresses research findings documented in the management science and business literature on the effects of using information technology. In the first subsection, the impact of information technology use on organizations is discussed from a macro-level viewpoint by integrating perspectives from economics, organizational theory, and coordination theory. Using research from a number of fields, the succeeding two subsections address, respectively, the effect of information technology use on groups and on individuals, as derived from laboratory experiments and case studies.

Organizational Impact

Major improvements in the capabilities of current and future systems raise questions concerning the continued validity of early research studies on the effects of information technology. For example, organizational research in the 1980's on the outcomes of using information technology revealed less employment decline in the economy than predicted by Leavitt and Whisler in 1958, with jobs being changed more than reduced (Malone, Yates, & Benjamin, 1987). However, at a macro-economic level, studies that are more recent have observed reductions in firm size associated with increased spending on information technology across the U.S. economy (Brynjolfson, Malone, Gurbaxani, & Kambil, 1994). Hammer and Champy (1993), in a study of reengineering in major U.S. firms concluded that:

> Information technology plays a crucial role in business reengineering, but one that is easily miscast. Modern, state of the art information technology is part of any reengineering effort, an essential enabler ...since it permits companies to reengineer business processes. But...merely throwing computers at an existing business problem does not cause it to be reengineered. In fact the misuse of technology can block reengineering altogether by reinforcing old ways of thinking and old behavior patterns (p. 83, Hammer & Champy, 1993).

Further, recent anecdotal evidence suggests that increases in information technology usage changes the skill mix within the organization as well as increasing required skill levels (Jones, 1998).

Early studies also suggested that levels of hierarchy would increase (Blau, Falbe, McKinley, & Tracy, 1976; Pfeffer & Lebleblici, 1977) while later ones predicted a decrease (Malone et al., 1987). Related research on centralization versus decentralization has also had mixed results. Early reports (Leavitt & Whisler, 1958; Pfeffer, 1978) posit that access to technology is a mechanism for control that will increase centralization, while later reports (Malone et al., 1987) predict that the move to computer mediated markets will cause more decentralization. The explosion in the capabilities of information technology makes interpretation of the various streams of research conducted across several decades difficult at best.

There are indications that the time lag in the effects of information technology may be quite long in duration -- on the order of several years -- for large organizations. The study of U.S. industry-level data across all sectors (over 2000 firms) for the period 1976-1989 by Brynjolfson et al. (1994) found that information technology is correlated to reductions in a firm's size. However, this effect was not immediate but lagged by about two years across both the service and manufacturing sectors of the economy. Mason et al. (1997), in calling for a stream of research in management information systems, go even further stating that "the effects of technological decisions unfold over long periods of time, typically measured in decades" (p. 272).

A review of empirical studies on the effect of information technology on productivity economy-wide and, more narrowly, in the manufacturing and services sectors shows that, in terms of return on investment, there have been major success stories as well as impressive failures. At first glance, research results appear to be inconclusive. Hypothesized reasons for the failure to reach a conclusion include: incorrect measurement of outputs and inputs; lags in outcome due to organizational learning and adjustment, redistribution and dissipation of profits, and mismanagement of information technology (Brynjolfson, 1993).

IBM Credit provides an example of how information technology can lead to failure or success. Early efforts to improve credit processing led to failure. These failing efforts focused on using information technology to speed information flow and task performance by overlaying technology on existing processes. After several unsuccessful attempts at improving performance, IBM Credit finally realized a hundred-fold increase in the number of contracts handled and a 90 percent decrease in cycle time without increasing the number of employees. This success was achieved by execution of a process reengineering effort, which was enabled using information technology (Hammer & Champy, 1993).

The implication of these findings for Army digitization is that the ability of information technology ***alone*** to influence performance is contingent upon achieving the proper balance among interrelated factors such as psychological, social, economic, and political, as well as among the technological sub-systems. Extrapolations from the management science and business literature suggest that achievement of the proper balance could result in significantly reduced personnel requirements, either major centralization or decentralization of organizational structures – depending on how the technology is used, and major increases in organizational performance. In any case, the effects of digitization may take from two to seven or more years to detect.

Information technology can also affect the pattern and content of organizational communications which may lead to changes in a number of organizational variables to include: (a) the structure of organizations, (b) the quantity of communications, and (c) the level of social interaction. For example, technology can provide new media (e.g., e-mail and teleconferencing) which affects the quality and quantity of communications. This in turn can lead to a higher number of weak social links (Crowston & Malone, 1994). An example of this would be the communication among members of a Listserver or Usenet group. Here the number of individuals contacted is increased, typically up to hundreds of people, while the quality of each contact decreases, primarily consisting of short, written bursts focused on the topic of the day.

Coordination theory, an interactionist view of organizations and information technology (Crowston & Malone, 1994) is based on the proposition that organizational requirements and information technology together combine to cause organizational change. Rockert and Short (1991) in a case study of 16 different firms, provide insights into the effects of information technology in electronically networked organizations. Electronically networked organizations exhibit higher levels of interdependence, which increases the complexity of roles and levels of skills required by people. Changes in roles and skill requirements for command and staff positions are an area of concern for the Army. These effects have the potential to impact recruiting, selection, promotions, and retention.

The coordination studies of Rockert and Short (1991) identify several organizational areas in which information technology-enabled networks have increased mangers' ability to manage subunits. Based on successes in industry, potential improvements in the command function for a digitized Army organization may be implied. Specifically, improvements in command can be made in the areas of teams (staffs), temporary organizations (task forces), planning, and control.

Areas identified as being potentially improved through the use of information technology become important in determining the outcomes resulting from the interaction of organization and technology. Outcomes associated with implementation of technology are not consistent across research studies, but depend in large part on the organization and the context in which the technology is applied. Rockert and Short (1991) found that networks do not automatically infer a flat organizational structure. The adoption of a networked organization does not imply that every worker is networked. As organizational tasks increase in complexity, more information technology networks were found in the organizations studied.

The implications for command in a networked environment are that the network, with increased communications and data flow, provides new ways to enhance operational capabilities. However, the structure of the organization is not a given and may not remain constant as networks are introduced. All soldiers may not need to be networked within a successfully digitized unit. As the complexity of the warfighting or support task increases, the complexity of the supporting networks may increase. A trade-off occurs between the reductions in task complexity achieved through the use of complex networks and number of networks which can be handled by commanders and staff at any given time and situation. While the full impact of networks on command of Army organizations is not yet known, these insights provide a point of reference from which to experiment.

Group Impact

The impact of information technology on groups has evolved from group research in organizational behavior. Using various theoretical underpinnings, many laboratory experiments have been conducted using information technology systems designed specifically to support group activities (i.e., group support systems). The number of reported case studies is fewer, primarily due to the short period of time that group support systems have been available to industry. Research on the impact of group support systems has adapted and incorporated theoretical models of cognitive processes that were developed to explain individual behavior. For example, group theory posits the use of team mental models that contain a shared set of schema (Klimoski & Mohammed, 1994).

Other literature (Gioia, 1986) conceives of groups as "thinking organizations." Groups may experience threats to survival which are generated by the notion that changes in technology occur faster than social changes, setting up a defensive posture in the group. Goodman, Ravlin, and Schminke (1987) present a theory focused on the effect of technology, cohesiveness, and norms on groups. This theory, supported by studies of technology change in the coal mining industry, states that the organizational environment is an important factor in predicting outcomes. The organizational environment refers to external forces with which the group must reckon. Some examples of external forces are shifts in the demographic structure of the population (e.g. baby boomers vs. generation X), changes in the National Military Strategy resulting from the end of the cold war, and an exponential growth in the capabilities of a number technologies. Organizational context is usually volatile, uncertain, confusing, and ambiguous. The theory espoused by Goodman et al. (1987) also states that organizational outcomes will differ depending on the type of technology available. This assessment of the roles of context and technology in predicting group outcomes is consistent with the coordination theory for explaining the inter-relationship between information technology and organizational behavior (Crowston & Malone, 1994).

An analysis of a number of studies (Benbasat & Nault, 1990) concluded that the use of group decision support systems increased group decision-making quality, especially for difficult tasks. Group decision support systems increased the number of alternatives considered by groups but mixed results were shown for achieving group consensus. The Army must determine the effect of specific information technologies within the context of warfighting and supporting operations given the mixed results provided by the research literature.

A review of 30 studies (McGrath & Hollingshead, 1994) focused on the effects of information technology on collaborative efforts within groups. These were primarily laboratory studies, using *ad hoc* groups, designed to isolate interactions among group members from other variables. Results (see Table 2) focused on the amount of interaction or participation by group members, group task performance, and user responses. The authors of this review indicate that while useful theoretical implications may be obtained, "it is apparent that any generalization one might make from these results is very shaky" (McGrath & Hollingshead, 1994, p. 91).

Table 2.
Studies of Groups Interacting with Technology (McGrath & Hollingshead, 1994).

Study area	Finding / Insights
Interaction or Participation	• Use of a computer-aided communication system is likely to lead to a pattern of more equally distributed participation. • Group process distributed over time is ignored in these studies (problem solving has been ignored). • Computer systems may surface conflict more effectively but may lack structured procedures for conflict resolution.
Group Task Performance	• Groups with computers (at least in early stages) tend to take longer to complete a task. • Products may tend to be of higher quality, but this may attenuate over time. • The structure of the task may influence decision quality more than computer systems as evidenced by improvements obtained using non-computerized decision aids.
User Responses	• Results for user satisfaction and user-rated effectiveness were split evenly between positive and negative responses.

The studies summarized in Table 2 do suggest possible areas for research and experimentation in the Army digitization program. The level and distribution of group member participation appears to change with the introduction of group support systems. Conflict resolution is also an area of concern as technology is inserted. The time required to complete the decision-making process with group support systems, as well as the quality of that decision, is of particular interest to the Army in performing warfighting tasks.

A more recent analysis found that users of decision support systems undergo a "learning effect" when initially using a system. Benefits of the system appear only after a learning period, which may explain the failure of previous short-term cross-sectional studies of decision support systems (Eierman et al., 1995). A case study (Orlikowski, 1995) documented the process and outcome of implementing one type of GroupWare in an ongoing business operation. This case study focused on one firm's implementation of LOTUS NOTES® software over an extended period time both within one department and between multinational units of the firm.

The results of the case study (see Table 3) provide insights that also may be useful in determining the effects of digitization on command. First, two types of change were observed in the group, planned and emergent. The planned change focused on the nature of work for workers and managers as well as changes in how the organization accomplished its mission and coordinated with other departments. Emergent change was not planned, but occurred during the process of installing and using the system. In this particular case, emergent changes had their greatest impact on the distribution of work, forms of collaboration, and the utilization of knowledge. The Army may see emergent change that impacts commanders, soldiers, system use, and organization structure as these digitized systems are developed, installed, and used.

Table 3.
Results of Case Study of Group Supported by LOTUS NOTES® (Orlikowski, 1995).

Period of Use	Type of Change	Domain of Group Change	Specific Group Changes	Unanticipated Group Outcomes
Initial	Planned:	Nature Of Specialists' Work	Process documentation Knowledge search	Documentation focus Censorship Ongoing learning Technological dependence
		Nature Of Managers Work	Resource management Process and performance monitoring	Fear of electronic surveillance Specialist competition
	Emergent:	Distribution Of Work	Support partners Intermediaries	Transfer reluctance
		Form Of Collaboration	Proactive collaboration Norms for electronic support and help giving	On-line interaction
Later	Planned:	Nature Of Global Support	Electronic linkages with overseas support offices	Lack of shared norms
		Inter-Departmental Coordination Mechanisms	Coordination with product development, management, and quality assurance	Developer resistance
	Emergent:	Knowledge Utilization	Training mechanism Knowledge dissemination	Time constraints Access control

The case study by Orlikowski also revealed several unanticipated group outcomes with organizational implications resulting from the move to GroupWare. Many of these unanticipated outcomes focused on reactions of employees to the system. Positive outcomes included the emergence of ongoing learning and on-line interaction. Outcomes with negative connotations included censorship, a focus on process rather than end state, a lack of shared norms, developer resistance, and information access controls. These issues have implications for the Army as command becomes increasingly supported by information technology. The changes planned in formal Army requirements documents and the supporting architectures have the potential to be influenced by emergent changes and unanticipated outcomes.

Individual Impact

In terms of the effects of information technology on individual users, fewer social context cues and less inhibited communications with both positive and negative effects have been discovered. The research to date has been mixed in terms of job skills. Technology has the potential to de-skill jobs by automating tasks and leaving dull jobs in both clerical and factory work. Even middle managers have the potential to become mere messengers. Conversely jobs can be upgraded, automating the repetitive parts of jobs, leaving interesting components for humans who will require greater skills than currently required (Zuboff, 1988).

The introduction of information technology presents two distinct options. First, the possibility of reduced autonomy and increased control by supervisors is possible through the centralization of information resulting in fewer independent actions by subordinates (Zuboff, 1988). The introduction of computer-paced work, which increases system control also, leads to reduced autonomy. On the other hand, there is the possibility of increased autonomy for workers through task automation and job consolidation that can create opportunities for more independent actions (Zuboff, 1988). These results seem to support the assertion by Crowston and Malone (1994) that the impact of information technology varies with the context in which it is used.

Assumptions underlying the nature of tasks performed by soldiers must be examined closely in conjunction with programs to digitize the force. Are soldiers in a digitized organization going to be highly controlled operators of computer-based systems, following orders much along the lines of the old Soviet model? Or will they be expected to use the information streaming from digital systems to continuously learn about conditions on the battlefield, execute mission-type orders, and adapt to the changing environment of combat or support operations? Will principal staff officers and commanders be required to sit in front of and operate the "boxes" or will their specialist through sergeant first class surrogates actually interact with the technology? The nature of command tasks must be communicated to system users, system developers, and training developers through requirements documents and supporting architectures used to implement Army digitization.

Woodward (1965) found that in the civilian sector, "different technologies imposed different kinds of demands on individuals and organizations, and these demands had to be met through an appropriate structure. Commercially successful firms seemed to be those in which functions and form were complementary" (p. vi.). The appropriate organizational form for a digitized Army does not yet exist, nor does anyone know with any certainty the characteristics of that form. Some, however, like MacGregor in his 1997 book, *Breaking the Phalanx: A New Design for Landpower in the 21st Century*, have provided us a glimpse of a possible form of the future digitized Army.

When considering the impact of job design in a digitized Army, it is important to understand how functions are performed in an electronic context (Weick, 1985). Consider battle command in terms of Boyd's (1987) OODA Loop (Observe, Orient, Decide, and Act). The first two steps, observe and orient, parallel what Weick (1985) has labeled ***sensemaking***. Sensemaking is the result of cognitive processing (cognition) which is fed by perceptions. The aim of sensemaking is for the commander, using his/her resources, to develop an understanding of the enemy, friendly troops, and terrain in terms of time, space, and purpose.

Commanders have a number of resources available to them to make sense out the situation (observe and orient) including: information received from subordinate commanders, the staff, or command information systems; what they personally hear and see on the battlefield; and their own personal intuition developed over years of studied practice. The formal process by which the commander directs collection of information by these resources is the commander's critical information requirements (CCIR). The CCIR results in one set of filters used by the commander and the resources at his/her disposal.

Human perception is a second filtering process. Perceptions in a digital environment may be distorted (Weick, 1985) because of imperfect paralinguistic clues inherent in various human-computer interface designs. Inserting information technology may make events harder rather than easier to understand, and may lead to frustration and reduced commander and staff performance. In other words, the sense making processes used by commanders and staff members may be disrupted at the computer terminal because commanders and staff may lose a degree of sensory information such as feeling and context, all of which are necessary for accurate perceptions.

To mitigate potentially distorted perceptions, Weick (1985) suggests five actions commanders and staffs can take to improve the accuracy of their perceptions. The first action, ***effectuate***, consists of prodding events to see what happens (e.g., recon by fire). Obtaining views from several qualitatively different sources is the second action, ***triangulation*** (e.g., verification of Joint Surveillance and Target Attack Radar System (JSTARS) report with live Unmanned Aerial Vehicle (UAV) video feed). ***Affiliate***, comparison with what someone else sees, is the third action (e.g., discussion with multiple subordinate commanders). ***Deliberate***, the slow, careful reasoning used to formulate ideas and reach conclusions, is the fourth action (e.g. the deliberate decision making process). The last action, ***consolidate***, is the process of putting events in context (e.g., receiving information that confirms or denies a decision point).

We believe the implications for commanders and staffs to be that individual and collective skills required to accomplish the five actions suggested by Weick need to be specifically identified and included in training on digitized command information systems. These skills are not uniquely digital but utilize all available resources.

The insights described in this section for the impact of information technology on organizations, groups, and individuals do not provide pat answers to the effect of digitization on command. They do provide areas which the Army can use as starting points for the development and execution of experiments for the purpose of fine-tuning requirements for the digital force across doctrine, training, leader development, organizations, materiel, and soldiers (DTLOMS).

The next section of this report describes theoretical and speculative effects of information technology.

THEORETICAL AND SPECULATIVE EFFECTS

Adaptive Structuration Theory and the Army

The preceding sections have summarized what we know from the management science and business literature about the process and effects of advanced information technology insertion in organizations. A couple of things are fairly clear. The process by which organizations adapt to information technology takes time before results emerge and the results themselves are difficult to predict. This situation is principally due to the complex nature of the interaction among the various factors that influence technology insertion and outcomes (see Figure 1). Moving to a more theoretical level of analysis, this section explores the information technology insertion process and presents a possible explanation for the emergent complex nature of the effects of information technology on organizations.

Adaptive Structuration Theory (DeSanctis & Poole, 1994; Poole & DeSanctis, 1990) explains the organizational impacts of advanced information technologies. It describes the process of digitization as the dynamic convergence of both the anticipated and unanticipated potential of information technology as well as contextual and organizational forces that existed before the technology was introduced. As people in existing organizations interact with the technology, the result is adaptation and modification of the technology, as it is perceived and used, as well as the people and structures within the organization. In order to understand and harvest the benefits of information technology, thorough attention must be paid to the human dimensions, including the moral force and its effect (Cavazos, 1985), as well as the more purely physical aspects of both the insertion process and the emergent organization. The following section is devoted to making several points concerning the implications of the theory to the Army's digitization program.

The Theory

Adaptive Structuration Theory (DeSanctis & Poole, 1994; Poole & DeSanctis, 1990), despite its abstract title, is really a very straightforward concept. Structuration, in the broadest sense, is the process of humans creating their own social environments. Structuration is "the process by which systems are produced and reproduced by members' use of rules and resources" (Poole & DeSanctis, 1990, p. 179). In other words, structuration is the result of the dynamic convergence and interaction of technology, people, and organization as each is adapted and changed by the other. Adaptive Structuration Theory maintains that existing organizational and contextual structures interact with the structure provided by information technology so that portions of each are adapted to produce an emergent technology-enriched organization. The structure that emerges over time from this process is both a means and an end. It is the basis for the organization's form, functions, and capabilities.

Adaptive Structuration Theory stresses the importance of the human dimension in determining organizational outcomes and in mediating the effects of information technology. Information technology, much more than previous technological innovations (e.g., machine gun, tank, and helicopter) is a ***social technology***. With information technology comes a structure of rules and procedures that apply to and intimately affect personnel in organizations who use it. These personnel do not passively receive information technology and its associated structure, as some developers, engineers, and proponents may like to believe. Rather, people actively adapt the technology to their own ends, accepting some portions "as is," modifying some portions, and rejecting still other portions. This process results in a restructuring of the technology as it is meshed with the sociocultural subsystems.

"Information technology in use ought to be thought of as a set of social practices that emerge and evolve over time" (McGrath & Hollingshead, 1994, p. 39). The effects of information technology on organizations are not only the result of the technology itself but are also the result of choices that organizational members make about what attributes of the technology are useful and how the technology is to be used, if at all. These choices are the result of the dynamic convergence of the technological forces and organizational and contextual forces that are described in the information technology framework pictured in Figure 2.

Ultimately, the process of inserting technology into the organization is "emergent, dynamic, self-reflective, and socially structured" (Fulk & Boyd, 1991, p. 419). As such, the impact of technology on organizational capabilities and functions is quite variable and difficult to predict. Figure 2 depicts the major elements of Adaptive Structuration Theory and their inter-relationships. The names of the key elements appear at the top of each box. Aspects of each element that are relevant to current Army digitization efforts are listed below the element names.

As shown in Figure 2, DeSanctis and Poole (1994) have identified four general characteristics of the appropriation process. The appropriation process is the means by which the structure and rules bound within the information technology jolt, jar, and modify the existing structure and rules within the organization. First, as technology, people and organizations converge, multiple simultaneous results can occur. The technological capabilities can be used directly and independently. Technological capabilities can be related to and interact with existing organizational capabilities to form a synergistic effect (process gains). Technological capabilities can entropically interact with existing organizational capabilities to constrain or interrupt them (process losses). Technological capabilities can be used to judge existing organizational capabilities leading to changes in them.

Second, technological capabilities can be appropriated and used by the organization with no changes from the way in which the technology was designed, or organizational personnel can modify the technology to be used in ways not anticipated by designers and planners. Third, technological capabilities can be appropriated by the organization for different instrumental uses including enhanced task performance, improved communications, power, or legitimacy. Finally, important aspects of the attitude of organization members involved in the appropriation process may change to include their confidence in the technology, their perception of the value of the technology, and their willingness to expend the effort required of the appropriation process above and beyond that needed to perform ongoing organizational missions.

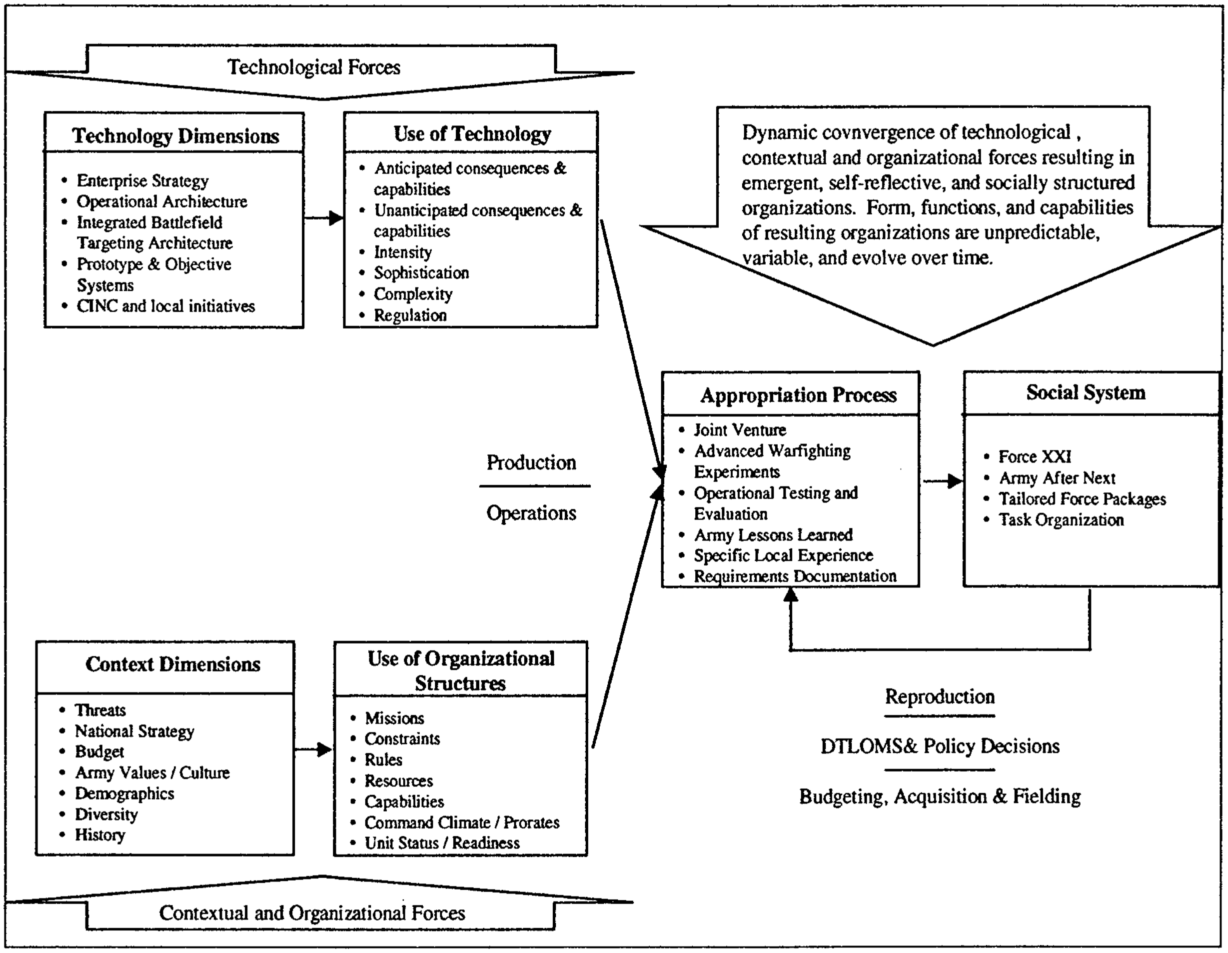

Figure 2. Adaptive Structuration Theory applied to the digitization process. Adapted from DeSanctis and Poole, 1994.

\The Theory and the Army

The theory of adaptive structuration is discussed here to make several points relating the theory to the Army's digitization program. First, the build-test-build strategy or spiral development cycle currently being executed as a part of the Army's Joint Venture effort is a recognized approach for gaining an understanding of the emergent and dynamic effects of a prototype information system on an organization. However, this approach only moves the organization towards realization of the promises of information technology if, because of the appropriation (experimentation) process, technological and human dimensions shortfalls are identified, documented, and acted upon. Given the budgeting and acquisition constraints faced by the Army, this approach will be only useful in identifying objective information systems requirements if unfulfilled user requirements are identified and used to influence the budgeting and acquisition process.

Second, the theory of adaptive structuration suggests that the information technology insertion process is not linear and its outcome is not easy to predict. It also suggests that the full effects of any given advanced information technology on an organization emerge only over time. Given the compound challenges associated with advanced information technology and the scope of information technology envisioned for the force, the full effects of advanced information technology on efficiency and effectiveness may only be realized in the longer term (more than five years). That being the case, the more immediate impact of digitization of the force on commanders and their staffs will not be the productivity gains promised by the use of information technology. Rather, the primary impact on commanders and staffs in the short-to mid-term (five or so years) will be the technology insertion or adaptive structuration process itself.

Expectations of improved operational performance such as those discussed in the *Army Times* (Wilson, 1997) in an article entitled, "Rating the Experimental Force at the NTC: EXFOR performance comes under scrutiny," are unrealistic. The article begins with the observation that "there was no increase in lethality, survivability, or operational tempo attributable to digitization during the Army's recent Force XXI Warfighting Experiment at the National Training Center..." (p. 3). Given the nature of the adaptation process, it most likely is too early in the process to expect increases in operational performance, a conclusion supported by the studies of Brynjolfson et al. (1994) and Mason et al. (1997) reported previously in this paper.

Third, personal and organizational time, resources, and energy are consumed in the appropriation (experimentation) process. This process has the potential to entropically compete with other organizational processes. The net result may be that some ongoing, essential organizational processes suffer. In other words, the theory of adaptive structuration would suggest that there is a price to be paid for experimentation. The price may be degraded readiness, lower morale, or increased stress.

Fourth, commanders, staffs, and noncommissioned officer (NCO) support chains at all levels where information technology is being introduced within their organizations have the opportunity to influence its effect on their organization. Recall that changes in organizational functions and capabilities that emerge from the adaptive structuration process are the result of human action as people in existing organizations interact with the technology. Commanders and their staffs (officers and NCOs) are in a unique position both to shape their subordinates interaction with the technology and to develop accurate impressions of the level of fit between the technology and human dimensions within their organizations.

Since commanders have the ultimate responsibility for everything their organizations achieve or fail to achieve, they are potentially the single best sources of information about how well or how poorly a given information technology helps the unit accomplish its assigned and implied missions. Staffs are probably the single best source of information about how well a given information technology helps them accomplish assigned combat functions. The NCOs, perhaps, are the best source of information about the impact of information technology on soldiers and their families.

Having reviewed the empirical evidence and Adaptive Structuration Theory's implications for the Army, we are left with our original question. That is, "What will be the effects of digitization on commanders and their staffs?" A clear understanding of the long-term effects of digitization efforts is required to answer this question. However, given that the technology insertion process as envisioned by the theory of adaptive structuration is dynamic and emergent and its results are variable and difficult to predict, any attempts to forecast precisely the ultimate results of the Army's digitization efforts would be speculative at best.

Consequently, in the section that follows we describe generally the more salient implications of digitizing the force on the command process. We first define the command functions and two methods by which commanders can integrate information technology into the force. We then describe three points on a continuum of organizational structures and behaviors, and how the nature of command may be different for different types of organizations. Finally, we identify and discuss several new competencies that may be required of commanders and their staffs in a digitized force.

IMPLICATIONS FOR ARMY BATTLE COMMAND

The Nature of Command

Characteristics and Imperatives of Command

The potential capability provided by the promises of information technology must be integrated into the primary functions of the organization. With respect to the command function, information technology must fully support the nature of command that is embodied in the characteristics and imperatives of command (U.S. Department of the Army, 1997). The goal of information technology in support of command functions and tasks is to maximize the commander's effectiveness and efficiency regardless of the environment. This goal will be elusive as the execution of command combines both art and science. The process of command and many of its supporting tasks can not be entirely determined by scientifically derived algorithms used to program more purely physical materiel systems and to evaluate their combat effectiveness. Thus, the human dimensions of command are a critical constraint on the development of information technologies to support command.

As defined in the draft Operations Field Manual (U.S. Department of the Army, 1997), the characteristics of command are: leadership, professional knowledge, vision and intellect, judgment and initiative, courage and resolve, self-confidence, the ability to communicate, and integrity and example. Command of an organization explicitly focuses on groups and group interaction. The imperatives of command defined in this field manual are: teamwork, common doctrine and training standards, control, delegation of authority, allocation of resources, and timely decision and actions. The question now posed focuses on effects that information technology has on these critical individual and group functions. The way information technology is integrated into an organization depends on the underlying assumptions about the nature of the supported functions.

Two Approaches for Integrating Information Technology into an Organization

A long-term case study by Zuboff (1988) focused on the effects of the adoption of advanced information technology on managers and workers in a number of companies in a variety of industries. Zuboff recognized that information technology generates information as it performs tasks, unlike other technologies. Based on her recognition of this difference between information technology and other technologies, she identifies two primary approaches to integrating information technology into the organization: ***automating*** and ***informating***. These two approaches are further distinguished by the underlying assumptions about command and the support provided by information technology.

Automating and informating are hierarchical in nature. Automating refers to the process of programming a system to perform a task and has the potential to perform tasks currently performed by humans. This is the role technological innovations have primarily played in the past.

Informating is a process requiring automation as a necessary condition but goes further providing a deeper level of transparency to activities that previously were either partially or completely opaque (Zuboff, 1988). Technology within these systems not only produces action, but it also produces streams of information. These electronic "voices" symbolically render events, objects, and processes such that they become visible, knowable, and shareable between the commander and staff. The Army continues to invest in technologies (sensors, weapons, command and control systems, and logistical systems) which have the characteristic of generating large amounts of electronic data.

The notions of automating or informating present a number of dilemmas in the transformation of knowledge, authority, and technique for both the commander as well as the information system designer who must fashion the information system to support the characteristics and imperatives required for command. The effects of the assimilation of information technology on the organization are very complex.

> The interdependence of the three dilemmas of transformation ... knowledge, authority, and technique - indicates the necessary comprehensiveness of an informating strategy. The shifting grounds of knowledge invite managers to recognize the emergent demands for intellective skills and develop a learning environment in which such skill can develop. That very recognition contains a threat to managerial authority, which depends in part upon control over the organization's knowledge base ... Managers who must prove and defend their own legitimacy do not easily share knowledge or engage in inquiry. Workers who feel the requirements of subordination are not enthusiastic learners. New roles cannot emerge without the structures to support them ... Techniques of control that are meant to safeguard authority create suspicion and animosity, which is particularly dysfunctional when an organization needs to apply its human energies to the new technological context.
>
> The interdependence among these dilemmas means that technology alone, no matter how well designed or implemented, cannot be relied upon to carry the full weight of an informating strategy. Managers must have an awareness of the choices they face, a desire to exploit the informating capacity of the new technology, and a commitment to fundamental changes in the landscape of authority if a comprehensive information

strategy is to succeed. Without this strategic commitment, the hierarchy will use technology to reproduce itself. Technological developments, in the absence of organizational innovation, will be assimilated into the status quo (Zuboff, 1988, p. 391).

A Continuum of Organizational Structures and Behaviors

The implications for command in a digitized environment are that future organizations will fall along a continuum, which ranges from Digitized Mechanistic at one extreme to Digitized Organic at the other. This continuum and its end points are specialized cases of mechanistic and organic organization models proposed over three decades ago by Burns and Stalker (1961). Based upon the presumed utility of the Adaptive Structuration Theory for understanding the implications of digitizing the force on battle command, we propose that a third, intermediate point can also be defined on the continuum of organizational structures and behaviors: Digitized Adaptive Organizations. Each of these three notional points on the continuum is discussed in succeeding subsections of this report.

Digitized Mechanistic Organizations

Digitized mechanistic organizations tend to be highly specified, specialized, centralized, standardized, and relatively closed (Burns & Stalker, 1961). They are most effective when processes are routine and in stable environments. The primary strategy for integrating information technology into digitized mechanistic organizations is to ***automate*** (Zuboff, 1988). According to Whitehead and Blair (1985) four sets of factors will tend to push Army organizations in this direction. First, there are the external environmental factors such as environmental pressure; competition for funds; uncertainty as to mission and priorities; and high level of external control. The second factor is determined by the age of the Army and its tendency to rely on historical precedents, an organizational condition that favors the mechanistic form of organizations. The third factor is driven by the technology itself, due to the broad and extensive ramifications of the overall information system. The fourth factor tending to push the Army toward the mechanistic end of the continuum is the traditional predisposition of the Army to emphasize legitimate authority over emergent leadership.

The top heavy, highly centralized, rigid organization envisioned by the digitized mechanistic scenario is reminiscent of the "Chateau Generalship" practiced during the First World War. Generals living in chateaux miles removed from the action, the situation, and their soldiers, using the information technology of the day, could pick up a landline and order thousands of their soldiers to march into battle. Today, this scenario could be played out as a terminal-centric corps commander watches the blue and red icons maneuver over a digitized terrain background and decides to intercede by skipping echelon and taking charge of company or platoon fire and maneuver. Also, under this scenario, planning could become an end unto itself and adherence to "the plan" could become more important than accomplishing the commander's intent. Planning is not fighting and control is not victory.

The digital mechanistic organization on the battlefield is seen as being highly controllable . Corps and division commanders having the capability to observe the actions of every element and entity on the battlefield, issue detailed instructions to individual platforms (e.g., tanks and infantry fighting vehicles). Plans are devised and issued, with adherence to the plan being the primary objective of all subordinate leaders much as seen in the old Soviet model of command and control. Staff officers and commanders in subordinate units are fixated on their screens, waiting for system instructions instead of visualizing and learning from what is occurring on the battlefield. Units and soldiers display a lack of initiative in rapidly changing situations, causing opportunities for victory to be missed.

Digitized Organic Organizations

Digitized organic organizations in contrast tend to have low degrees of specification, formalization, centralization, routinization, and closedness (Burns & Stalker, 1961). They are most effective when processes require problem solving and when the environment is dynamic and uncertain. Their principal strategy for integrating information technology into the organization is to ***informate*** (Zuboff, 1988). According to Whitehead and Blair (1985), at least four factors will tend to push Army organizations in the direction of this extreme on the continuum. The first is the battlefield environment envisioned for the digitized force (U.S. Army Training and Doctrine Command, 1994), namely an environment that is dynamic, complex, and diverse. Second, the technology of the Army is intensive, complex, sophisticated, and non-regulating. Third, personnel required to operate discretionary technologies in dynamic environments tend to see themselves as professionals and therefore desire more autonomy. Fourth, the unstructured problems with varying degrees of uncertainty confronting the Army call for a complex learning system.

At the extreme, this set of factors may create an organization that is so flexible that it is ineffective. Everyone having access to all information may result in commanders who take counsel of their own fears as they watch the blue icons to their left and right disappear from their electronic monitors. Or, it may result in an intelligence staff officer or NCO missing an essential element of enemy information while he or she searches logistics and supply data for the status of electronic replacement parts for the military intelligence battalion's disabled electronic warfare equipment. Finally, it may result in commanders who miscalculate a subordinate unit's combat effectiveness because they have taken the data and the common picture into consideration but have not looked into the soldiers' faces to see their fatigue and fear, and to feel what their soldiers are feeling. These vignettes are not a comprehensive view or inevitable consequence of the digital organic organization; instead, they are offered to provide a glimpse of the possible consequences of advanced information technologies' impact on organizations.

The digital organic organization on the battlefield would be highly independent, staffed with professionals who plan and execute missions with minimal instruction. They would have a tendency to be freewheeling, rapidly adjusting their plan to maximize the success of their unit. This freewheeling, however, may degrade the ability of the higher level commander to mass effects against the enemy. Synchronization of battlefield systems against enemy forces is difficult, as consensus on the plan is needed between many dispersed commanders. Units in contact, seeing icons of adjacent units disappear from their screens, take independent actions that make efforts to hold and counterattack difficult at best. Having full awareness of the situation, the second-guessing of commanders at various level of command is a potential side effect, particularly if combat results are less than envisioned by soldiers.

Digitized Adaptive Organizations

The digital adaptive organization proposed is a type of organization that can reflect the characteristics of either the digital mechanistic or the digital organic organization contingent on the technological and social environment in which it operates. The contingencies are reflected in METT-T (mission, enemy, troops, terrain, and time) factors for operational units. This proposed type of organization tailors the capability of the information technology to automate routine functions and informate those functions requiring a focus on knowledge and learning.

The Army, in general, will probably not become primarily organic. However, it must cope with high levels of vulnerability, uncertainty, confusion, and ambiguity that result from both external and internal environmental turbulence. According to Whitehead and Blair (1985), this type of scenario calls for an orientation toward decentralized decision making, increased discretion to lower level leaders, reduction of formal rules and regulation, loosely coupled organizational design, relatively autonomous subordinate organizations, and decentralization of subsystems to minimize mechanistic tendencies.

Commanders for operations in digitized environments would tailor the proposed digital adaptive organization on the battlefield. Tasks best supported by automating have been automated, freeing the commander and staff to focus on warfighting. Tasks best suited to informating have been allocated to trained commanders, staff, and soldiers who interface and learn from the information constantly streaming from the system. This proposed type of organization has the ability to handle a large volume of data, through automated processes, yet has the flexibility to anticipate changes on the battlefield, providing the commander with information needed to rapidly mass the effects of forces or conduct support operations.

The digital adaptive organization most likely to be encountered will probably have subordinate organizations of both the digital mechanistic type and digital organic type, depending on the functions they provide for the Army. This arrangement provides the flexibility to operate on mission-type orders, but with the discipline and control needed to synchronize forces in combat. This organization has the capability to continue operations during periods when the information system is down, reducing the risk to the force as digital command and control networks increasingly become the primary targets for opposing forces.

Given the findings in the literature on the impact of information technology on organizational forms and organizational leadership, experimentation in this area would be useful. Factors inferred from the literature, which may determine a mechanistic versus an organic organizational form, include: (a) type of unit (combat vs. combat service support), (b) organizational level (battalion vs. corps), (c) type of mission, and (d) the commander's leadership style. In the next section, we speculate on the impact of three alternative organizational forms on command.

Command as a Function of Organizational Structure and Behavior

Table 4 compares and contrasts the nature of command by each of its fourteen characteristics and imperatives (U.S. Department of Army, 1997) over the range of organization structures and behaviors just described. The discussion that follows focuses on five of the characteristics and imperatives of the digitized commander and battle staff: leadership, teamwork, control, authority, and timely decisions and actions. The purpose of the discussion is to explore in more detail some of the possibilities that exist at the extreme ends of the continuum of organizational behavior. The nature of command in the proposed contingency dependent, digitized adaptive organization needs to be determined for each of many combinations of METT-T factors.

Table 4.
Nature of Command and Organizational Types – A speculative adaptation of the Burns and Stalker (1961) model

Command: Characteristics & Imperatives	Digitized Mechanistic	Digitized Adaptive	Digitized Organic
Leadership	• Need less • Centralized / concentrated at top • More manager than leader • Emphasis on stability and control • Power based on formal authority • Most procedure programmed into system • Tele-leadership	Contingency dependent based on factors such as: Type of unit (e.g., infantry, military police, and transportation) Organizational level Type of mission Commander's leadership style	• Based on knowledge • Location varies by task • Emerges • Disposable leadership
Professional Knowledge	• Narrow / Specialized - "Science" • Embodied in systems procedures and in the it itself • Assumption is that professional knowledge can be identified and programmed during system development • Limited requirements for continuing education		• Broad / Generalized - "Art" • Emphasis on openness • Constant requirement for continuous education.
Vision & Intellect	• Linear - objective reality • Limited range of options - strict screening criteria • Next higher HQ goals / vision adopted (nested) • Maximization of organizational interests • Emphasis on plan and planning		• Parallel, exchange, change • Maximal range of options • Own organizational goals • Maximization of self interest • Emphasis on creativity and originality
Judgment & Initiative	• According to plan • Constrained by organizational structure and plan		• Constrained by group consensus
Courage & Resolve	• Courage and resolve to execute directed task • "Watch your lane and pull trigger"		• Courage and resolve to do the right thing
Self- Confidence	• Confidence in reliance on system.		• Confidence to facilitate a learning environment
Ability to Communicate	• Vertical • Fixed media		• Multi-directional • Multimedia
Integrity & Example	• Faithfully replicate orders and information received • Faithfully execute orders received		• Faithfully communicate personal best view / opinion • Do what you think best
Teamwork	• Hardware and software forms the basis of the team • Team operates system and is monitored by system • Inflexibility in team functions		• Information / knowledge forms the basis of the team • Team is in constant learning mode • Flexible functions
Common Doctrine & Training Standards	• Prescriptive		• Ephemeral
Control	• Obtrusive • Situational • Professional • Process oriented		• Unobtrusive • Personal • Paternalistic • Output oriented
Delegation of Authority	• Centralized planing and execution - minimal		• Decentralized planning and execution - maximal
Allocation of Resources	• Centralized allocation		• Competition
Timely Decisions & Actions	• Depends on layers		• Depends on consensus

Leadership

Leadership in the digitized mechanistic organization is needed less than in the other organizational models. The information system supports a concentration of decision making at the top levels. This model calls more for a manager having an emphasis on stability and control, rather than a leader with emphasis on learning and change. Power is based on the formal authority of the leader. In this organizational model, underlying professional and technical knowledge is programmed into the system and is used as a mechanism for control. Leaders using digital systems will tend to reduce the level of personal interface with soldiers, preferring to use the system for monitoring and compliance issues.

The leader in the digitized organic organization has authority based on knowledge. The location of the leader varies based on task knowledge and is dependent on the formation of task-based temporary organizations. Leaders tend to emerge in this organization and leaders are seen as disposable at the conclusion of the organization's mission.

Teamwork

Teamwork in the digitized mechanistic organization is centered on the hardware and software of the information technology. The system is programmed with the knowledge required for task completion, leaving the team to support the system. Team and individual performance is monitored by the system and can be observed several echelons above. Team functions are inflexible, being tied directly to the information system.

Teamwork in the digital organic organization is centered on knowledge and information. Team members gain knowledge by staying in a continuous learning mode and making sense of reality as information streams through the system. They understand the process by which the system works including system limitations and shortcomings. The team is flexible in the execution of functions and rapidly adapts to environmental changes.

Control

Control in the digital mechanized organization is obtrusive, situational, professional, and process oriented. The system is designed to maximize control over soldiers and units in an explicit manner. Whether used or not, soldiers are aware that every entry into the system is subject to review and scrutiny. Interaction between commander and soldiers is primarily through the system and carried out in a strictly professional manner. Measures of effectiveness focus on the completion of processing steps and adherence to rules.

The digital organic organization has control that is unobtrusive, personal, paternalistic, and output oriented. The system is designed to facilitate self-control, providing soldiers and units the capability to learn. Interaction between commanders and soldiers is on a personal, face-to-face basis. Measures of effectiveness focus on the outcomes or mission accomplishment, with process being a secondary concern.

Authority

Authority in the digital mechanized organization is manifested in centralized planning and execution of missions. The commander prepares and issues very detailed plans. The system supports the placement of weapons and units several echelons down in the organization. The conduct of combat operations relies on the execution of the original plan, with deviations from plan requiring top level approval. The ability to take advantage of opportunities that arise during the course of combat is minimal.

In contrast, the digital organic organization is focused on decentralized planning and execution of missions. The system supports decentralized planning, providing decision aids at the lowest levels. The ability to take advantage of opportunities is maximized, but the synchronization of combat power-massing effects is hampered as authority to act is delegated.

Timeliness of Decisions and Actions

The timeliness of decisions and actions in the digital mechanistic organization is dependent on the number of layers of command involved. With relatively few layers of command, the commander has the ability to make and implement a decision quickly. With relatively more levels, however, the decision process is slower as a large amount of data must be processed at the highest level in order to provide detailed instructions.

In the digital organic organization, timeliness is dependent on how quickly consensus by participating commanders can be reached. When consensus is reached, actions occur rapidly as each commander executes based on mission-type orders. When consensus cannot be reached, however, the unit remains frozen as commanders negotiate among the group for a decision.

Potential New Commander and Staff Competencies

Regardless of the scenario that develops over the longer term, the inevitable proliferation of information technology within the Army will require commanders and staff to develop additional competencies. In this section, we discuss nine potentially new competencies that might be required of commanders and their staffs.

Ability to Identify and Adjust to Information Technology Requirements

The most significant effect of digitization on commanders and staffs in the near- or mid-term (five years or so) will not be any dramatic changes in operational capabilities or in the fundamental nature of warfighting. Recall that our review of what we know from the management science and business literature demonstrated that it may take at least three to five years just to identify information system requirements and design in large organizations, another three to five years to implement them, and two to seven years to actually begin reaping the productivity improvements from the information system. This process could take even longer for the Army given its operating environment and the nature of its missions.

The most significant effect on commanders and staffs in the near- or mid-term will be the technology insertion process itself. Given that, the ability of commanders and staff officers to identify and communicate knowledgeably about information technology requirements and required adjustments in their units to improve task-technology fit is critical to the success of the digitization effort. "How did we do?" is no longer the only question relevant from training and experimentation with the new information technology. The relevant questions now take two forms. For commanders and staffs the question becomes, "What did we learn?" For Training and Doctrine Command and Army Materiel Command, it becomes "How can we rapidly adjust doctrine, training, leader development, organizations, and material (including non-digital systems) to capitalize on what commanders and staffs have learned?"

Ability to Quickly Master Individual and Collective Learning Requirements

Closely paralleling the ability to identify and communicate about technology-driven requirements, the ability to quickly gain mastery over those changing technologies becomes even more important for commanders and their staffs. Collective learning becomes a mission essential task and individual learning a leadership competency. The rate of change in required skills that need to be mastered is greater in the digital environment than previously encountered by soldiers and units.

Further, learning objectives within the three pillars of leader development (institutional, operational, and self-development) are no longer limited to the cognitive objectives and functions embodied in Bloom's taxonomy of educational objectives (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). Bloom's taxonomy, well known to military educators, consists of six levels of cognition: knowledge, comprehension, application, analysis, synthesis, and evaluation. Additionally, emotional or affective learning objectives coupled with psychomotor objectives must be considered. Affective learning objectives may include characterizing and organizing the emotions and temperament of electronic correspondents using a system devoid of paralinguistic clues. Psychomotor coordination such as eye-hand coordination may be needed for keyboarding, touch typing, and operating interface devices as they are developed.

Affective leaning objectives have to do with emotion, feeling, and temperament (Krathwohl, Bloom, & Mansia, 1964). Affective learning objectives include receiving, responding, valuing, organizing, and characterizing. Psychomotor learning objectives involve eye-hand coordination, physical movement, and dexterity (Dave, 1970). They include imitation, manipulation, precision, articulation, and naturalization. Institutional learning objectives for a digital environment must be expanded to include affective as well as psychomotor or behavioral objectives as well as new cognitive objectives. Affective and psychomotor learning objectives become more important due to the tendency of information technology, by virtue of the precise and idiosyncratic nature of the man-machine interface, to eliminate affective and paralinguistic cues in communication.

The linear, sequential learning process embodied in the three mutually supporting pillars of the leader development system -- operational assignments, institutional training, and self-development -- may not be very effective. Operational assignments and institutional education provide experience and knowledge upon which the officer or NCO can build. This chain may be broken however, when officers and NCOs spend a major portion of their assignments or institutional education learning to operate within a prototype system they may never see again. For example, a prototype battle command system with all its functionality may be pieced together for the sole purpose of conducting a demonstration or warfighting experiment. Once the demonstration or experiment is finished, the equipment and system may be disassembled. Self-development may suffer because there is not an objective system the officer can learn; time that could be spent on self-development is consumed by the additional requirements of the technology insertion process.

Ability to Acquire Tacit (How to) Knowledge as well as Explicit (What) Knowledge

The ability of leaders and staff to acquire (and use) different types of knowledge during the technology insertion process may be mitigated by the change of the relative importance of explicit versus tacit knowledge. In the near- and mid-term, instead of knowing "what," it will be more important to know "how to." Knowing how to adjust the organization as new technology arrives, how to quickly build cohesion as old patterns of relationships are changed, and how to work around systems and technologies that fall short or fail becomes critical. This type of knowledge comes from experience and cannot be developed in the traditional classroom or out of a book.

Ability to Master Conceptual as well as Mechanical Aspects of Command and Control

The work of commanders and staffs will become more conceptual and cognitive as opposed to mechanical and physical. Plans must be developed to incorporate these aspects of conceptual abilities into officer and NCO professional development programs if we are to avoid the potential degradation of the commander and staff performance during the technology insertion process.

Ability to Define Information Requirements and Appropriate Information Filters

As data and information continues to proliferate, the ability of commanders and staffs to set information filters to receive timely and relevant information becomes increasingly important. The ability to set such information filters results from a thorough knowledge of human, procedural, and technological components of each of the stove-piped battlefield operating information systems. Currently, establishing and executing CCIR and the information processing rules embodied in existing information systems are the primary way these filters are set.

Ability to Formulate and Execute Information Search Strategies

The other side of that coin that sets information filters is the ability to formulate and execute data and information search strategies. Knowing where the information may be, how it might be cataloged and organized, and understanding the limitation and idiosyncrasies of the human, procedural, and technical components of available information systems resources all form parts of this competency.

Ability to Manage Decision Context as well as to Make Decisions

Commanders, especially at higher levels, must know how to manage decision contexts as well as how and when to make decisions. Managing decision contexts involves knowing who is assigned to specific issues or missions, the resources, data, and information they receive, and the guidance or intent under which they operate. While this may not be a new competency per se, in that commanders have to be able to do this now, managing decision contexts becomes more important as it may be the most significant aspect of a distributed decision that a commander is able to control.

Ability to Delegate as a Function of Decision Context

Delegation is not a new competency for commanders in digital environments. However, compared to analog environments, digital environments afford subordinates a greater range of freedom of action and self-leadership. In order properly to delegate authority, commanders will have to take increased variance in levels of subordinate latitude into account. Effective delegation will result in achievement of the right degree of tight- or loose-coupling as demanded by various situations over time. Decisions to delegate or not to delegate authority will have to be reconsidered more often than is now the case.

Ability to Sustain all Current (Analog) Commander and Staff Competencies

Finally, combat will remain an intensely personal experience even in a digitized environment. All of the basic soldier skills, leadership competencies, and leadership principals required of commanders and their staffs in the past will be required in the digital environment of the future. Technical competence and tactical proficiency, understanding soldiers and feeling what they feel, the ability to synchronize the fight will remain as competencies required in a digital environment. Granted, these are not new commander and staff competencies; however, they are included here so as not to lose sight of their significance.

CONCLUSIONS

Information Available Directly from the Management Science and Business Literature

The framework provided by Yadav et al. (1997) was used to highlight the numerous factors affecting the process and consequences of inserting information technology into an organization. This framework underscores the complexity of determining the effects of digitization on command and control functions. Factors that influence the effectiveness of information technology include those associated with the information technology systems themselves, with the environment in which the information systems will be developed and employed, and with the processes that govern how the systems are developed, operated, and used.

Moreover, the Adaptive Structuration Theory (DeSanctis & Poole, 1994) show that the net effect of digitization is not just a matter of summing together the consequences of many organizational and contextual factors that are impacted by information technology. Both the organization and the technology being inserted into the organization are affected during the insertion process. Furthermore, the consequences of the insertion of information technology cannot be precisely determined until the insertion process and the mutual adaptation processes have run their course -- a period of time that may well go on for at least several years.

There are many gaps in our knowledge of the effects and consequences of digitization. We could find very few references to cite when it comes to the likely consequences of digitization on management or leadership, per se. What we cited, while documenting the results of the literature search, was relevant principally to three sets of effects: (a) changes that occur in descriptions of jobs and organizational structure; (b) changes in behavior of leaders and their subordinates in terms of such factors as roles, lines of authority, and interdependence of actions; and (c) changes in the affective responses of the participants in terms of how they "felt" about the social and personal consequences of digitization. There is virtually nothing in the management science and business literature that we searched that adequately addresses how participants' process information, think, or make decisions in a digitized environment relative to an analog environment or, for that matter, how leaders could and should lead differently.

In short, there has been virtually no reliable research found on the impact of digitization on cognitive processes. The only notable exception we were able to find was Leidner and Elam's 1995 study of 91 senior and middle managers. They had hypothesized a positive effect of information technology use on managerial cognition. In their view, increased information availability would lead to richer and more complex mental maps and knowledge structures. This hypothesis, however, was not supported by their empirical evidence. Clearly, it must be concluded that there is a need for much more reliable and objective research and data on factors that influence the process and the consequences of digitizing the Army.

Digitization and Battle Command

The benefits of digitization for the Army are not without risk. In the relatively short time that information technology has been available to industry, government, and academia, we have learned that a large number of factors need to be monitored and controlled. Many, if not most of these factors influence personal, organizational, and operational outcomes during as well as after the insertion of the information technology. It is certainly clear that much more is involved in digitizing an organization than merely acquiring and fielding hardware and software.

In order to fulfill the promises of digitization while avoiding its perils, the Army must define the underlying assumptions about the purpose of digital technology used for command. These assumptions, we believe, boil down to balancing the need to control many critical aspects of the organization with the need to create opportunities for organizational learning and adaptability. Given choices as to these assumptions, warfighting and support processes and tasks must be analyzed to determine the effect of digitization on combat functions that contribute to readiness, mission success, and operational flexibility, as is currently being done with the Army's Operational Architecture (OA) initiative.

The Army's experimentation process, which is valid from a theoretical perspective, facilitates this analysis. However, capturing the lessons learned must go beyond an examination of the outcomes of battles and measures of the effectiveness of support operations. The lessons learned must also address the human dimensions of digitization. Developing operational, system, and technical architectures cannot be ends unto themselves. If there is to be any permanent effect of the current experimentation process on the Army, lessons learned, and operational, systems, and technical architectures must be captured in a systematic and structured manner. These lessons must then be integrated and fed back into appropriate revisions of requirements documents and throughout the acquisition process of funded programs and projects. The lessons learned must also integrated with doctrine and training development to support operational use of the objective systems.

Identification of lessons learned, development of operational, systems, and technical architectures, pushing requirements documents through the bureaucracy, and aggressively managing the acquisition process are the most critical activities for commanders who have these responsibilities in the near to mid term. Finally, a process of continuous collective learning must emerge as the Army digitizes command.

Evaluation of the Army's Digitization Program

Emphasis on desired operational outcomes have tended to define the Army's digitization push. This is evident in the data collection activities at the Combat Training Centers where the performance of analog units was measured and used as a benchmark to evaluate the performance of the experimental digital unit. Using this type of criteria for measuring success, some have asserted that the results were predictably disappointing. As we have argued, given the complexity of the digitization process, it is too early to expect significant operational improvements.

As a case in point, there were several unit after action reviews (AARs) facilitated by observer controllers at the recent experimental brigade task force advanced warfighting experiment at the National Training Center. These AARs focused on the experimental unit's operational strengths and weaknesses. However, to our knowledge, there was not one comprehensive after action review of the process by which the technology was inserted into the force or of the experimental process itself. One should ask how well these two processes were conceived and executed. Recall that not only is the technology new but the insertion process and the experimentation process are also outside of typical DOD 5000 series acquisition procedures. Thus, three major variables have to be evaluated: The outcome of inserting information technology, the insertion process itself, and the experimentation process that determines the quality of the other two variables. All three of these major variables have an ability to define and drive required changes across doctrine, training, leader development, organizations, materiel, and soldiers throughout the force.

Emphasis on the operational outcomes may overshadow an adequate evaluation of the processes of digitization and experimentation. The danger of ignoring the digitization and experimentation processes is that gross mistakes, inefficiencies, and mismanagement of these processes may result in less than acceptable unit performance outcomes. Further, strengths in these processes may be overlooked and inadvertently changed for the worse. In other words, if these processes are not carefully monitored, their outcomes will be left as much to chance as anything else. It is important that AARs of the Army's processes of digitization and experimentation be conducted after every major warfighting experiment. These AARs should include representatives from every participating agency and organization in the experiment (including civilian contractors) who have authority to make decisions for their respective organizations. These AARs should be conducted in the tradition of Army AARs. That is, emphasis should be placed on ***what went right***, and therefore should be sustained, as well as what went wrong, and therefore should be improved. Ideally, these AARs should be facilitated by an agency that does not have a direct, personal stake in the outcomes of the digitization or experimentation processes (e.g., budgets at stake, programs at risk, efficiency reports on the line).

The Army has a very strong culture of collective reflection and self-examination embodied in the AAR process. Given the dynamic complexity of the digitization process and the inherent unpredictability of its outcomes, as described in the preceding pages, the Army should use the organizational strength represented by the AAR process to shape both the digitization process and its outcomes. The digitization process is a hugely complex and high-risk venture. Given that both the technology and the process to insert it are new, dynamic leadership of both is needed to properly implement advanced information technology.

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